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AN 01-60F-2

HANDBOOK

ERECTION AND MAINTENANCE INSTRUCTIONS

USAF MODEL

T-6

NAVY MODELS

SNJ-3, SNJ-4, SNJ-5, SNJ-6

AIRCRAFT

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

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5 AUGUST 1944
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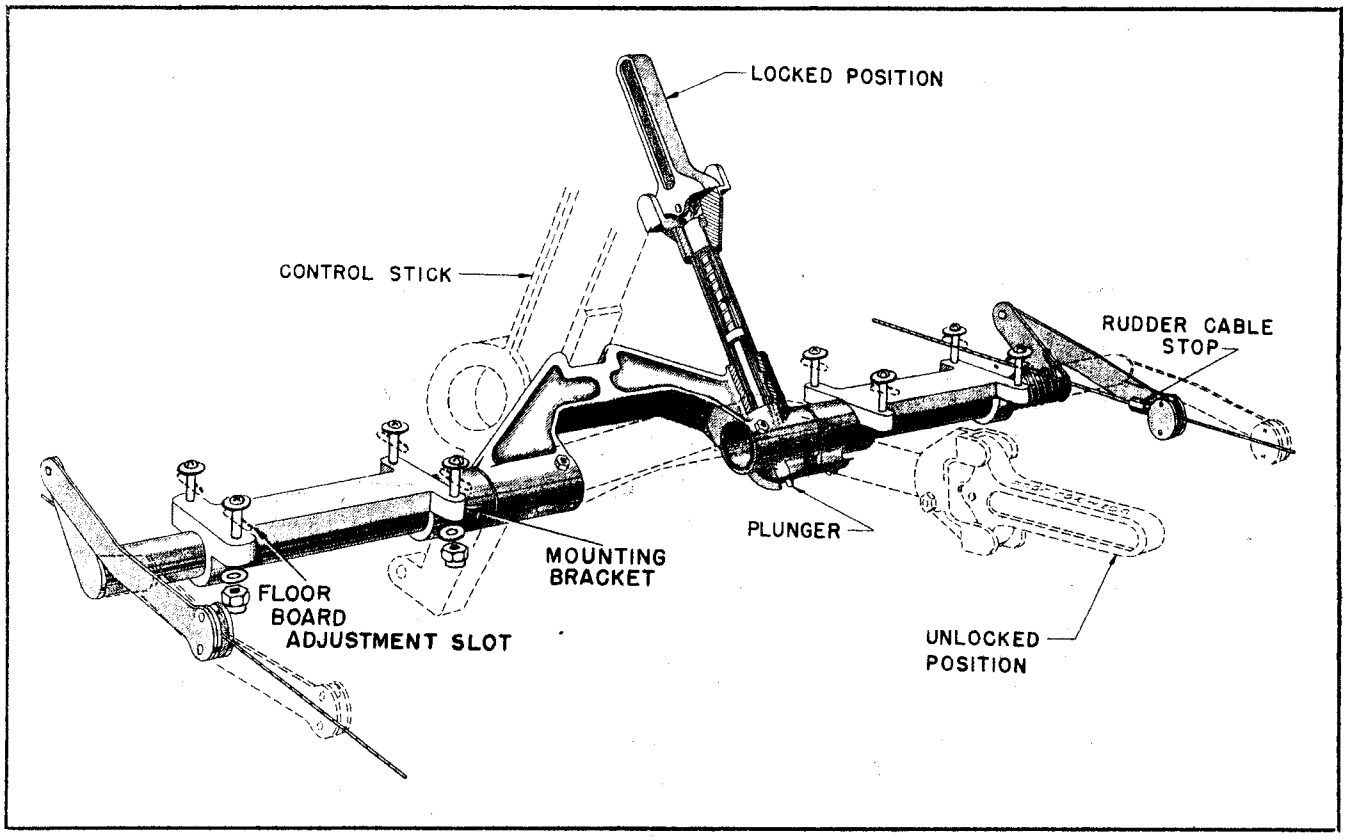

Figure 192 — Surface Control Lock Assembly

CONTROL CABLE CHART

Cable Location	*Reqd. No.*	*NAA Dwg. No.*	*Cable Dia.*	*Length in Inches (C/L of Fitting)*	*End Fittings*	
Elevator Control—Intermediate Upper	1	88-52229	1/8	93-13/32	NAF310621-S21D-4LH	NAF310621-S21D-4RH
Elevator Control—Intermediate Lower	1	88-52226	1/8	102-7/16	NAF310621-S21D-4RH	NAF310621-S21D-4RH
Elevator Control—Front Upper	1	88-52228	1/8	78-25/32	NAF310621B-4	NAF310621-S21D-4RH
Elevator Control—Front Lower	1	88-52227	1/8	111-1/2	NAF310621B-4	NAF310621-S21D-4LH
Elevator Trim—Rear	1	66-52527-5	1/16	233-7/8	1T2-L	AN668-2
Elevator Trim—Intermediate Upper	1	88-52565	1/16	39-5/64	NAF310621C-2	NAF310621-8D-2LH
Elevator Trim—Intermediate Lower	1	88-52566	1/16	33-27/64	AN667-2	AN669-2
Elevator Trim—Front	1	88-52564	1/16	231-1/2	AN669-8D-2LH	AN669-8D-2RH
Aileron Control—Outer Wing Rear	2	88-52313	1/8	76-3/32	AN668-4	NAF310621-S21D-4LH
	2	*66-52313	1/8	69-15/32	AN668-4	NAF310621-S21D-4LH
Aileron Control—Outer Wing Front	2	88-52312	1/8	75-5/32	AN668-4	NAF310621-S21D-4LH
	2	*66-52312	1/8	67-21/32	AN668-B-4	NAF310621-S21D-4LH
Aileron Control Wing Center Section—Rear	2	66-52311	1/8	90-5/32	1T1-4	NAF310621-S21D-4RH
Aileron Control Wing Center Section—Front	2	66-52310-5	1/8	92-13/32	1T1-4	NAF310621-S21D-4RH
	2	66-52310	1/8	92-9/16	1T1-4	NAF310621-S21D-4RH
Flap Position Indicator	1	55-52629	1/16	77-7/16	AC066135	AN665-21R
Tail Wheel Control—RH	1	88-34160-5	5/32	40-1/8	AN667-5	AN669-S5LH
Tail Wheel Control—LH	1	88-34160-4	5/32	39-3/4	AN667-5	AN669-S5LH
	2	*66-34012	5/32	33-5/32	NAF310621B-5	NAF310621-S32D-5LH
Manual Starter Engaging Control	1	88-45041	1/16	24-3/8	77-45039	77-45042
Parking Brake	1	77-33450	1/16	25-15/16	NAF310621B-2	AC 066135
Rear Brake—Rear Rudder to Master Brake Cylinder	2	66-33476-3	5/32	72-11/32	AN668-5	AN669-S5-RH
Front Brake—Front Rudder Pedal Master Brake Cylinder	2	66-33477	5/32	12-5/8	NAF310621B-5	NAF310621B-5
Instrument Flying Hood Release Latch—Front	1	58-73012	1/16	48-3/4	AN665-21R	1T5
Instrument Flying Hood Release Latch—Rear	1	59-73034	1/16	85-3/8	AN665-21R	1T5
Landing Gear Position Indicator—LH	1	36-33562-2	1/16	53	AC 066135	AN665-21R
Landing Gear Position Indicator—RH	1	36-33562-3	1/16	88-3/8	AC 066135	AN665-21R

**Used on earlier airplanes.*

(6) BEARINGS.—Sealed-type ball bearings are incorporated in all pulleys, bell cranks and control surface hinge points with the exception of wooden trim tabs which utilize Ledaloyl self-lubricating hinge bearings.

(7) CABLES.—All primary surface control cables are 1/8 inch diameter, with the exception of the rudder pedal equalizer cable which is 3/32 inch diameter. All trim tab control cables are 1/16 inch diameter.

b. MAINTENANCE REPAIRS.

(1) MINOR DAMAGE.—When broken wires are found in the cables of the trim tab control system or the main control system, where such breakages occur in that length of cable normally passing over a pulley or through a fairlead, they should be cut off short and soldered to the cable.

(2) CABLE REPLACEMENT.

(a) Aircraft control cables, 7 strands of 19 wires each, that are found to be frayed (individual wires broken) will be considered serviceable unless there are more than six wires broken in any 1 inch length of cable. The number of broken wires will be noted, particularly where the cables pass over pulleys or guides. Only those with broken wires in excess of the number specified in any 1 inch length need be replaced. Wherever possible, therefore, duplicate spare cables should be utilized for replacements. No difficulty should be experienced when installing control cables in the field. It is impractical to swage a replacement cable and for this reason they are manufactured with one end swaged while the other end is unfinished except for a drop of solder to keep the strands from fraying. When the cable is to be installed, the unfinished end is threaded through drum holes, pulleys, fair-leads, etc., as the case may be, while the swaged end is secured to its proper connection. The opposite end, before being connected, is fitted with the proper size bearing and the cable end secured around the latter by splicing and soldering. Whenever possible, use the bearing from the replaced cable to finish the raw end of the new one. Secure the bearing by splicing and soldering in the manner the bearing was secured to the old cable.

(b) The ends of rudder and elevator trim tab drum cables should be equidistant from their respective drums before either end is connected to fuselage cables. Drops of solder should be applied to the cables at the inside of the drum holes to keep them from slipping on the drums. Following this operation the trim tab cables are wrapped around the drums and passed into the fuselage for the proper connection.

(c) All cables and splices should be tested for proper strength prior to installation. They should be arranged to simulate installation, including pulleys where required and gradually tested by applying a load to one end of the cable for a period of 3 minutes. A suitable guard should be placed over the cable while it is being tested to prevent personal injury in the event of cable failure. The test load should be applied to cables as follows:

Cable Size	Load in Pounds
1/16	300
3/32	550
1/8	1150
5/32	1550

(d) Contractor furnished 1/8 inch cable assemblies for T-6C, D, and F, and possibly the earlier T-6G airplanes, incorporate NAF310621-S21D terminals and AN155-21S or AN155-22S turnbuckle barrels which have 12-28 threads. These terminals and turnbuckles have been declared obsolete and are no longer available in AF stock, which necessitates the use of AN669-S4 terminals and AN155-32S barrels, which have 1/4-28 threads when replacement cables are fabricated locally.

(e) It has been found that cable assemblies available in AF supply, under the same part number, may have either 12-28 or 1/4-28 threads. When individual cable assemblies having 12-28 threads require replacement, they will be replaced with like assemblies obtained from AF stock, if available. The terminals and turnbuckle barrels will be checked prior to installation of the cable assembly to insure that the fittings have the proper threads. (See figure 192A.)—When cable assemblies with 12-28 threads are not available, and local fabrication is necessary, the entire cable system for the particular control surface affected will be replaced with cable assemblies incorporating AN standard terminals and barrels having 1/4-28 threads.

(3) COLOR MARKINGS.—*(See figure 193).*—To facilitate rigging and adjustment procedure, color markings for cables, cranks, and horns should be used to identify control cables and horns or arms to which they are attached. The width of each color in the marking band should be 1/2 inch. Cables may be banded with cellulose tape in appropriate colors and coated with clear lacquer approximately 1/2 inch behind each wrap. Horns and arms should be banded with lacquer in appropriate colors approximately 1/2 inch below the fork to which cables attach.

NOTE

Band at both sides of all turnbuckles.

(4) RUST PREVENTION.

(a) On airplanes operating from extremely dusty landing fields or through dusty (desert) areas, control cables will be thoroughly cleaned where they pass over pulleys, or through fair-leads, and at other points of contact throughout the airplane, and will not be coated with lubricant or rust-preventive compound.

(b) In coastal or insular areas where conditions are conducive to corrosion, clean cables at points of contact and coat with rust-preventive compound, Specification No. AN-C-52.

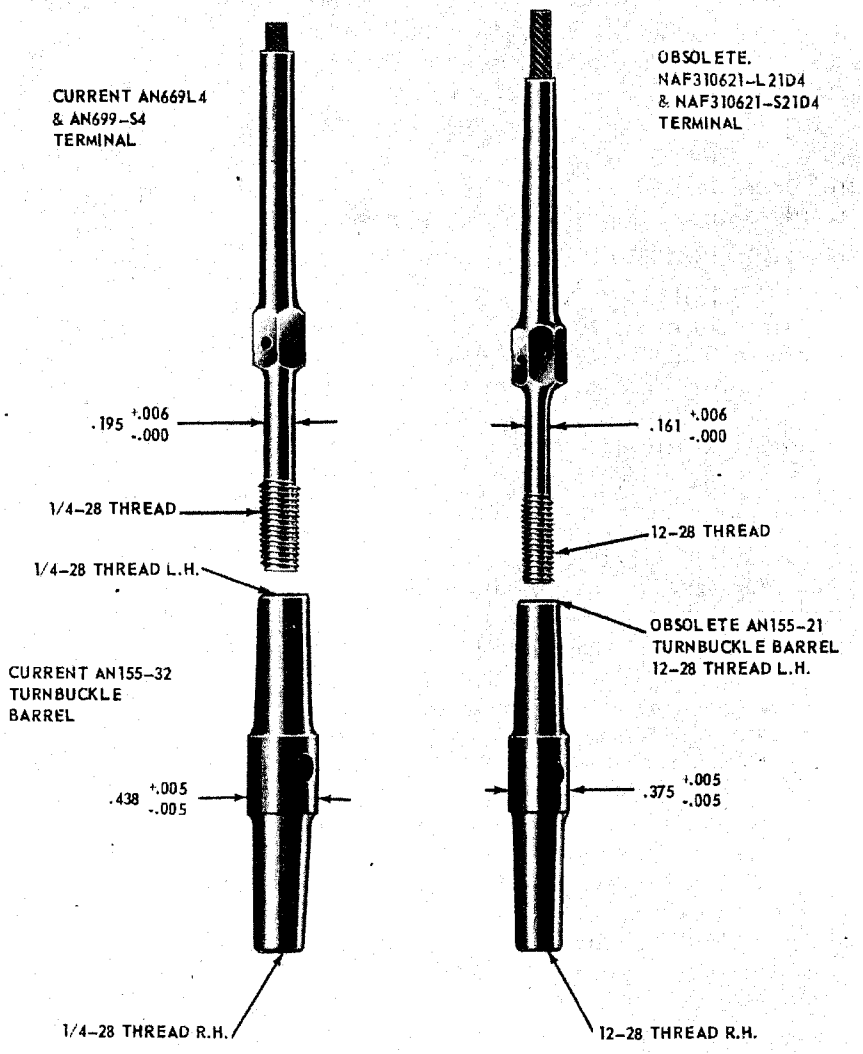

Figure 192A—
Control Cable Turnbuckles

c. RIGGING AND ADJUSTMENT.

NOTE

After performing any cable rigging operation, always ascertain that the cables are not crossed. Make a complete check for any other obstacle to proper cable operation.

(1) GENERAL.

(a) It is to be noted that control cable tensions will vary considerably with changes of air temperature. Cable tensions should be checked more frequently where these conditions are encountered and adjusted to compensate for the temperature changes. Cables should be rigged to the proper tension when the air temperature is as close as possible to the temperature at which the airplane is to be flown and is uniform for the whole airplane; that is, when one side of the airplane is not exposed to the hot sun. A tension tolerance of plus or minus 5 pounds is all that is permissible.

NOTE

Accurate cable tension is insured through the use of a cable tension indicator. (See figure 194.) Cable tension indicators are individually calibrated and provided with a conversion chart for converting the dial readings to pounds tension.

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By: John R. Burnett
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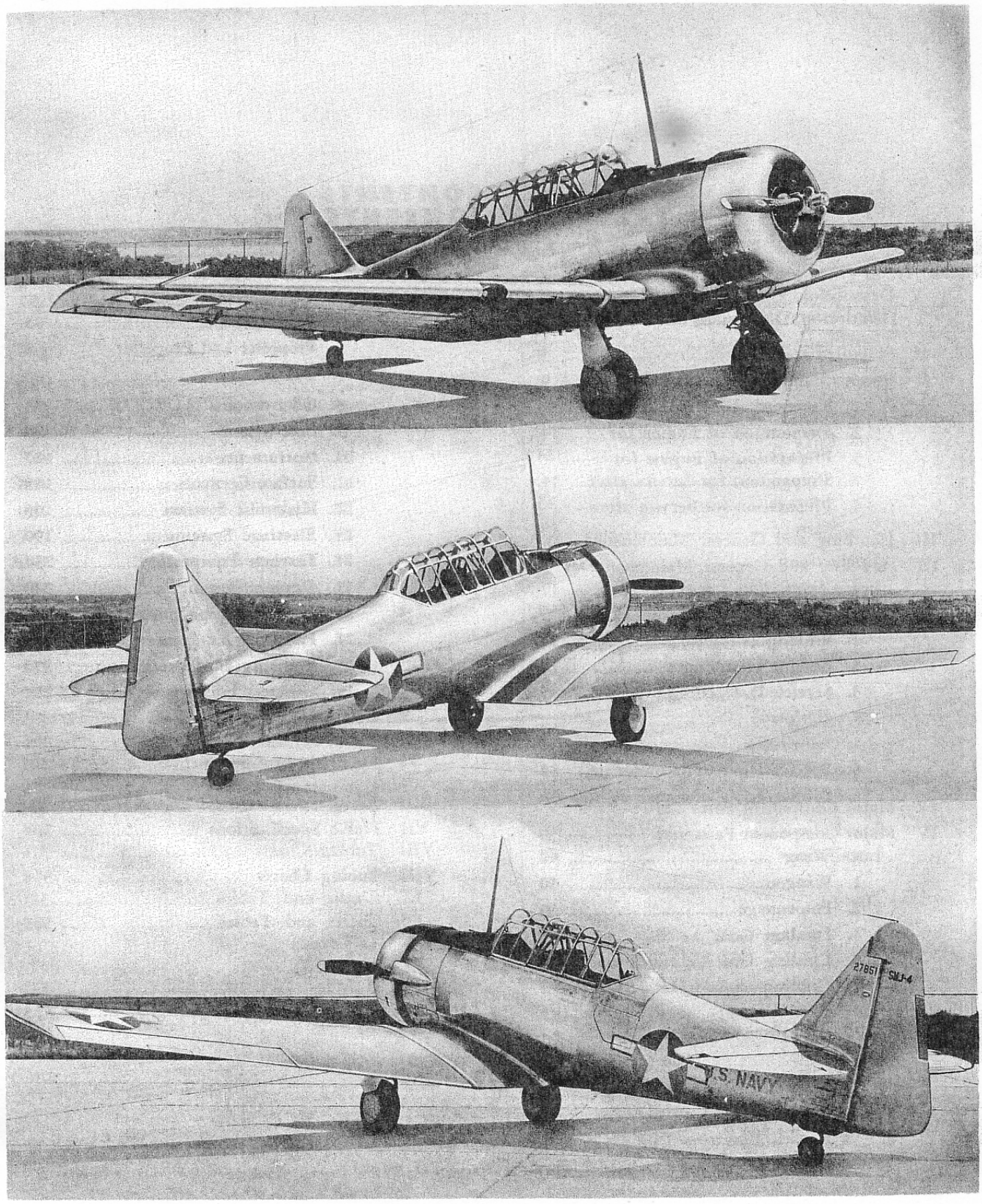


Figure 1 — Three Views of AT-6C

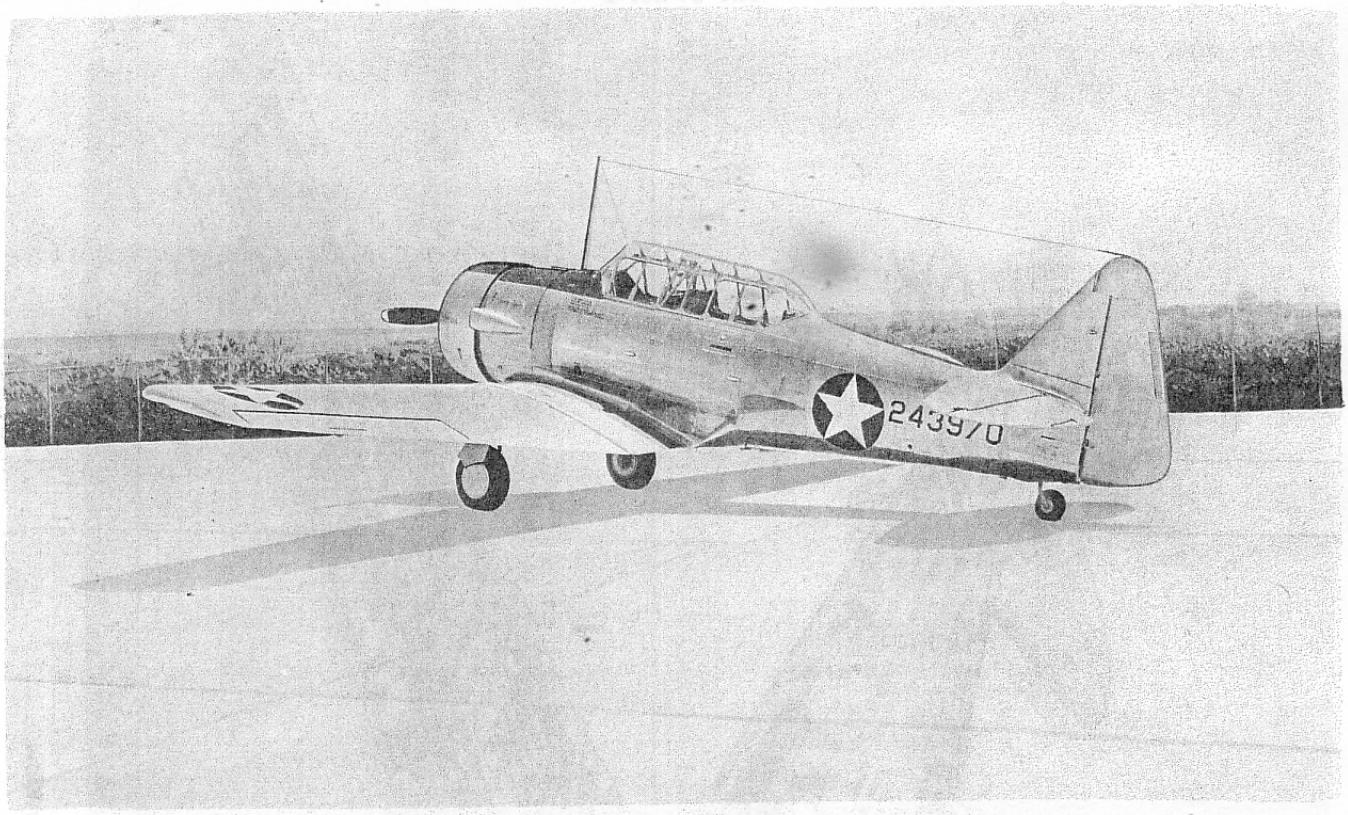


Figure 2—Three-Quarter Rear View of AT-6C (Metal Monocoque)

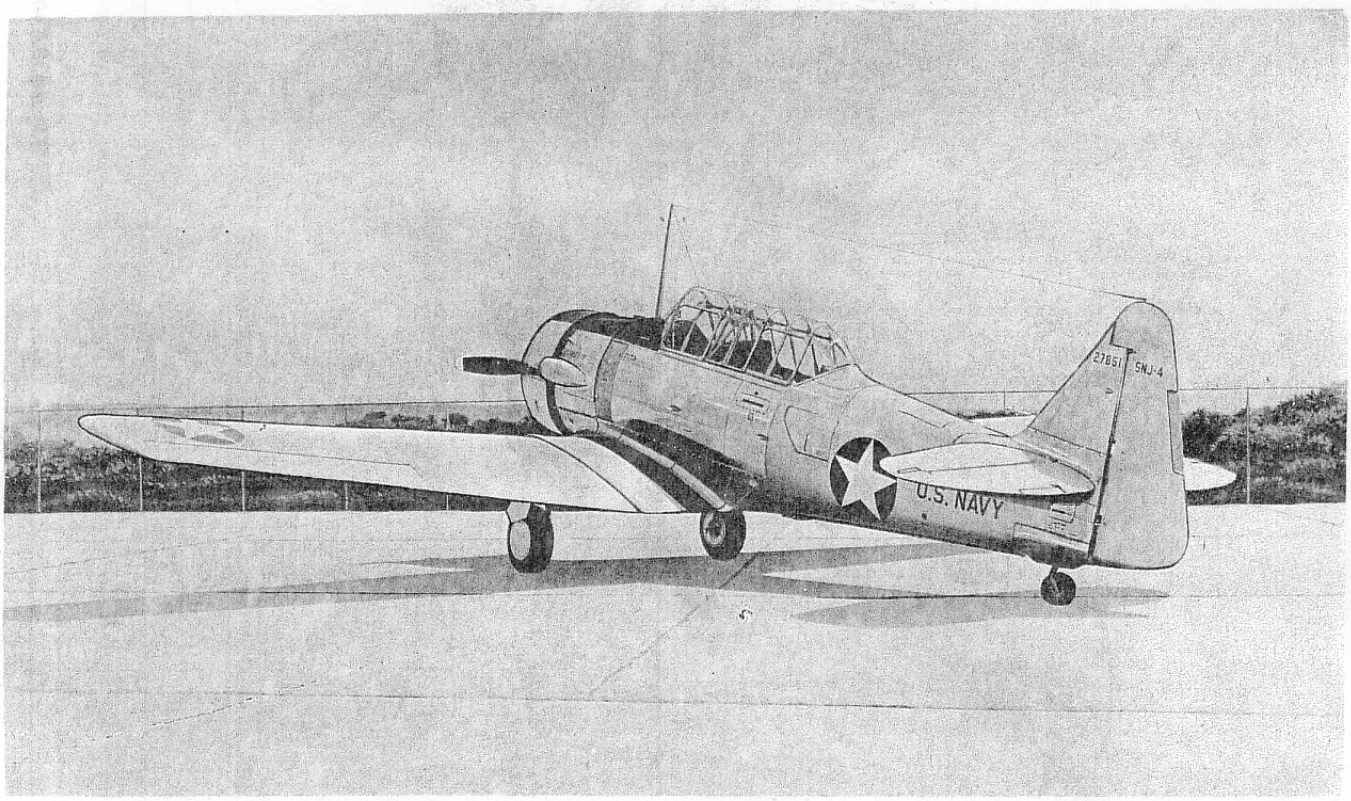


Figure 3—Three-Quarter Rear View of SNJ-4 (Wood Monocoque)

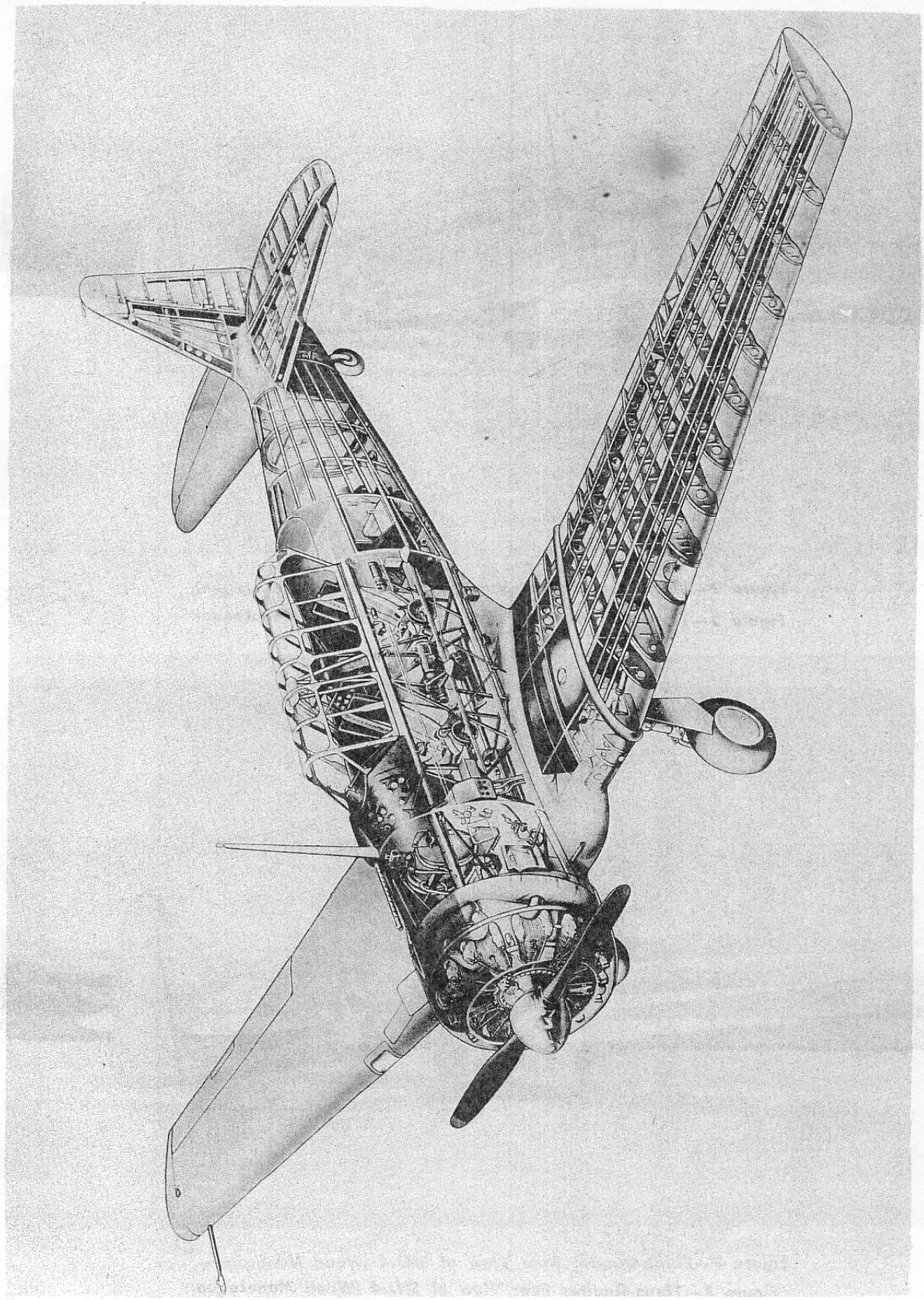


Figure 3A — Phantom View

SECTION I

DESCRIPTION, DIMENSIONS, AND LEADING PARTICULARS

1. DESCRIPTION.

a. GENERAL.—The AT-6 and SNJ series of airplanes are two-place, single-engine, low-wing monoplanes designed and manufactured by North American Aviation, Inc. as advanced trainers with provision for the installation of bombs and gunnery equipment. The tactical mission of the airplane, therefore, is to provide a means for the advanced training of student pilots and their transition flying to combat-type airplanes. Each airplane is of all-metal construction except that in some later airplanes wood is employed in various parts of the structure. Airplanes delivered to the United Kingdom are identical with the standard AT-6C, D, F, SNJ-4 and 5 (Navy) airplanes except for the following items:

Yellow band, seven feet wide, painted on each wing.

Sutton harness installed in lieu of type B-11 safety belt.

Provisions for ballast weight in rear of fuselage.

Provisions for British radio and interphone equipment.

Cockpit covers provided.

These items and other minor innovations are described in more detail in their proper places throughout this handbook. Later airplanes of the trainer series are designated as AT-6D, F, and SNJ-5 (Navy) airplanes and may be distinguished from the previous models by the installation of a 24-volt electrical system in place of a 12-volt system.

b. WING.—The tapered wing is of all-metal stressed skin, full cantilever, low wing design, consisting of a detachable center section and two detachable outer wing panels with removable tips.

(1) AILERONS. — The cable-controlled, fabric-covered, metal frame ailerons are balanced statically and dynamically.

(2) WING FLAPS.—The split-type, all-metal wing flaps are hydraulically operated.

c. EMPENNAGE.—The vertical and horizontal stabilizers are of metal construction, with the exception of wood-constructed horizontal stabilizers installed on some later airplanes. Rudder and elevators are of metal construction, fabric-covered, and are statically and dynamically balanced.

d. FUSELAGE.—The fuselage structure consists of two sections bolted together just aft of the rear cockpit. The engine mount is mounted on the front of the forward fuselage.

e. LANDING GEAR. — The landing-gear equipment consists of a main landing gear, hydraulically operated, and a steerable, nonretracting tail wheel.

f. HYDRAULIC SYSTEMS.—Two individual hydraulic systems are incorporated in the airplane; namely, the main system to operate the flaps and the landing gear, and the brake system.

g. POWER PLANT.

(1) ENGINE.—These airplanes are powered by a single Pratt and Whitney, model R-1340-49, or R-1340-AN-1, nine-cylinder, air-cooled, radial engine.

(2) PROPELLER.—The engine drives a two-blade, 9-foot diameter, Hamilton Standard, constant-speed propeller.

(3) FUEL SYSTEM.—The fuel system consists essentially of two removable tanks housed within the center section structure, a type F-10 engine-driven fuel pump mounted on the engine accessory housing, a fuel unit on the forward side of the fire wall with a fuel cock at the bottom of the fuel unit, and a fuel selector valve. (AT-6 airplanes are equipped with integral fuel tanks.)

(4) OIL SYSTEM.—The oil system consists of an oil tank, an oil regulator, a surge valve, an engine-driven pump, an oil Y-drain valve, pressure and temperature indicators, and the necessary piping.

h. EQUIPMENT.

(1) FLIGHT CONTROLS.—Flight is controlled by a conventional stick in the cockpit which operates the ailerons and elevators. Pedals for controlling the rudder and operating the wheel brakes are conventionally located.

(2) COMMUNICATIONS EQUIPMENT.—These airplanes are equipped for radio communications by voice and key on several frequencies.

(3) HEATING AND VENTILATING SYSTEM. —The airplanes are equipped with a cockpit heating and ventilating system.

(4) GUNNERY EQUIPMENT. — The gunnery equipment consists of provisions for three model M-2, .30-caliber Browning machine guns (two in AT-6, AT-6A, late AT-6D, and AT-6F), and provisions for a gun camera.

(5) BOMBING EQUIPMENT.—Complete provisions have been incorporated in each airplane (not on AT-6, AT-6A, and AT-6F) for a flush-type bomb rack on the lower surface of each outer wing panel.

(6) OXYGEN EQUIPMENT.—Earlier airplanes are equipped with a high-pressure oxygen system. Later airplanes are equipped with a demand-type oxygen system.

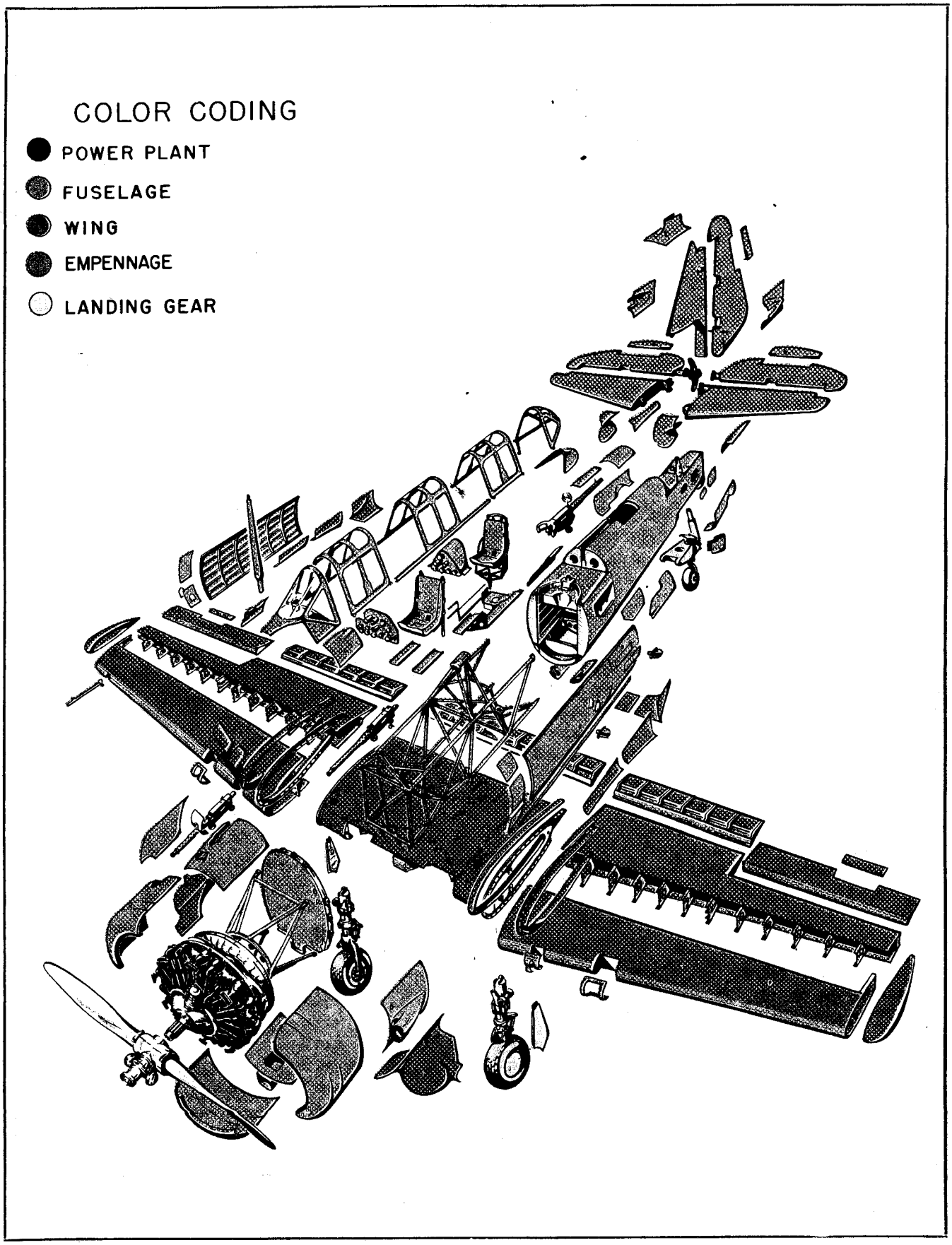


Figure 4 — Airplane Break-Down Diagram

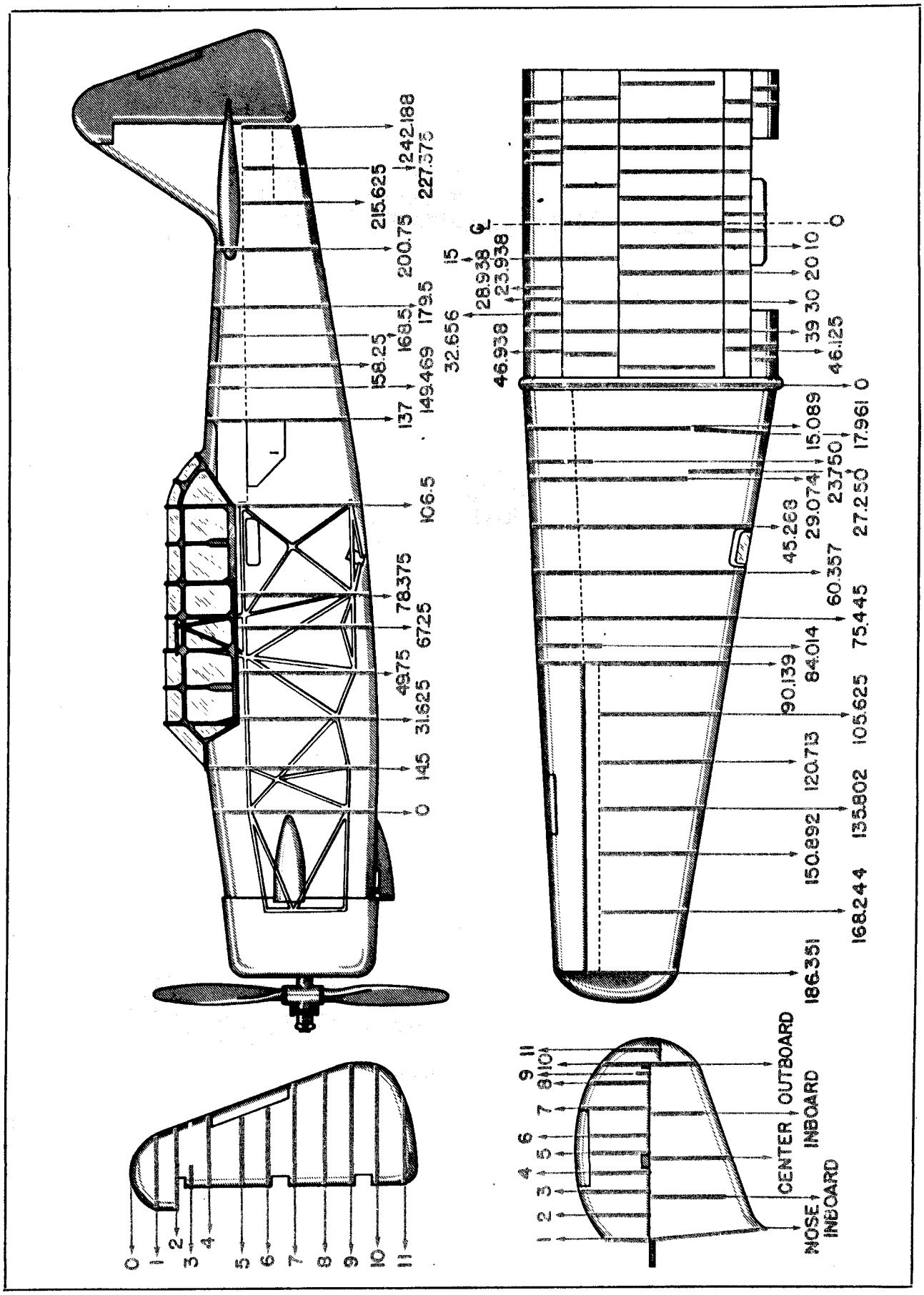


Figure 5 — Airplane Stations Diagram

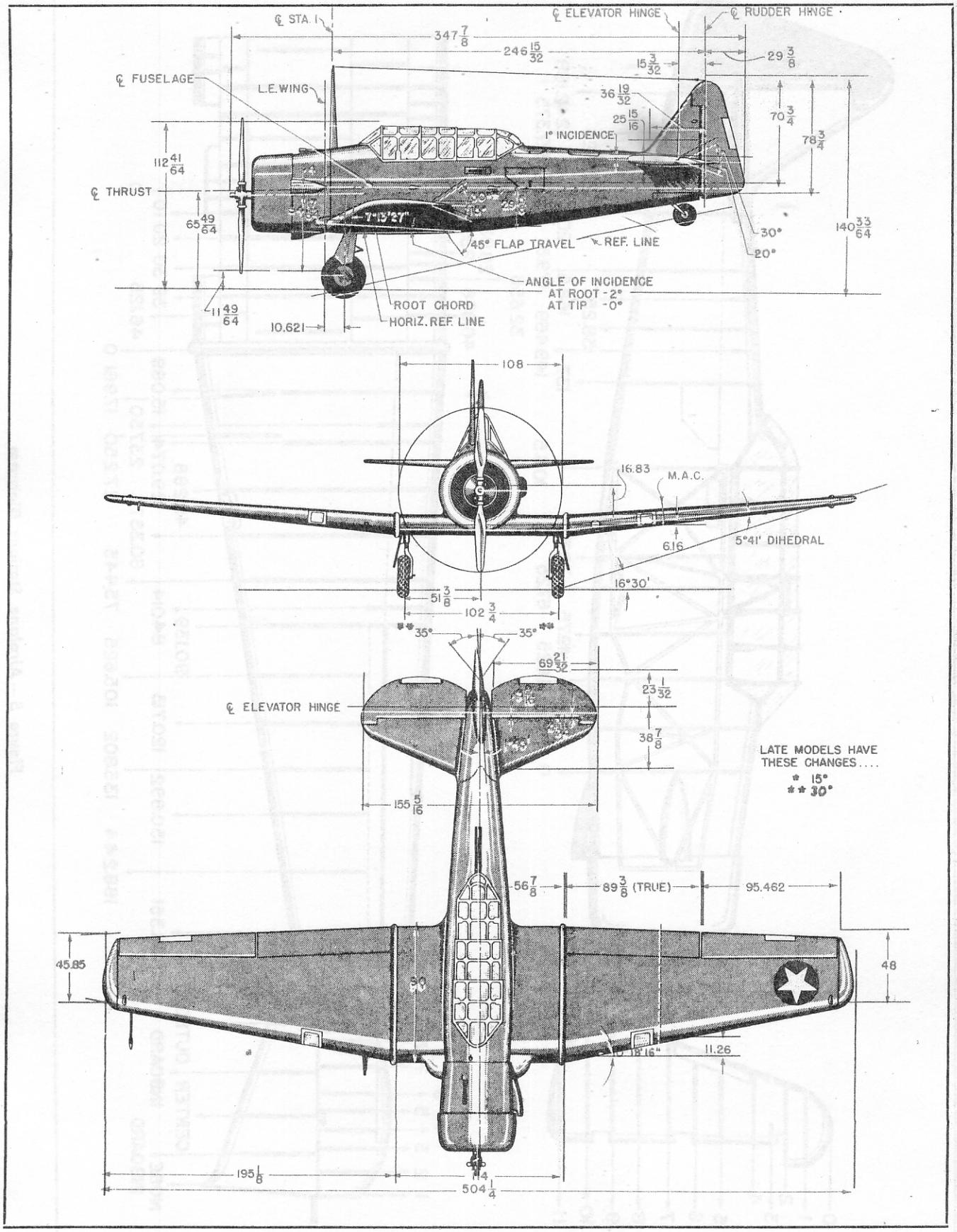


Figure 6 — Airplane Three-View Diagram

PRINCIPAL DIMENSIONS

Dimensions and leading particulars given in column I are those applicable to most models of the AT-6 and SNJ (Navy) series airplanes. Variants and the applicable models are listed in column II.

GENERAL	COL. I	COL. II
Over-all wing span	42 ft, 1/4 in.	42 ft, 7-1/4 in. (AT-6 only)
Over-all length	28 ft, 11-7/8 in.	
Over-all height, antenna mast, thrust line level	12 ft, 9 1/4 in.	
Over-all height, antenna mast three point position	12 ft, 6 in.	
Height, propeller hub thrust line level	65-49/64 in.	68-11/16 in. (AT-6 only)
Clearance, propeller tips, thrust line level	11-49/64 in.	16-5/8 in. (AT-6 only)
Normal cg to wing leading edge, wheels down	30.54 in.	
Normal cg to wing leading edge, wheels up	30.27 in.	
CG limits to wing leading edge	29.60 to 33.75 in.	
Elevator hinge to wing leading edge	235-5/8 in.	
Minimum clearance of propeller and ring cowl	1 in.	
Angle of normal cg with wheel (side elevation)	18°, 11 min	
Angle of rearward cg with wheel (side elevation)	20°, 41 min	
Angle of wing tip and wheel bottom (front elevation)	16°, 30 min	
Angle of thrust line with ground (three-point position)	11°, 55 min	12°, 31 min (AT-6, A, B, SNJ-3)
WINGS		
Airfoil section at root	NACA 2215	
Airfoil section at tip	NACA 4412	
Span	42 ft, 1/4 in.	42 ft, 7 1/4 in. (AT-6 only)
Mean aero. chord (semi-wing)	75.96 in.	76.20 in. (AT-6 only)
Leading edge of M.A.C.	11.26 in.	11.07 in. (AT-6 only)
Chord at root	90 in.	
Chord at tip	48 in.	
Dihedral-leading edge	5°, 41 min	
Incidence at root	2°	
Incidence at tip	0°	
Washout at tip	2°	
Sweepback	10°, 18 min, 16 sec	
FLAPS		
Chord, each flap	14-11/32 in.	
Length of center section flap	113-1/4 in.	
Length of each outer wing flap	89-3/8 in.	
EMPENNAGE		
Horizontal stabilizer		
Overall span	12 ft. 11-5/16 in.	
Maximum chord (leading edge to hinge line)	38-7/8 in.	
Incidence (fixed setting) *(See figure 6F)*	1°	
Vertical stabilizer		
Maximum chord (leading edge to hinge line)	36-19/32 in.	
Setting, fixed *(See figure 6E)*	1°, 45 min left	
Elevators (each)		
Span	12 ft, 11-5/16 in.	
AREAS		
Wings (total area including ailerons)	253.73 sq ft	258.10 sq ft (AT-6 only)
Ailerons (each)		
Area aft of hinge line, including booster tab	8.98 sq ft	
Area of balance	2.42 sq ft	
Total area of each aileron	11.40 sq ft	
Area of booster tab	.44 sq ft	

AREAS	COL. I	COL. II
Flaps		
Area of center section flap	11.40 sq ft	11.06 sq ft (AT-6 only)
Area of each outer wing flap	8.73 sq ft	
Total area (3 flaps)	28.86 sq ft	28.52 sq ft (AT-6 only)
Empennage		
Total area horizontal tail surface, including 5.33 sq ft fuselage	50.11 sq ft	
Total area vertical surfaces	18.54 sq ft	
Horizontal stabilizer		
Total area, including 5.33 sq ft fuselage	28.34 sq ft	
Elevators (each)		
Area aft of hinge line, including tab	9.13 sq ft	
Area trim tab	.73 sq ft	
Area of balance	1.75 sq ft	
Total area, including tab and balance	10.88 sq ft	
Vertical stabilizer	5.33 sq ft	
Rudder		
Area aft of hinge center line	10.95 sq ft	
Area of balance	2.26 sq ft	
Area trim tab	60 sq ft	
Total area including balance and tab	13.21 sq ft	

SETTINGS AND RANGES OF MOVEMENT OF CONTROL SURFACES

Ailerons *(See figure 6B)*		
Aileron travel	UP 30° DOWN 15°	Up 15° Down 15° (T-6D, -F, SNJ-5, SNJ-6)
Booster tab travel	UP 15° DOWN 30°	
Flap movement *(See figure 6A)*	45°	
Elevators *(See figure 6C)*		
Elevator travel	UP 30° DOWN 20°	
Trim tab travel	UP 8° DOWN 16°	
Rudder *(See figure 6D)*		
Rudder travel	Right 35° left 35°	Right 30° left 30° (T-6D, -F, SNJ-5, SNJ-6)
Trim tab travel	Right 4° left 10°	

ALIGHTING GEAR

WHEEL TYPE ALIGHTING GEAR

Type	Hydraulically retractable
Tread (width from center of tire to center of tire)	102-3/4 in.

MAIN SHOCK STRUTS

Type	Combination air and oil
Make (Bendix)	NAA 77-33102 AC Spec No. 40228
Fluid required	Spec. No. AN-VV-0-366
Approximate maximum air pressure	750 lb per sq in.

WHEELS (MAIN)

Type II drop-center—27 in.	AC Spec. No. AN-W-6
Tire	27 in. 8 ply
Tire pressure	32 lb per sq in.

BRAKES

Type	Hayes-Hydraulic "Servo"
Fluid required	Spec. No. 3586-C (Blue)

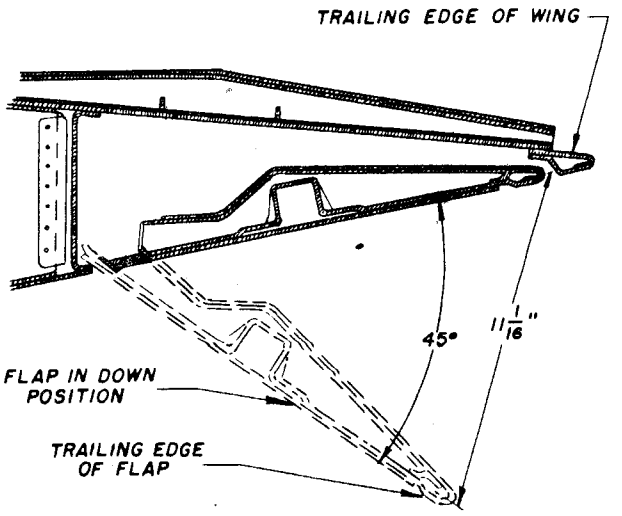


Figure 6A — Flap Movement

The distance between trailing edge of the flap and trailing edge of wing when flap is in the full 45 degree "DOWN" position measures 11-1/16 inches.

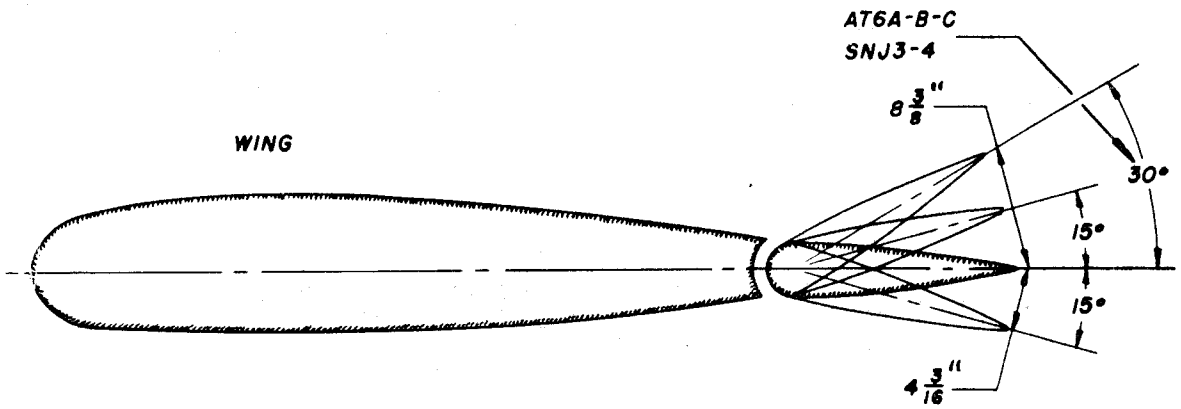


Figure 6B — Aileron Movement

The chord of the 15 degree angle measures 4-3/16 inches when in full "UP" or "DOWN" position, and 8-3/8 inches when in the 30 degree position. This measurement is to be made at the inboard end of the aileron trailing edge.

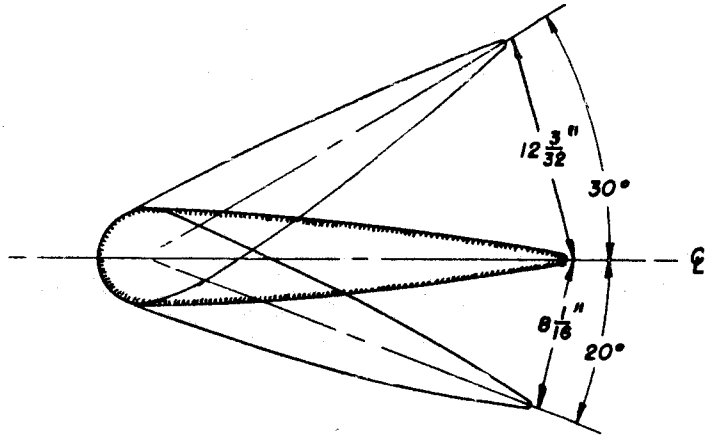
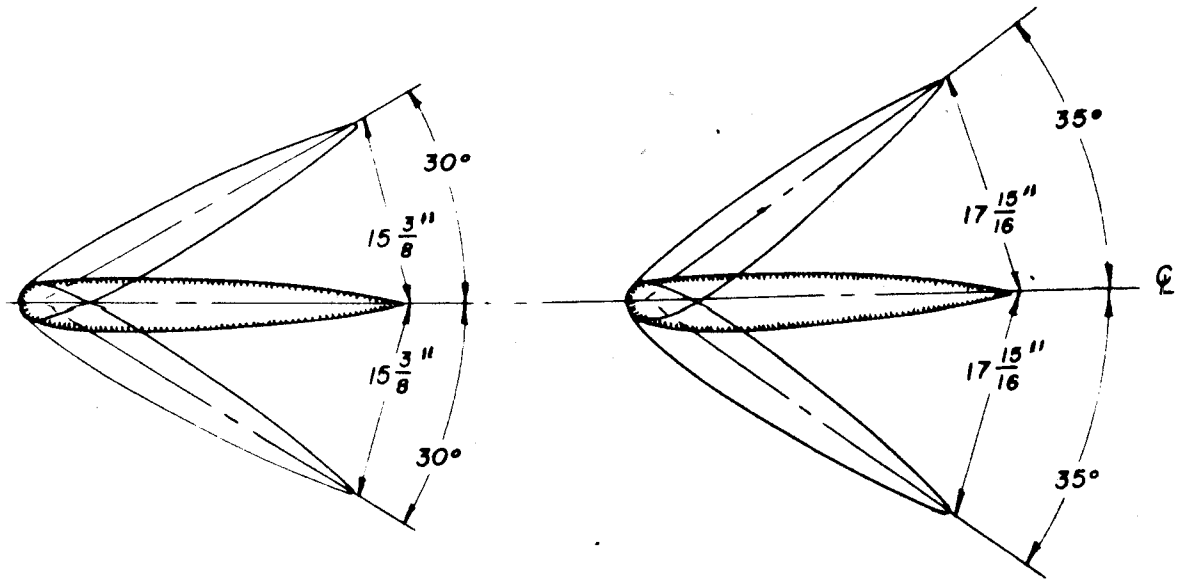


Figure 6C — Elevator Movement

The chord of the 30 degree angle in elevator full "UP" position measures 12-3/32 inches measured from trailing edge at outboard end of trim tab cut-out (or opening) at rib No. 7. The chord for the 20 degree angle in "DOWN" position measures 8-1/16 inches from the same point.



AT6D AND SNJ5 ONLY

Figure 6D — Rudder Movement

AT-6D and SNJ5 Only.—The chord of the 30 degree angle in full "RIGHT" or "LEFT" rudder position is 15-3/8 inches measured at trailing edge from a point one inch below rib No. 9 at the greatest width opposite the lower hinge.

AT-6A, B, C and SNJ3, 4 Only.—The chord of the 35 degree angle in full "RIGHT" or "LEFT" rudder position is 17-15/16 inches. This is measured at the trailing edge from a point one inch below rib No. 9 at the greatest width opposite the lower hinge.

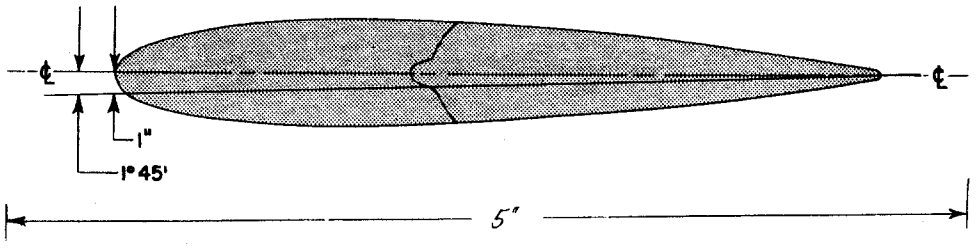


Figure 6E — Vertical Stabilizer, Fixed Setting

The chord of the 1-¾ degree angle on the vertical stabilizer fixed setting measures one inch at the lower end of the stabilizer leading edge where it is attached to the fuselage fillet.

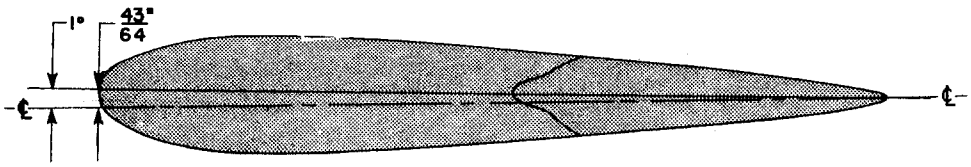
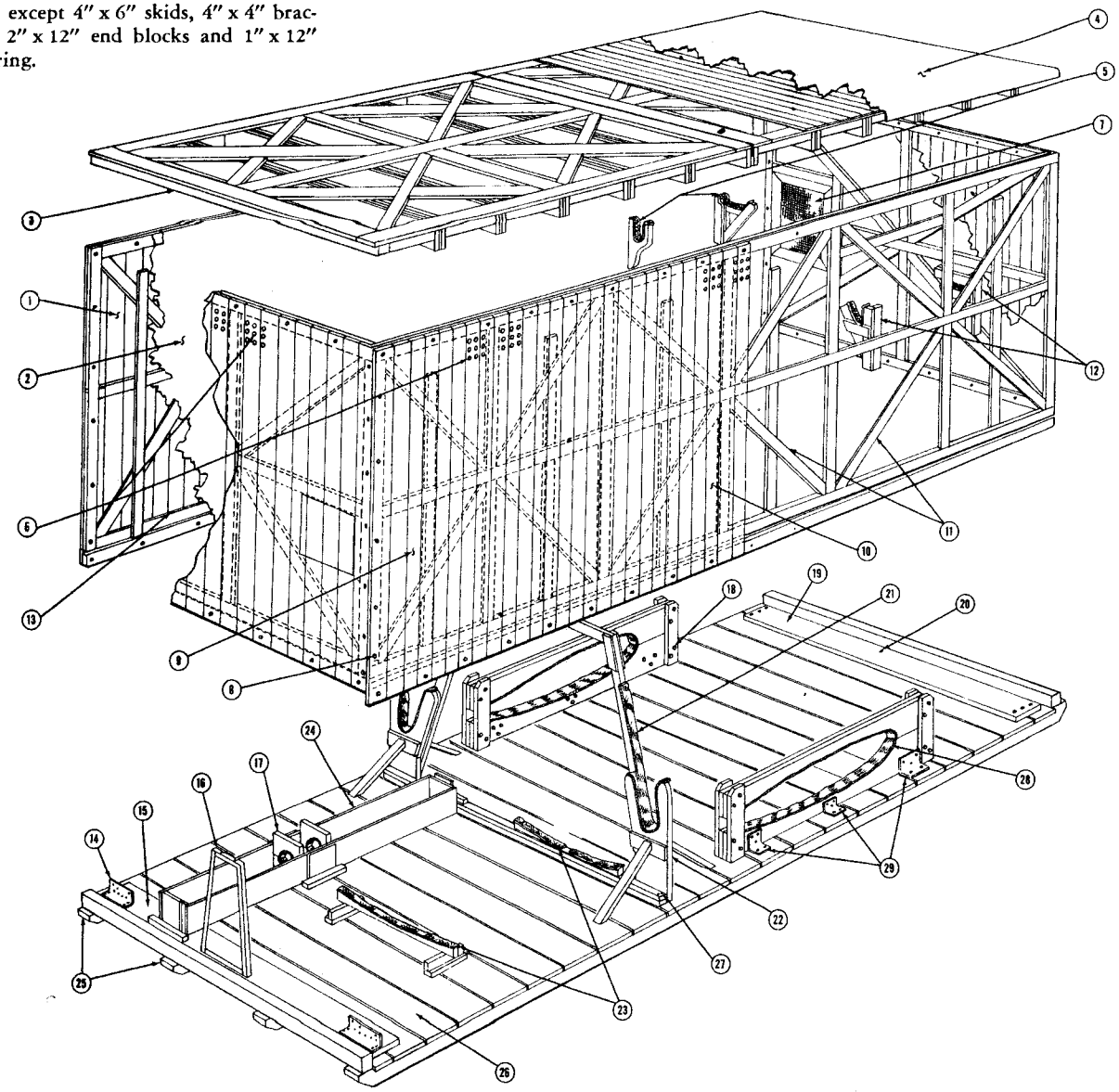


Figure 6F — Horizontal Stabilizer, Fixed Setting

The chord of the one degree angle at leading edge of the stabilizer fixed setting measures 43/64 inch at the inboard end of the stabilizer.

	COL. I	COL. II
TAIL WHEEL		
Type	Steerable-lockable and non-retractable	
Tire	12.5	10 in. (AT-6, A, B, SNJ-3)
Tire pressure	38 lb per sq in.	
TAIL SHOCK STRUT		
Type	Combination air and oil	
Make (Bendix or Gladden)	AC Spec. No. 25272	
ENGINE		
Model	Pratt and Whitney R-1340-AN-1	R-1340-49 (AT-6, AT-6A, B only)
Type	Radial, air-cooled	
Number of cylinders	9	
Blower ratio	10:1	
Compression ratio	6.03:1	
Rated power at sea level take-off	600 bhp/2250 rpm	
Normal rating at 5000 ft	550 bhp/2200 rpm	
Carburetor: Stromberg	NA-Y9E1-511	
Fuel	87 octane or grade 91/96	
PROPELLER		
Manufacturer	Hamilton Standard	
Type (2 blades)	Constant speed	
Hub	No. 12D40	
Blade	No. 6101A-12	
Diameter	9 ft	
Control governor	No. 1M12-A	No. 1P12-A (AT-6 only)
Pitch setting		
Low (fine)	13°	
High (coarse)	28°	
	28° Index	
TANK CAPACITIES		
Fuel		
Tanks (2)	55.2 U.S. (46 Imperial) gal	89 U.S. (74 Imperial) gal (AT-6 only)
Total	110.4 U.S. (92 Imperial) gal	178 U.S. (148 Imperial) gal (AT-6 only)
Oil		
Tank (1)	10.2 U.S. (8.5 Imperial) gal	Normal—10.8 U.S. (8.97 Imperial) gal (AT-6 only)
Expansion space	2 U.S. (1.7 Imperial) gal	Overload—15.5 U.S. (12.9 Imperial) gal (AT-6 only)

NOTE: All lumber construction on AT-6 airplane crate is 2" x 4" yellow pine except 4" x 6" skids, 4" x 4" bracing, 2" x 12" end blocks and 1" x 12" flooring.



1. Inside View of Construction of Side Wall
2. 15-lb. Roofing Paper Used on Side Walls and Ends
3. Overlapping Joint at All Corners in Top Section
4. 15-lb. Roofing Paper Used on Roof
5. Vertical Stabilizer Cradles
6. Air Vent—1/4" Hardware Cloth and Screen Used
7. Door—2' x 3' (Swings Outward)
8. 3/8" x 6" Lag Bolts Used to Attach Sides to Ends
9. Outside View of Side Wall
10. Tongue and Groove Yellow Pine Used on Sheeting
11. Two 2" x 4" Used as Bracing on Side Walls
12. Rudder Cradles
13. 7" x 3/8" Lag Bolts Used to Secure Top and Bottom to Sides and Ends
14. Wing Angle-Iron 3/8" x 5" Lag Screws—3/8" x 3 1/2" Machine Bolts
15. End Block
16. Tail Stand Frame—Support for Monocoque
17. Propeller Clamp
18. 1/2" x 7" Machine Bolts
19. End Block
20. 3/8" x 6" Lag Bolts Used on End Blocks
21. "A" Frame (Wooden)
22. Wing Cradle
23. Horizontal Tail Assembly Cradles
24. Propeller Box
25. 4" x 6" Skids
26. 1" x 12" Flooring
27. 3/8" x 7" Lag Screws
28. Center Section Cradle
29. Angle-Irons 1/2" x 4 1/2" Machine Bolts and 1/2" x 4" Lag Bolts

Figure 7 — Airplane Crate

SECTION II
SHIPMENT AND ERECTION PROCEDURE

1. SHIPMENT

a. GENERAL.—*(See figures 7, 8, 9, 10.)*—After preparations for crating have been made, which include the draining of fuel, oil, and hydraulic systems (exclusive of the brake system), and the coating of exposed metal parts with a film of corrosion preventive, the airplane then is partially disassembled to facilitate shipment. The main section of the airplane, consisting of the entire fuselage, wing center section, and power plant, is hoisted into position on the platform section of a wooden crate. The crate consists of the platform and the ceiling and wall assemblies, which are hoisted into their proper positions and rigidly secured by bolts and screws. The wing outer panels, tail assemblies, propeller, and loose equipment are securely mounted by means of webbing to "cradles" in various positions in the crate. After the crating has been completed, the waterproofed roof inspected for possible cracks or tears, final inspection seals affixed, and hoisting notches cut to facilitate further handling, the airplane is ready for shipment. Location of cradles and containers within the crate are listed as follows:

Name	*Location*
Center section cradles	Front section on floors parallel next to side walls.
Wing cradles	On each side of platform just aft of center section cradles.
A-frame	Extends from wing cradles to and across ceiling.
Wing bolting angle attachment plates	At both rear corners of platform.
Horizontal tail assembly crates	One on platform parallel and under A-frame: one in center of platform and between wing and wing cradle.
Propeller box	Extends from wing end on rear left platform to wing cradle.
Rudder cradle	On left side wall, forward.
Vertical stabilizer cradle	On right side wall, forward.
Loose equipment box	On platform inside door.
Fairings	Attached to left side wall, rearward.
Right wing gun	On top of right wing center section cradle (others stationary).

b. PREPARATION FOR CRATING.

(1) GENERAL.—In preparing the airplane for shipment, personnel should first take steps toward insuring a safe arrival of the airplane in the crate. The following detailed instructions are recommended for safe handling of the airplane.

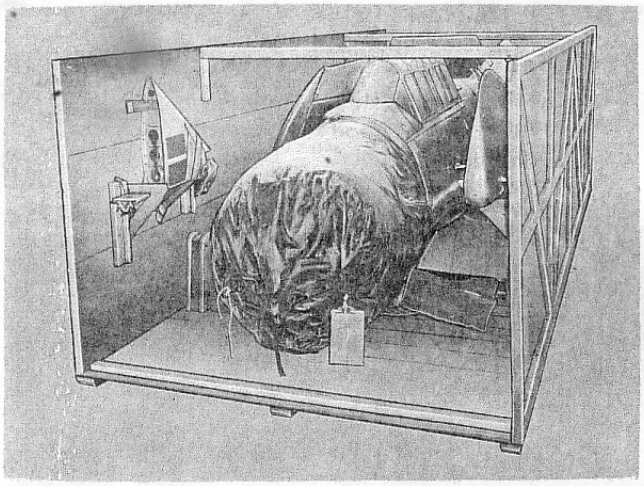


Figure 8—Airplane in Crate—Front View

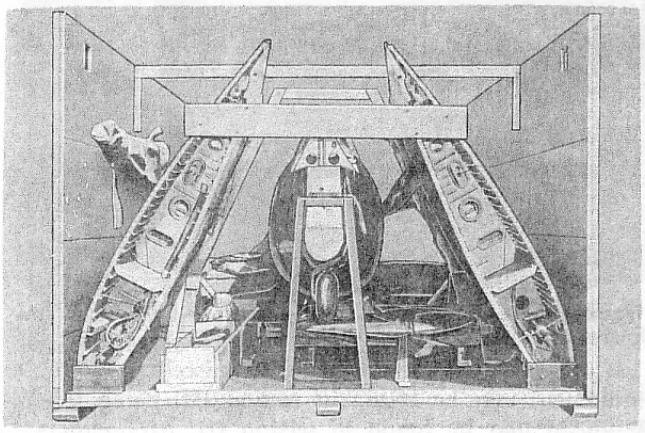


Figure 9—Airplane in Crate—Rear View

(2) ENGINE.—Installed engines should be prepared for shipment by applying a coating of corrosion-preventive compound inside and out, as instructed in paragraph 3. When this procedure has been fully completed, cover engine and cowling with heavy wrapping paper and standard engine cover.

NOTE

Cylinder and crankcase dehydrator plugs should be inspected weekly at points of shipment and replaced when necessary.

(3) SURFACES AND LOOSE EQUIPMENT.—Instructions for preparation of surfaces and loose equipment for crating follow:

(a) All exterior metal surfaces with the exception of painted surfaces should be sprayed with corrosion-preventive compound.

(b) Remove from baggage compartment all loose equipment which may consist of the following:

Engine tool kit
Armorer's tool roll
Mooring kit
Miscellaneous loose equipment
Blind flying hood
Engine cover

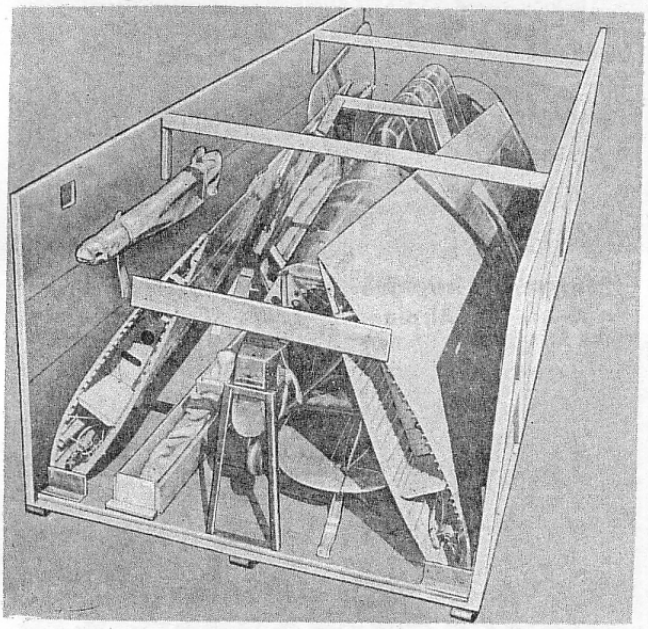


Figure 10 — Airplane in Crate — Three-Quarter View

List of parts contained in kits and miscellaneous loose equipment may be found in section III, paragraph 5. Place loose equipment in miscellaneous loose equipment box.

(c) Remove antenna mast and pitot tube. Wrap in heavy paper and attach to left wall by means of webbing.

(d) Detach outer panel, rudder, elevator, vertical and horizontal stabilizer assemblies, and wing gun (if carried). Attach machine gun windbreaker to leading edge of wing. Removal and disassembly instructions for fixed and movable surfaces are contained in section IV.

c. CRATING.

(1) GENERAL.—With all preparations having been completed for crating, a final visual inspection should be made to ascertain that no steps have been overlooked that might necessitate partial or complete uncrating procedure. A specially prepared check-off list contained at end of this section should be consulted. For handling procedure refer to section III. The sequence of operations for crating the airplane follows:

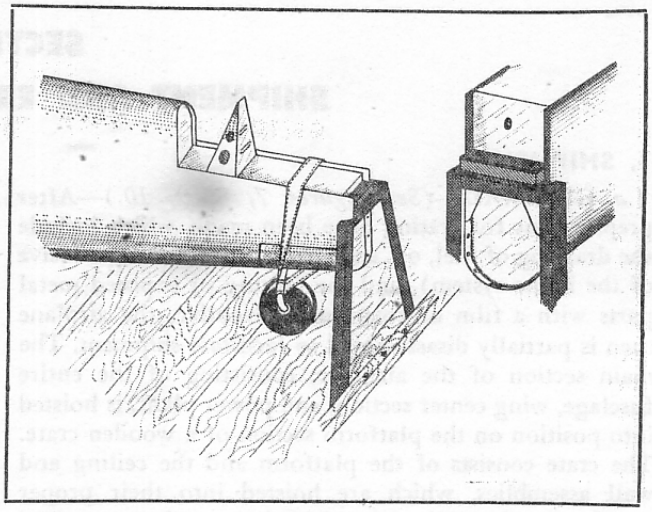


Figure 11 — Fuselage Rear End Attachment

(a) Install hoist shackles and hoist the airplane clear of the floor.

(b) Place the landing gear in the retracted position and secure the landing gear control handle in the UP position to prevent an inadvertent release of the UP position latches.

(c) Slide the floor of the crate under the airplane.

(d) Lower the airplane onto the floor of the crate, engaging the ends of the wing center section in the lower portion of the center section cradles. The upper and lower cradles should be properly padded to protect the surface of the wing.

(e) Bolt the rear end of the fuselage to the rubber mounting on top of the tail stand. (See figure 11.)

(f) Secure the wing center section in the lower cradles by means of the upper cradles, or "caps," and attaching bolts. (See figure 12.)

(g) Secure the horizontal tail assembly to the cradles under the fuselage by means of webbing straps. Nail ends of straps to platform using necessary wooden blocks. (See figure 13.)

(h) Place propeller in propeller box and secure by means of bolts at the propeller hub.

(i) Place the left wing outer panel in the wing cradle on the right side of the A-arm, bottom surface of the wing toward the fuselage, wing tip forward and leading edge down. (See figure 14.) Use same procedure for right wing.

(j) Swing the wing outer panel trailing edges inboard, and secure them at the bolting angles, with bolts, to a suitable cross brace.

(k) Secure the bolting angle at the leading edge to the floor of the crate, utilizing bolts and a heavy angle plate.

(l) Assemble sides and support with cross braces, using dollies, hoists, or any other available equipment. Lag screws and bolts are used in assembling, as illustrated in figure 7.

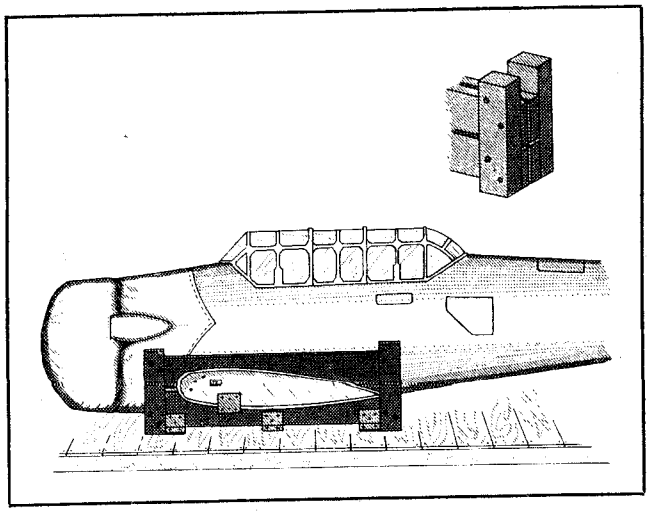


Figure 12—Wing Center Section Cradles

(m) Attach vertical stabilizer to bracket on the front section of the right wall, using webbing for support. (See figure 15.)

(n) Attach rudder to bracket on the front section of the left wall, securing by means of webbing. (See figure 16.)

(o) Install all loose equipment, including loose equipment box which is to be located directly inside door at front left corner of platform.

(p) Install ends and top of crate.

(q) After assembly of the crate, tar paper or any other suitable roofing material is applied to the top.

d. UNCRATING.

(1) GENERAL.—For handling procedure, refer to section III. To remove the airplane from the shipping crate, the following procedure is recommended:

(a) Enter the crate through the door located at the forward end.

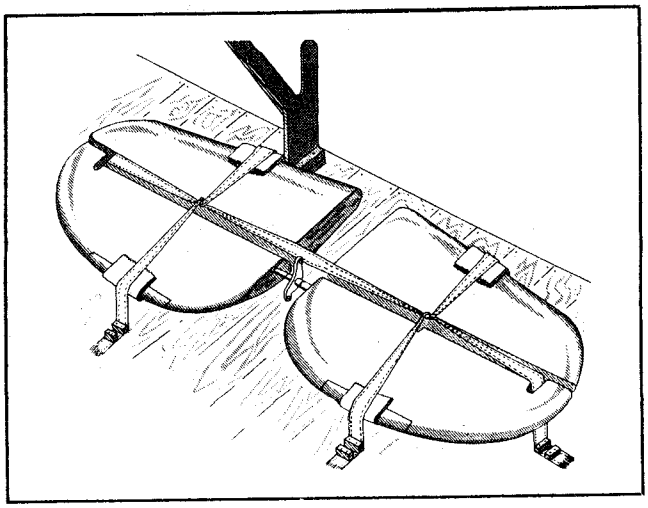


Figure 13—Horizontal Tail Assembly Attached to Platform

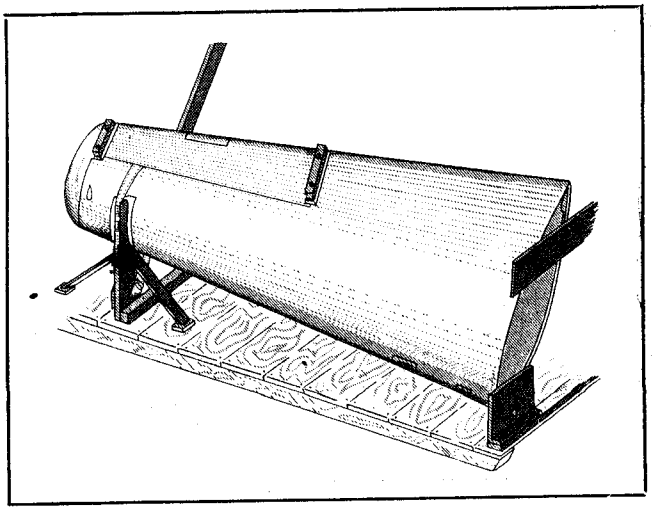


Figure 14—Outer Wing Panel in Cradle

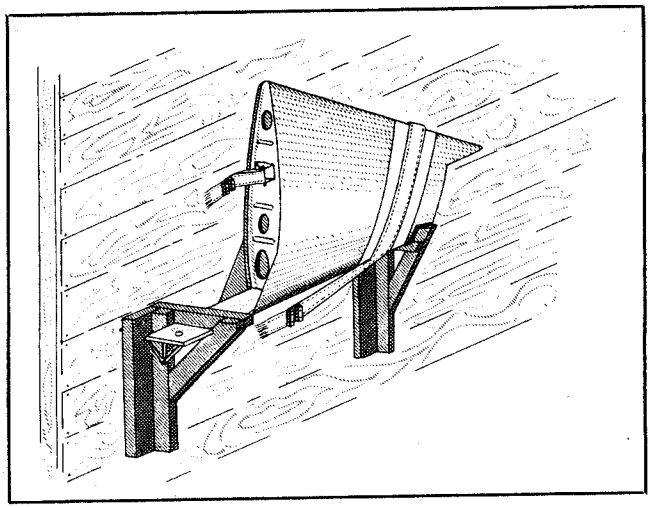


Figure 15—Vertical Stabilizer Attached to Wall

(b) Unscrew lag bolts around edge of top and four bolts located near center, and remove top of crate.

(c) Brace sides and remove the ends of the crate. Take care not to jar the sides, as component parts are attached thereto.

(d) Remove rudder, vertical stabilizer, and all loose parts from sides.

(e) Remove sides.

(f) In order to remove the outer wing panels, remove top cross braces and extract the bolts from the plates securing the roots of the panel to the floor of the crate. Detach the brace securing the panel roots together near their respective trailing edges. Lift the panels clear, using caution in handling.

(g) Remove the horizontal tail assembly and box of loose equipment from floor of crate.

(h) Remove propeller from box.

(i) Remove the upper portions of the center section cradles and three bolts fastening plate to bolt angle and bottom of the cradle.

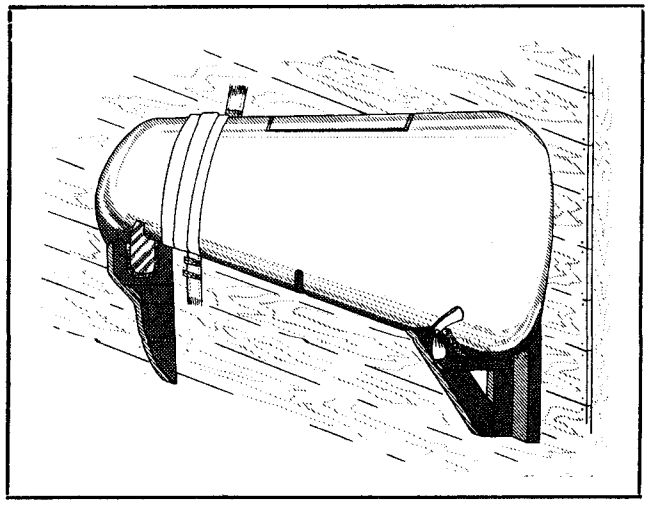


Figure 16—Rudder Attached to Wall

(j) Remove hoisting rings from loose equipment box and attach to center section.

(k) Pass the cable or chain through the hoist rings extending upward from the top of the center section.

CAUTION

Be sure the load capacity of the cable or chain exceeds 3600 lb.

(l) Slip a tube or bar through the lift-tube aperture near the rear of the fuselage, and attach hoisting ropes or cable.

(m) Detach the rear of the fuselage from its support. Remove the bolts securing the support to the floor, and remove the support.

WARNING

Do not remove this support until the upper portions of the center section cradle have been removed and the tail of the airplane is supported by means of the lift-tube.

(n) Lift the airplane straight up out of the crate, exercising care in handling.

NOTE

Ascertain that everything has been removed from the crate before stowing for future use.

(o) Extend landing gear by placing selector handle in the "DOWN" position, releasing latches holding the landing gear in the "UP" position.

CAUTION

Since there is no hydraulic fluid in the system, it is suggested that precaution be taken in extending the gear. When the gear has reached the "DOWN" position, a check should be made to determine whether or not the lockpins have securely locked the landing gear struts in the "DOWN" position. A spacer bar also should be placed between the landing gear struts as a safety device to prevent the gear from collapsing in the event the "DOWN" position latches should be fouled.

(p) Before attempting to assemble the airplane, it is suggested that the corrosion-preventive compound be completely removed from each component part, using naphtha, kerosene, gasoline, or any suitable solvent.

(q) Assembly and installation instructions are contained in section IV. Refer to section III for servicing instructions and paragraph 4, this section for preparation of engine and accessories for flight.

e. CHECK-OFF LIST.

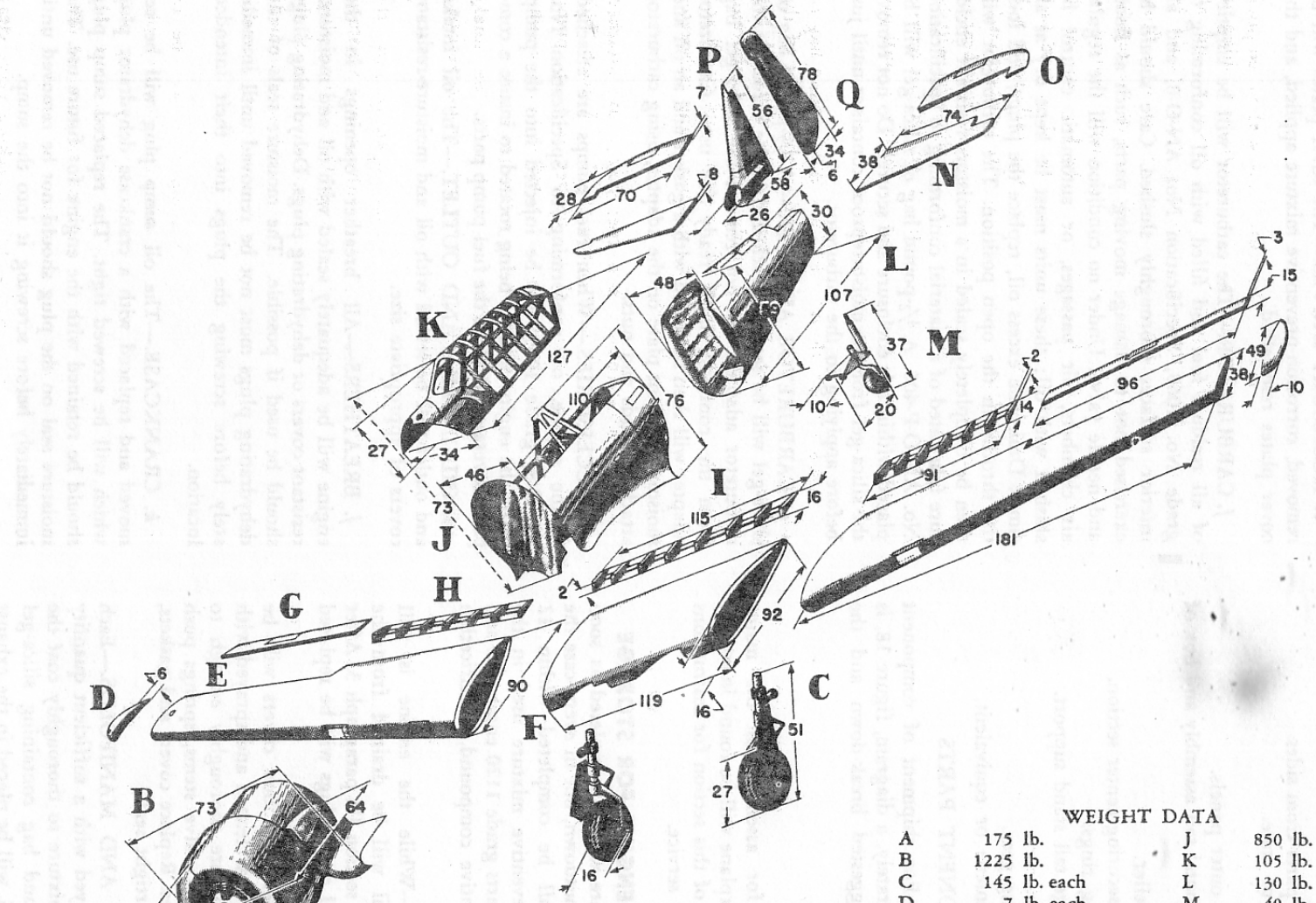
(1) GENERAL.—To insure proper preparation of the airplane for shipping, and to see that all parts have been included in the crating, consult the following check-off list:

(2) PREPARATION FOR CRATING.

(a) Drain oil.
(b) Refill with corrosion-preventive mixture.
(c) Operate engine.
(d) Pump lubricating oil into fuel pump.
(e) Seal breather openings.
(f) Spray cylinders.
(g) Install dehydrator plugs.
(h) Empty carburetor; safety plugs.
(i) Place bag of silica-gel in intake scoop and exhaust opening.
(j) Seal vent openings.
(k) Disconnect oil lines.
(l) Safety engine drain plug.
(m) Remove propeller; spray shaft.
(n) Remove thrust bearing plates and oil them.
(o) Spray engine externally.
(p) Cover engine.
(q) Spray metal surfaces.
(r) Remove loose equipment.
(s) Place loose equipment in box.
(t) Detach wing outer panels, tail assemblies, and right wing gun.

(3) CRATING.

(a) Install hoist shackles and hoist airplane.
(b) Retract landing gear.
(c) Lower fuselage on platform.
(d) Bolt rear end of fuselage to tail stand.
(e) Bolt caps to wing center section.
(f) Strap down horizontal tail assembly.
(g) Place propeller in box.
(h) Place and secure wings in cradles.
(i) Secure wings at bolting angles to platform.
(j) Assemble sides of crate.
(k) Attach vertical stabilizer and rudder.
(l) Install all loose equipment.
(m) Install ends and top of crate.
(n) Apply tar paper to roof.
(o) Attach inspection seals.



WEIGHT DATA

A	175 lb.	J	850 lb.
B	1225 lb.	K	105 lb.
C	145 lb. each	L	130 lb.
D	7 lb. each	M	40 lb.
E	210 lb. each	N	25 lb. each
F	500 lb.	O	19 lb. each
G	24 lb. each	P	15 lb.
H	8 lb. each	Q	18 lb.
I	11 lb.		

NOTE: All Weights listed are to the nearest pound. All dimensions shown are to the next integral inch.

Figure 17 — Exploded Shipping View

(p) Cut hoisting notches.

(4) UNCRATING.

(a) Enter crate through door.
(b) Remove top.
(c) Remove loose parts from sides.
(d) Remove ends of crate.
(e) Remove sides.
(f) Remove wing outer panels.
(g) Remove horizontal tail assembly and box of loose equipment.
(h) Remove propeller.
(i) Remove bolts securing center section.
(j) Attach hoisting rings.
(k) Detach fuselage tail stand support.
(l) Hoist airplane.
(m) Extend landing gear.
(n) Remove cosmolene or equivalent.

f. SHIPPING COMPONENT PARTS OF AIRPLANE.—For shipment of component parts of the airplane separately, a diagram, figure 18, is provided to show a suggested break-down and the weights involved.

2. ERECTION

Detailed instructions for assembly of the major component parts of the airplane will be found in section IV. Refer to paragraph 4 of this section for instructions for preparing engine for service.

3. PREPARATION OF ENGINE FOR STORAGE

The following procedure will be completed as soon as possible after engine shutdown, but in every case the following procedure shall be completed within 12 hours. The corrosion-preventive mixture used in the engine consists of three parts grade 1120 engine oil and one part corrosion-preventive compound, Specification No. AN-VV-C-576.

a. OIL DRAINAGE.—While the engine is still warm, the lubricating oil will be drained from the crankcase as instructed in section III paragraph 3. After the drain is completed, all drain plugs will be replaced and safetied.

b. ROCKER BOXES.—Rocker box covers will be removed and each rocker box cleaned and sprayed with a corrosion-preventive mixture thoroughly enough to coat the valve rocker arms, valve stems, springs push rods, and interior of boxes. Replace covers and gaskets, and screw down to an airtight seal.

c. EXHAUST PORTS AND MANIFOLDS.—Each exhaust port will be sprayed with a sufficient quantity of corrosion-preventive mixture to thoroughly coat the exhaust valve. A ½-pound bag containing silica-gel Specification No. AN-D-6, will be placed in the exhaust opening of the exhaust manifold, anchored in place and the opening sealed by covering with an oil and moisture-resistant diaphragm. The silica-gel bag will not be removed from its moistureproof container until immediately before being inserted in the opening.

d. THRUST BEARINGS.—Thoroughly coat thrust bearings with corrosion-preventive mixtures; install cover plate.

e. ACCESSORY DRIVES.—The cover plates will be removed, corrosion-preventive mixture applied, and the cover plates reinstalled.

f. CARBURETOR.—The carburetor will be emptied of all residual fuel and filled with oil conforming to grade No. 1065, Specification No. AN-O-8, and all interior surfaces thoroughly slushed. Care should be exercised not to damage moving parts, such as floats and needle valve. Under no condition will the regular air chambers, air passages, or automatic control be slushed with oil; these units must be kept dry at all times. Drain the excess oil, replace the plugs, and lock the throttle in the open position. The carburetor will then be completely sealed in a moisture-resistant enclosure fabricated of a material conforming to Specification No. AN-O-P-406. A ½-pound bag of silica-gel will be placed within this enclosure and secured. Do not remove the silica-gel from its moistureproof container until just before applying to the carburetor.

g. CARBURETOR ADAPTER.—A ½-pound bag of silica-gel will be securely anchored in the throat of the carburetor adapter. Do not remove the silica-gel bag from the container until ready for use. Carburetor adapter will then be sealed with a gasket and an oil and moisture-resistant plate on the adapter, using carburetor attaching studs and nuts.

h. ACCESSORIES.—When fuel pumps are attached to the engine, oil conforming to Specification No. AN-O-8, grade 1065 will be injected into the pump while the engine shaft is being rotated to insure a complete coverage of oil on the fuel pump parts.

i. OIL INTAKE AND OUTLET.—The oil intake and outlet will be sealed with oil and moisture-resistant covers of appropriate size.

j. BREATHERS:—All breather openings in the engine will be adequately sealed with oil and moisture-resistant covers or dehydrating plugs. Dehydrating plugs should be used if possible. The moisture seals of the dehydrating plugs must not be removed until immediately before screwing the plugs into their intended location.

k. CRANKCASE.—The oil sump plug will be removed and replaced with a crankcase dehydrator plug which will be screwed tight. The replaced sump plug should be retained with the engine for future use. The moisture seal on the plug should not be removed until immediately before screwing it into the sump.

l. CYLINDER BORES.—After checking valve clearances, spray the interior of each cylinder through the spark plug holes with a corrosion-preventive compound while rotating the propeller shaft. This initial spraying will be done with the piston at bottom dead

center in each case. Following this initial spraying, each cylinder will be resprayed through the spark plug holes without rotation of the crankshaft. Thereafter the propeller shaft will not be rotated. If by accident the shaft is rotated, the cylinders must be resprayed in accordance with the above procedure to insure adequate coverage of all surfaces. Engine cylinder dehydrator plugs will be installed in all spark plug openings and tightly sealed. The moisture seal will not be removed from the dehydrator plugs until immediately before screwing them into the individual spark plug holes.

m. MAGNETOS. — The magnetos will need no preparation for storage since the cam, springs, and all other steel parts of the breaker mechanism are coated with oil. However, an inspection must be made to ascertain that the oil coating is sufficient. In the event that oil is to be applied, extreme care must be taken so that no oil reaches the breaker points, as the life of the breaker points will be materially shortened if exposed to oil or grease. Oil grade 1120, Specification No. AN-O-8, is suitable for coating magneto parts.

n. OTHER ENGINE OPENINGS.—All other openings in the engine will be closed with moistureproof seals to maintain the internal parts of the engine as airproof and moistureproof as possible.

4. PREPARATION FOR SERVICE AFTER STORAGE

a. ENGINES.

(1) Engines installed in aircraft that have had the valves and valve mechanisms treated for temporary periods of idleness can be placed in service immediately, as the light coating of oil on the valves is soon burned away. Before starting the engine, inspect for the presence of oil that may have drained into the lower intake pipes under the blower section. Rotate the propeller slowly by hand at least four or five revolutions to make sure that the cylinders are free from any accumulation of water, oil, or fuel, and that the valves operate freely. If the valves stick, treat as noted in paragraph (2) *(d)* following, before operating the engine. If, after starting the engine, the spark plugs foul from excessive engine oil, remove them and wash with acetone.

(2) Engines which have been treated for extended storage will be prepared for service as follows:

(a) Remove all capping and plugs from tubes and other openings. Replace all disconnected fuel and oil lines, controls, etc.

(b) Wipe off all external steel parts with a rag. Wipe off the breaker mechanism of the magnetos thoroughly. No relubrication of magnetos is necessary.

(c) Remove the oil screens, thoroughly clean in gasoline, and reinstall.

(d) Remove the shipping plugs from the spark plug holes, and before installing the spark plugs, slowly rotate the crankshaft four or five revolutions to determine that the valve mechanism is operating properly, and that excessive corrosion-preventive is not present in the cylinders. Remove any excess compound with a hand pump or by draining. Lubricate the stems of any stuck valves with a mixture of gasoline and lubricating oil. Turn the engine over by hand until all valves are free. If the valves will not free, have them repaired. Do not put an engine with stuck valves into service.

(e) Remove the three lower intake pipes, and inspect for excess oil collection. If excess oil is found, also examine the intake pipes on each side of those removed. Continue this inspection toward the top cylinder until intake pipes are found free of excess oil. When removing intake pipes, loosen or remove the packing gland nut at the crankcase before loosening intake pipe at the cylinder. This precaution will prevent damage to packing, intake pipes, and attaching flanges.

(f) Reverse these operations to reinstall intake pipes.

(g) Put enough oil in the tanks for the ground test. After the engines have been ground-tested, drain the oil system and refill with new oil. Dispose of the drained oil. Being mixed with corrosion-preventive compound, it can not be reclaimed.

b. AIRPLANE.

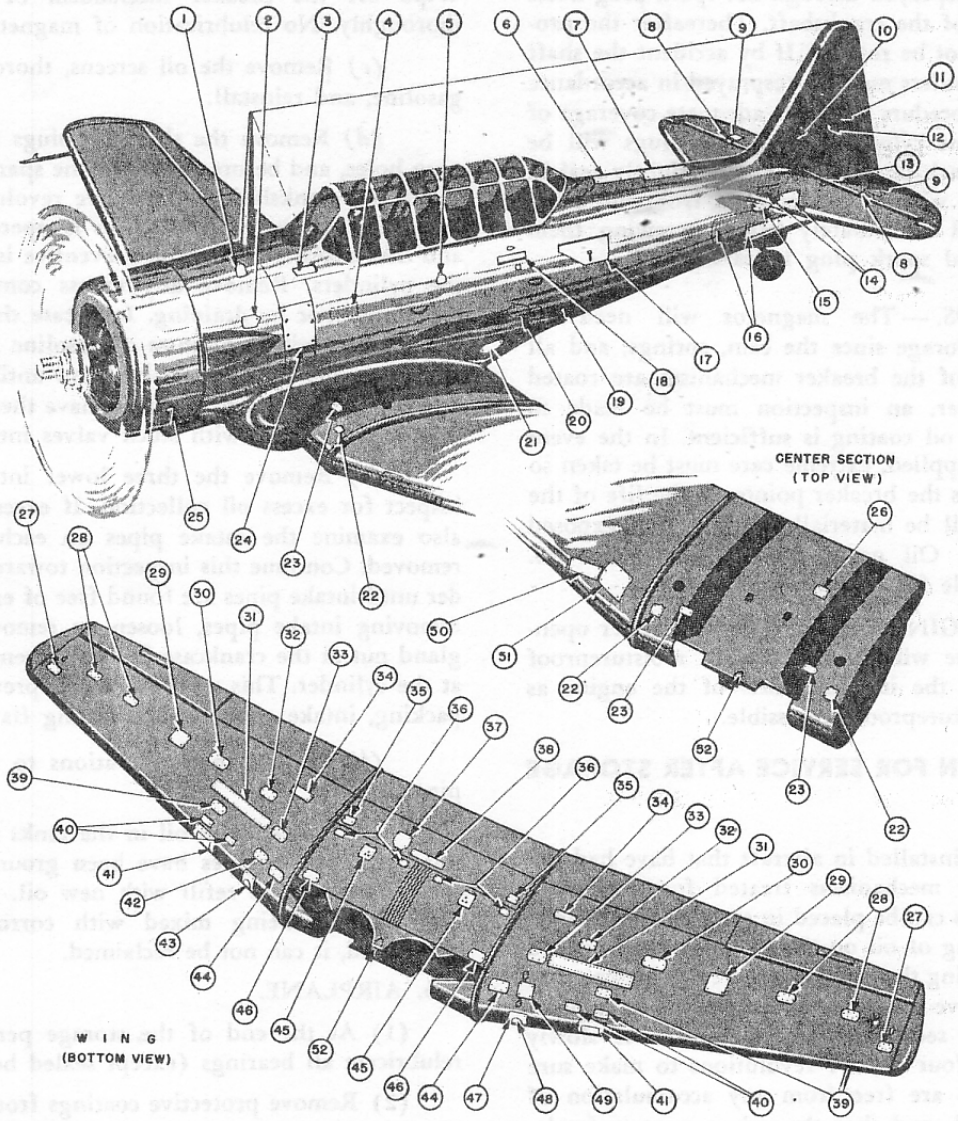
(1) At the end of the storage period, clean and relubricate all bearings (except sealed bearings).

(2) Remove protective coatings from brake drums. The following mixture is suggested for removing primer coatings:

Benzol	3 parts
Acetone	1 part
Denatured Alcohol	1 part

Standard paint removers are not recommended for this purpose as they contain paraffin which will impair braking efficiency.

(3) Remove excess rust preventive from all parts of the airplane (except control cables).



1. Oil Tank Filler Neck
2. Starter Brush - Lifting Lug
3. Handhold
4. Door - Exhaust Heater Valve (RH only)
5. Hydraulic Fluid Reservoir
6. Rear Gun Strip
7. Dynamotor, Control Cable Turnbuckles, Rudder and Tail Wheel Idler Arms and Tension Springs
8. Elevator Center Hinge, Trim Tab Operating Drum and Zerk
9. Elevator Trim Tab Operating Screw and Control Rod
10. Rudder Horn Inspection
11. Rudder Trim Tab Screw and Control Rod
12. Hinge
13. Rudder Stops and Lower Hinge
14. Oleo Cover Plate
15. Inspection - Cable Connections
16. Cowling - Tail Wheel Complete
17. Baggage Compartment
18. Hand Fire Extinguisher
19. Camera Doors
20. Viewfinder Cover
21. Recepticle - Outside Power (24-Volt only)
22. Oleo Service Plate
23. Fuel Tank Vent Line
24. Main Fuse Panel
25. Cowling Lock Fitting
26. Fuel Selector Valve Cut-Out
27. Navigation Light Junction Box
28. Structural Inspection Provisions
29. Aileron Bell Crank or Quadrant
30. Structural Inspection Provisions
31. Cover-Outboard Bomb Rack Cut-Out
32. Cover - (AT-6 and AT-6A only)
33. Bomb Rack Cable Access
34. Aileron Cable Inspection
35. Aileron Pulley Bracket
36. Tank Strap Turnbuckles
37. Fuel Selector and Drain Cock
38. Aileron Pulley Brackets
39. Landing Light Junction Boxes
40. Bomb Arming Control
41. Landing Lights
42. Gun Camera Rear Access
43. Gun Camera Bay
44. Landing Gear Operating Cylinder, Wing Bolting Angle, and Electrical and Hydraulic Lines
45. Fuel Sump Doors
46. Landing Gear Lockpins and Linkage
47. Gun Bay Cover Assembly
48. Cover
49. Ejection Chute Outlet
50. Door - Ammunition Bay
51. Door Assembly - Gun Bay
52. Cover-Main Fuel Line

Figure 18 — Access Provisions Diagram

SECTION III
HANDLING AND GENERAL MAINTENANCE

1. ACCESS AND INSPECTION PROVISIONS

The access provisions diagram, figure 18, includes a list of all access doors, covers, and parts accessible therein.

2. GROUND HANDLING

a. GENERAL.—Do not push, pull, or lift the airplane by any means other than those prescribed and outlined in the following paragraphs. Provisions have been made for the proper execution of all necessary handling operations and if the following instructions are adhered to, damage to the airplane or its equipment will be prevented. The exercising of utmost care at all times in handling operations can not be too greatly stressed. Special tool part numbers noted in this section are for convenience in making use of equipment already on hand.

b. STEPS, HANDHOLDS, AND WALKWAYS.—Two fixed steps are provided on the left side of the fuselage, one at each cockpit. A cut-out in each instrument panel shield is provided for a handhold to facilitate entrance and exit of the crew. A flush-type handhold located on the left side of the fuselage cowling just forward of the windshield, and a retractable step, extending through the engine compartment cowling just forward of the leading edge of the left wing, are provided to aid in starting the engine and servicing the oil tank and engine. Walkways of Tri-m-ite cloth applied with neoprene are provided on the wing center section on either side of the fuselage. The wings should not be walked on except where walkways are provided.

WARNING

Do not use windshield or antenna mast as handholds or the enclosure tracks and engine cowling supports as steps.

c. HOISTING PROVISIONS.

(1) HOISTING THE AIRPLANE.—*(See figure 19.)*

(a) To hoist the complete airplane with the power plant installed, remove the access covers on the upper surface of the center section near the leading edge, and attach the hoist fittings 36-55009, provided with the airplane. Using the complete airplane sling, 88-55073 illustrated in figure 24, the lift tube bar, 88-05002, is inserted in the lift-mooring tube located in the aft section of the fuselage. The ends of the sling are then attached to the hoist fittings and the lift tube bar.

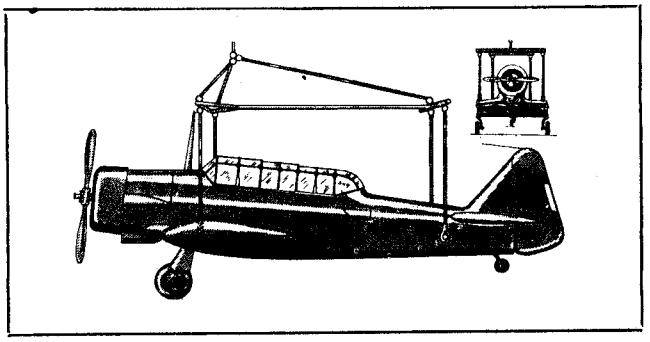


Figure 19—Hoisting Airplane

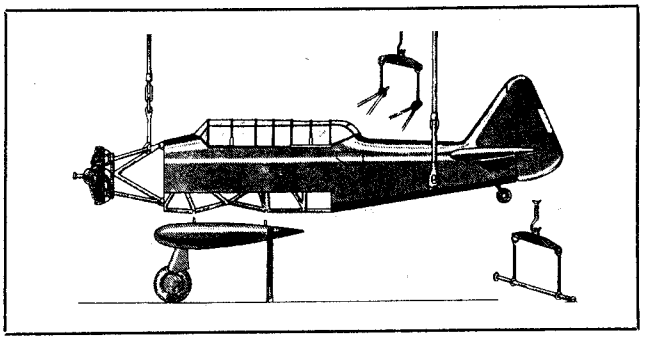


Figure 20—Hoisting Fuselage from Center Section

(b) Hoisting of the fuselage from the center section may be done in the manner shown in figure 20.

(c) In the event the power plant has been removed, the fuselage may be hoisted from the center section by employing the complete fuselage sling, 88-55070 or equivalent. The crossbar of the sling assembly is attached to the forward face of the fire wall by the upper engine mount bolts. The lift tube bar, 88-05002, is inserted in the lift-mooring tube in the aft section of the fuselage. Then, as illustrated in figure 21, the ends of the sling are securely fastened to each part.

WARNING

Never hoist the airplane by the two lugs located on the engine mount at the two upper points of attachment to the fuselage. These lugs are for hoisting the power plant only.

(2) HOISTING THE POWER PLANT.

(a) Hoisting the complete power plant assembly by use of the hoisting eyes provided at the rear of No.1

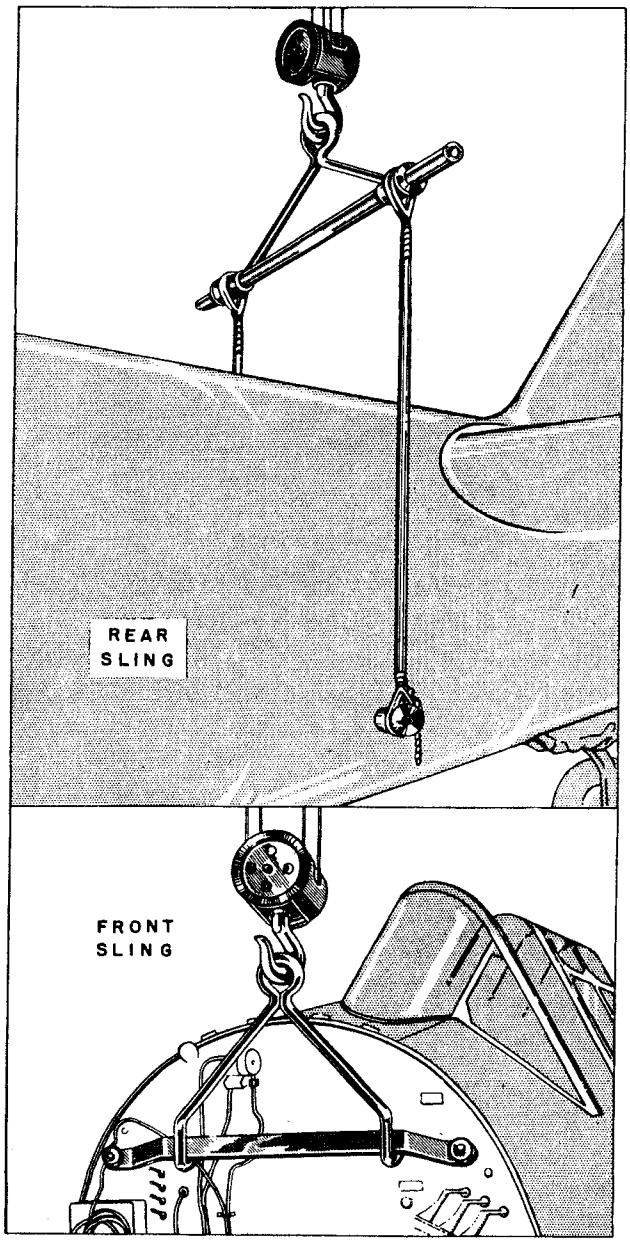


Figure 21 — Complete Fuselage Sling

engine cylinder involves considerable work, because of the necessity of removing the cylinder pressure baffles in order to gain sufficient access to the eyes. However, the complete power plant may be safely hoisted when propeller is not installed, without using the engine hoisting eyes, by employing an engine and mount sling, 88-55052, as shown in figures 26 and 21. Prior to the installation of this sling, the propeller shaft must be protected by lacing a suitable padded leather boot around it and installing a propeller shaft thread protector cap, 36544-40, furnished with the airplane. Assured of ample protection to the propeller shaft, the sling is made secure at that point, preferably with several loops around the shaft, and fastened to the mount.

(b) When hoisting the engine separately, the lifting eyes provided on the engine should be used. Remove the cylinder pressure baffles and attach an engine sling, 88-55058 or equivalent.

(c) If the power plant is in a horizontal position, it is advisable to hoist it by using the engine lifting eye, 88-55054. The eye is firmly fitted to the engine crankshaft.

d. LIFTING.—A lift-mooring tube is provided in the aft section of the fuselage just forward of the tail surfaces as a means by which the tail of the airplane may be lifted or moored. A lift-tube bar, 88-05002, or similar bar up to 1-5/8 inches diameter, may be passed through this tube and the airplane lifted by support of personnel at each end or by means of a hoist. The lifting bar must be passed completely through the aperture to prevent damage to the tube. When lifting the tail of the airplane by this method with the power plant installed, the same precautions shall be taken as specified for jacking the tail of the airplane. Do not lift the tail of the airplane by means of the horizontal stabilizer.

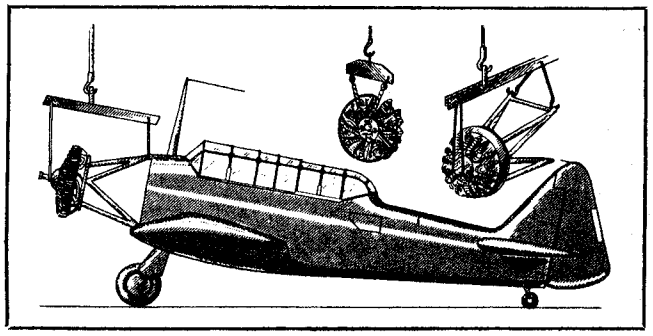


Figure 22 — Hoisting Power Plant

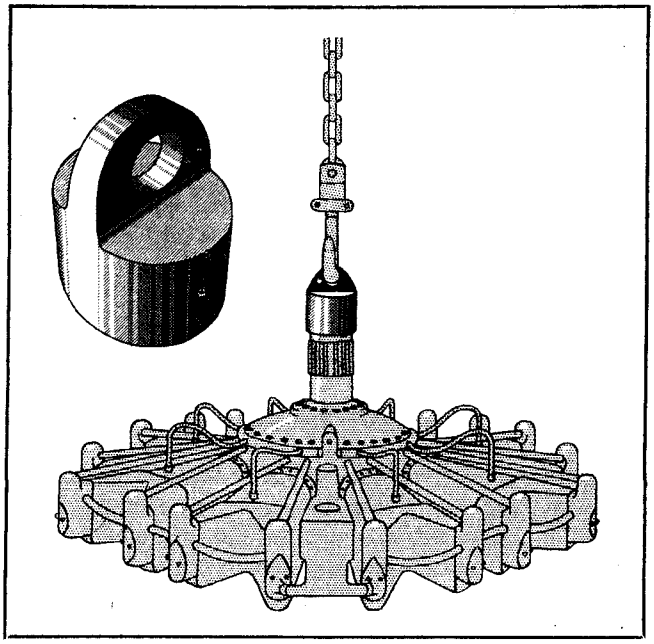
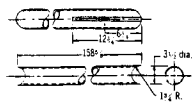
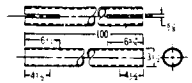


Figure 23 — Engine Lifting Eye



Det.—28 C. R. Stl. Tube—1 req.



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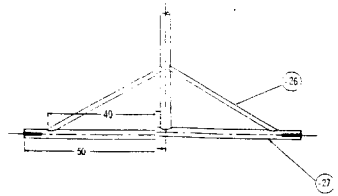
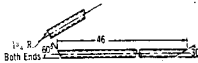
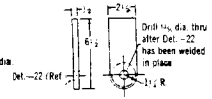


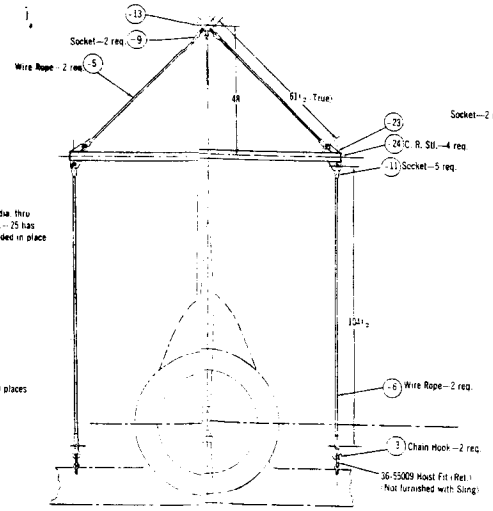


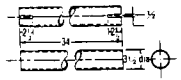
Det.—26 C. R. Stl. Tube—2 req.



Det.—22 (Ref.)

Det.—20 C. R. Stl.—2 req.





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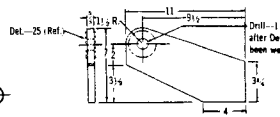
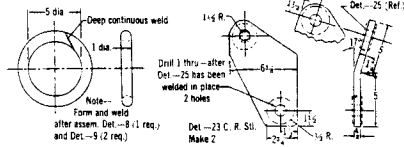
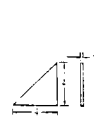


Det.—21 C. R. Stl. make 1

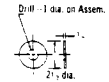


Det.—23 C. R. Stl. Make 2

Det.—13 C. M. Stl.—1 req.

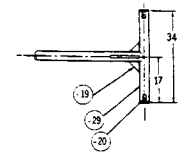


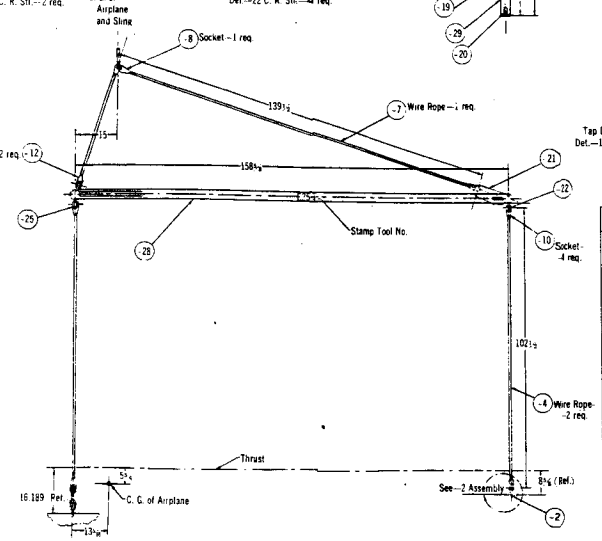
Det. 19 C. R. Stl.—2 req.

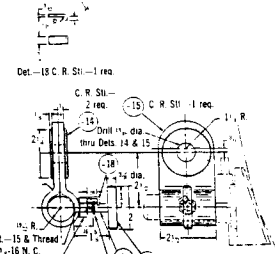


Det.—25 C. R. Stl—10 req.

Det.—22 C. R. Stl.—4 req.



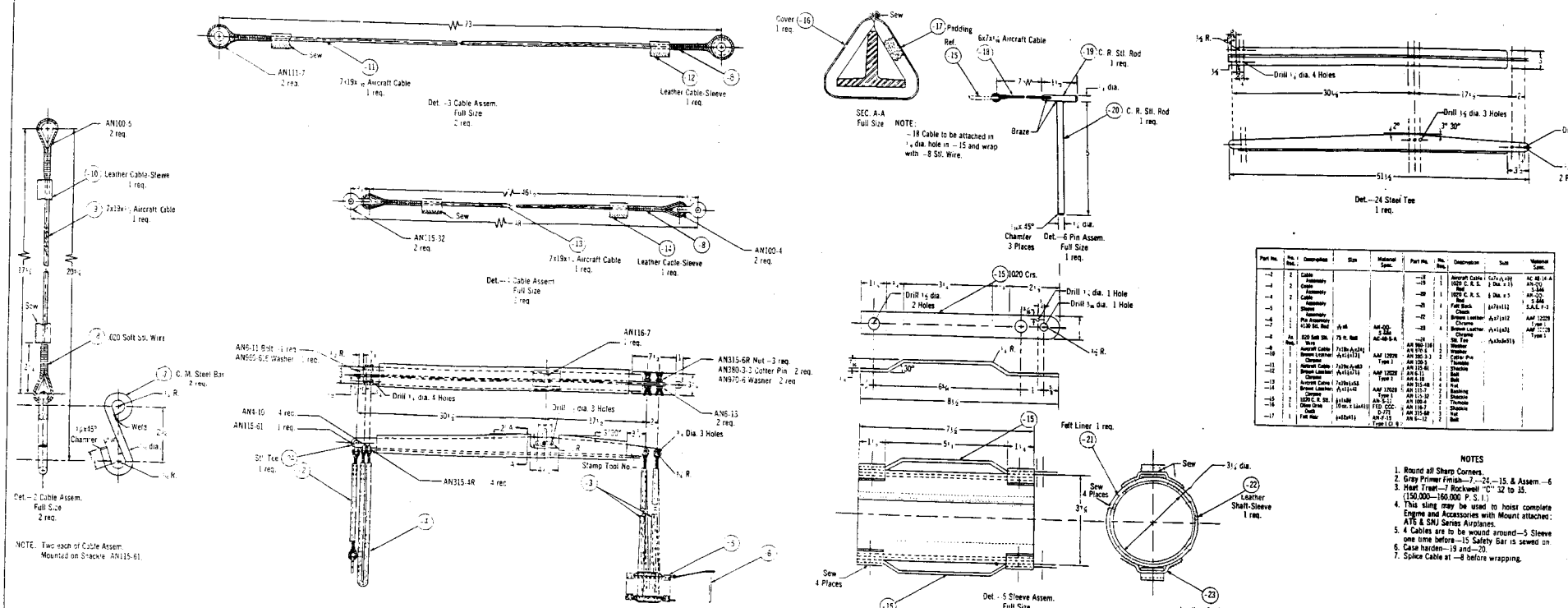




Part No.	No. Req.	Description	Size	Material Spec.	Part No.	No. Req.	Description	Size	Material Spec.
—1	1	Weld Assembly Courteous Workmen Ship			—15	1	X1229 Str. Rod	¾ Dia. x 2	AN-QQ-S-686
		Clean Hook	½ Dia. Eye		—17	1	X1035 Str. Rod	½ Dia. x 11	AN-QQ-S-686
		Drop Forged			—18	1	X1075 Str. Tube	¾ O.D. x .065	AN-WW-T-850
—4	2	Lashing Hardware Req. Braid Wire Rope	6x12x½ Dia. x 58	FED. QQ-C-576 Class 4	—19	1	X1075 Str. Tube	2½ O.D. x .065	FED. QQ-T-391 Class 4
—5	2	Lashing Hardware Req. Braid Wire Rope	6x19x½ Dia. x 58	FED. QQ-C-576 Class 4	—20	2	X1020 Str. Stl.	¼ x ¼	FED. QQ-S-781 Class A
—6	2	Lashing Hardware Req. Braid Sleeved Wire Rope	6x19x½ Dia. x 100	FED. QQ-C-576 Class 4	—21	2	X1020 Str. Stl.	½ x 11	FED. QQ-S-781 Class A
—7	1	Lashing Hardware Req. Braid Sleeved Wire Rope	6x19x½ Dia. x 168	FED. QQ-C-576 Class 4	—22	4	X1020 Str. Rod	2½ Dia. x 4	AN-QQ-S-686
—8	1	Wire Rope Socket Drop Forge Closed	½ Dia. Rope	Class A	—23	2	X1020 Str. Stl.	½ x 10	FED. QQ-S-781 Class A
—9	2	Wire Rope Socket Drop Forged Closed	1 Dia. Rope	AN-QQ-S-686	—24	4	X1035 Str. Rod	2½ Dia. x 2	AN-QQ-S-686
—10	4	Wire Rope Socket Drop Forged Open	½ Dia. Rope	AN-QQ-S-686	—25	10	X1020 Str. Rod	¾ Dia. x 4	AN-QQ-S-686
—11	5	Wire Rope Socket Drop Forged Open	½ Dia. Rope	AN-QQ-S-686	—26	2	X1025 Str. Tube	1½ O.D. x .134 I.D. x .95	AN-WW-T-850
—12	2	Wire Rope Socket Drop Forged Open	1 Dia. Rope	AN-QQ-S-686	—27	1	X1025 Str. Tube	3½ O.D. x .120 I.D. x .010	AN-WW-T-850
—13	1	X1130 Str. Rod	1 Dia. x 20	AN-QQ-S-686	—28	1	X1025 Str. Tube	3½ O.D. x .134 I.D. x .158	AN-WW-T-850
—14	2	X1020 Str. Rod	2½ Dia. x 2	AN-QQ-S-686	—29	1	X1525 Str. Tube	3½ O.D. x .2 I.D. x .134	AN-WW-T-850
—15	1	X1020 Str. Stl.	1x21x11	FED. QQ-S-781 Class A	AN960-616	1	Washer—Plain		
					AN335-6	1	Hex Nut		

NOTES

1. ⅄ Rad. All Corners
2. Use with Hoist Fittings 36-95000 & Lift Tube 88-05002 to hoist Complete Airplane.



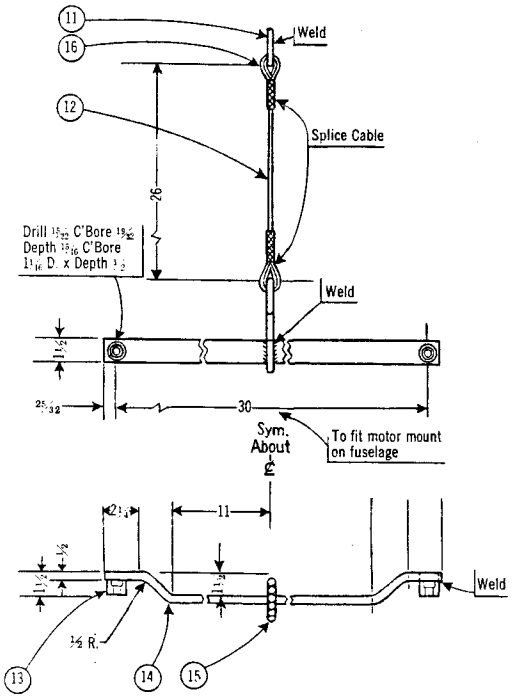
Part No.	No. Req.	Description	Size	Material Spec.
-2	2	Cable Assembly		
-3	2	Cable Assembly		
-4	2	Cable Assembly		
-5	1	Sleeve Assembly		
-6	1	Pin Assembly		
-7	1	4130 Stl. Rod	5/16 dia.	AMS-6370
-8	As Req.	620 Soft Stl. Wire	.75 in. Roll	AC-48-S-A
-9	1	Aircraft Cable	7x19x 3/32	AN 3-3
-10	1	Brown Leather Chrome	4"x11x(1/32)	AAF 12029 Type I
-11	1	Aircraft Cable	7x19x 1/8	AN 3-4
-12	1	Brown Leather Chrome	4"x11x(3/16)	AAF 12029 Type I
-13	1	Aircraft Cable	7x19x 1/8	AN 3-4
-14	1	Brown Leather Chrome	4"x11x42	AAF 12029 Type I
-15	2	1020 C. R. Stl.	1/2 dia.	AN-QQ-S-626
-16	1	Olive Drab Cloth	.10 in. x 54 in.	FED. CCC-C-771
-17	1	Felt Filler	4"x12x(1/2)	AN-F-15 Type I, Cl. 2

Part No.	No. Req.	Description	Size	Material Spec.
-18	1	Aircraft Cable	6x7x 1/8	AC 48-14-A
-19	1	1020 C. R. S. Rod	1/2 dia. x 3 1/2	AN-QQ-S-626
-20	1	1020 C. R. S. Rod	1/2 dia. x 5	AN-QQ-S-626
-21	1	Felt Black Cloth	4"x9x(1/2)	S.A.E. F-3
-22	1	Brown Leather Chrome	4"x7 1/2x12	AAF 12029 Type I
-23	4	Brown Leather Chrome	4"x1 1/4x(3/16)	AAF 12029 Type I
-24	As Req.	Stl. Tee	4"x3.5x3.5(1/2)	
-25	1	Washer	AN 960-1016	
-26	1	Washer	AN 970-8	
-27	1	Cotter Pin	AN 380-3-3	
-28	1	Turnbuckle	AN 128-3	
-29	1	Shackle	AN 115-61	
-30	1	Bolt	AN 6-11	
-31	1	Bolt	AN 6-10	
-32	1	Nut	AN 315-4R	
-33	1	Bushing	AN 115-7	
-34	1	Shackle	AN 115-32	
-35	1	Thimble	AN 100-4	
-36	1	Shackle	AN 115-7	
-37	1	Nut	AN 315-6R	
-38	1	Bolt	AN 6-15	

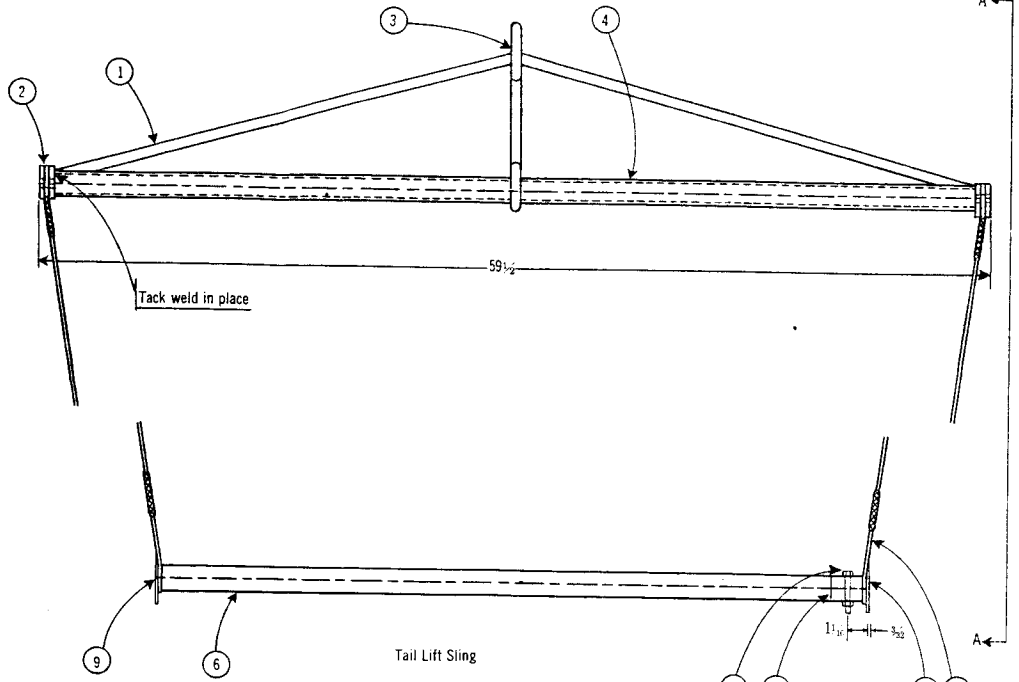
NOTES

1. Round all Sharp Corners.
2. Gray Primer Finish—7, —24, —15, & Assem. —6
3. Heat Treat—7 Rockwell "C" 32 to 35. (150,000—160,000 P. S. I.)
4. This sling may be used to hoist complete Engine and Accessories with Mount attached; ATS & SNJ Series Airplanes.
5. 4 Cables are to be wound around—5 Sleeve one time before—15 Safety Bar is sewed on.
6. Case harden—19 and —20.
7. Splice Cable at —8 before wrapping.

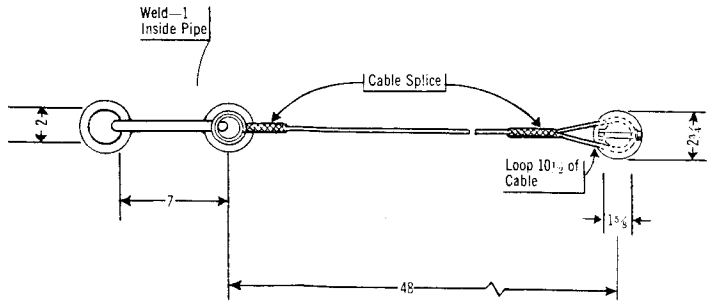
Figure 26 — Sling — Quick-Change Engine Unit (88-55052)



Forward Sling



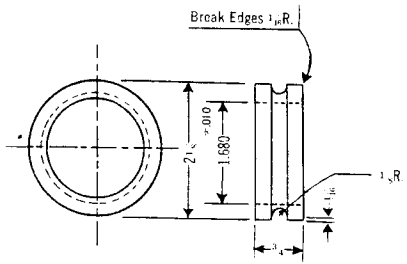
Tail Lift Sling



View A-A

MATERIAL SPECIFICATIONS

Detail	No. Req'd.	Material	Size
1	1	Cold Rolled Steel	1 1/16 Dia.
2	2	Cold Rolled Steel	2 1/2 Dia.
3	1	Cold Rolled Steel	1 1/16 Dia.
4	1	Iron Pipe	1 1/4 x 59 1/2
6	1	Shelby Tube	1 1/2 x .095 x 44 1/2
7	1	Bolt and Nut	1/4 x 28 x 2
8	1	Shelby Tube	1 3/8 x .043 x 2 1/4
9	1	Cold Rolled Steel	3/8 x 2 3/4 Dia.
10	2	Aircraft Cord	7/16 Dia. x 66 1/2
11	1	Cold Rolled Steel	1/2 Dia. x 8
12	1	Aircraft Cord	7/16 Dia. x 38
13	2	Cold Rolled Steel	1 1/4 Dia. x 1
14	1	Cold Rolled Steel	1/2 x 1 1/2 x 33
15	1	Cold Rolled Steel	1/2 Dia. x 10
16	2	Thimble	AN-100-6



Detail—2

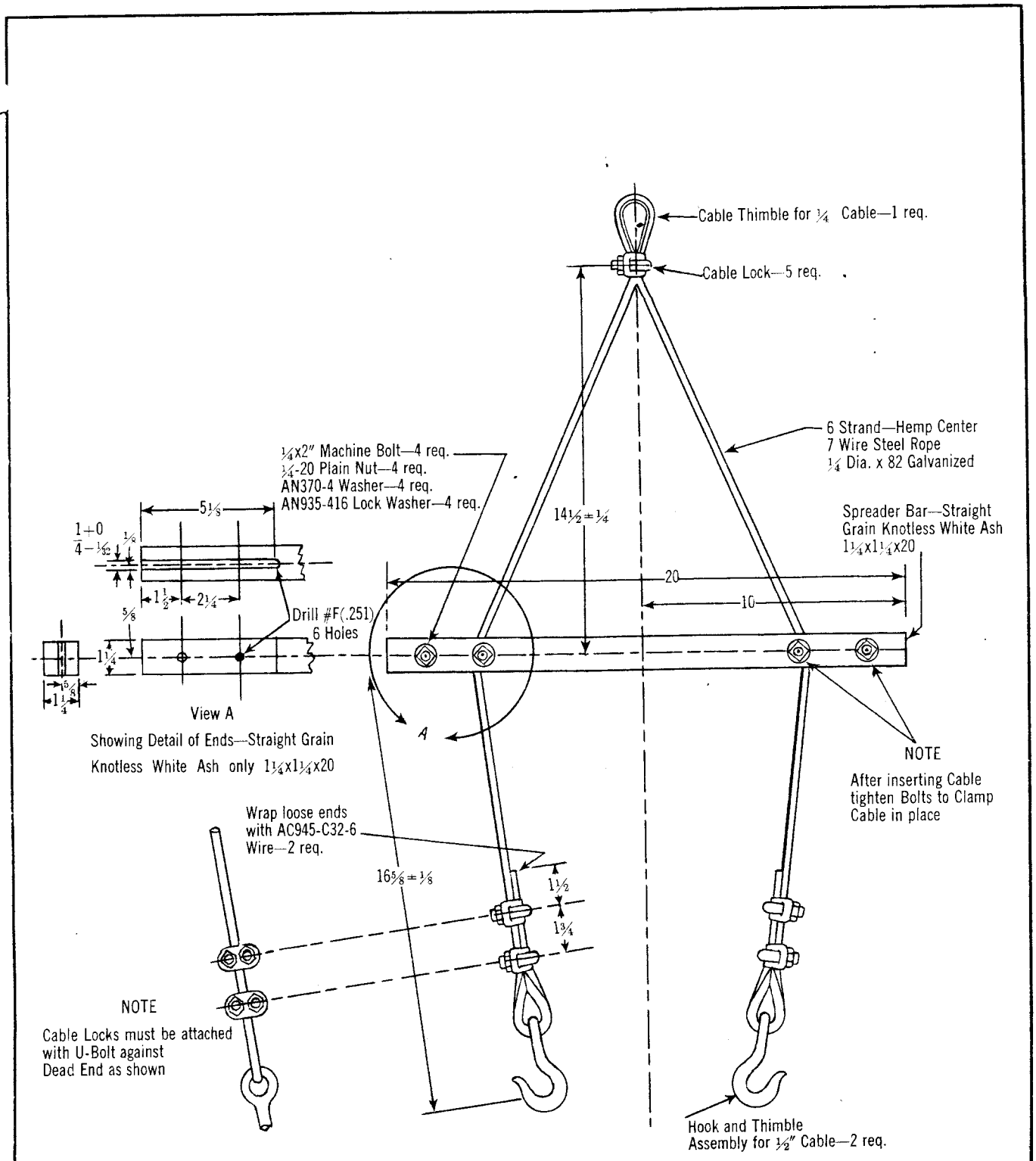


Figure 27 — Engine Hoisting Sling Assembly

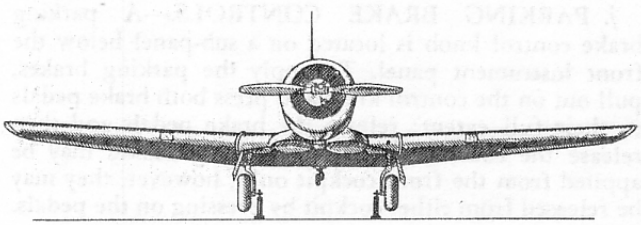


Figure 28—Jacking at Landing Gear

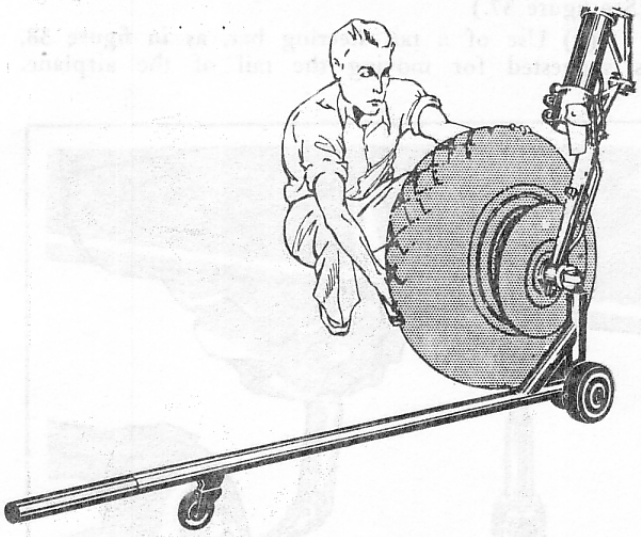


Figure 29—Axle Hand Jack

e. JACKING ARRANGEMENTS.

(1) Jacking points are provided inboard of the landing gear struts.

(2) Blocks equipped with jacking points are installed at two well-marked locations on the front spar of the outer wing panels, approximately 30 inches outboard of the wing joint bolting angle.

WARNING

Do not jack the airplane at the wing jacking points when the fuel tank doors are removed from the center section.

Note

Whenever wing jacks are utilized in such a manner that failure of a jack could result in injury to personnel or damage to the airplane or other property, or removal of airplane parts, such as stressed skin plates, could result in damage to the airplane or other property, added protection will be provided in the form of suitable trestles, stands, shoring, chain hoists or other adequate supporting devices. All protection devices, when applied to the under side of the airplane, will be of the required height, padded in the areas contacting the airplane, and will have sufficient supporting surface to allow support of the airplane without damage to the airplane. Overhead supports, such as chain hoists, will be applied only to those upper portions of the airplane designated as lifting points.

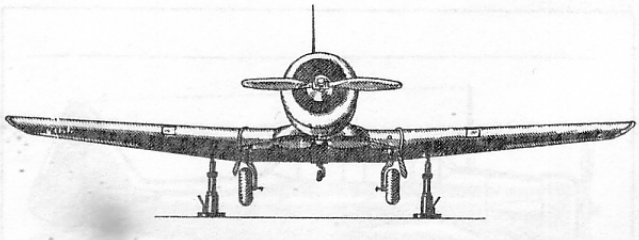


Figure 30—Jacking at Outer Panels

(3) To jack the airplane when the outer wing panels are removed, the center section bolt angle pads, 88-55060, are suggested. These are attached to the center section bolt angle in the vicinity of the front spar to afford proper jacking points.

(4) The tail jacking point is located on the fuselage just forward of the tail wheel. Always make certain that the head of the jack to be used is suitable for the type of jacking point provided.

CAUTION

When jacking the tail of the airplane with the power plant installed, block the landing gear wheels, insert the bar, 88-05002, in the lift-mooring tube, and suspend sandbags or other like weights (at least 200 pounds) from the bar. This will prevent the airplane from accidentally nosing over.

(5) A jacking conveyor, similar to that shown in figure 34, may be employed to jack and transport the airplane when "swinging" the compass. The conveyor is attached at the lift-mooring tube. Its use allows easier balance and mobility.

f. LEVELING.—*(See figure 35.)*—The longitudinal leveling brackets are located on the fuselage diagonal tubes at the left side of the rear cockpit. The lateral leveling brackets are located on the upper fuselage cross tube immediately aft of the front cockpit seat. A level on these brackets will be parallel to the longitudinal and lateral reference datum lines of the

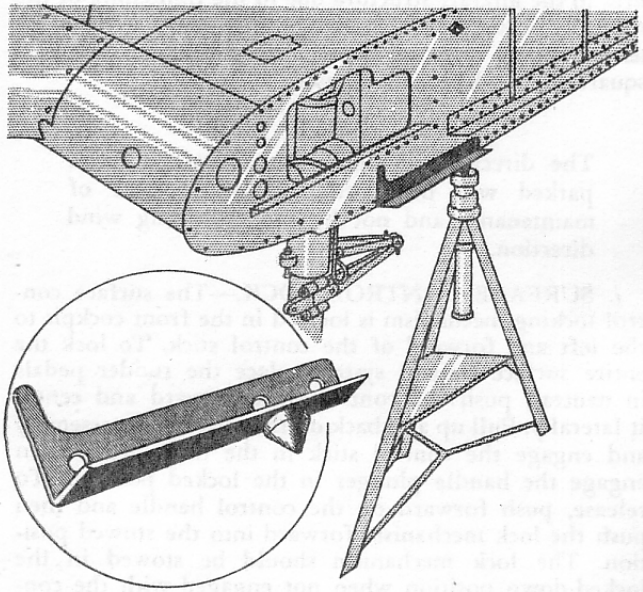


Figure 31—Center Section Bolt Angle Jacking Pad

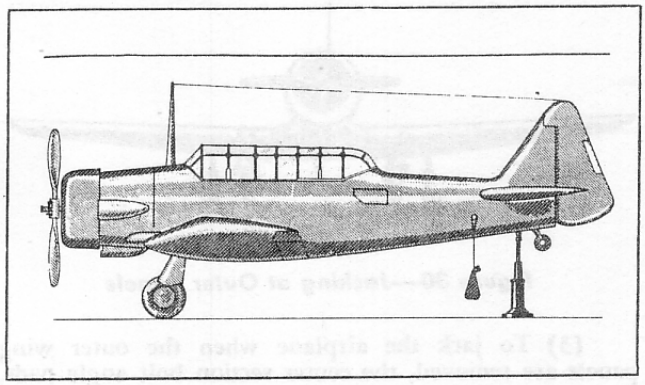


Figure 32—Jacking at Tail

airplane, respectively. (The longitudinal reference datum line is parallel with the thrust line.) When placing the airplane in the level flight position with the power plant installed, the same precautions shall be taken as specified for jacking the tail of the airplane.

g. DATUM POINT.—Two datum points for fuselage and gun alignment are provided on the center line of the airplane on the lower surface. One point is located on the wing center section directly aft of the fire wall, and the other is located on the fuselage rear section forward of the camera doors. The points are well marked with 1½ inch diameter red circles and are provided with a nut plate for attaching plumb bobs.

h. MOORING.—*(See figure 36.)*—Lock the surface controls and block the wheels. Insert mooring rings which are stowed in the baggage compartment into the sockets provided on the lower surfaces of the outer wing panels near the tips and attach the ropes or lines thereto. Manila hemp rope, ⅜ inch diameter, should be used for mooring. All mooring ropes, except those to the landing gear, should approximate an angle of 45 degrees to the ground. Sufficient slack should be provided in the ropes between the mooring anchors and the aircraft fittings to prevent them from causing failures in the aircraft structure due to the tightening of the ropes by absorption of moisture. Slip knots will not be used in tying mooring ropes. Anti-slip knots such as a square or bowline will be used.

NOTE

The direction in which the aircraft is to be parked will be determined by the ease of maintenance and not by the prevailing wind direction.

i. SURFACE CONTROL LOCK.—The surface control locking mechanism is located in the front cockpit to the left and forward of the control stick. To lock the entire surface control system, place the rudder pedals in neutral, push the control stick forward and center it laterally. Pull up and back on the lock handle assembly and engage the control stick in the lock recess; then engage the handle plunger in the locked position. To release, push forward on the control handle and then push the lock mechanism forward into the stowed position. The lock mechanism should be stowed in the locked-down position when not engaged with the control stick.

j. PARKING BRAKE CONTROLS.—A parking brake control knob is located on a sub-panel below the front instrument panel. To apply the parking brakes, pull out on the control knob and press both brake pedals to their full extent; release the brake pedals and then release the control knob. The parking brakes may be applied from the front cockpit only; however, they may be released from either cockpit by pressing on the pedals.

k. TOWING.

(1) Proper towing of the airplane is accomplished by use of a towing bar, such as 99-55031, attached to towing rings provided inboard of the landing gear strut. (See figure 37.)

(2) Use of a tail steering bar, as in figure 38, is suggested for moving the tail of the airplane.

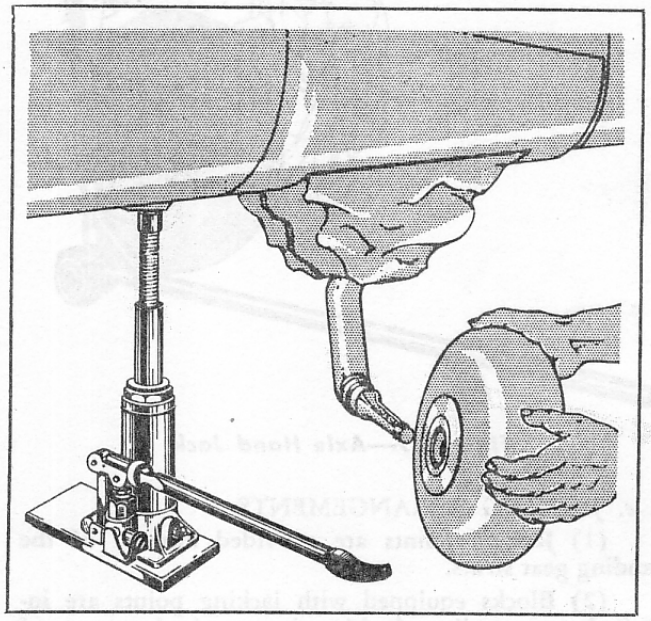


Figure 33—Tail and Axle Hydraulic Jack

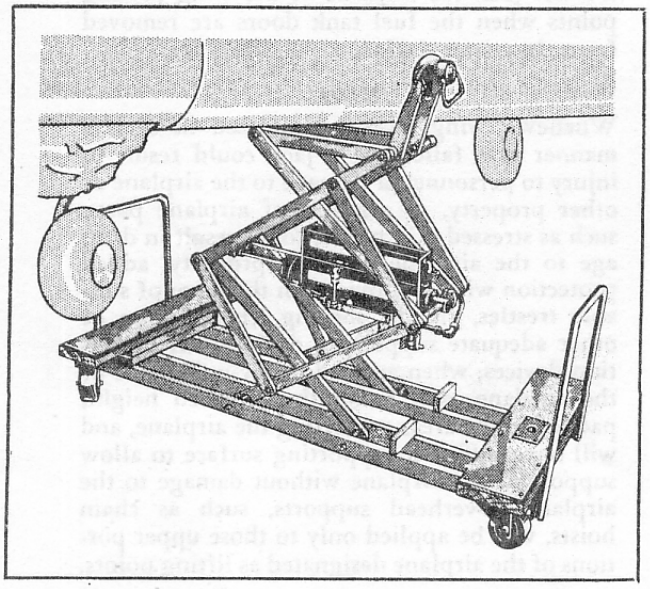


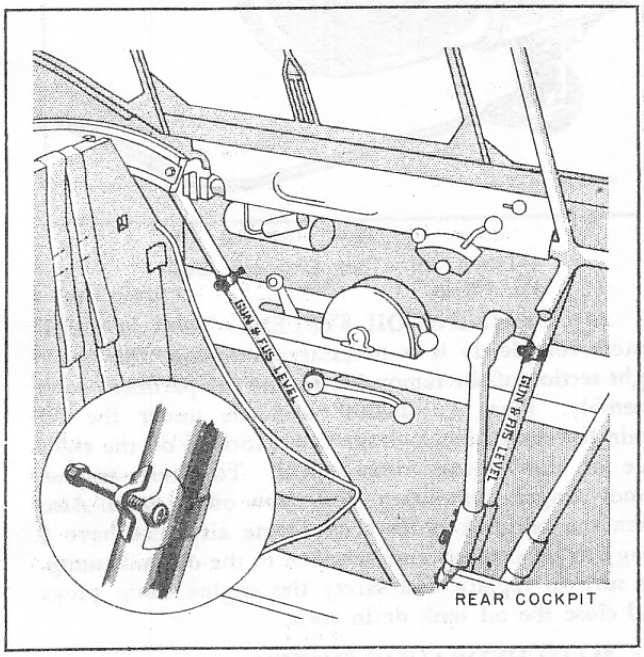
Figure 34—Tail Jacking Conveyer

WARNING

Do not tow the airplane with the controls locked.

l. ENGINE COVER.—*(See figure 40.)*—An airplane engine cover is provided in the baggage compartment to protect the power plant installation. On British airplanes an enclosure cover is also provided.

m. LOCKING AIRPLANE.—The forward sliding section of the cockpit enclosure may be locked by inserting a padlock through the hole in the enclosure track at the left forward corner of the stationary section. The rear sliding sections may be locked by inserting a padlock through the hasps provided at the rear of the gunner's hood. The baggage compartment may be locked by means of the lock in the door handle, the keys for which are stowed in the map and data case located at the right side of the front cockpit.



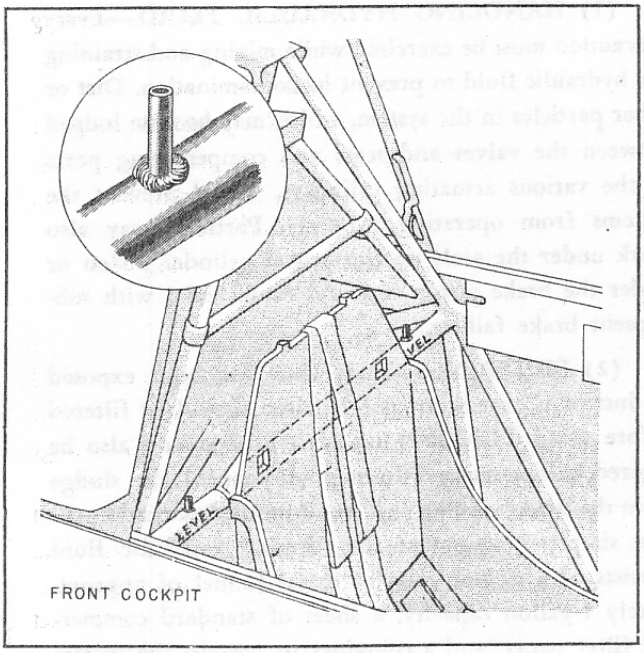


Figure 35 — Leveling Brackets Diagram

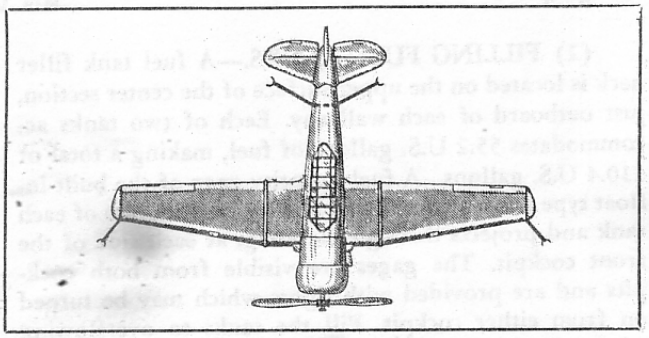


Figure 36 — Mooring Diagram

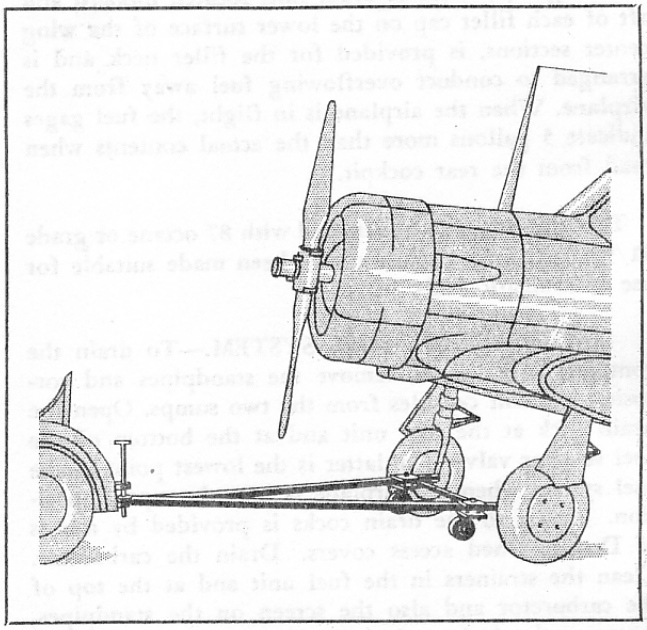


Figure 37 — Towing Bar

3. SERVICE INSTRUCTIONS

a. FUEL SYSTEM.

(1) DRAINING THE FUEL SUMPS.—Drain the fuel sumps to remove any accumulation of water and foreign matter each time fuel is serviced to the tanks. Open the drain cocks at the bottom of sumps. Access to the drain cocks is by means of access holes in the lower surface of the center section. Also drain the strainer by means of a drain cock at the bottom of the fuel unit located at the lower forward side of the fire wall. An access cover is provided on the engine compartment cowling below the fuel unit. When the fuel tanks are filled, and it is desired to clean the fuel strainer located within the fuel unit, be sure to set the fuel selector valve in the "OFF" position.

(2) FILLING FUEL TANKS.—A fuel tank filler neck is located on the upper surface of the center section, just outboard of each walkway. Each of two tanks accommodates 55.2 U.S. gallons of fuel, making a total of 110.4 U.S. gallons. A fuel quantity gage of the built-in-float type is attached directly to the upper surface of each tank and projects through the wing, at each side of the front cockpit. The gages are visible from both cockpits and are provided with lights which may be turned on from either cockpit. Fill the tanks to overflowing when the airplane is in a three-point position, as the gages are accurate only when the airplane is in a level flight position. A drain line, located inboard and aft of each filler cap on the lower surface of the wing center sections, is provided for the filler neck and is arranged to conduct overflowing fuel away from the airplane. When the airplane is in flight, the fuel gages indicate 5 gallons more than the actual contents when read from the rear cockpit.

This airplane is to be serviced with 87 octane or grade 91/96 fuel. Late airplanes have been made suitable for use of aromatic fuels.

(3) DRAINING FUEL SYSTEM.—To drain the complete fuel system, remove the standpipes and corrosion-resistant capsules from the two sumps. Open the drain cock at the fuel unit and at the bottom of the fuel selector valve. The latter is the lowest point in the fuel system when the airplane is in a three-point position. Access to the drain cocks is provided by means of Dzus-fastened access covers. Drain the carburetor. Clean the strainers in the fuel unit and at the top of the carburetor and also the screen on the standpipes. Access to the drain cocks is provided by means of access holes in the lower surface of the center section. Drain the fuel unit strainers by means of a drain cock at the bottom of the fuel unit located at the lower forward side of the fire wall. An access cover is provided on the engine compartment cowling—below the fuel unit. To remove possible accumulation of water and foreign matter from the system, open the drain cocks daily, as instructed above.

(4) FILTERS.—Refueling units will be equipped with filters which will remove all solid particles having minor dimensions five microns or larger, and capable of removing 99.5% of all free water.

b. OIL SYSTEM.

(1) FILLING OIL TANK.—The oil tank filler neck is reached through a Dzus-fastened access door in the upper left section of engine compartment cowling. An overflow collector ring forms part of the filler neck with the drain line terminating at the lower side of the engine compartment. Fill the tank to overflowing with engine oil, Specification AN-O-8, grade 1120 (SAE 60).

Deleted in revision dated 22 March 1946

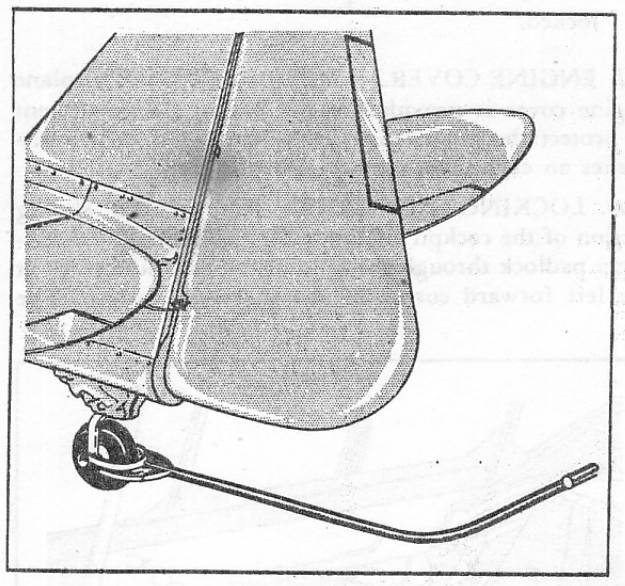


Figure 38—Tail Steering Bar

(2) DRAINING OIL SYSTEM.—To drain the oil system completely it is necessary to remove the lower right section of the removable engine compartment cowl assembly. Place a suitable receptacle under the oil drain line; open the Y-drain valve, located on the right side of the engine compartment. To drain engine, remove engine sump plugs and allow oil to drain. Also open the oil tank drain cock (some airplanes have a plug) to remove any condensation in the oil tank sump. Be sure to replace and safety the engine sump plugs and close the oil tank drain cock.

c. MAIN HYDRAULIC SYSTEM.

(1) HANDLING HYDRAULIC FLUID.—Every precaution must be exercised while mixing and straining the hydraulic fluid to prevent its contamination. Dirt or other particles in the system, which may become lodged between the valves and seats and compensating ports in the various actuating cylinders, would prevent the systems from operating properly. Particles may also work under the seals on the master cylinder piston or under the brake piston seal and cause leaks, with subsequent brake failure.

(2) FILTERING.—Fluid that has been exposed to dust or is otherwise contaminated should be filtered before using. Fluid that has been used should also be filtered before reuse. Filtering will remove the sludge from the used fluid, as well as all metal flakes and grit. The simplest equipment for filtering hydraulic fluid consists of a ribbed glass or metal funnel of approximately 1-gallon capacity, a sheet of standard commercial filter paper, and a container to support the funnel and hold the filtered oil. The filter paper is folded into

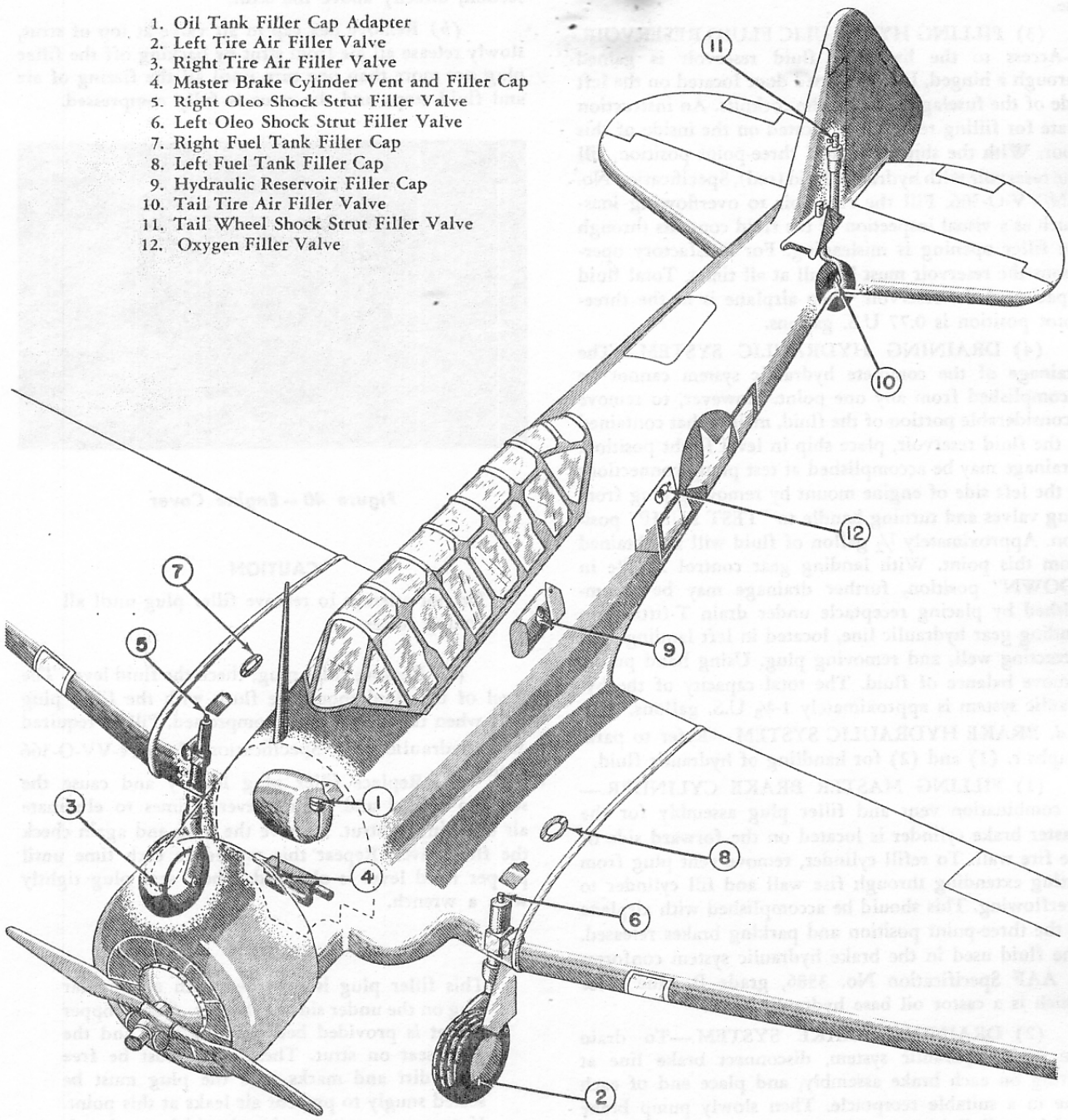


Figure 39 — Filler Cap and Valve Location Diagram

a funnel shape and placed in the funnel. The oil will pass through the filter slowly and should be protected from dust particles in the air by a cloth dampened in hydraulic oil and placed around the funnel at the open end of the container. The filtered oil should be placed in clean containers, properly marked to identify the contents, and should be kept sealed until required for use.

(3) FILLING HYDRAULIC FLUID RESERVOIR.—Access to the hydraulic fluid reservoir is gained through a hinged, Dzus-fastened door located on the left side of the fuselage between the cockpits. An instruction plate for filling reservoir is located on the inside of this door. With the ship in normal three-point position, fill the reservoir with hydraulic fluid (red), Specification No. AN-VV-O-366. Fill the reservoir to overflowing inasmuch as a visual inspection of the fluid contents through the filler opening is misleading. For satisfactory operations the reservoir must be full at all times. Total fluid capacity of the reservoir when airplane is in the three-point position is 0.77 U.S. gallons.

(4) DRAINING HYDRAULIC SYSTEM.—The drainage of the complete hydraulic system cannot be accomplished from any one point. However, to remove a considerable portion of the fluid, mainly that contained in the fluid reservoir, place ship in level flight position. Drainage may be accomplished at test pump connections at the left side of engine mount by removing plug from plug valves and turning handle to "TEST PUMP" position. Approximately ½ gallon of fluid will be obtained from this point. With landing gear control handle in "DOWN" position, further drainage may be accomplished by placing receptacle under drain T-fitting on landing gear hydraulic line, located in left landing gear retracting well, and removing plug. Using hand pump, remove balance of fluid. The total capacity of the hydraulic system is approximately 1-⅜ U.S. gallons.

d. BRAKE HYDRAULIC SYSTEM.—Refer to paragraphs *c.* (1) and (2) for handling of hydraulic fluid.

(1) FILLING MASTER BRAKE CYLINDER.—A combination vent and filler plug assembly for the master brake cylinder is located on the forward side of the fire wall. To refill cylinder, remove vent plug from fitting extending through fire wall and fill cylinder to overflowing. This should be accomplished with airplane in the three-point position and parking brakes released. The fluid used in the brake hydraulic system conforms to AAF Specification No. 3586, grade B, blue color which is a castor oil base hydraulic fluid.

(2) DRAINING BRAKE SYSTEM.—To drain the brake hydraulic system, disconnect brake line at fitting on each brake assembly, and place end of each line in a suitable receptacle. Then slowly pump brake pedals until fluid leaves the system. To clean the brake system, flush it with formula No. 1, denatured alcohol.

e. SHOCK ABSORBER STRUTS.

(1) FILLING MAIN LANDING GEAR SHOCK STRUTS.—If shock struts require refilling, the following servicing should be accomplished after rolling the airplane forward to a position on level ground, out of the wind and away from the slipstream of other airplane propellers. Adhere to the following procedure:

(a) To refill either shock strut, remove the access cover located on the upper surface of wing center section, directly above the strut.

(b) Remove hex cap in air valve at top of strut, slowly release all air from strut by backing off the filler plug not more than one turn until all the fizzing of air and fluid stops and the strut is fully compressed.

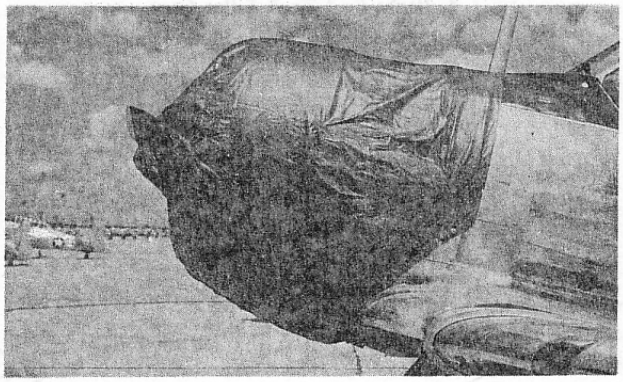


Figure 40 — Engine Cover

CAUTION

Do not attempt to remove filler plug until all fizzing ceases.

(c) Remove filler plug; check the fluid level. The level of the fluid should be flush with the filler plug hole when the strut is fully compressed. Fill as required with hydraulic fluid, Specification No. AN-VV-O-366 (red).

(d) Replace filler plug loosely and cause the strut to extend and retract several times to eliminate air traps in the strut. Remove the plug and again check the fluid level. Repeat this procedure each time until proper fluid level is obtained. Then, seal plug tightly with a wrench.

NOTE

This filler plug is provided with an angular ring on the under side of the hex. A soft copper gasket is provided between this ring and the plug seat on strut. These seats must be free from dirt and marks, and the plug must be sealed snugly to prevent air leaks at this point. If necessary, a new gasket should be used each time the plug is replaced.

(2) INFLATING MAIN LANDING GEAR SHOCK STRUTS.—When inflating the shock strut as in the following procedure, rock the airplane occasionally

to overcome packing friction, thus preventing over-inflation.

CAUTION

Do not overinflate, as hard taxying and bounce at contact will result. This is also important because of possible damage to the valve core as high pressure is released.

The actual air pressure required to inflate the strut depends upon the axial load on the strut due to the weight of the airplane, friction due to packing, and any bending or torsional loads on the strut. Under normal loading conditions, approximately 200 pounds per square inch pressure will be required. Because of the small quantity of air in the strut and the relatively high pressure, it is inadvisable to attempt to measure the pressure with a gage. After the strut has been correctly adjusted, readjustment should not be made for minor changes; a variation of one-quarter inch is permissible. To inflate strut adhere to the following procedure:

(a) Attach high-pressure air hose to valve and inflate strut until it lifts the weight of the fully loaded airplane to a static position of 1-½ inches for Bendix struts, and 1-⅜ inches for Cleveland struts.

(b) Replace hex cap, which is a secondary seal, and screw down tightly, but not so tightly that the seat in the cap is forced inward, thereby depressing the valve core stem.

(c) Test valve core and seat around filler plug by putting a little soapy water around these joints to show the presence of air bubbles. Usually, leaks around other parts will be evidenced by seepage of fluid.

(3) FILLING TAIL WHEEL SHOCK STRUT.—Instructions for servicing shock strut are engraved on a metal plate attached to strut.

(a) Remove access cover at left side of airplane near the tail end of the fuselage.

(b) Remove hex cap on air valve at top aft end of strut piston. Slowly release all air from strut by backing off filler plug, which contains the air valve, one turn until all fizzing of air and fluid stops and strut is fully compressed.

CAUTION

Do not attempt to remove filler plug until all fizzing stops.

(c) Remove filler plug and check fluid level. The level of the fluid should be flush with the filler plug hole when strut is fully compressed. Fill, if necessary, with hydraulic fluid, Specification No. AN-VV-O-366. To clean cylinder, flush with kerosene or naphtha.

(d) Make certain filler plug gasket is in good condition. Replace filler plug loosely; cause strut to extend and retract several times to eliminate air traps in the strut. When certain air traps have been removed and fluid level is correct, seal plug tightly with a wrench.

(4) INFLATING TAIL WHEEL SHOCK STRUT.—To inflate tail wheel shock strut, follow closely the procedure outlined below:

(a) Attach high pressure air hose to the air valve at the top of the shock strut and inflate strut approximately 2 inches. This inflation is normally 160 pounds per square inch on a fully loaded airplane. Most airplanes are equipped with a metal fairing on which a red line is painted. The strut in this installation is properly inflated when the red line is flush with the lower edge of the fuselage rear cowl. Some airplanes are equipped with a canvas shroud assembly and a red line is painted directly on the upper end of the strut. This strut is properly inflated when a dimension of 1-⅞ inches exists between the lower edge of the red line and the top of the strut packing gland flange.

(b) Remove hex cap, which is a secondary seal, and screw down tightly, but not so tightly that the seat in the cap is forced inward, thereby depressing the valve core stem.

(c) With soapy water, test valve core and seat around filler plug for air leakage. Usually, leakage around gland nut will be evidenced by seepage of fluid. In the event of the latter, the strut must be completely deflated prior to tightening gland nut.

f. TIRES.

(1) INFLATING MAIN LANDING GEAR TIRES.—Access to valve is gained by removing Dzus-fastened outside wheel fairing. The landing gear tire pressure should be such that the deflection marks on the side of the tire just contact the ground line when the airplane is in the three-point position. Under normal loading conditions, this pressure will be approximately 32 pounds per square inch. Tires should be checked and inflated with airplane on hard level ground.

(2) INFLATING TAIL WHEEL TIRE.—Access to valve is gained by removing screw-fastened right side wheel fairing. The tail wheel tire pressure should be such that the inflation marks on the side of the tire just contact the ground line when the airplane is in a three-point position on a flat hard surface. Under normal loading conditions, this inflation will be equivalent to approximately 38 pounds per square inch.

The proper degree of inflation for tires which are not equipped with inflation marks or lines may be obtained by using inflation check templates. Refer to section IV, paragraph 4.

g. OXYGEN CYLINDERS.

(1) HIGH-PRESSURE SYSTEM.—The detachable high-pressure oxygen cylinders employed in earlier airplanes are interchangeable and must be removed for filling. Before removal of the cylinders for filling purposes, bleed the system by opening the regulators. Access

to the cylinders is gained from the rear cockpit by removal of the yokes which secure them in their respective cradles. The high-pressure cylinders should be filled with oxygen at approximately 1800 pounds per square inch. Transferring the oxygen from supply cylinder to airplane cylinder is facilitated by means of a spring-loaded check valve in each cylinder. When the oxygen cylinders are connected to the line in the airplane, the check valve in the cylinders will release the pressure from the cylinder into the lines.

(2) DEMAND-TYPE SYSTEM.—It is not necessary to remove the low pressure cylinders incorporated in the demand-type system of later airplanes for filling. Attach a hose from an oxygen supply cylinder to the filler valve, located on the left side of the rear fuselage and accessible from the outside through the baggage compartment door. Turn the handle on the filler valve to secure the coupling. To facilitate the procedure, a pressure gage capable of registering up to 500 pounds per square inch should be attached to the oxygen supply hose; however, the oxygen regulator in the airplane will suffice if no gage is available. Open the supply cylinder valve and allow oxygen to flow into the cylinders until the pressure gage registers 425 pounds per square inch. As the oxygen regulator is the only means of determining the amount of oxygen that has entered the cylinders, it should be watched closely to prevent excess pressure. After ascertaining that a pressure of 425 pounds per square inch has been built up in the cylinders, allow oxygen to escape from the regulator until the pressure is reduced to 400 pounds per square inch. This procedure will ascertain proper functioning of the system and at the same time bleed air from the oxygen. A specially dried type of breathing oxygen must be used and should be subjected to dampness tests, as well as tests for impurities. Damp oxygen will blister the user's face. Special care must be exercised in installation and maintenance of the entire system.

WARNING

Prior to filling, the cylinders must be thoroughly dry and under no circumstances is oil or hydraulic fluid to be permitted on or near the system. This necessary precaution is taken because of the highly explosive nature of the oxygen when in contact with oil or grease of any kind.

4. (Deleted)

5. LUBRICATION REQUIREMENTS.

a. GENERAL.—See figure 41 for lubrication instructions including the period, location, and type of lubricant used. A zerk-type grease gun, located on the lower left engine mount tube and packed with low-temperature lubricating grease, provides means of lubrication at points equipped with zerk-type lubricator fittings. The lubricator fittings are printed *yellow* to insure ready identification. Ball bearings used in pulleys, bell cranks, hinge points, and rod ends are shielded type bearings. Where light lubricating oil is specified but not available, clean engine oil will be found satisfactory. Where possible, assemblies requiring lubrication shall be lubricated at point of assembly. Excess application of lubricants is to be avoided. Apply lubricant sparingly to cockpit enclosure tracks. Excess lubricant will attract dirt and grit and may cause malfunction of the mechanism.

b. APPLICATION OF GREASES.—Where a reservoir is not provided around the bearing, apply lubricant sparingly and wipe off excess.

(1) Seat adjustment tubes, etc., require only a thin flim of grease. Do not lubricate lightly-loaded slides that work freely unless protection against corrosion is necessary.

(2) Most of the ball bearings used in the airplanes are of the shielded type and are pre-packed with lubricant by the manufacturer. Periodical cleaning, inspection, and lubrication is required. Use Specification No. PS661 solvent to dissolve grease or oil. Move bearings through solvent and allow to "dry". Evaporation may be hastened by employment of a dry air blast.

CAUTION

Do not spin bearings by hand or air jet as damage to races and balls will result.

Lubricate with Specification AN-G-25, using tool 37B5054 or Alemite No. 6212.

(3) Unsealed ball bearings and needle bearings shall be packed with grease to approximately ⅔ capacity. When antifriction bearings are completely filled with lubricant, the following troubles are likely to occur:

(a) Lubricant will be expelled by the motion of the bearing.

(b) Lubricant will be expelled when the bearing becomes warm (thermal expansion).

(c) Resistance to motion at low temperatures will be excessive.

(4) In greasing the wheels, the roller assemblies shall be taken out of the hub, the grease completely removed from both assemblies, and the bearing cones cleaned with suitable solvent. After the roller assemblies have dried completely, they shall be thoroughly daubed with grease, Specification No. AN-G-15, care being exercised to see that lubricant enters the space between the rollers within the retainer ring.

NOTE

No grease shall be packed into the wheel hub. A little is permitted on the bearing race only. Prior to installation of the wheel, the axle shall be cleaned and the protective lacquer film removed with a suitable wash thinner.

(5) It is possible, when filling the hub spider on the propeller, to force in an excessive amount of grease which is discharged between the shim plate and through the barrel openings when the engine is running; there-

fore the practice of forcing grease into the hub spider until the grease appears around the shim plate is not recommended. To determine if a sufficient amount of grease has been forced into the hub spider, adjust the power-type zerk gun to cut out at a pressure of 2000 pounds. When using a hand-type zerk gun, note sudden increase in resistance. Any continuation of zerking beyond this point does no good and is undesirable.

c. APPLICATION OF OILS.—Where manufacturer's instructions or applicable technical orders for the lubrication of mechanisms designed for lubrication do not furnish special directions, the following rules should be observed:

(1) One small drop of oil will adequately lubricate any fine instrument bearing. Excessive oiling of instruments often interferes with proper function.

(2) Apply oil sparingly, never more than enough to coat the bearing surfaces.

(3) Since cables are sufficiently lubricated by the manufacturer, additional lubrication for the prevention of corrosion is unnecessary.

(4) Examine the magneto cam follower felt at the regular routine inspection periods to see that it is properly lubricated. If oil appears on its surface when the felt is squeezed with the fingers, do not add oil. If it is dry, moisten it with oil, Grade 1120, Specification AN-O-8. Do not apply too much oil, as the excess will be thrown off during operation and will come between the contact points, causing pitting and burning.

(5) Apply a thin film of oil, U.S. Army Spec. No. 2-120, to machine guns, contacting exterior and all accessible interior mechanisms. Use ram rod and suitable oil-saturated material for bores.

(6) The propeller counterweight shaft can be lubricated through the slot in the counterweight without removing the cap. If the counterweight cap is removed, care should be exercised to insure that the location of stop nuts on the adjusting screw is not disturbed, as any change in the stop nuts will affect the angle setting of the propeller blades.

(7) It is absolutely essential that the camera be properly lubricated. Cameras are not installed on AT-6D and SNJ-5 (Navy) airplanes at the factory. To oil and grease the camera thoroughly, the roll film magazine, the camera body, and the lens shutter should be gone over. The oiling and greasing should be done carefully to prevent it from spreading and perhaps getting on the film and the contact glass or dropping down on the lens. Because it is necessary to use an oil with an extremely light body which has a tendency to evaporate and dry up when the camera is not in use, frequent oiling is necessary. If the camera remains idle for several weeks between periods of use, it should be completely lubricated before going into the airplane.

WARNING

Oil or grease only where arrows indicate or directions stipulate. After oiling or greasing the various parts, go over the camera carefully to make sure no excess oil or grease is left. Use only the oil and grease specified for the camera as it will not freeze at low temperature and slow the camera action. The oil to be used is "Oil, Lubricating, General Purpose, Specification AN-O-6." The grease to be used is "Grease, Low Temperature Lubricating (Low Volatility Type), Specification AN-G-25."

(8) Reservoirs provided to lubricate mechanism should be filled to indicated capacity or to level mark. Where no level is indicated, avoid over-filling. Add just enough to allow gears or other rotating parts to dip into bath. Never fill above point where shafts go through housing.

(9) Where wicks supply oil to bearings from small reservoirs, keep reservoir filled. Bearing itself requires no oiling except at time of initial installation.

(10) When felt pads are provided, keep oiled so that lubricant appears on surface when pad is squeezed.

d. ANTI-SEIZE AND SEALING COMPOUNDS.

(1) Union type (straight thread) couplings, AAF Specification No. 2-118.

(2) Pipe thread couplings, Specification No. AN-C-53.

(3) All oxygen system fittings, Specification No. AN-C-86.

(4) Fuel and oil system fittings, Specification No. AN-G-14.

(5) Threaded rod adjustments, AAF Specification No. 2-118.

(6) Spark plugs, Anti-Seize Compound, Specification AN-C-147.

NOTE

Compounds shall be applied sparingly to the male portions of the fittings only. Excess compound must be avoided as plugging of lines, valves, and so forth, may result with consequent damage to the system. *Do not apply grease or oil to oxygen fittings.*

6. SPECIAL TOOLS AND EQUIPMENT

Each airplane is supplied with certain special tools and equipment required for its proper maintenance and operation. These parts are stowed in the baggage compartment on the left side of the fuselage at the time of the airplane's delivery from the factory. Included are one Mooring Kit, one Pratt & Whitney Engine Tool Kit, one Armorer's Tool Roll, one Engine Cover, and miscellaneous loose equipment and special tools. (See figures 42 through 46.)

Special tools for maintenance and overhaul of the airplane (see figure 47) are included in operational squadron tool kit, stock No. 8043-T950, class 18, for first and second echelons, and service squadron and major overhaul tool kit, stock No. 8043-T953, class 18, for third and fourth echelons. Special tools will be requisitioned in accordance with existing regulations.

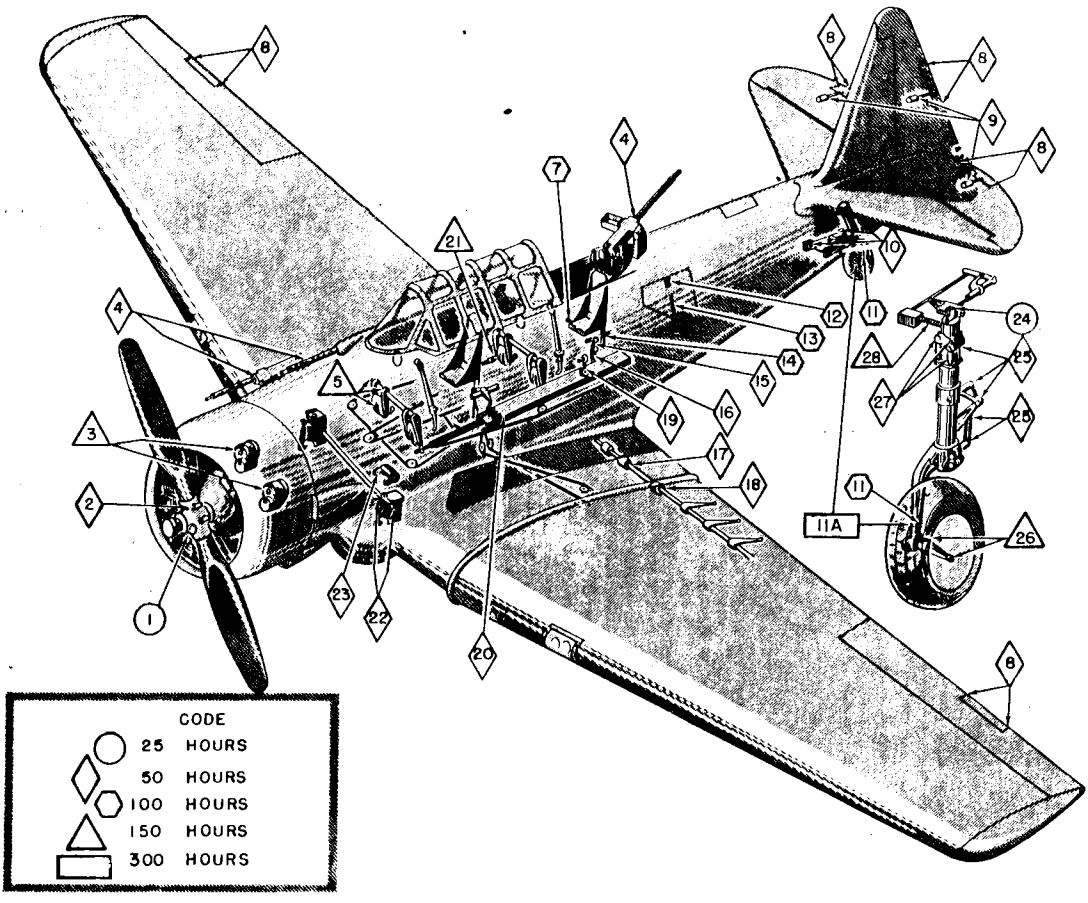


Figure 41 — Lubrication Diagram

Note: This diagram is based on normal operations under normal conditions. When operating under abnormal conditions, such as continuous practice landings or in localities where dust or salt air is prevalent, frequent inspection (at least every 25 hours) of the torsion link bushings, rudder pedals, and flap actuating rod universals should be made and the parts lubricated if necessary. *Do not lubricate Oilite Bearings.*

No.	Part	Lubricant	Spec.
1.	Propeller Counter weights	Grease: General purpose, aircraft lubricating	AN-G-15
2.	Propeller Hub Spider	Grease: General purpose, aircraft lubricating	AN-G-15
3.	Magnetos	Oil: Lubricating Aircraft Engines	AN-O-8 Grade 1120
4.	Machine Guns	Oil: Preservative special	2-120
5.	Rudder and Brake Pedals	Grease: General purpose aircraft lubricating	AN-G-15
6.	Deleted		
7.	Seat Adjustment Mechanism	Oil: General purpose, low temperature lubricating	AN-O-6a
8.	Control Tab Bearings	Oil: General purpose, low temperature lubricating	AN-O-6a
9.	Trim Tab Operating Drums	Grease: Lubricating low temperature (low volatility type)	AN-G-25
10.	Tail Wheel Assembly (4 zerks)	Grease: General purpose, aircraft lubricating	AN-G-15
11.	Wheel Bearings	Grease: General purpose, aircraft lubricating	AN-G-15
11A.	Tail Wheel Knuckle Bearings	Grease: Lubricating, low temperature	AN-G-25
12.	Baggage Compt. Lock Mechanism	Oil: General purpose, low temperature lubricating	AN-O-6a
13.	Baggage Compt. Door Lock Plunger	Oil: General purpose, low temperature lubricating	AN-O-6a
14.	Seat Support Tubes	Oil: General purpose, low temperature lubricating	AN-O-6a
15.	Flap Control Handles (1 zerk each)	Grease: Lubricating, low temperature (low volatility type)	AN-G-25
16.	Landing Gear Control Handles (1 zerk each)	Grease: General purpose, aircraft lubricating	AN-G-25
17.	Flap Operating Cylinder (4 zerks)	Grease: Lubricating, low temperature (low volatility type)	AN-G-25
18.	Flap Actuating Rod Universal	Oil: General purpose, low temperature lubricating	AN-O-6a
19.	Hydraulic Pressure Control Lever (2 zerks)	Grease: General purpose, aircraft lubricating	AN-G-15
20.	Flap and Landing Gear Position Indicator Shaft (2 zerks)	Grease: General purpose, aircraft lubricating	AN-G-15
21.	Rudder Pedal Adjustment Slides	Oil: General purpose, low temperature lubricating	AN-O-6a
22.	Landing Gear "UP" Position Latch (2 zerks each)	Grease: Lubricating, low temperature (low volatility type)	AN-G-25
23.	Hand Fuel Pump Bell Crank (1 zerk)	Grease: Lubricating, low temperature (low volatility type)	AN-G-25
24.	Landing Gear Lockpin	Oil: General purpose, low temperature lubricating	AN-O-6a
25.	Main Landing Gear Torque Arm (4 zerks)	Grease: General purpose, aircraft lubricating	AN-G-15
26.	Brake Linkage	Oil: General purpose, low temperature lubricating	AN-O-6a
27.	Main Landing Gear Fitting (5 zerks)	Grease: General purpose, aircraft lubricating	AN-G-15
28.	Landing Gear Position Indicator Switch Actuating Rod and Guide	Oil: General purpose, low temperature lubricating	AN-O-6a

SPECIFIED LUBRICANTS FOR AT-6 AND SNJ SERIES AIRPLANES

Applications	*Lubricant*	*Specification*
1. All anti-friction bearings: ball bearings and needle bearings (except landing gear wheel bearings)	Grease: Lubricating low temperature (low volatility type)	AN-G-25
2. All zerk fitted bearings except: (a) Dynafocal engine mounts, (b) Propeller hubs	Grease: Lubricating low temperature (low volatility type)	AN-G-25
3. Bearings containing plain bushings. Note: Do not lubricate Oilite bearings	Grease: Lubricating low temperature (low volatility type)	AN-G-25
4. Guides for flaps, landing gear, hatch mechanisms, and windows	Grease: Lubricating low temperature (low volatility type)	AN-G-25
5. Enclosed springs and plungers	Grease: Lubricating low temperature (low volatility type)	AN-G-25
6. Control surface bearings	Grease: Lubricating low temperature (low volatility type)	AN-G-25
7. Enclosed universals	Grease: Lubricating low temperature (low volatility type)	AN-G-25
8. Engine tachometer shafts	Grease: Lubricating low temperature (low volatility type)	AN-G-25
9. Control surface gears, chains, sprockets, actuating worms and screws	Grease: Lubricating extreme pressure	AN-G-10
10. Gear box for landing gear retracting and wing flap	Grease: Lubricating extreme pressure	AN-G-10
11. Enclosed flexible control cables and drive shafts. (Except engine tachometer shafts.)	Grease: Lubricating extreme pressure	AN-G-10
12. Landing-gear wheel axle bearing	Grease: General purpose aircraft lubricating	AN-G-15
13. Generator bearings	Grease: General purpose aircraft lubricating	AN-G-15
14. Magneto bearings and distributor gears	Grease: General purpose aircraft lubricating	AN-G-15
15. Dynamotor bearings	Grease: General purpose aircraft lubricating	AN-G-15
16. Hamilton-Standard propeller hub	Grease: General purpose aircraft lubricating	AN-G-15
17. Lubrication of jewels in instruments	Oil: General purpose low temperature lubricating	AN-O-6a
18. Spray or slosh tank interiors after anodic treatment or welding.	Oil: Lubricating, refrigerating—machine	VV-O-581, Grade 10
19. Sperry flight indicator gimbals and oil pads	Oil: General purpose, low temperature lubricating	AN-O-6
20. Regular engine oil when average ground temperature is below 4°C. (40°F) and does not rise above 27°C (80°F). Note: Safe operating temperatures specified in T.O. No. 06-10-1 for this grade of oil are: *Grade of Oil. Max.* 85°C (185°F) *Min.* 10°C (50°) 1100 *Safe "Oil In" Temp.*	Oil: Lubricating, aircraft engine	AN-O-8 Grade 1100
21. Regular engine oil when ground temperature remains above 4°C (40°F.) Note: Safe operating temperatures specified in T.O. No. 06-10-1 for this grade of oil are: *Grade of Oil Max.* 95°C (203°F) *Min.* 20°C (68°F) 1120 *Safe "Oil In" Temp.*	Oil: Lubricating, aircraft engine	AN-O-8 Grade 1120
22. Lubrication of all airplane machine guns	Oil: Preservative, special	2-120
23. General lubrication of control linkage, pinned joints, exposed universals, roller and slides, hinges, latches and seat guides	Oil: General purpose, low temperature lubricating	AN-O-6
24. Hydraulic system. Caution: Do not use petroleum base fluid in brake system of trainer airplanes. (See item 28.)	Oil: Hydraulic, petroleum base	AN-VV-O-366
25. Landing-gear shock struts	Oil: Hydraulic, petroleum base	AN-VV-O-366
26. Brake system	Fluid: Hydraulic, castor oil base	3586 (Blue)
27. Attachment of slide rubber fittings such as rubber fittings to shock absorbers, rubber grommets, etc.	Glycerine (glycerol)	O-G-491
28. Installation of rubber vibration absorbers in mounting engines	Water	

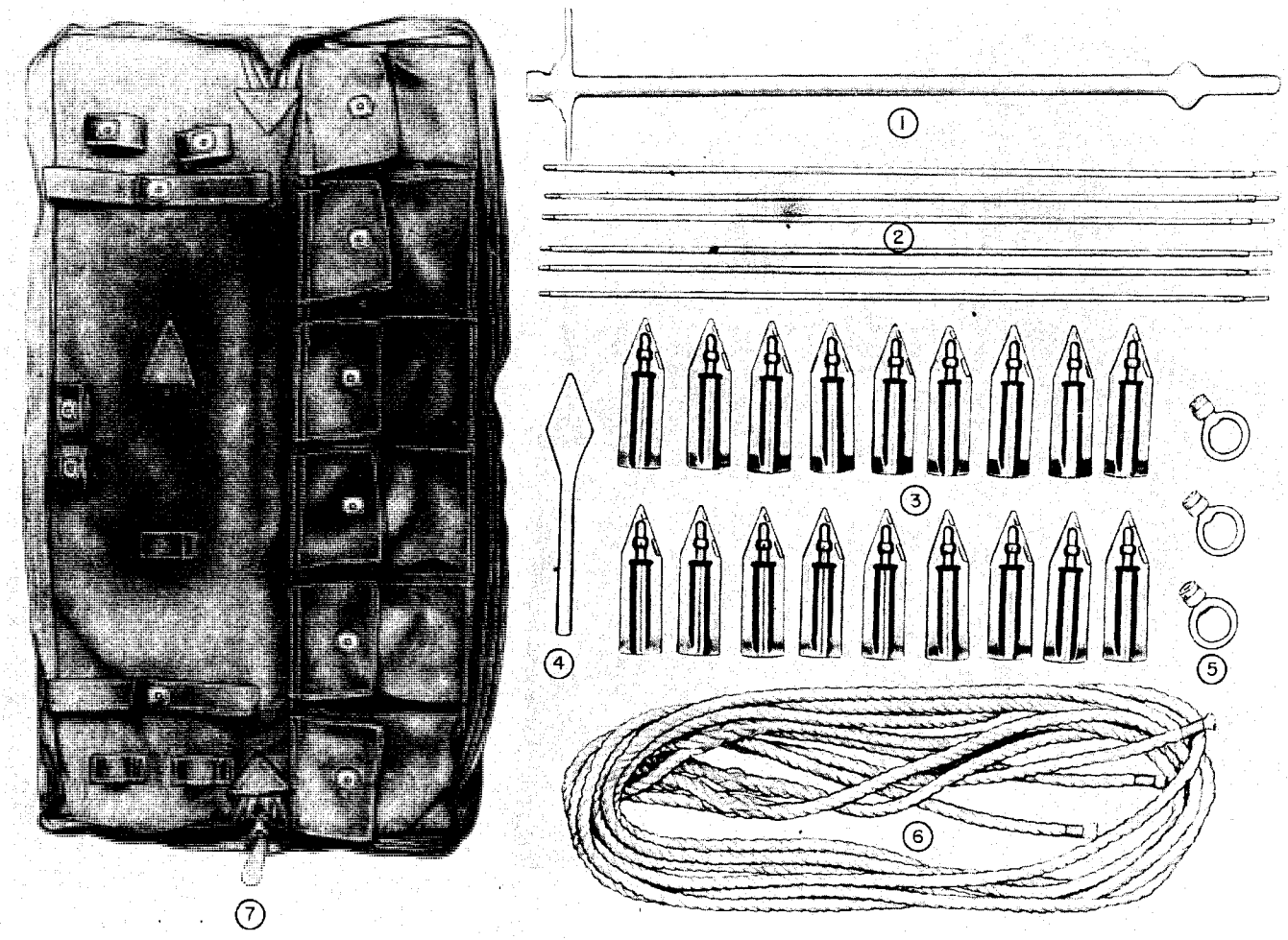


Figure 42 — Mooring Kit

1. Anchor Driving Rod	36B4466
2. Anchor Rods	36A4468
3. Ground Breaking Arrows	36A4467
4. Ground Breaking Pin	38B3323
5. Anchor Rod Eye Assembly	36A4469
6. Ropes (3)	33D2721

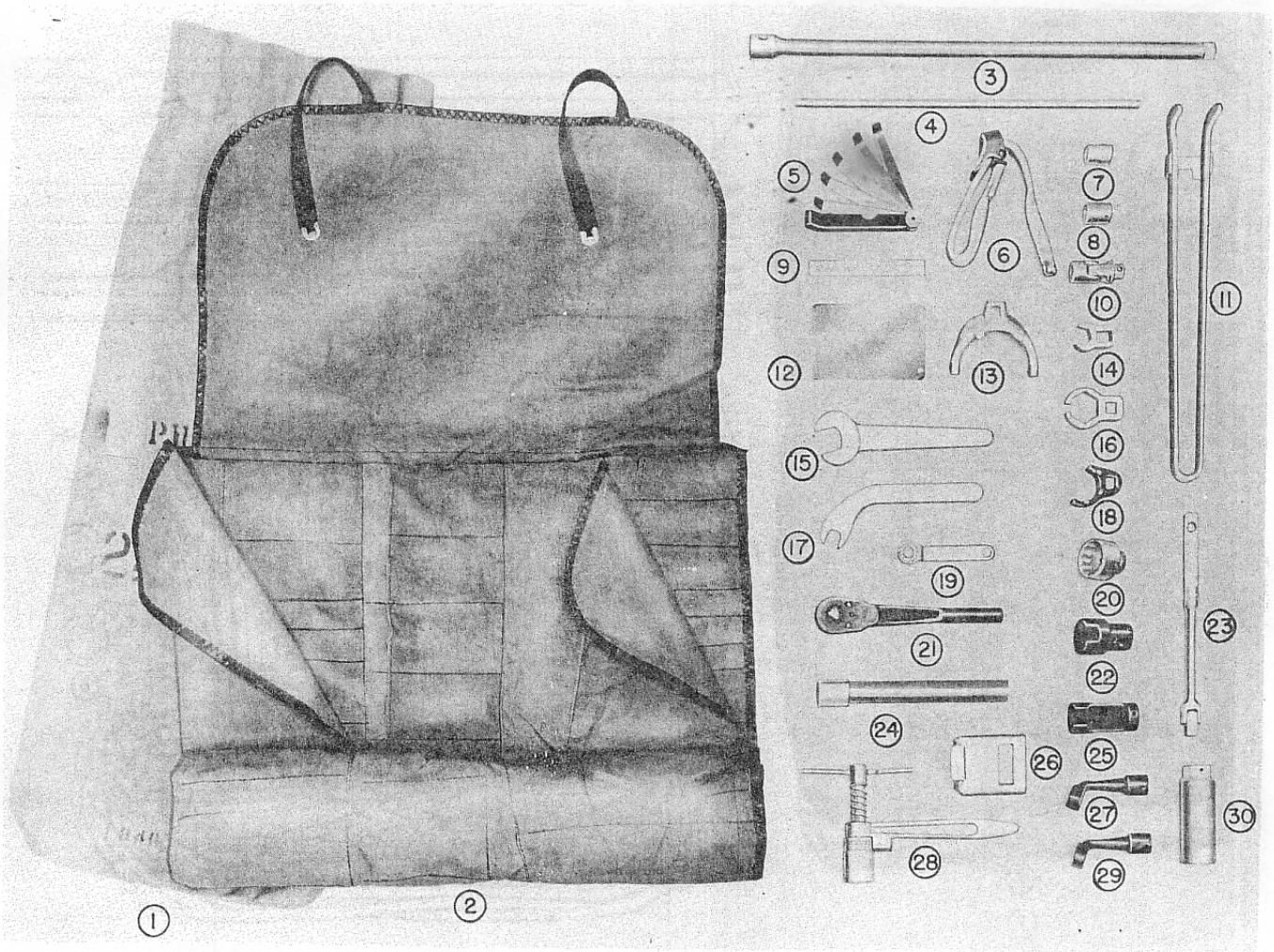


Figure 43 — Engine Tool Kit

1.	Tool Kit Bag	PWA211
2.	Tool Container	PWA36
3.	16-inch Extension, 3/8-inch sq.	PWA1396
4.	Bar-Wrench-Cross Handle	PWA1400
5.	Valve Clearance Gage	PWA672
6.	Adjustable Strap Wrench	PWA1886
7.	7/8-inch Socket Wrench	PWA1404
8.	1/4-inch Socket Wrench	PWA1270
9.	Mag Breaker Points Aligning Strip	PWA996
10.	3/8-inch Sq. Universal Joint	PWA1405
11.	Depresser-Valve Spring	PWA459-1
12.	Mirror	PWA1059
13.	Intake Pipe Wrench	PWA1399
14.	Starter and Generator Wrench	PWA1471
15.	13/16-inch O.E. Relief Valve Wrench	PWA956
16.	Ratchet Shaft Nut Wrench	PWA1502
17.	Carb. Rear Center Nut Wrench	PWA148
18.	Push Rod Cover Wrench	PWA1424
19.	3/8-inch Palnut Wrench	PWA1608
20.	1-inch Socket Wrench	PWA1402
21.	3/8-inch Ratchet Handle	PWA1394
22.	Rocket Arm Depresser	PWA1392
23.	Handle-hinge 3/8-inch Sq.	PWA1397
24.	Fibre-Drift	PWA1395
25.	Spark Plug Elbow Wrench	PWA1683
26.	Depresser-Valve Spring	PWA459-2
27.	Cylinder Nut Wrench	PWA1393
28.	Valve Adj. Screw and Locknut Wrench	PWA1075
29.	Gun Synchronizer Wrench	PWA2379
30.	Spark Plug Wrench	PWA2254

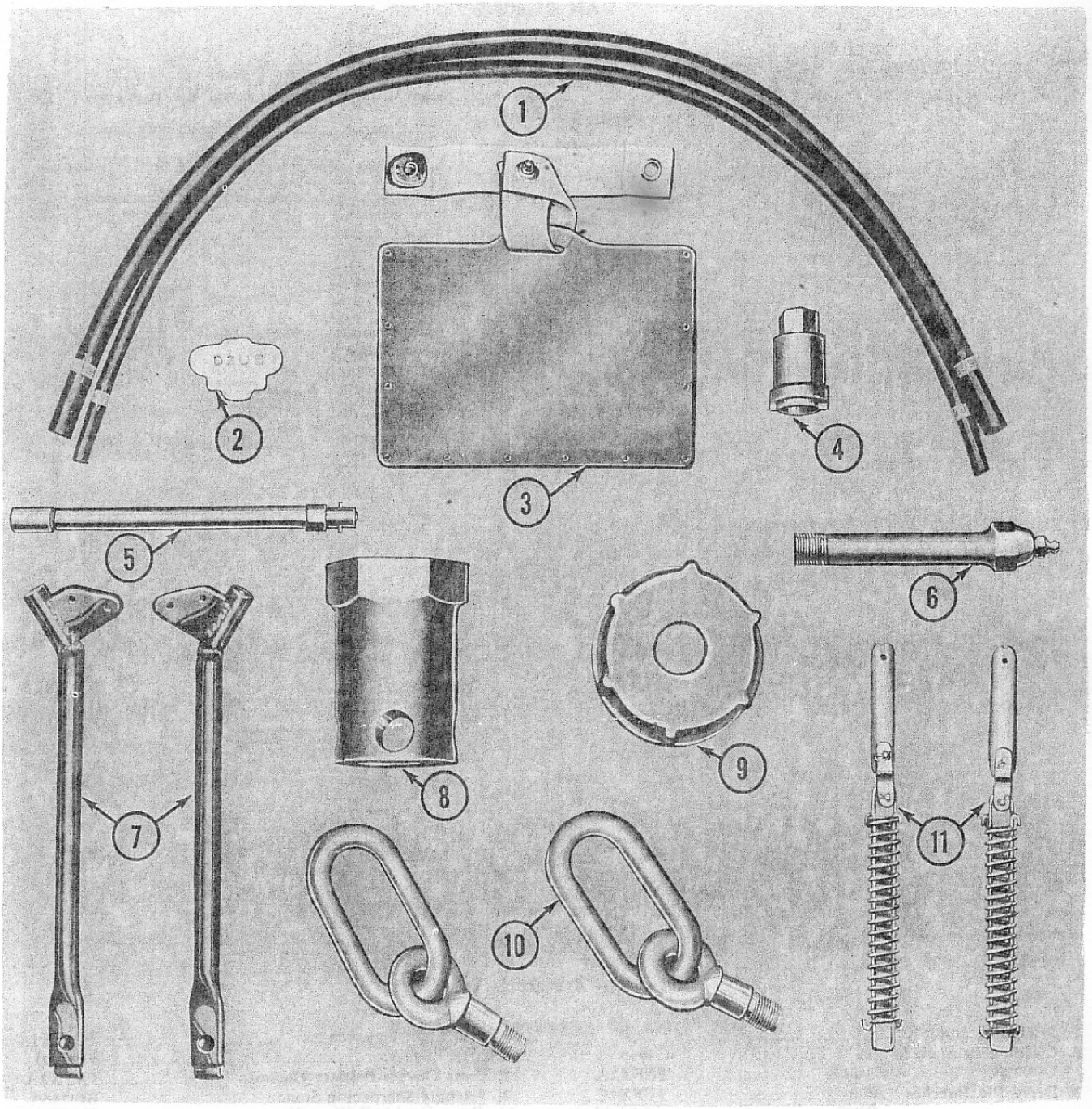


Figure 44 — Loose Equipment

1.	Wire Assembly	88-710-58
2.	Dzus Wrench	19-33447
3.	Check List Holder	39D3922
4.	Wrench	25-58178-2
5.	Grease Gun Extension	12D40T-1
6.	Lubricator	19A-53415
7.	Pivots, Right and Left Side	55-73013
8.	Propeller Wrench	S8499F
9.	Propeller Shaft Protector Cap	36554-40
10.	Hoist Fittings	36-55009
11.	Antenna Assembly	88-710-52
	Plate Assembly (not shown)	23-53096-18
	2 Sacks, Attaching Parts	

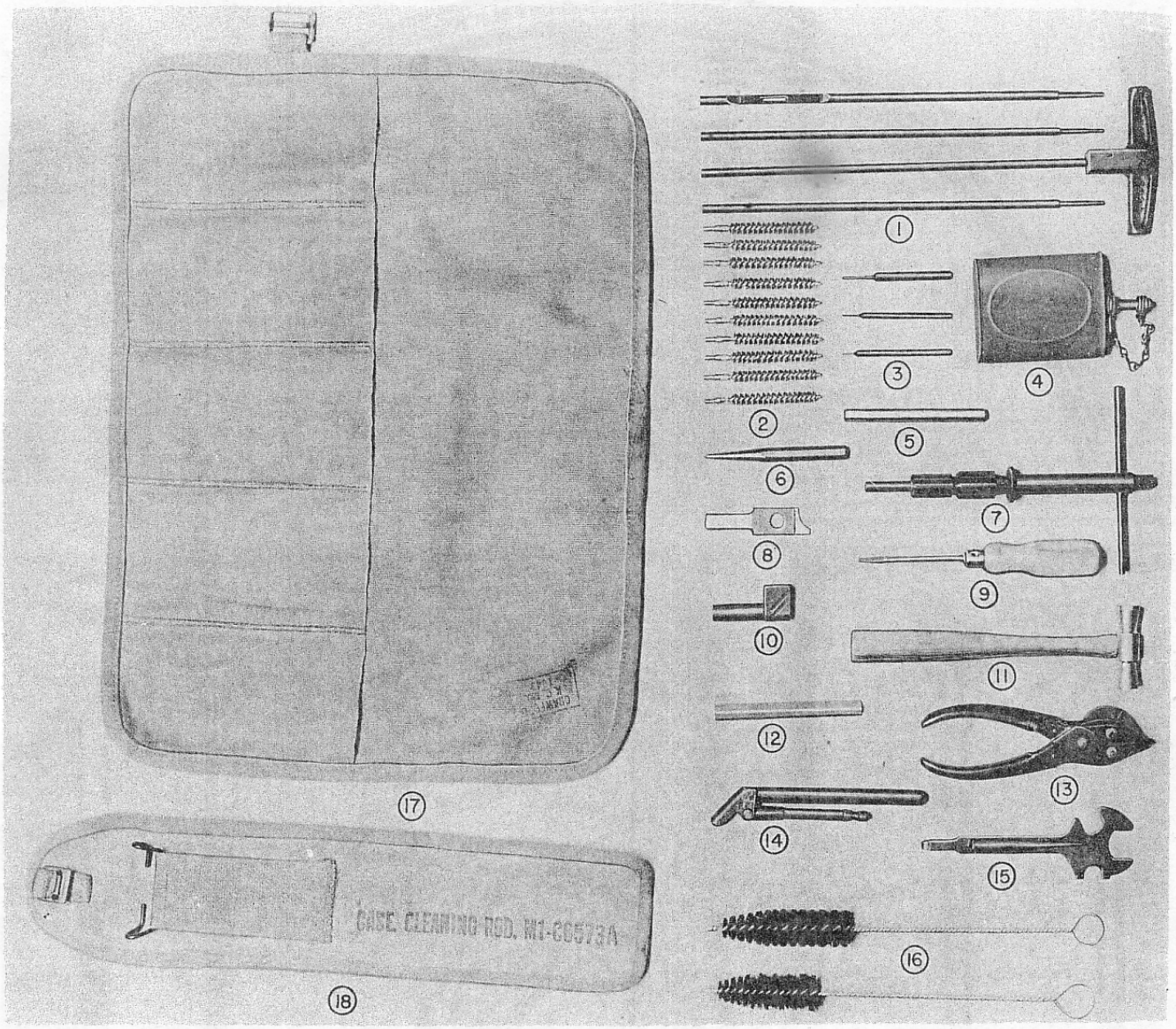


Figure 45 — Armorer's Tool Roll

1. Jointed Cleaning Rod D8237
2. Cleaning Brushes, M-2 ..... C4035
3. Drive Pin Punches .03-in. TCFX2A
   .05-in. TCFX2C
   .08-in. x 3/4 ..... TCFX2F
4. 3-oz. Oval Oiler C59737
5. Brass Light Drift 3/8 Rd x 4 ..... TCCX2D
6. 4-in. Center Punch TCDX1A
7. Carbon Removing Tool, M-4 ..... C64302
8. Headspace and Timing Gage A196229
9. 3-in. Blade Screwdriver TG-AX1A
10. Barrel Reflector B147001
11. Brass Double-Bellface Hammer TAFX2A
12. Triangle Sharpening Stone B147160
13. 6-in. Side Cutting Paral Jaw Pliers THBX1A
14. Ruptured Cartridge Extractor C3854
15. Combination Tool, M-2 ..... B13134
16. Chamber Cleaning Brushes, M-6 ..... B108828
17. Tool Case
18. Cleaning Rod Case, M-1 ..... C6573

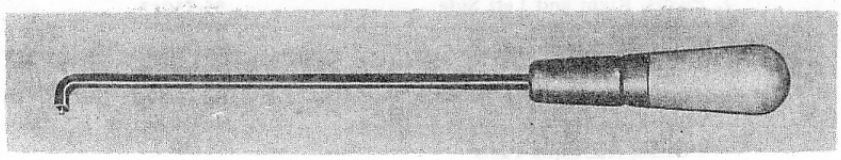
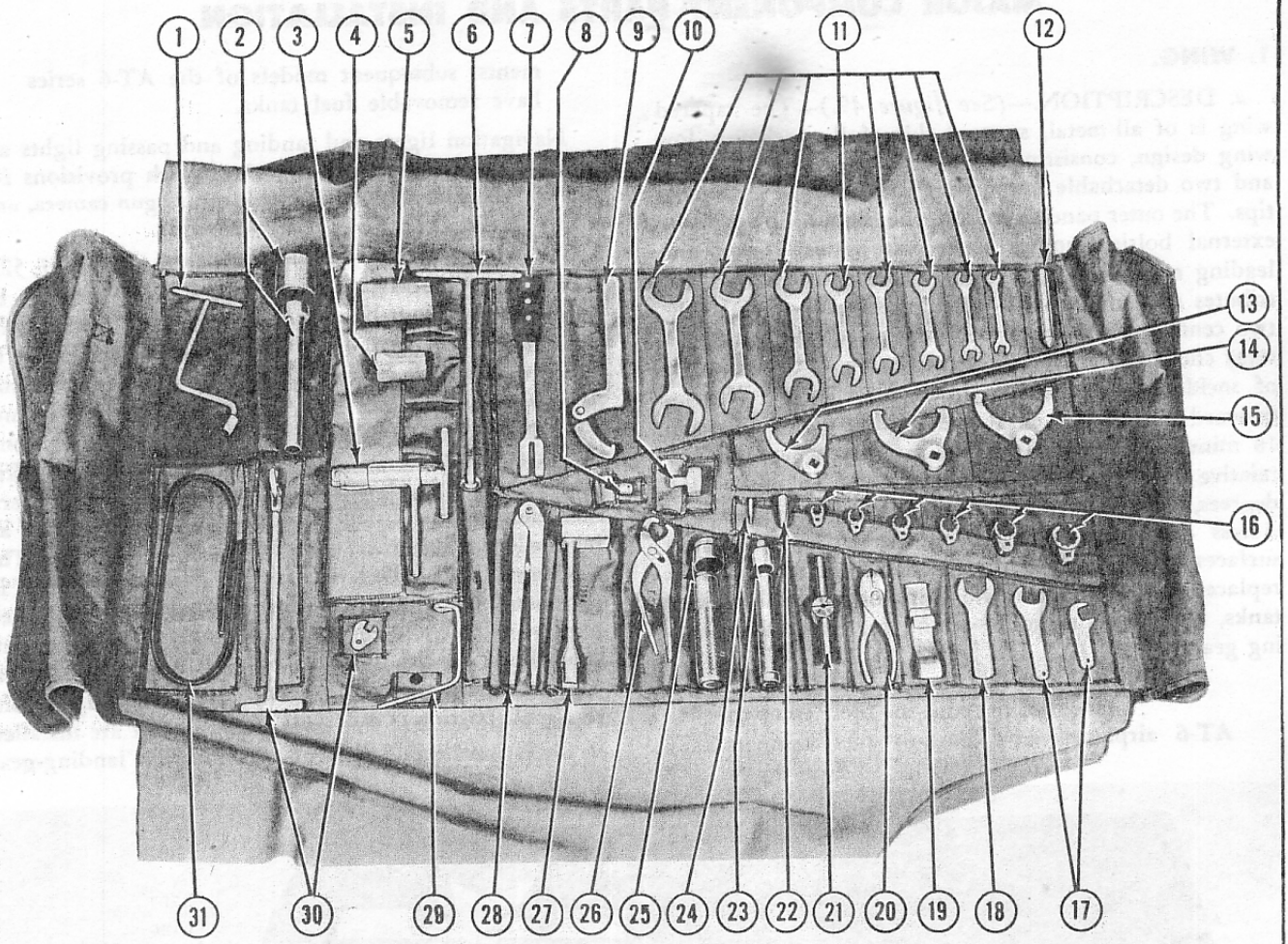


Figure 46 — Armorers Tool Release



LEGEND

1. Main Landing Gear Lockpin Assembly Wrench T574
2. Flap Piston Packing Injector Tool T520
3. Snap Ring Remover Tool T560
4. Tail Wheel Hub Nut Wrench T559
5. Main Landing Gear Wheel Retaining Nut Wrench T518
6. Starter Crowfoot Wrench T516
7. Lower Engine Ring Cowling Installation Tool T545
8. Adapter T35
9. Adjustable Spanner Wrench ... T86
10. Main Landing Gear Lockpin Tool T575
11. Double Open End Offset Wrench Set T68
12. Hydraulic Selector Valve Seating Tool T527
13. Landing Gear and Flap Cylinder Spanner Wrench T542
14. Tail Wheel Shock Strut Packing Nut Wrench T556
15. Main Landing Gear Packing Nut Wrench T549
16. Hydraulic Line Installation Wrench Set T50
17. Main Landing Gear Operating Piston Adjusting Wrench Set T567
18. Landing Gear and Flap Cylinder Packing Gland Nut Wrench T519
19. Tire Installation Clip T5
20. Electrical Plug Pliers T54
21. Master Brake Piston Seat Wrench T583
22. Hydraulic Hand Pump Piston Guide Tool T524
23. Hydraulic Selector Valve Packing Rings Installation Tool T526
24. Master Brake Cylinder Stem Assembly Cup Pilot T594
25. Hydraulic Brake Cylinder Snap Ring Tool T523
26. Adjustable Conduit Pliers T580
27. Fuel Tank Drain Plug Wrench T554
28. Hydraulic Spanner Nut Adjustable Wrench T49
29. Engine Driven Hydraulic Pump Wrench T546
30. Generator Open End Pull Wrench Set T517
31. Bleeder Hose T55

Figure 47 — Major Overhaul Tool Kit

SECTION IV
MAJOR COMPONENT PARTS AND INSTALLATION

1. WING.

a. DESCRIPTION.—*(See figure 49.)*—The tapered wing is of all-metal, stressed skin, full cantilever, low wing design, consisting of a detachable center section and two detachable outer wing panels with removable tips. The outer panels are joined to the center section by external bolting angles along the upper, lower, and leading edge skin surfaces. A plate at each joint distributes shear from each outer panel main spar to the two center section spars. The center section is of constant chord design and is set at positive 2-degree angle of incidence. Each outer panel is twisted 2 degrees forward at the tips, has a sweepback of 10 degrees, 18 minutes, 16 seconds at the leading edges and has, relative to the center section, a dihedral angle of 5 degrees, 41 minutes measured along the leading edges. Access doors are provided on the upper and lower surfaces of the wing to facilitate inspection, servicing, replacement, etc. The center section contains two fuel tanks, and mounting and housing for retractable landing gear.

NOTE

AT-6 airplanes have built-in fuel compartments; subsequent models of the AT-6 series have removable fuel tanks.

Navigation lights and landing and passing lights are installed in the outer panels along with provisions for the installation of a fixed machine gun, gun camera, and bomb racks.

(1) CENTER SECTION.—*(See figures 50, 51, 52.)*—The wing center section is attached to the fuselage by means of four bolts at two points of attachment to the front spar and four bolts at two points of attachment to the rear spar. It has an NACA 2215 airfoil section and is constructed of 24ST Alclad sheet, 24ST aluminum-alloy extrusions and sheet, and Alclad rolled sections, consisting of two spars, power-pressed ribs, and skin which is stiffened in a spanwise direction by stringers. The structure is of constant chord design and has an incidence of plus 2 degrees and no dihedral angle. The lap-jointed skin panels vary from .025 to .064 inch in thickness. Type AD rivets (A17S aluminum) are used for assembly, all skin riveting being flush to approximately 35 percent chord on the top skin to 10 percent chord on the bottom skin. A trailing edge, split-type wing flap, and flap operating cylinder are installed in the aft portion of the center section. The landing-gear

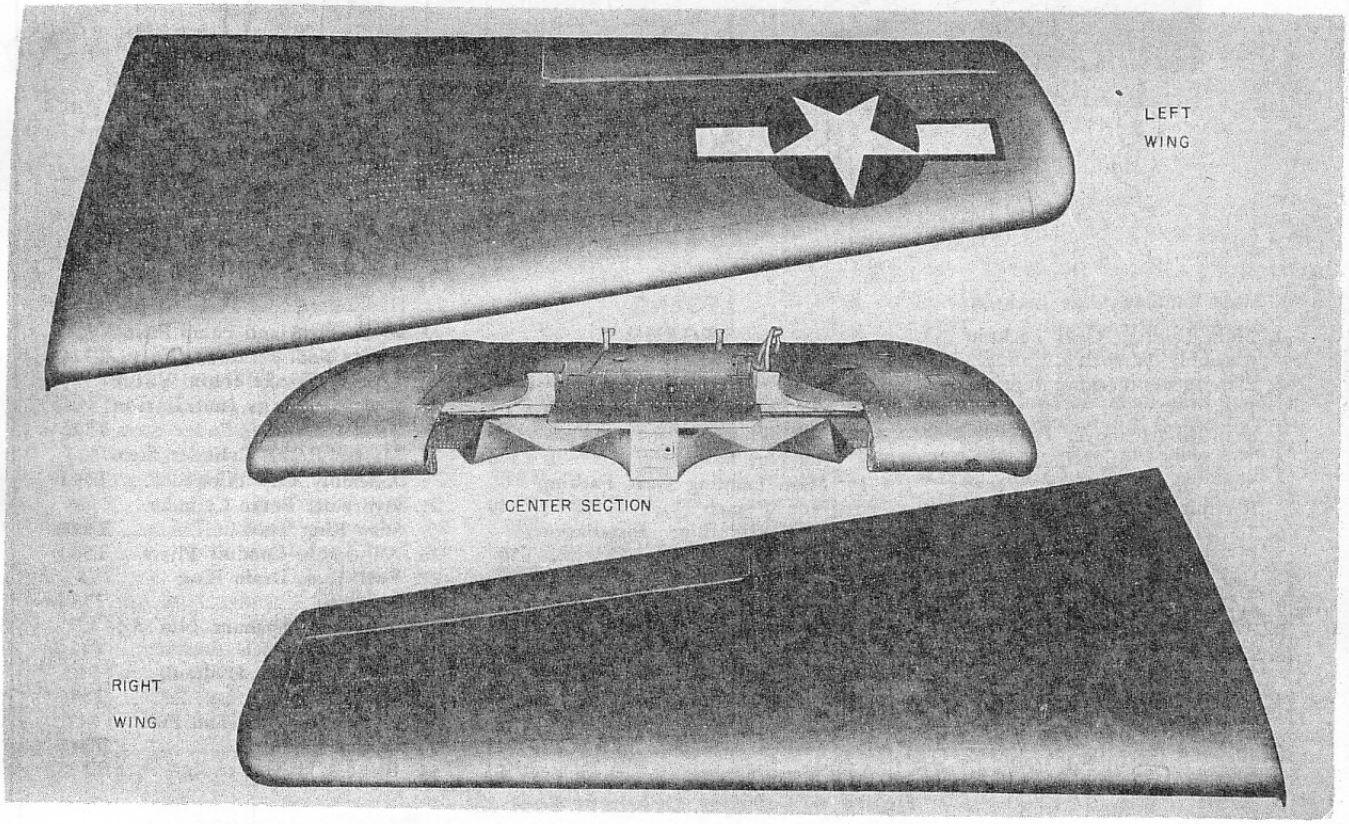


Figure 49 — Complete Wing

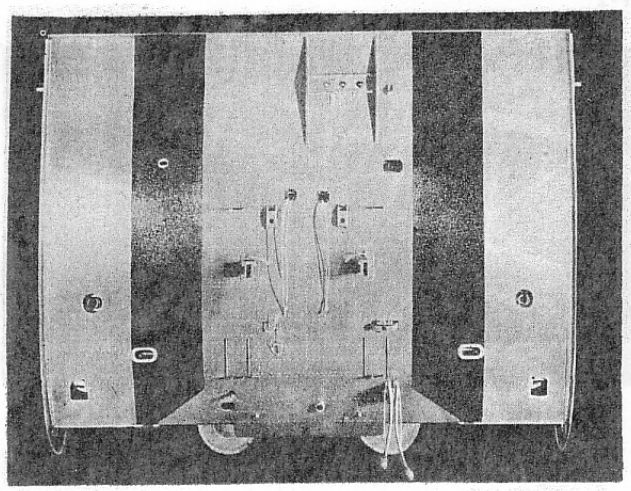


Figure 50 — Wing Center Section—Upper Surface

support castings and lockpin mechanism are installed near the outboard ends of the center section on the front spar. Wheel wells are provided in the leading edge of the structure to accommodate the landing gear wheels in the fully retracted position. Removable cantilever edges give easy access to the landing-gear struts. Two fuel tanks, accessible through removable compartment doors, are also housed in the center section. Filler caps and fuel gages for the fuel tanks are located one on either side of the center section above each tank, while the fuel selector valve rod and drain cock are installed on the left side of the center section. A fresh air intake port and tube are contained in the left leading edge of the structure. Various electrical wiring and hydraulic and instrument lines are routed through the center section to connect with their respective units. Walkways are provided on either side of the center section next to the fuselage, while hoisting shackles are installed near the bolting angle leading edge on the front spar.

(2) OUTER WING PANELS.—*(See figure 53.)* —The outer wing panels and the center section are joined by external bolting angles along the upper, lower, and leading edge skin surfaces. Each outer panel incorporates an angle of incidence of plus 2 degrees at the root which gradually changes to an angle of incidence of 0 degrees at the tip. Both panels are bolted to the center section at a dihedral angle of 5 degrees 41 minutes measured along the leading edge and have a NACA 2215 airfoil section at the root, tapering to a NACA 4412 airfoil section at the tip. They are constructed of 24ST Alclad sheet, 24ST aluminum-alloy extrusions and sheet, and Alclad rolled sections, consisting of one main spar, power-pressed ribs, and skin which is stiffened in a spanwise direction by stringers. Aluminum alloy extrusion stringers are used on earlier airplanes; rolled section stringers constructed of 24ST aluminum alloy sheet are substituted on late AT-6C and SNJ-4 (Navy) and all AT-6D and SNJ-5 (Navy) airplanes. The lap-jointed skin panels vary from .020 to .051 inch in thickness on earlier AT-6 series airplanes. On later AT-6D and SNJ-5 (Navy) airplanes, .020 gage skin is replaced by .025 gage and some .025 gage skin is replaced by .032 gage skin. Type AD rivets (A17S aluminum) are used for assembly, all skin riveting being flush to approximately 35 percent chord on the top skin and to 10 percent chord on the bottom skin. Each outer panel incorporates a trailing edge split-type wing flap and an aileron which extends from the flap to the wing tip. Navigation lights are installed just inboard of each wing tip on both the upper and lower surfaces of the wing. Lights in the left wing are red; those in the right wing are green. A landing light is installed in the leading edge of each outer wing panel and a red passing light is installed in the left outer panel adjacent to the landing light in the same bay. Cover glasses conform to the contour of the leading edge of the wing. On earlier AT-6 series airplanes provisions for a fixed machine gun and gun camera are contained in the right and left outer panels respectively, while bomb rack provisions are installed on the lower surfaces of both

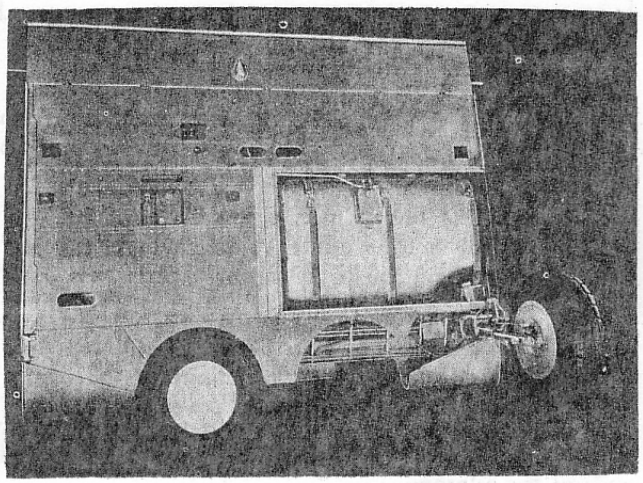


Figure 51 — Wing Center Section—Lower Surface

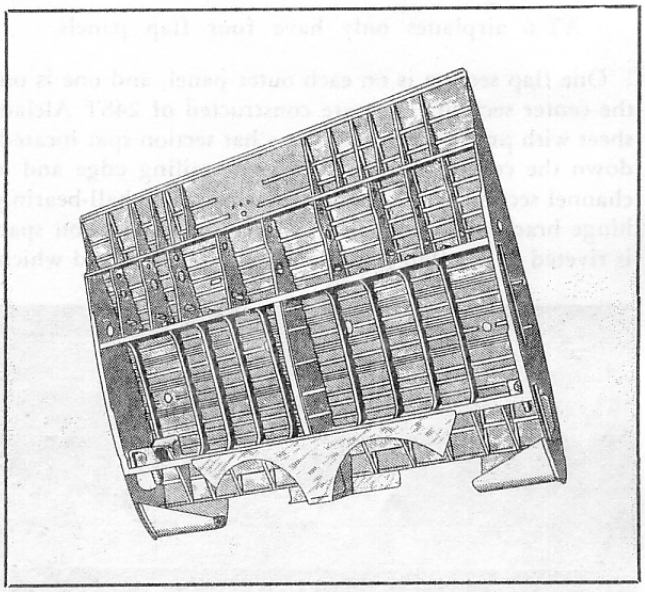


Figure 52 — Wing Center Section — Structure

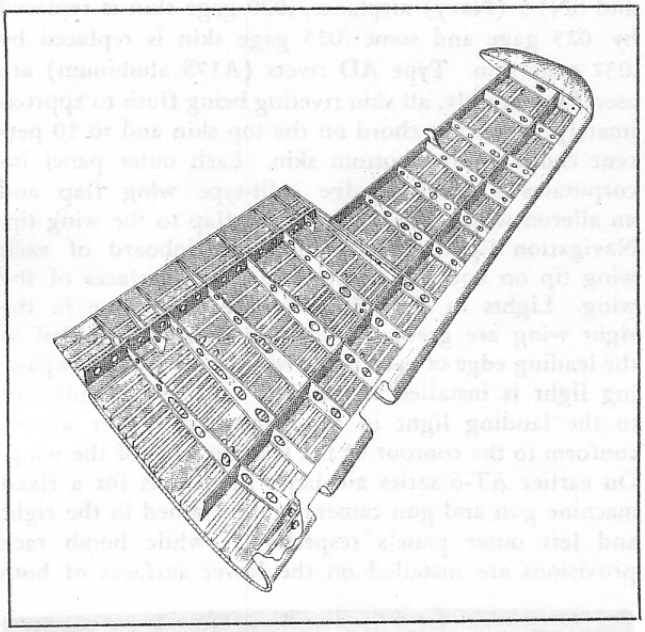


Figure 53 — Wing Outer Panel Structure

outer panels. The pitot head assembly protrudes from the right outer panel leading edge and connects to lines extending into the fuselage. Sockets for the insertion of mooring rings are installed near the tip of each outer panel, and jacking points are contained on the front spar of both panels approximately 30 inches outboard of the bolting angle. A free air thermometer bulb is installed on the lower surface of the left outer wing panel on early airplanes.

(3) WING FLAPS.—*(See figure 54.)*—Three split-type landing flap panels are incorporated in the lower surface of the wing trailing edge between the inboard ends of the ailerons.

NOTE

AT-6 airplanes only have four flap panels.

One flap section is on each outer panel, and one is on the center section. They are constructed of 24ST Alclad sheet with pressed-flanged ribs, a hat section spar located down the center, a channel section trailing edge and a channel section at the leading edge to which ball-bearing hinge brackets are attached. Where the hat section spar is riveted to the flap skin, a torsion box is formed which

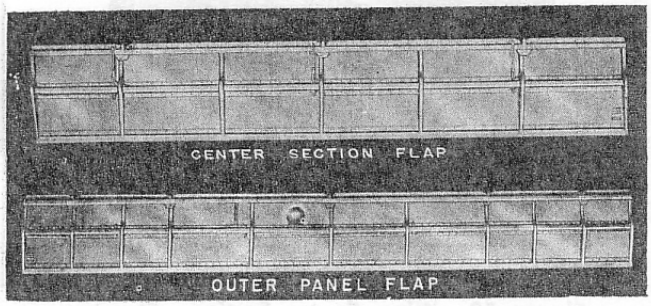


Figure 54 — Wing Flap Structure

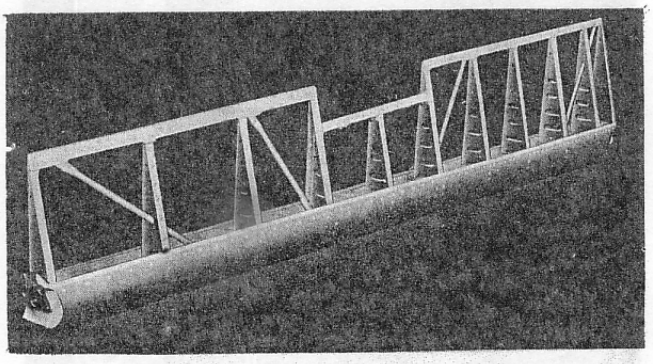


Figure 55 — Aileron Structure

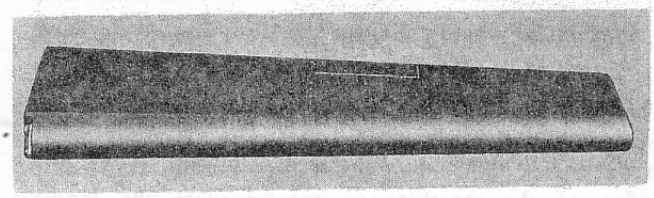


Figure 56 — Aileron

reacts the main bending loads. The maximum loads on the flaps occur when the flaps are in the fully extended position, which is 45 degrees down. Flap panels are attached to the wing by the ball-bearing hinge brackets on the flaps connecting with brackets on the wing. The panels are moved by actuating rods connected to the flap hat section and the flap push-pull rods. The push-pull rods are connected in turn to the flap operating cylinder and equalizer arms located beneath the trailing edge of the center section. The center section rods are connected at their outboard ends to the outer panel rods by universal joints. The operating cylinder actuates the rods which move all flaps in unison. Refer to section IV, paragraph 12 for further information concerning the operating cylinder. A flap position indicator cable leads from its bracket position on the center section flap panel up through the left outer panel into the fuselage where it connects to the control shelf flap position indicator at the left side of the front cockpit. All flap panels have a constant chord design.

(4) AILERONS. — *(See figures 55, 56, 57.)* — Frise-type ailerons are installed in the trailing edge of each outer panel and are located outboard of the wing flaps from which they extend to the wing tips. The aileron frame structure is made principally of 24ST and 24SO Alclad and is covered with doped fabric. A 24ST Alclad spar, extending the full length of the aileron, and a 24ST Alclad leading edge skin, .025 inch in thickness, form a torsionally rigid box. Forward of the spar are flanged leading edge or nose ribs. Aft of the spar are trailing edge ribs. Both are made of 24SO Alclad and are .020 inch and .032 inch in thickness respectively. The nose ribs are riveted to the leading edge skin by means of the flanges and to the trailing edge ribs where the two meet at the spar. The latter ribs extend to the Alclad trailing edge strip to which the trailing edge ribs are

riveted in turn. Further rigidity is given the structure by ½ inch 24SO aluminum-alloy tube braces which, with ends flattened, are riveted to the trailing edge strip and to the spar. These braces are positioned diagonally. The trailing edge ribs are equipped with integral flanged cap strips in which dimpled holes are spaced to provide for the insertion of countersunk fabric attaching screws. Two balancing counterweights, lead permanent mold castings weighing 5.25 pounds and 6.25 pounds respectively, are secured inside the outboard end leading edge skin and provide adequate static balance. Each aileron is shaped to conform with the 2-degree twist in the outer panels. Three hinges with sealed-type ball-bearings support and connect each aileron to the outer panel trailing edges. Drain holes are provided in the lower surface of each aileron. The ailerons have an angular movement of 15 degrees UP and 15 degrees DOWN. Aileron movement on earlier airplanes is 30 degrees UP and 15 degrees DOWN, utilizing a differential motion of 2 to 1. Angular movement is limited by a stop on the center hinge bracket. Additional stops are provided on the control stick torque tube assembly in the fuselage.

(5) AILERON TABS.—Either a booster or a trim tab is mounted on the trailing edge of each aileron. Booster tabs, installed on earlier airplanes, are adjustable from the ground only, and automatically operate upon movement of the ailerons. A push-pull rod extending from the tab is attached to a hinge bracket mounted on the wing. The attachment is such that the tab achieves its own automatic angular travel when the aileron changes position. Trim tabs are installed on later airplanes and are adjustable from the ground only. A connecting rod extending from the tab is attached to a hinge fitting on the aileron. Unlike the booster tab, the trim tab has no angular travel of its own but remains in a fixed position in relation to the aileron when the latter changes position. (Refer to rigging and adjustment instructions in paragraph 11, this section, for information concerning the proper adjustment of either type of aileron tab.) Neither of these tabs is adjustable from the cockpit nor are their mechanisms to be interchanged. Tabs on some later airplanes are constructed of wood and phenolic fiber assembled with casein glue; those installed on earlier airplanes are of riveted Alclad construction. Wooden tabs consist of a leading edge spar and trailing edge strip joined together by ribs which fit into cut-outs in both members. The spar web is of 3-ply Douglas fir which is 3/16 inch in thickness. The spar cap forward of the web is made of pine; the spar cap aft of the web is made of spruce. Inboard and outboard ribs are both made of pine while the remaining three ribs of the tab are made of 3-ply Douglas fir which is ⅛ inch in thickness. The spruce trailing edge strip is ⅛ inch thick. Three-ply Douglas fir, 1/16 inch thick constitutes the skin covering. Drain holes are located in the lower surface of the skin. Two Ledaloyl bearing hinge assemblies installed in the tab leading edge provide a means of attachment to the aileron. A horn to which the connecting or push-pull rod fastens is installed on the lower surface of the tab near the inboard end. Metal tabs consist of a 24ST Alclad leading edge channel section, 24SO Alclad ribs and are covered by 24ST Alclad skin .016-inch thick. The flanged ribs are riveted to the channel section and the skin is riveted to the ribs. The skin, formed from one piece of material, is shaped around the tab structure. The trailing edge of the tab is thus formed by the bend in the skin. Drain holes are provided in the lower surface of the skin. Two ball-bearing hinge assemblies are riveted to the channel section and provide a means of attachment to the aileron. A connecting or push-pull rod horn is secured to the lower surface of the tab near the inboard end.

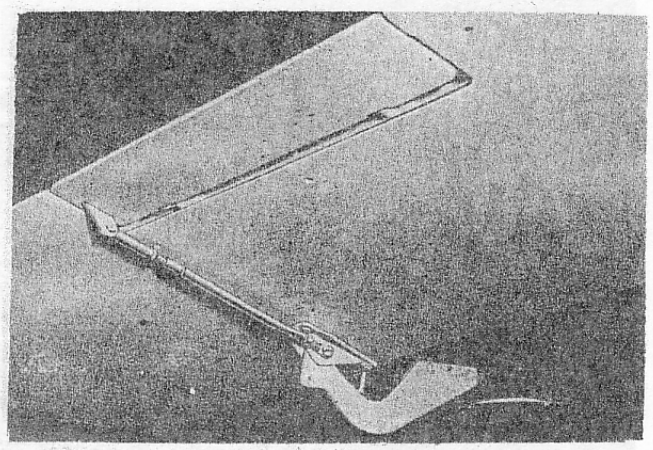


Figure 57 — Aileron Tab Push-Pull Rod

b. REMOVAL AND DISASSEMBLY.—The major sub-assemblies of the wing may be removed individually or, following instructions for removal of the center section from the fuselage, the complete wing may be removed as a unit. Make certain the parking brakes are disengaged before disconnecting the brake lines and that the wheels are blocked. Place a bar or rigid tubing with hooked ends between the towing lugs at the jacking point of each wheel to prevent possible collapse of the wheels during removal proceedings.

(1) WING TIP.—Remove the screws securing the wing tip to the outer panel and the bonding braid. Remove the assembly.

(2) OUTER WING PANELS.

(a) Remove all inspection and access door covers in the vicinity of the attachment angle. (See section III.)

(b) Put the flap panels in the "DOWN" position and disconnect the flap push-pull rod at the universal joint located immediately outboard of the bolting angle by removing the bolt from the inboard end of the joint. (See figure 58.)

(c) Remove the free air thermometer from the lower surface of the left outer wing panel. Unthread the bulb through the grommet located in the lower surface of the wing and through the lightening hole located in the auxiliary spar. Unthread the bulb and

tube through the grommet located in the center section trailing edge, and coil the tube in a large circle, taping it to the fuselage structure. This thermometer is not installed on later airplanes.

CAUTION

Do not bend, fold or pinch the capillary tube units and do not, under any circumstances, attempt to disassemble them or remove any portion of them.

(d) Disconnect the pitot lines in the leading edge of the right outer panel near the bolting angle. Access to connecting fittings is obtained through an inspection door on the underside of the right outer panel just outboard of the bolting angle.

(e) Remove the landing-gear hydraulic operating cylinder piston attaching bolt on the forward face of the landing-gear strut.

(f) Disconnect the landing-gear operating cylinder hydraulic lines at the wing joint plate.

(g) Disconnect the aileron cables at the turnbuckles, access to which is gained through an inspection door on the lower surface of the outer panel near the wing joint bolting angle.

(h) If the fixed wing machine gun is installed, disconnect the gun charging cable from the gun, which is located in the right outer panel. The access door for this purpose is located below the gun outboard of the wing joint bolting angle.

(i) If bomb racks are installed, disconnect the two bomb release cables at the bell crank in each outer panel, access to which may be obtained by means of the access door directly inboard of the bomb rack in the lower surface of each outer panel.

(j) Disconnect the electrical wiring and its conduit at the junction box located in the leading edge of the center section just inboard of the wing joint bolting angle; thread the flexible conduit and wire through the grommet in the center section end plate, allowing the wire and conduit to remain with the outer panel.

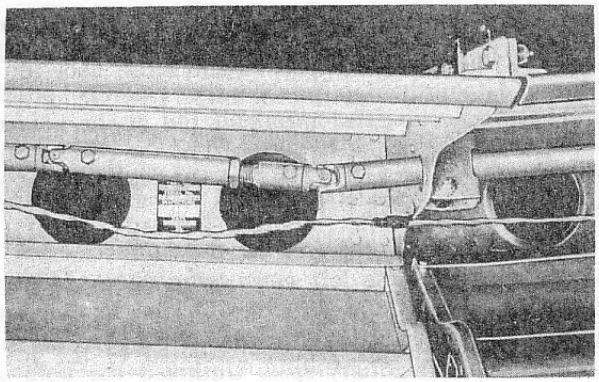


Figure 58 — Flap Push-Pull Rod Universal Joint

WARNING

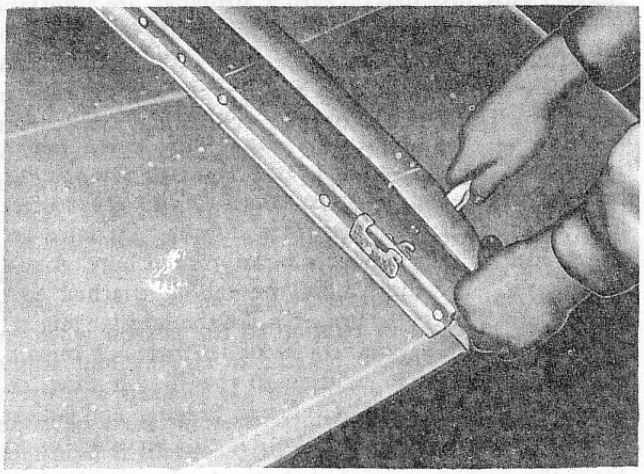
DO NOT disconnect the conduit at the access cover in the outer panel, as reassembly will be difficult.

(k) Remove the wing joint bolting angle cover by removing the attaching screw located outboard on the bottom surface of the cover approximately midway between the trailing and leading edges of the wing, and by removing the safety wire and raising the latch on the upper surface trailing edge. This action will free the cover from the lower surface trailing edge fitting. (See figure 59.)

(l) Support the outer wing by means of padded cradles near the root and near the tip.

(m) Remove the five bolts attaching the angle on the main spar of the outer panel to the center section end plate. Access to the bolts is obtained through an inspection door on the underside of the wing just outboard of the wing joint bolting angle. (See figure 60.)

(n) Remove the bolts from the wing joint bolt-



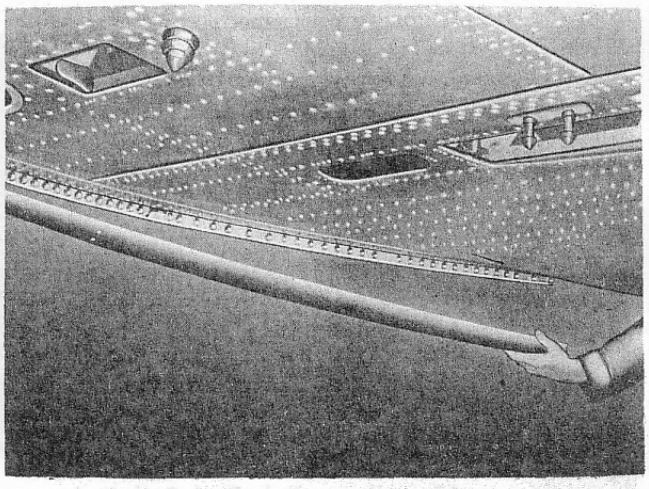


Figure 59 — Wing Joint Bolting Angle Cover Attachment

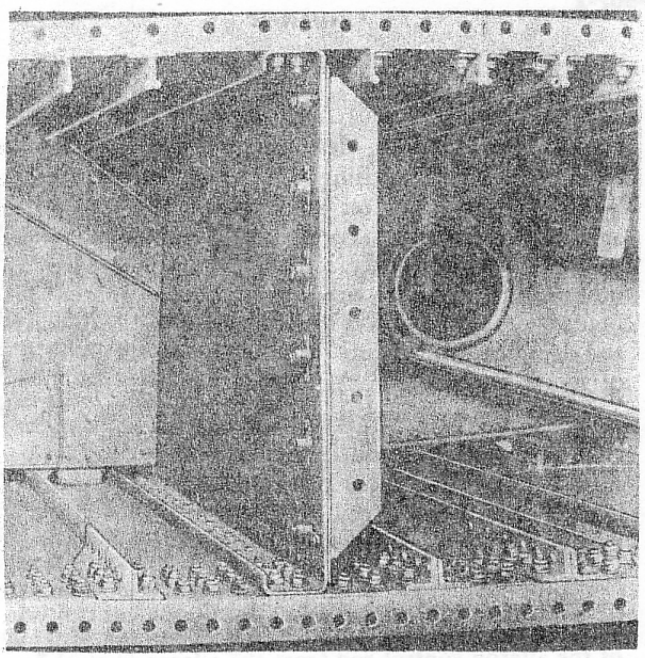


Figure 60 — Outer Panel Main Spar

ing angle starting at the trailing edge and working to the leading edge of the lower surface first and then the upper surface.

(o) When rolling the outer panel away from the center section, exercise care in guiding the landing-gear hydraulic operating cylinder piston rod through the end plate.

(3) CENTER SECTION. — Removal instructions for the wing center section constitute removal instructions for the entire wing as a unit.

(a) Remove the fuselage side panels and wing-to-fuselage fairing which are attached by screws.

(b) Disconnect the fuel line located at the center section front bulkhead.

(c) Disconnect the pitot pressure and static lines from the T-fittings located behind the right side of the fire wall above the center section, but allow the T-fittings to remain with the fuselage lines. (See figure 61.)

(d) Disconnect the cold air intake tube at the free sleeve fitting located between the center section elbow fittings and the cockpit ventilator control neck.

(e) Disconnect the landing-gear position indicator cables from the indicator bell cranks, and coil and tape them to the center section.

(f) Remove the clamps and dust boot from the landing gear down-position lock control rod. Loosen the lock nut on the lower end of the control rod and disconnect the rod.

(g) Disconnect the flap position indicator cable from the angle on the center section flap panel; pull the cable through the fair-lead in the center section.

(h) Disconnect the fuel tank vent line at the fittings located on the upper surface of the center section at each side of the fuselage.

(i) Disconnect the fuel cock selector control rod by removing the two cotters from the yoke on the fuel cock. (See figure 62.)

(j) Remove the fuel gage light assemblies from the gages mounted on the center section, one on each side of the pilot's seat, by removing two screws from each, allowing the light assemblies to remain with the fuselage by taping them to the lower longeron tube.

(k) Disconnect the three flap hydraulic valve line fittings located at the rear of the center section below the fuselage.

(l) Disconnect the aileron control cables from the stick torque tube horn. Wire the ends together to prevent the cables from slipping into the center section. Identify them for convenience of reassembly.

(m) If the fixed wing machine gun which is located in the right outer panel is installed, disconnect the gun charging cable at the barrel fitting between the two pulleys at the right side of the fuselage.

(n) If bomb racks are installed, disconnect the

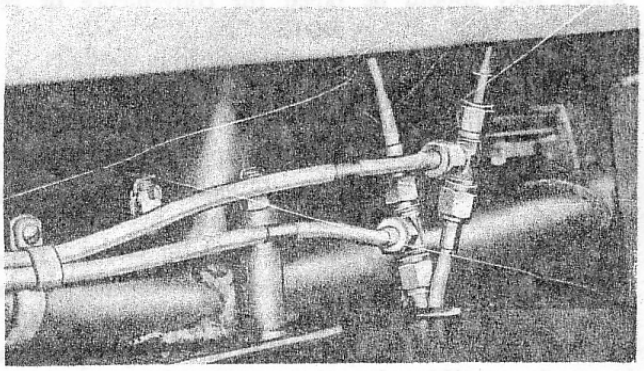


Figure 61 — Pitot Line Connection at Center Section

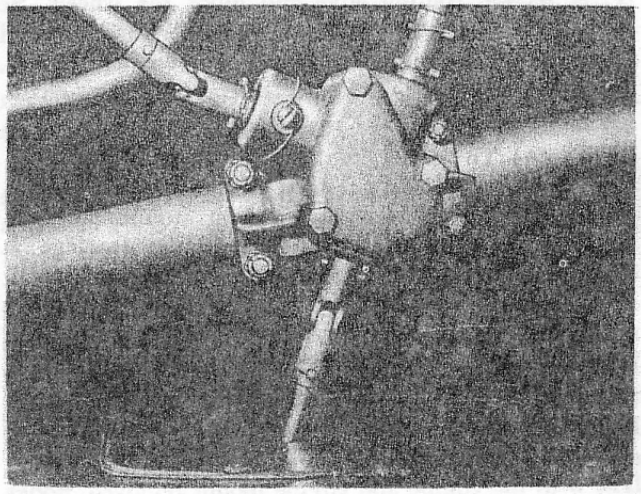


Figure 62 — Fuel Selector Control Rod Attachment

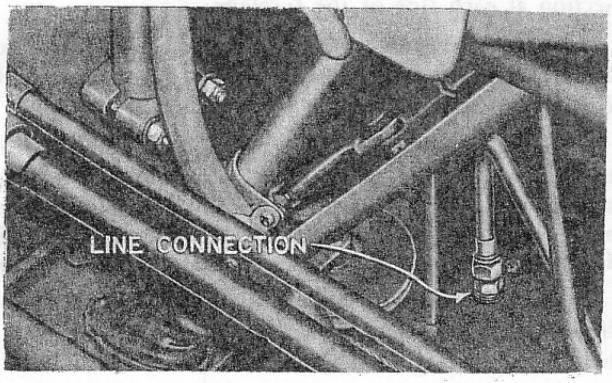


Figure 63—Brake Hydraulic Line Connection at Center Section

right and left arming and release cables at the two connections between the pulleys at the left side of the fuselage.

(o) Remove the cover from the electrical junction box located on the left of the fuselage just aft of the fire wall, and disconnect two flexible conduits at the junction box. Pull the wiring from the junction box; lower the conduits to the center section where they should be taped for convenience of reassembly.

NOTE

On late model airplanes these flexible conduits are not installed.

(p) Disconnect the two landing-gear hydraulic lines at the fittings on the left upper surface of the center section just aft of the fire wall.

(q) Disconnect the two brake hydraulic lines at the fittings located on each side of the center section upper surface just aft of the fire wall. (See figure 63.)

(r) Hoist the airplane into level flight position by passing a lifting bar through the lift tube at the rear of the fuselage and attaching hoist chains to it.

(s) Place suitable padded supports under the center section trailing edge and block the wheels. Be sure rigid bar or tubing with hooked ends is placed between towing lugs at the jacking point of each wheel.

(t) Remove the two nuts and washers at each of the four points of the fuselage-to-center-section attachment.

(u) To hoist the fuselage assembly from the center section it is necessary, if the power plant is installed, to arrange a hoisting sling around the upper engine mount members forward of the fuselage attachment fittings. Place a suitable bar through the lift tube in the rear portion of the fuselage and arrange hoisting slings around it. The fuselage assembly may then be hoisted, utilizing the two slings with a separate hoist for each sling, or a crane or hoist equipped with an equalizer or spreader bar. When hoisting the fuselage with the engine and engine mount removed, hooks must be added to the ends of the hoisting sling and the hooks inserted through the holes in the bottom of the upper engine mount terminals. (See section III.)

CAUTION

DO NOT use the engine mount lugs to hoist the airplane.

Hoist the fuselage clear of the center section at least 10 inches, exercising caution to see that proper hoisting chain clearances are observed to prevent damage to the fuselage assembly or installed equipment and that all disconnect control rods, lines, wires and other installations are either supported or guided clear. Make sure that the lower section of the fuel cock control rod does not swing to the rear and engage the inner edge of the access hole.

(4) AILERON TABS.—Disconnect the aileron trim tab connecting rod from the bracket on the lower surface of the tab. This procedure also applies to the booster tab push-pull rod installed on earlier airplanes. Disconnect the tab at the two tab hinges; remove the tab.

(5) AILERONS.—Disconnect the adjustable end of the aileron control rod from the aileron control horn. (See figure 64.) Then disconnect the aileron from the outboard, inboard and center hinge fittings respectively; remove the aileron.

(6) WING FLAPS.—Each of the three landing flaps should be in the "DOWN" position prior to removal.

(a) Disconnect the flap position indicator cable from the angle plate riveted to the center section flap panel. (See figure 65.)

(b) Disconnect the upper fixed end of the small flap actuating rods from the attachment points on the push-pull rods.

(c) Disconnect the three flap panels from the outer panels and center section at their respective hinge points.

(d) Remove the flap panel.

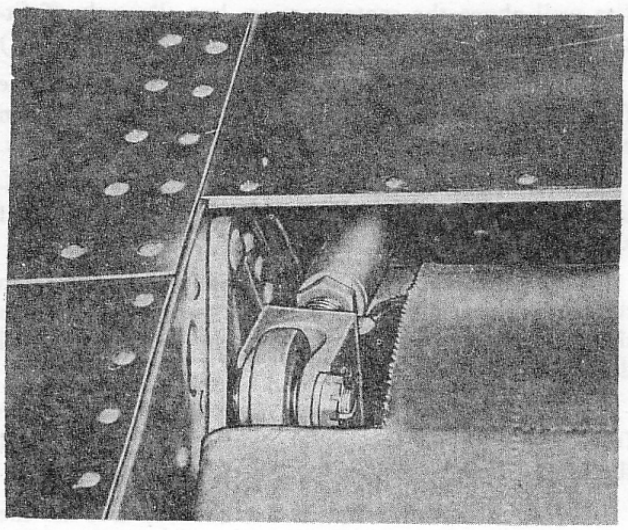


Figure 64—Aileron Control Rod and Horn

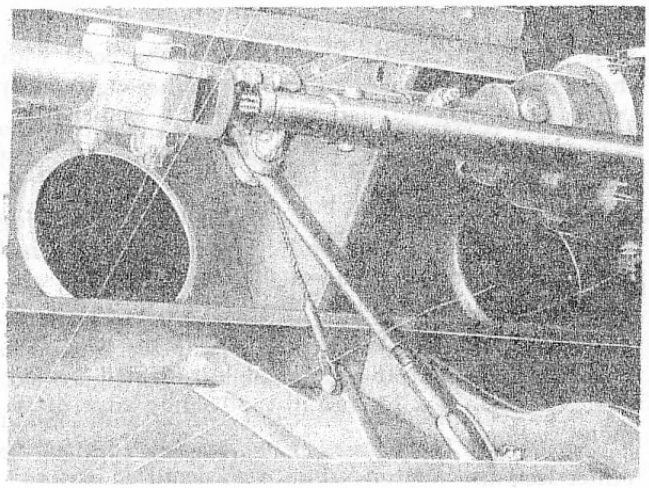


Figure 65 — Flap Position Indicator Cable

c. ASSEMBLY AND INSTALLATION.—The major sub-assemblies of the complete wing assembly may be installed individually or the complete wing assembly may be installed beneath the fuselage in one unit as explained in following paragraphs. Do not remove the plugs from the ends of the pitot tube, fuel and hydraulic lines until ready to make line connections. These plugs are provided in order to prevent possible loss of fluid and entrance of foreign matter.

(1) CENTER SECTION. — *(See figure 66.)* — Prior to installation, the center section should be leveled and supported in position with the landing gear down. Place a bar or rigid tubing with hooked ends between the towing lugs at the jacking point of each wheel to prevent the wheels from retracting during the wing installation. The fuselage should be hoisted and then lowered to the center section and attaching points lined up. Care should be exercised when lowering the fuselage to see that all fittings, rods, wire, lines, fuel selector valve control shaft, etc., are either clear or guided into their proper position as required. Make sure that spacers are in position. Secure attachment bolts with nuts, cotters, and washers; adhere to the following procedure:

(a) Connect the electrical wiring at the left leading edge to the center section to respective terminals in the junction box just above this location. Attach the two conduits to the junction box; secure the conduits to the fuselage tube with clamps as required.

(b) Attach the fuel gage light assemblies with screws to the fuel gages mounted on the center section, one at each side of the pilot's seat.

(c) The aileron cables, extending through the fiber fair-leads to the upper surface of the center section, are identified for convenience of assembly, and the ends are tied together to prevent them from slipping into the center section. Connect the cables to the aileron torque tube horn located between the two cockpits. Check to make sure the installation is correct.

(d) If the fixed wing machine gun which is located in the right outer panel is installed, connect the gun charging cable to the barrel fitting between the two pulleys at the right side of fuselage.

(e) If bomb racks are installed, connect the right and left bomb arming release cables to the two connections between the pulleys at the left side of the fuselage.

(f) Connect the three flap hydraulic lines to the hydraulic cylinder fittings extending through the upper surface of the wing trailing edge at the left side of the fuselage.

(g) Safety the fuel selector valve drive shaft to the fuel cock unit with two cotters; make certain all taper pins are safetied.

(h) Lower the flaps, thread the end of the flap position indicator cable through the fair lead at the left trailing edge of the center section, and attach the clevis end of the angle plate riveted to the center section flap panel. An adjustable clevis end is provided at the upper end of the cable, attaching to the indicator arm installed on the forward end of the control shelf in the front cockpit. Adjust the clevis end to obtain the correct position indication.

(i) Connect the two landing-gear position indicator cables to the indicator arms installed on the control shelf at the left side of the front cockpit; adjust the cable clevis ends to obtain the correct position indication.

(j) Connect the two landing gear hydraulic lines to the fittings on the center section leading edge at the left side of the fuselage.

(k) Connect the landing gear "DOWN" position lock mechanism by attaching the non-adjustable end of the actuating rod to the bell crank located in the side of the center section. Slide the dust boot on the rod, and attach the adjustable end to the corresponding bell crank forward of the control shelf. Attach the lower end of the dust boot to the flange on the mechanism support casting, and clamp the small upper end of the boot to the rod when the landing-gear control is set in the "UP" position.

CAUTION

Place a suitable spreader bar between the landing gear struts at the wheel jacking points before moving the landing gear controls to the "UP" position.

(l) Connect the fuel line leading from the fuel unit on the forward side of the fire wall to the fitting extending from the center section through the fire wall.

(m) Install hot and cold air ducts between the ventilation control valves and center section elbow fittings. Secure the ducts to the valves with bolts.

(n) Connect the hydraulic brake line at each side of the fuselage to the connector fittings provided

on the upper surface of the center section leading edge.

(o) Install the fuselage side filler former at each side of the fuselage between the fire wall and center section.

(p) Connect the two pitot lines at the T-fittings located immediately above the leading edge of the center section at the right side of the fuselage.

(q) Check for proper adjustment and functioning of the control linkage, lock mechanisms, and indicator cables involved in this installation. Make certain the rubber grommets are installed where required.

(r) Install the wing-to-fuselage fillets and fuselage side panels. Install the front fillets first. Make certain the hydraulic fluid reservoir vent line is inserted through the hole in the fairing located aft of the center section under the fuselage and extending approximately 6 inches below the fairing.

(2) OUTER WING PANELS.—Each outer wing panel is twisted 2 degrees forward resulting in an angle of incidence of 0 degrees at the tip. Later model wings have an aileron movement of 15 degrees up and 15 degrees down travel. These wings are marked with a star stenciled on the upper surface. Check that aileron movement is identical on both wings. Prior to installing an outer wing panel, clamp or tape the aileron in the "NEUTRAL" position and the flap panels in the "UP" position. Make certain all cables, tubes, lines, etc., are located or supported clear of the bolting angles and other parts of the wing structure. Each outer panel should then be supported near the tip and near the bolting angle by a suitable supporting cradle. With the foregoing accomplished, adhere to the following procedure:

(a) Place the panel in position, align the bolt holes, and bolt the outer panel to the center section.

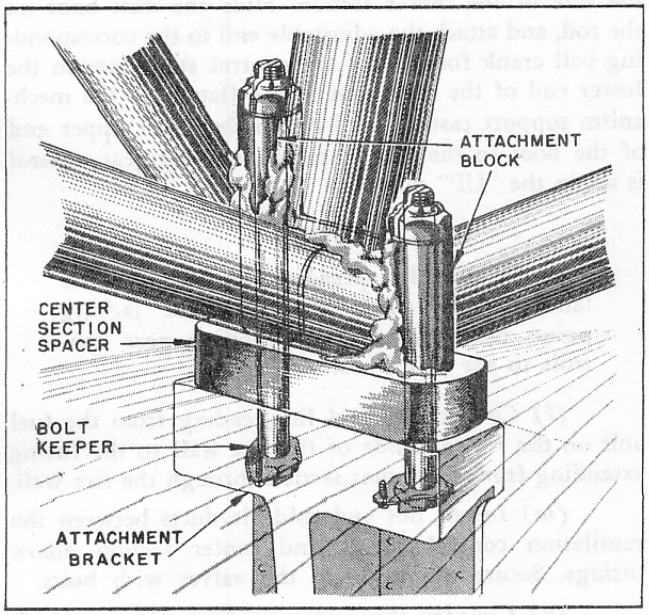


Figure 66 — Fuselage-to-Wing Center Section Attachment

It is structurally satisfactory to install the bolts with the heads either inboard or outboard. (See figure 67.)

(b) Attach the front spar of the outer panel to the center section end plate by means of the outer panel spar bolting angle through which five bolts are inserted. These bolts should be started before installing those in the wing joint bolting angle and tightened after the latter are tightened.

(c) Connect the end of the landing gear operating cylinder piston rod to the attachment fitting on the front landing-gear strut assembly. (See figure 68.)

(d) Connect the electrical wiring and conduit at the junction box located in the leading edge of the center section.

(e) The aileron cables are identified for convenience of assembly, and the ends are attached to prevent them from slipping into the wing structure. Access

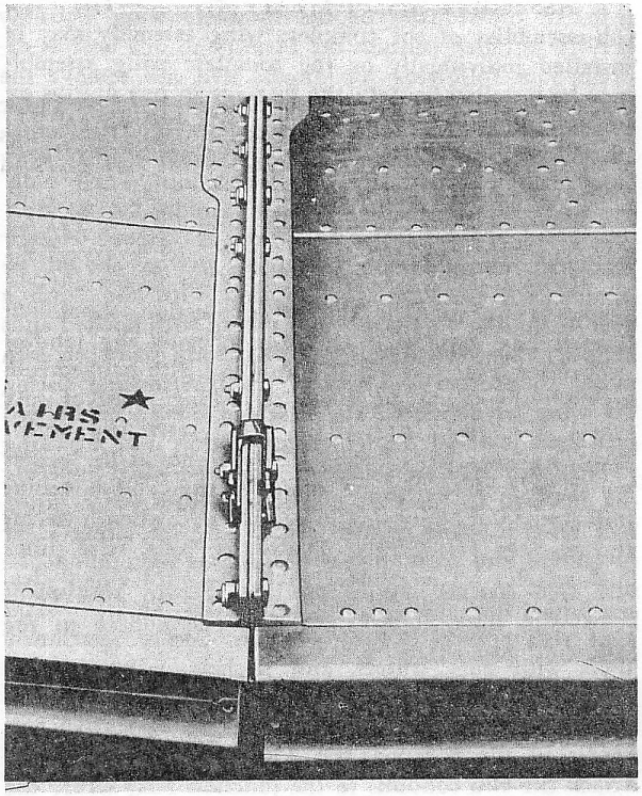


Figure 67 — Wing Bolting Angle Attachment

to the aileron cables is made through Dzus-fastened inspection doors on the lower surface of the outer panel, approximately 2 feet outboard of the wing joint bolting angle. Connect the cable ends at the turnbuckles provided.

(f) If the fixed wing machine gun is to be installed, connect the gun charging cable to the gun which is located in the right outer panel. The access door for this purpose is located below the gun outboard of the wing joint angle.

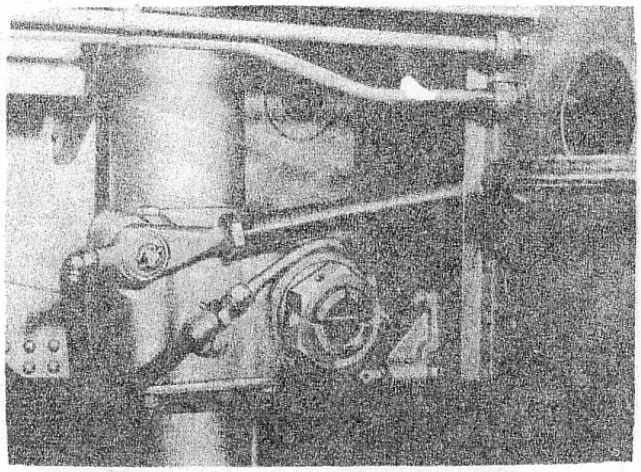


Figure 68 — Landing Gear Operating Cylinder Piston Rod Attachment

(g) If bomb racks are to be installed, connect the two bomb release cables to the bell crank in each outer panel, access to which may be obtained by means of the access door directly inboard of the bomb rack in the lower surface of each outer panel.

(h) Connect the pitot lines in the leading edge of the right outer panel near the bolting angle.

(i) Connect the flap push-pull rod at the universal joint located immediately outboard of the bolting angle between the center section and the outer wing panel.

(j) Install the wing joint cover assemblies, incorporating extruded neoprene channels cemented to the edges of the covers with "caram" running board cement or equivalent.

(k) Check the installation and install all cover plates.

(l) Connect the two hydraulic lines from the retracting strut to the connector fittings on the center section end plate in the leading edge.

(3) WING TIPS.—Start two screws in the top and two in the bottom sides of the tip. Select locations approximately in the center.

(a) Align the trailing edge of the wing tip with the trailing edge of the aileron when the trailing edge of the aileron is in direct alignment with the trailing edge of the wing. Connect the bonding braid.

(b) Start all screws; align the nose of the wing tip with the wing.

(c) Tighten all screws and recheck the alignment.

(4) AILERONS.—Place the aileron in position; secure it to the center, outboard and inboard hinge fittings respectively and then:

(a) Check the alignment of the hinge point centers in the event any of the hinge brackets have been replaced.

(b) Attach the adjustable end of the aileron control rod to the aileron control horn.

(5) AILERON TABS.—Place the trim tab in position; connect the two support tab hinges. Connect the aileron trim tab connecting rod on the lower surface of the tab to the aileron hinge bracket. The connecting point is on the axis of rotation of the aileron. This procedure also applies to the booster tab push-pull rod installed on earlier airplanes in which instance the rod is connected to a fixed part of the aileron hinge. Refer to DESCRIPTION, paragraph 1*a.* (5) for additional information concerning the difference between the trim tab and booster tab.

(6) WING FLAPS.—Prior to installing the flap panels, operate the flap controls to obtain the position of the actuating mechanism relative to the full "DOWN" position of the flaps.

(a) Attach the three flap panels to the lower surface of the center section and outer wing panels at their respective hinge points.

(b) Attach the upper fixed end of the small flap actuating rods to the points of attachment on the

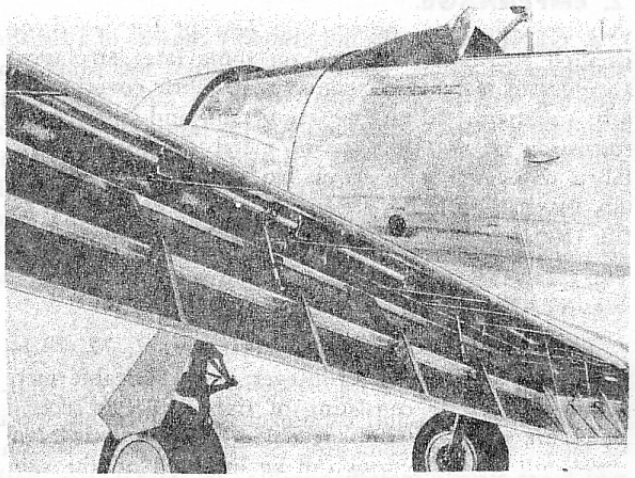


Figure 69 — Wing Flaps

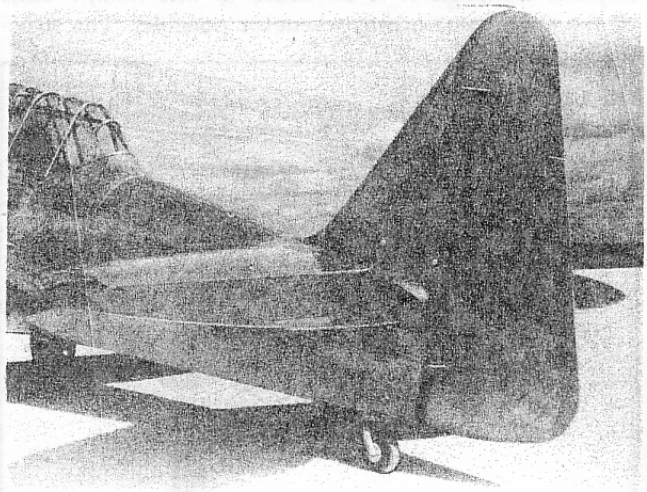


Figure 70 — Empennage

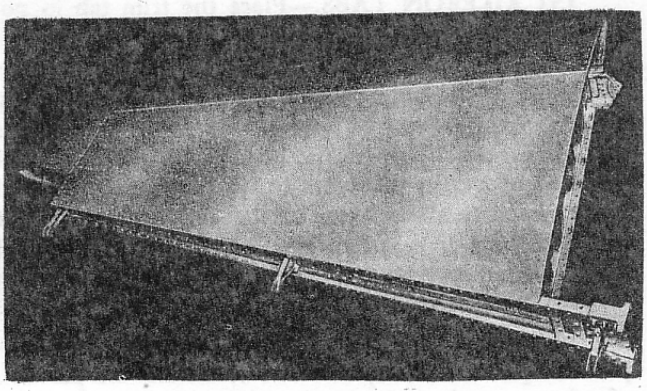


Figure 71 — Stabilizer

push-pull rod, the lower adjustable ends of the actuating rods being attached to the flap panel ribs.

(c) Attach the flap position indicator cable to the angle plate riveted to the center section flap panel.

(d) For rigging and adjustment, refer to paragraph 11. *c* of this section.

2. EMPENNAGE.

a. GENERAL.—The tail assembly consists of a fin and stabilizer of metal construction (except for wood-constructed stabilizers installed on some later airplanes); a rudder of metal construction with fabric covering and provided with adjustable trim tab; and an elevator consisting of two sections of metal construction with fabric covering, each section having an adjustable trim tab. Navigation lights are installed on both sides of the fin. (Refer to section I for tail dimensions and Airplane Stations Diagram.)

b. STABILIZER.

(1) DESCRIPTION.—*(See figures 71, 72, 73.)*—The stabilizer is a full cantilever, non-adjustable metal or wood structure consisting of right and left sections which are strictly interchangeable. In emergencies, both metal and wood sections can be installed on the same airplane although it is advisable to interchange units of the same construction whenever possible. The structure has a permanent setting of plus 1 degree relative to the longitudinal axis of the airplane. Metal units, formed from 24ST Alclad sheet with the exception of the aluminum-alloy tip assembly, consist essentially of two spars, regularly spaced ribs, and skin which is stiffened by spanwise stringers. The flush riveted leading edge and side skins are .040 and .032 inch in thickness, respectively, with the stringers spot-welded to the side skins. The heavier metal provides extra protection for the leading edge. The tip assembly, secured by screws and readily removable, is .032 inch in thickness. On wooden stabilizers the skin, as well as the spar and rib webs, is made from 3-ply mahogany, poplar core, plywood. The face grain of the skin describes a 45-degree angle to the main spar, which design gives the structure greater strength. Internal units include spruce stiffeners with spruce tricleat caps, spruce spar caps, and elevator hinge supporting blocks of maple. Other structural blocks are of spruce. The skin is 1/16 inch thick with the exception of the tips which are 3/32 inch thick. The tips of the wooden stabilizer are not removable. The front spar base is made from birch veneer while the rear spar base is made from compregwood. The latter is an impregnated and compressed maple laminated plywood. Laminated spruce provides strength for the leading edge. The stiffeners are held securely in position in the rib cut-outs by means of small wedges. Glue adheres one to the other and is used as a bonding agent. The skin is glued to the stiffeners, ribs, and spar caps. Either casein or resin glue is used in the assembly. A smooth fabric covering doped in place completes the structure. The basic design of the metal and wood stabilizers is essentially the same. Both are provided with drain holes. Like the fin, the stabilizer is mounted simply. Four bolts, two on either side of the rear spar joint, and two bolts, one on either side of the front spar, secure the structure to the fuselage.

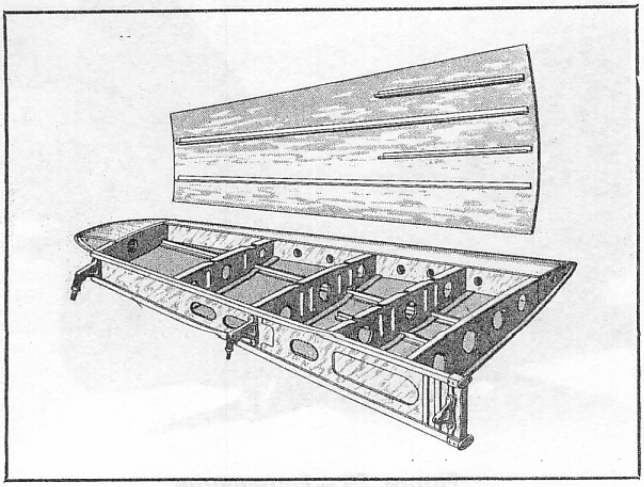


Figure 72 — Metal Stabilizer Structure

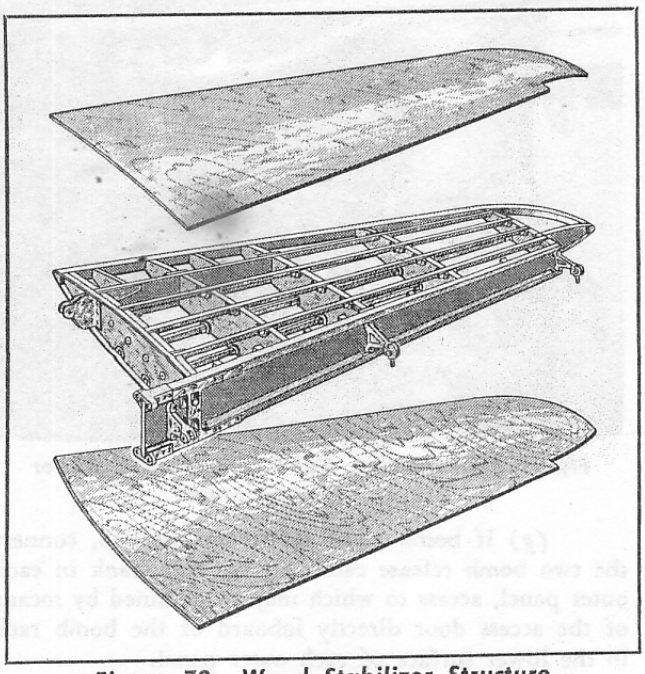


Figure 73 — Wood Stabilizer Structure

NOTE

Although the original requirements call for the various types of wood described above, certain substitute woods might be found in the various units of construction, as further requirements permit and as the manufacturers deem such substitutions necessary.

A second type of wood stabilizer, differing somewhat in construction from the one described above, is also used on some later airplanes. On this type the skin is made from 3-ply Douglas fir, poplar core, plywood, and is 3/32 inch thick on all surfaces, including the tips. The skin grain is parallel to the rear spar. Also made from Douglas fir plywood are the front spar webs, front spar cap strip, ribs, and formers. Plain Douglas fir constitutes the rear spar webs and tricleats. Blocks are made from Douglas fir and maple. The rear spar cap strip, the bow of the leading edge and the front spar base are made from laminated Douglas fir. Fillers, flanges, pads, and the rear spar base are made from compregwood. Stiffeners are eliminated from this structure as are the nose ribs although one extra rib is added to the main body of the stabilizer. It is fabric-covered. Like the first wood stabilizer described, certain substitute woods may be used for units of construction.

(2) REMOVAL.—It is recommended that the two stabilizer sections be removed as a unit after removal of the fin. The elevator may be removed while connected to the stabilizer. (Refer to paragraph *c.* (2) for information concerning the disconnecting of elevator cables, etc.)

(a) Remove the four bolts attaching the lower edge of the rear spar to the fuselage. Two bolts are on each side of the spar joint.

(b) Remove the two bolts attaching the front spars of the stabilizer sections to the fuselage.

(c) Lift the stabilizer assembly clear.

(d) Separate the two stabilizer sections by removing the four bolts holding the upper and lower edges of the rear spar together.

(3) INSTALLATION. — *(See figure 75.)* — The stabilizer assembly consists of two interchangeable sections which are bolted together through fittings provided on the upper end lower edges at the inboard ends of the rear spar. The stabilizer sections may be installed individually or, prior to installing the vertical surfaces, as a complete attembly. Before installing the stabilizer, insert sheet metal shims between the spar flange and base allowing for maximum gap of only .010 inch. Drill holes through the shims to correspond with those in the fittings. The elevator sections may or may not be attached to the stabilizer sections. Place the stabilizer in position on the fuselage tail and secure it to the fuselage. The rear spar of each stabilizer section is held to the fuselage by two bolts; the front spar of each section is held to the fuselage by one bolt.

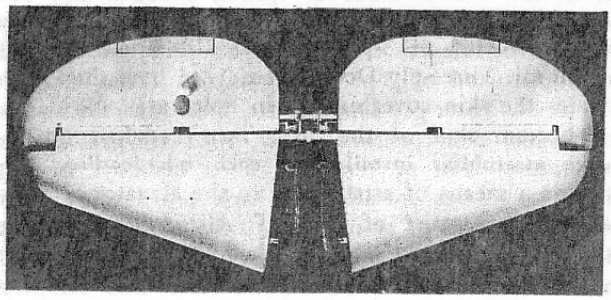


Figure 74 — Horizontal Tail Assembly

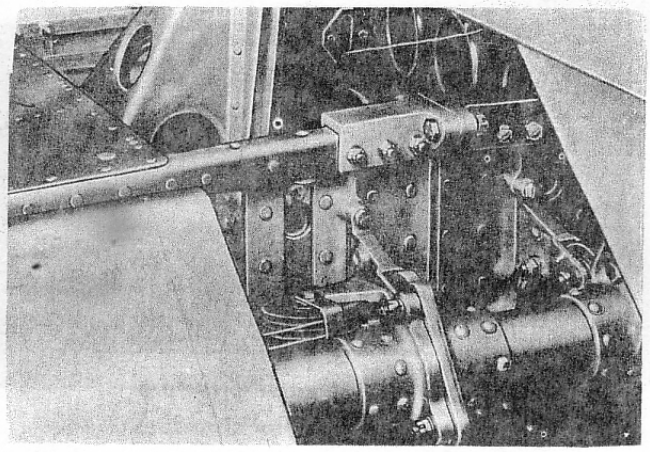


Figure 75 — Horizontal Stabilizer Installation

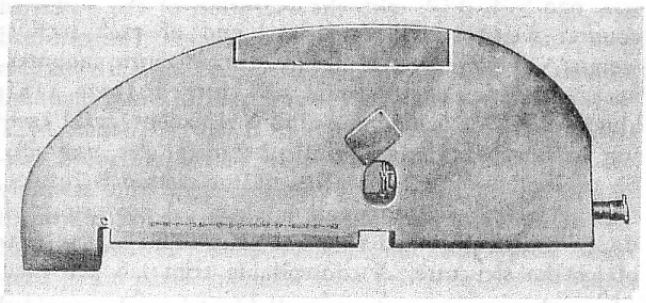


Figure 76 — Elevator

c. ELEVATOR.

(1) DESCRIPTION.—*(See figures 76 and 77.)*— The elevator assembly consists of two interchangeable sections bolted to either end of a control horn torque tube to which are attached the center hinge points for the complete assembly. When the two sections are bolted together, the entire structure is supported by hinge brackets which are bolted to the rear spar of the stabilizer. The general construction of the elevator is substantially the same as that of the rudder. The 24ST Alclad aluminum frame for each elevator section is constructed around a 1¾-inch diameter 24ST aluminum-alloy torque tube which forms the primary load-bearing member of the structure. The ribs are formed from .020 inch thick 24SO Alclad sheet. In original rib forming, power-pressing was utilized to provide the integral cap strips, stiffening beads, and flanged cut-outs. The ribs extend from the leading edge to the trailing edge and are riveted to the torque tube by means of flanged collars. The leading edge forward of the torque tube is

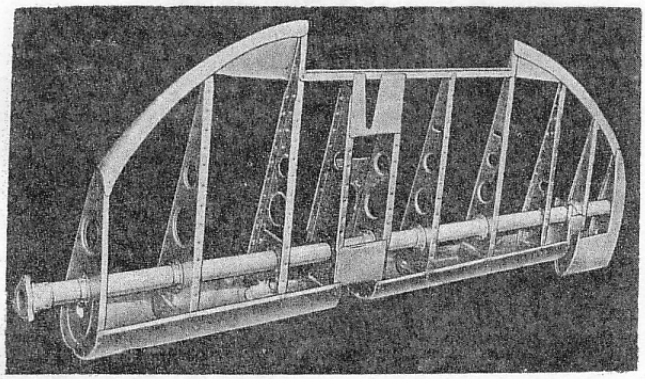


Figure 77 — Elevator Structure

formed from several 24ST Alclad sheet sections which are .020 inch thick with the exception of the outboard nose skin which is .032 inch in thickness. The cast-lead counter weight at the outboard end of each section weighs 5.25 pounds. The elevator control horn, mounted upon the complete assembly, is forged from 14ST aluminum-alloy (aluminum-alloy permanent mold casting in later airplanes), while the metal cap assembly on the outboard end of each elevator section is formed from 52S½H aluminum-alloy sheet. A covering of doped fabric, provided with adequate drain holes, completes the structure. A controllable trim tab provided with drain holes, a trim tab operating mechanism, and cable are assembled on the frame. The entire elevator assembly has an angular movement of 30 degrees "UP" and 20 degrees "DOWN." Adjustable stops are located on the aileron torque tube in the fuselage.

(2) REMOVAL.—The two interchangeable elevator sections must be removed individually if the fin is installed, but may be removed together otherwise. Apply the following instructions, accordingly:

(a) Disconnect the cable ends from the tab control cables in the fuselage by removing the turnbuckles.

(b) Slip the trim tab drum cables out of the holes and fair-leads on the fuselage deck and the holes at the rear spar of the stabilizer. Unthread them from the pulleys.

(c) Disconnect the elevator control cable from the elevator control horn.

(d) Disconnect the elevator assembly from the hinge brackets on the rear spar of the stabilizer. The assembly may now be removed if the fin is removed. If not, observe the next instruction.

(e) Disconnect the torque tube of the elevator section from the elevator horn torque tube and remove the elevator.

(3) INSTALLATION.—The two interchangeable elevator sections must be installed individually if the fin is installed, but may be installed together otherwise. Apply the following instructions, accordingly. After interchanging the elevator sections or installing a spare section, make certain the drain holes on the upper surfaces are covered and that new drain holes are added to the lower surfaces.

(a) Attach each elevator section to the hinge brackets on the rear spar of the stabilizer at the two hinge points on the elevator control horn torque tube flanges after the elevator sections and torque tube have been bolted together. This applies if the fin is installed. If this is not the case, the elevator sections may be bolted to the control horn torque tube and the complete assembly lifted into position on the fuselage.

(b) Check for proper alignment of the hinge point centers in the event any of the hinge brackets have been replaced.

(c) Attach the elevator control cables to the elevator control horn.

(d) Thread the trim tab drum cables around the pulleys, through the holes at the rear spar of the stabilizer, and through the holes and fair-leads on the fuselage deck.

(e) Connect the cable ends with turnbuckles to the tab control cable in the fuselage.

NOTE

Cable ends are color-coded to facilitate installation.

d. ELEVATOR TRIM TABS.

(1) DESCRIPTION.—A trim tab mounted on the trailing edge of each elevator section is adjustable by a control wheel on the left side of each cockpit. The tab is connected to a thread actuating rod and drum cable assembly in its respective elevator section by a push-pull rod which extends from a horn on the tab to the clevis of the actuating rod. Trim cables lead from the drum assembly to the cockpit control wheels. (Refer to paragraph 11 for further information concerning trim tab controls, rigging and adjustment.) Tabs on some later airplanes are constructed of wood and phenolic fiber assembled with casein glue; those installed on earlier airplanes are of riveted Alclad construction. Wooden tabs consist of a leading edge spar and trailing edge strip joined together by ribs which fit into cut-outs in both members. The spar web is 3-ply Douglas fir which is 3/16 inch in thickness. The spar cap forward of the web is made of pine; the spar cap aft of the web is made of spruce. Inboard and outboard ribs are made of pine as is the No. 2 inboard rib. The middle rib and its neighboring outboard rib are constructed of 3-ply Douglas fir. There are five ribs in all. Three-ply Douglas fir, 1/16 inch thick, constitutes the skin covering. Drain holes are provided in the bottom skin of the tabs. Two Ledaloyl bearing hinge assemblies installed in each tab leading edge provide a means of attachment to the elevator sections. Metal tabs consist of a 24ST Alclad leading edge channel section and 24SO Alclad ribs. The complete structure is covered by 24ST Alclad skin which is .016 inch thick. Rivets hold the flanged ribs to the channel

section while the skin is riveted to the ribs and to a 24ST Alclad trailing edge strip which lies between the two skin panels. Two ball-bearing hinge assemblies are secured to the channel section and provide a means of attachment to the elevator sections.

(2) REMOVAL.—Disconnect the trim tab push-pull rod from the bracket on the tab. Remove the attaching bolts from the brackets and remove the tab.

(3) INSTALLATION.—Place the trim tab in position, and secure it to the two brackets on the trailing edge of the elevator. Connect the trim tab push-pull rod to the bracket on the tab.

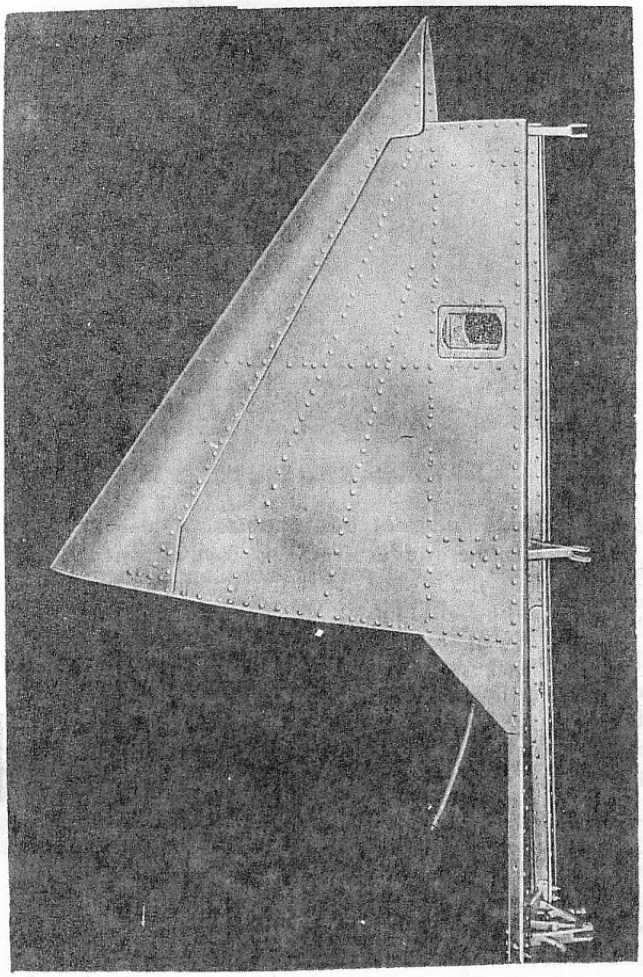


Figure 78 — Fin

e. FIN.

(1) DESCRIPTION.—*(See figures 78 and 79.)*—The fin is a full cantilever non-adjustable structure formed from 24ST Alclad sheet and 24ST formed sections with a permanent setting of 1 degree and 45 minutes, to the left of the longitudinal axis of the airplane. It consists of a front and rear spar, pressed-flanged ribs with stiffening intercostals, and a smooth metal covering. The rear spar is the main load-bearing member of the structure and has U-flanges formed along its length. The flush riveted leading edge and both spot-weld side skins are .040 and .025 inch thick, respectively. The heavier metal provides extra protection for the leading edge. The mounting of the structure is simple. Two bolts secure the rear spar to the fuselage bulkhead; two bolts and a fitting secure the front spar to the fuselage tripod assembly. Frosted white navigation lights are installed on both sides of the structure.

(2) REMOVAL.—Before removing the fin, it is necessary to disconnect the navigation light wiring and conduit from the junction box on the forward side of the fuselage rear bulkhead. Access to the junction box is gained through the access hole on the sides of the fuselage under the stabilizer and elevator. The rudder

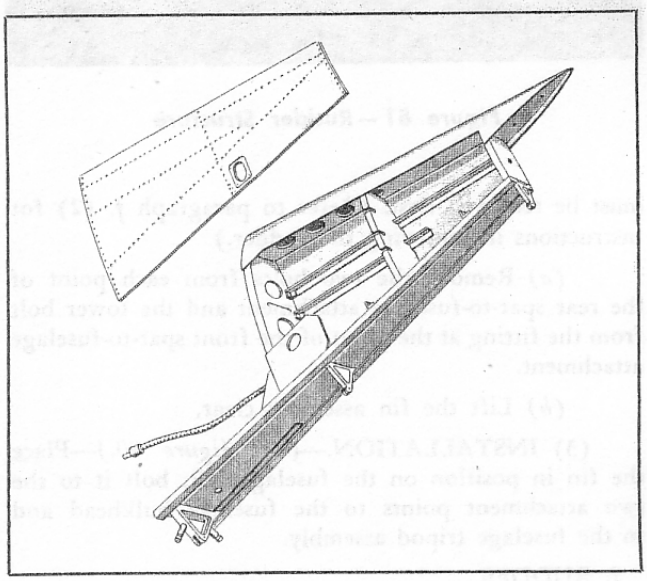


Figure 79 — Fin Structure

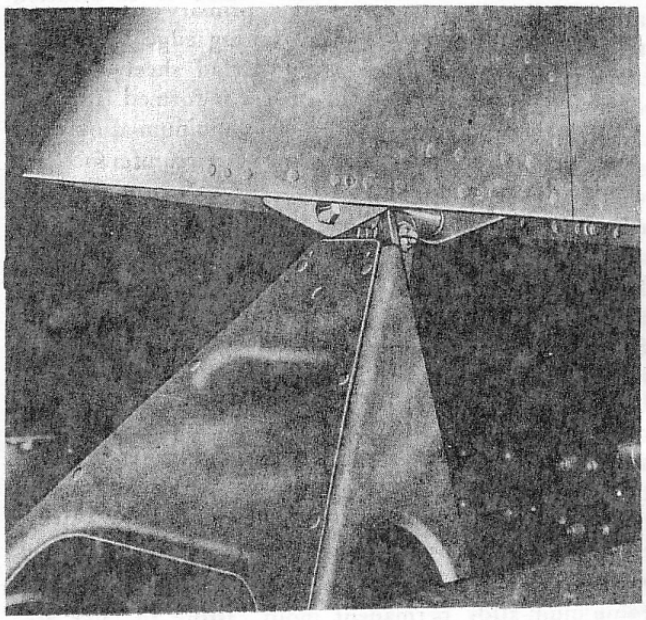


Figure 80 — Fin Installation

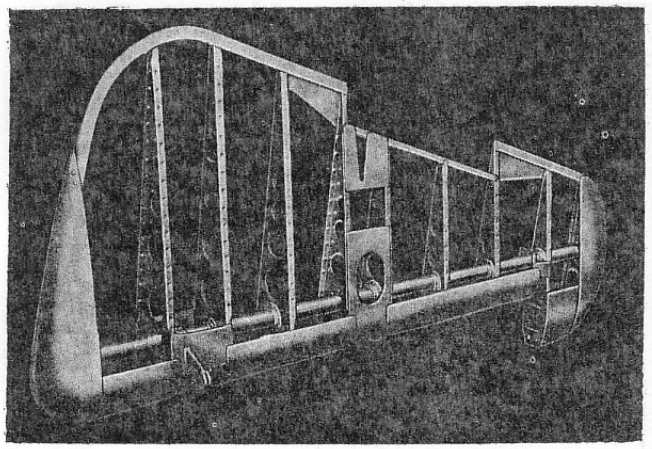


Figure 81 — Rudder Structure

must be removed first. (Refer to paragraph *f.* (2) for instructions in removing the rudder.)

(a) Remove the two bolts from each point of the rear spar-to-fuselage attachment and the lower bolt from the fitting at the point of the front spar-to-fuselage attachment.

(b) Lift the fin assembly clear.

(3) INSTALLATION.—*(See figure 80.)*—Place the fin in position on the fuselage tail; bolt it to the two attachment points to the fuselage bulkhead and to the fuselage tripod assembly.

f. RUDDER.

(1) DESCRIPTION.—*(See figures 81 and 82.)*—The rudder is statically and dynamically balanced. The 24ST Alclad aluminum rudder frame is constructed around a 1-3/4 inch diameter 24ST aluminum-alloy torque tube which forms the primary load-bearing member of the structure. The trailing edge is excepted since it is formed from 24SO Alclad sheet .032-inch thick. The curved top of the rudder is formed from two shallow half sections of 52S1/2H aluminum-alloy sheet welded together about the common circumference and riveted to the uppermost rib of the structure. The ribs are formed from .020-inch thick 24SO Alclad sheet. In original rib forming, power-pressing was utilized to provide the integral cap strips, stiffening bends, and flanged cut-outs. The ribs extend from the leading edge to the trailing edge and are riveted to the torque tube by means of flanged collars. The leading edge forward of the torque tube is formed from several 24ST Alclad sheet sections which are .020-inch thick with the exception of the top leading edge skin which is .032-inch thick. A 3-pound cast-lead counterweight attached to the top of the rudder provides adequate static balance. A control horn, forged from 14ST aluminum-alloy (aluminum-alloy permanent mold casting in later airplanes), is attached to the torque tube at the lower hinge point. A controllable trim tab, a trim tab operating mechanism and cable, three sealed-type ball-bearing

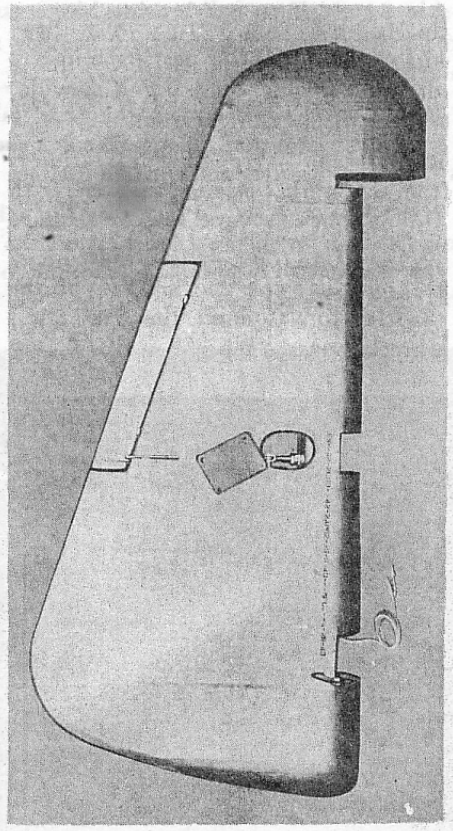


Figure 82 — Rudder

hinge fittings and the control horn are assembled on the frame. The rudder frame is covered with doped fabric. The rudder has an angular movement of 30 degrees to the right and 30 degrees to the left on AT-6C airplanes serial No. 42-49005 to 42-49069 inclusive, 42-43847 to 42-44411 inclusive; on SNJ-4 (Navy) airplanes serial No. 27629 to 27851 inclusive, 51350 to 51676; and on all AT-6D and SNJ-5 airplanes.

The rudder assembly is attached to three hinge brackets on the rear spar of the vertical stabilizer. An adjustable stop is located on either side of the lower hinge bracket to limit rudder movement. Drain holes are provided at the bottom of the assembly.

(2) REMOVAL.—Disconnect the turnbuckles from the tab control cable in the fuselage by removing the turnbuckles; then proceed with the following instructions:

(a) Slip the trim tab drum cable away from the pulleys at the lower hinge bracket and out of the hole at the lower end of the fin rear spar.

(b) Disconnect the rudder control cable from the rudder horn.

(c) Disconnect the antenna from the top of the rudder at the hinge point center line.

(d) Remove the bolts attaching the rudder to the lower, middle, and top fin spar hinge brackets, respectively.

(e) Remove the rudder.

(3) INSTALLATION.—Place the rudder in position, engaging the holes in the two upper torque tube fittings with the two upper fin spar hinge brackets, and proceed as follows:

(a) Secure the lower fitting with the lower hinge bracket.

(b) Check for proper alignment of the hinge point centers in the event any of the hinge brackets have been replaced.

(c) Attach the antenna to the top of the rudder at the hinge point center line.

(d) Attach the rudder control cable to the rudder horn.

(e) Thread the trim tab drum cable around the pulleys at the lower hinge bracket fin rear spar, attaching the cable with turnbuckles to the tab control cables in the fuselage.

g. RUDDER TRIM TAB.

(1) DESCRIPTION.—A trim tab mounted on the trailing edge of the rudder is adjustable by means of a control wheel on the left side of each cockpit. The tab is connected to a threaded actuating rod and drum cable assembly in the rudder by a push-pull rod, which extends from a horn on the tab to the clevis of the actuating rod. Trim cables lead from the drum assembly to the cockpit control wheels. (Refer to paragraph 11 for further information concerning trim tab controls, rigging and adjustment.) Tabs on some later airplanes are constructed of wood and phenolic fiber assembled with casein glue; those installed on earlier airplanes are riveted Alclad construction. Wooden tabs consist of a leading edge spar and trailing edge strip joined together by ribs which fit into cut-outs in both members. The spar web is of 3-ply Douglas fir which is 3/16 inch thick. The spar cap forward of the web is made of pine; the spar cap aft of the web is made of spruce. The end ribs are made of pine while the remaining three ribs are made of 3-ply Douglas fir. The spruce trailing edge is 5/16 inch thick. Three-ply Douglas fir, 1/16 inch thick, constitutes the skin covering. Drain holes are provided at the bottom of the tab. Two Ledaloyl bearing hinge assemblies installed in the tab's leading edge provide a means of attachment to the rudder. Metal tabs consist of 24ST Alclad leading edge channel section and 24ST Alclad ribs with the exception of the lower rib of the structure which is formed of 24SO Alclad. The complete structure is covered by 24ST Alclad skin .020 inch thick. Rivets hold the flanged ribs to the channel section while the skin is riveted to the ribs. The skin is formed from one piece of material and is shaped around the structure of the tab. The trailing edge of the tab is thus formed by the bend in the skin. Two ball-bearing hinge assemblies are secured to the channel section and provide a means of attachment to the rudder.

(2) REMOVAL.—Disconnect the trim tab push-pull rod from the tab bracket; then disconnect the tab hinges and remove the tab.

(3) INSTALLATION.—Place the trim tab in position; secure it to the two brackets on the trailing edge and the rudder. Connect the trim tab push-pull rod to the tab bracket.

3. FUSELAGE.

a. GENERAL. — *(See figure 83.)* — The fuselage structure consists of two sections, bolted together just aft of the rear cockpit. The engine mount, which is of welded chrome molybdenum steel tube construction, and the engine cowling are mounted on the front of the forward fuselage structure. Removable side panels and access doors are provided to permit necessary inspection and servicing. Space and installation provisions are made in the fuselage for radio and photographic equipment, armament and gunnery mountings and equipment, oxygen system, miscellaneous furnishings and facilities for operation of the airplane. A cockpit

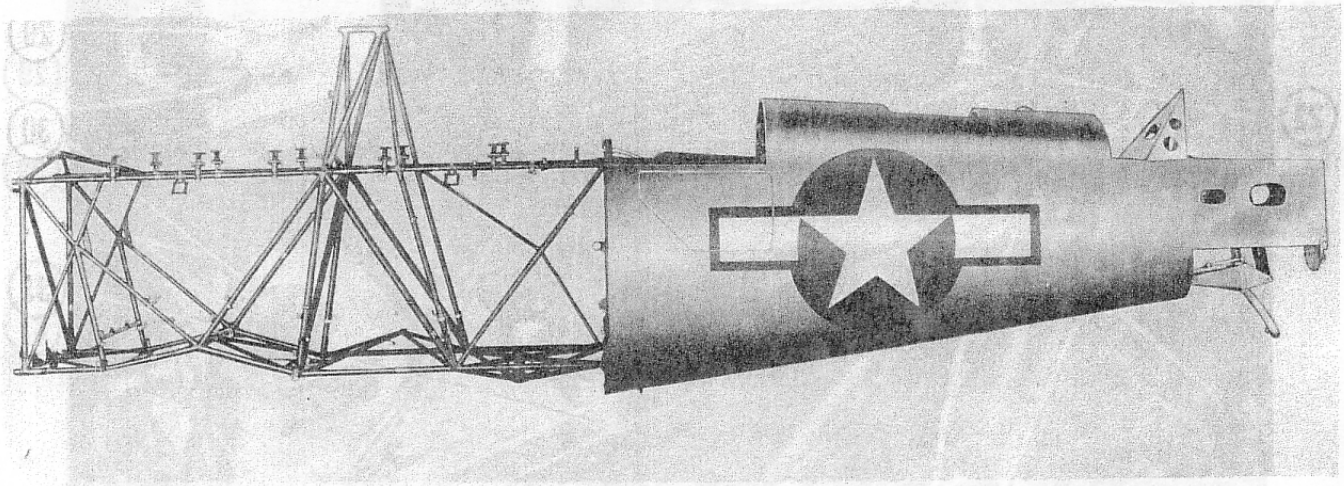


Figure 83 — Fuselage Structure

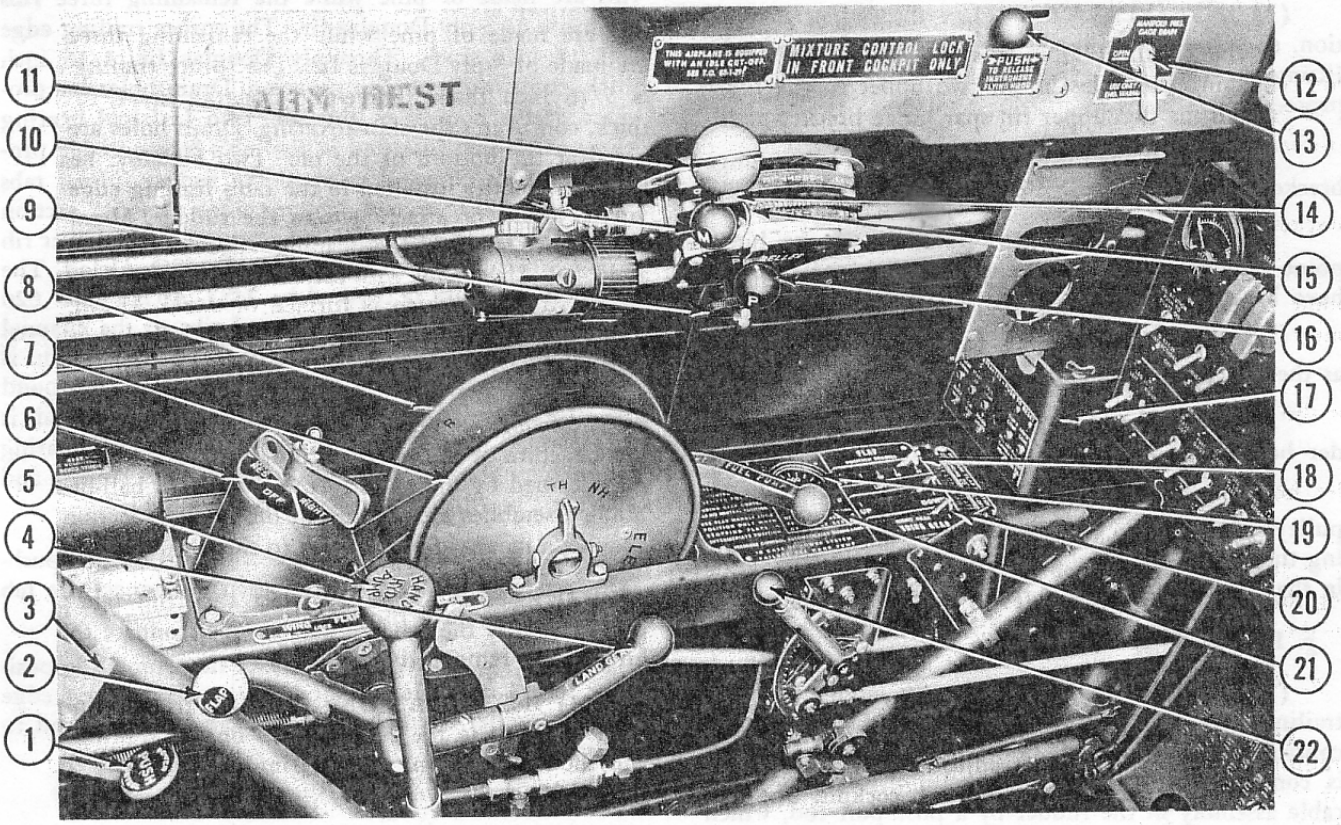


Figure 84 — Left Side Front Cockpit — AT-6D and SNJ-5 Airplanes

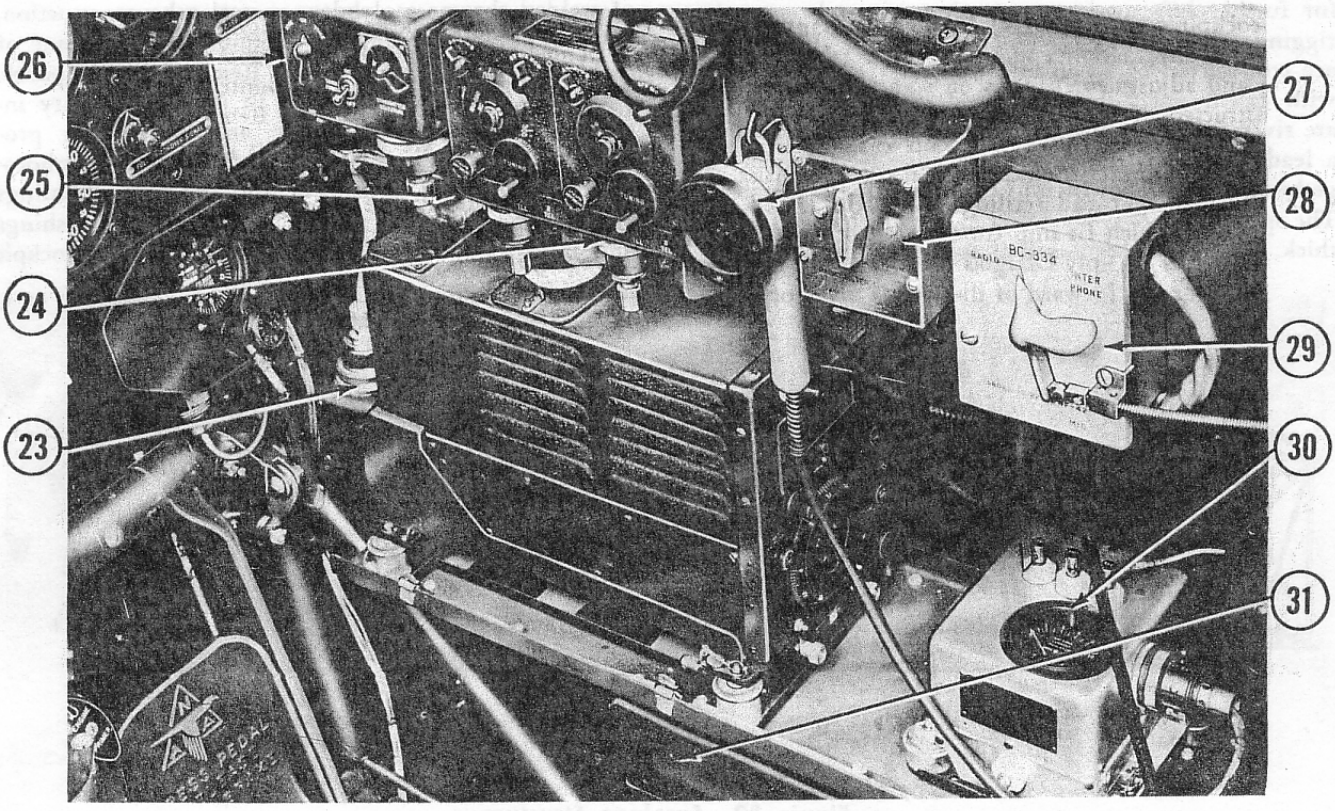
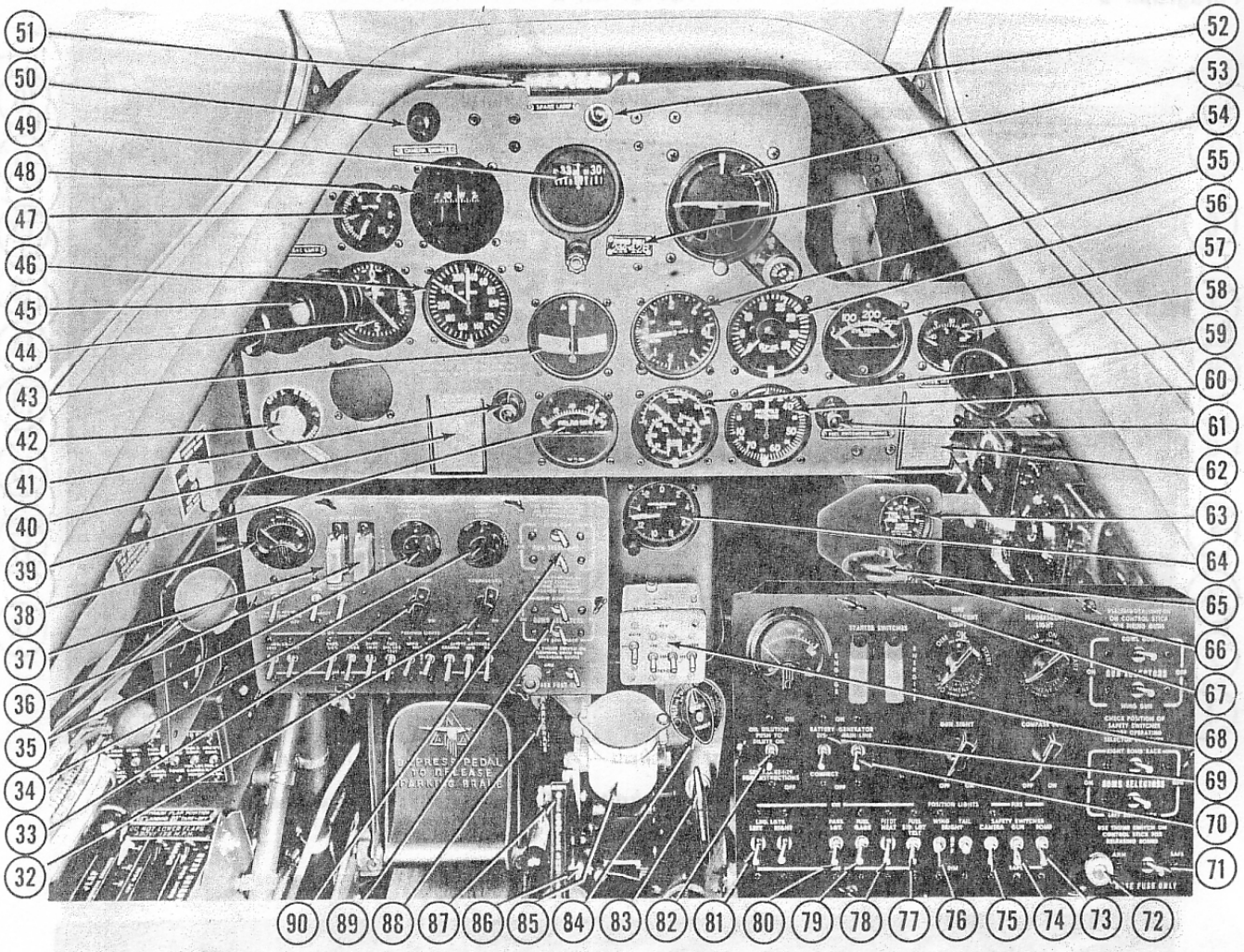


Figure 85 — Right Side Front Cockpit — AT-6D and SNJ-5 Airplanes



1. Hydraulic Power Control
2. Flap Control
3. Flight Report Case
4. Landing Gear Control
5. Hydraulic Hand Pump
6. Fuel Selector Valve
7. Elevator Trim Tab Control
8. Rudder Trim Tab Control
9. Engine Control Lock
10. Mixture Control
11. Throttle Control
12. Manifold Press. Gage Drain Valve
13. Blind Flying Hood Release
14. Throat Microphone Switch
15. Mixture Control Lock Release
16. Propeller Pitch Control
17. Generator Circuit Breaker
18. Flap Position Indicator
19. Hydraulic Pressure Gage
20. Landing-Gear Position Indicator
21. Hand Fuel Pump Handle
22. Carburetor Air Temp Control
23. Transmitter
24. Low Frequency Receiver
25. High Frequency Receiver
26. Transmitter Switch Box
27. Microphone
28. Radio Filter Box
29. Radio—Interphone Selec Switch
30. Antenna Current Indicator
31. Map and Data Case
32. Compass Light Rheostat
33. Gun Sight Rheostat
34. Right Fluorescent Light Rheostat
35. Left Fluorescent Light Rheostat
36. Starter Energize Switch
37. Starter Engage Switch
38. Generator Ammeter
39. Fuel-Air Ratio Indic.
40. Altimeter Correction Chart
41. Marker Beacon Signal Light
42. Ignition Switch
43. Bank and Turn Indicator
44. Altimeter
45. Clock
46. Air-Speed Indicator
47. Suction Gage
48. Magnetic Compass
49. Directional Gyro
50. Camera Signal Light
51. Blind Flying Hood Catch
52. Spare Lamp
53. Gyro Horizon
54. Radio Call Plate
55. Rate of Climb Indicator
56. Tachometer
57. Cylinder Head Temp Indic.
58. Carburetor Mixture Temp
59. Engine Gage Unit
60. Manifold Pressure Gage
61. Fuel Switch-Over Signal Light
62. Compass Correction Chart
63. Oxygen Pressure and Flow Gage
64. Accelerometer
65. Bomb Release Switch
66. Oxygen Regulator
67. Gun Trigger Switch
68. Recognition Light Switches
69. Battery Disconnect Switch
70. Generator Main Line Switch
71. Bomb Arming Safety Switch
72. Bomb Arming Signal Light
73. Bomb Safety Switch
74. Gun Safety Switch
75. Camera Safety Switch
76. Position Light Switches
77. Fuel Switch-Over Sig Light Test Switch
78. Pitot Heater Switch
79. Fuel Gage Light Switch
80. Passing Light Switch
81. Landing Light Switches
82. Oil Dilution Switch
83. Gun Charger
84. Engine Primer
85. Gun Sight
86. Cockpit Ventilators
87. Oil Cooler Shutter Control
88. Parking Brake Handle
89. Bomb Rack Selector Switches
90. Gun Selector Switches
91. Pedal Adj Latch (Not in View)

Figure 86 — Center Front Cockpit — AT-6D and SNJ-5 Airplanes

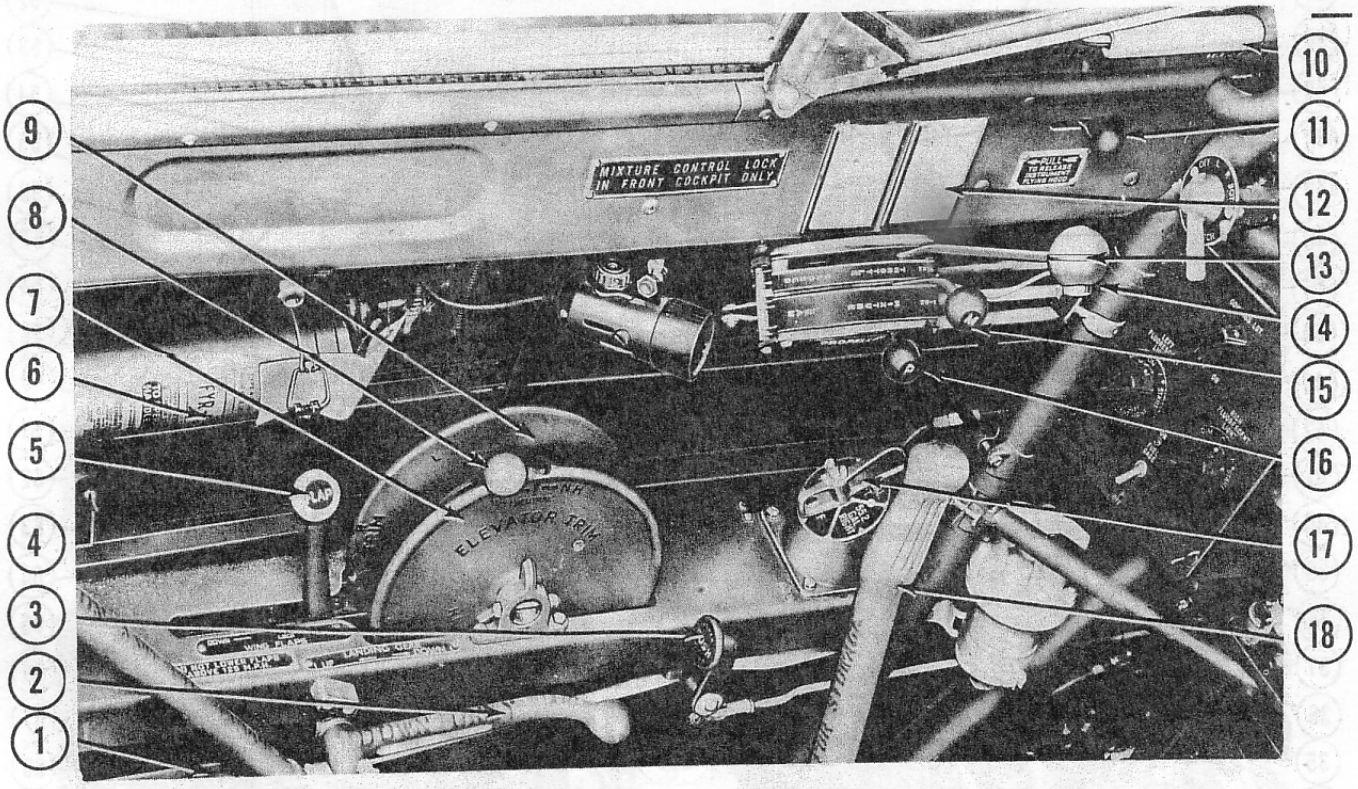


Figure 87 — Left Side Rear Cockpit — AT-6D and SNJ-5 Airplanes

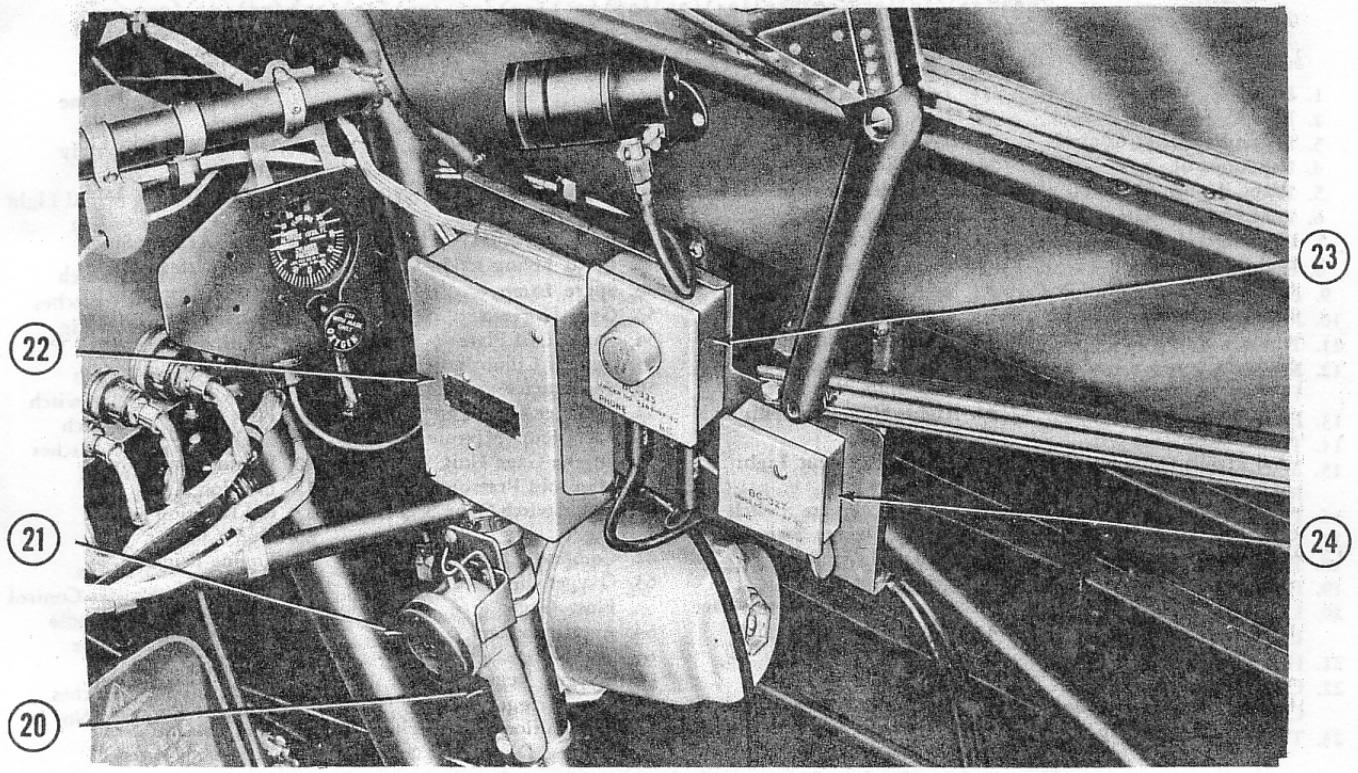
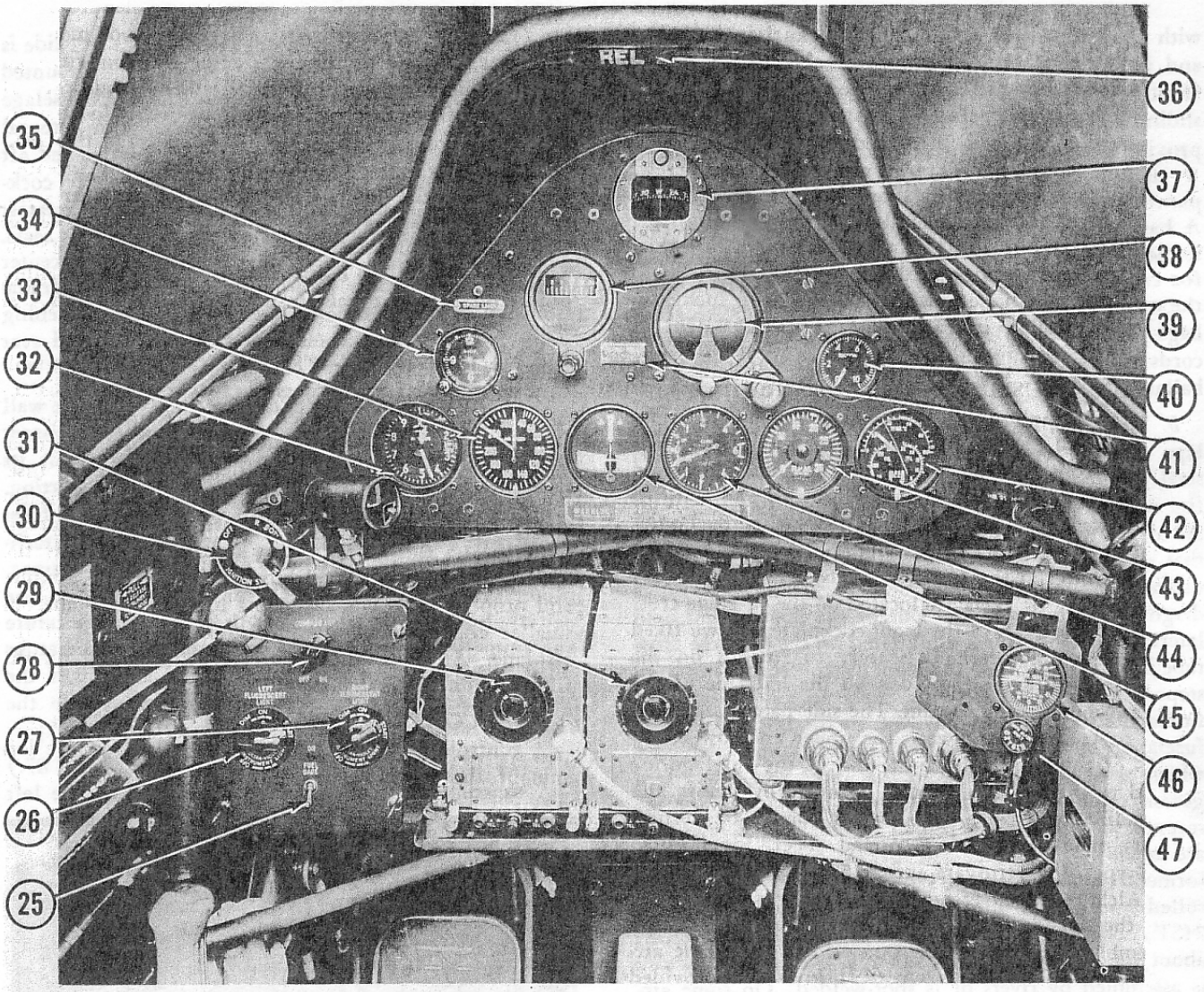


Figure 88 — Right Side Rear Cockpit — AT-6D and SNJ-5 Airplanes



1. Flight Report Case
2. Landing Gear Control
3. Hydraulic Power Control
4. Ventilator Door Handle
5. Flap Control
6. Fire Extinguisher
7. Elevator Trim Tab Control
8. Hand Fuel Pump Handle
9. Rudder Trim Tab Control
10. Gunner's Hood Handle
11. Blind Flying Hood Release
12. Altm and Compass Correction Charts
13. Throttle Control
14. Throat Microphone Switch
15. Mixture Control
16. Propeller Pitch Control
17. Fuel Selector Valve
18. Control Stick (Stowed)
19. Pedal Adjusting Latch (Not in view)
20. Microphone Switch
21. Microphone
22. Interphone Amplifier
23. Radio Volume Control
24. Interphone—Radio Switch
25. Fuel Gage Light Switch
26. Left Fluorescent Light Rheostat
27. Right Fluorescent Light Rheostat
28. Compass Light Rheostat
29. Low Freq Receiver Tuning Dial
30. Ignition Switch
31. High Freq Receiver Tuning Dial
32. Altimeter
33. Air-Speed Indicator
34. Clock
35. Spare Lamp
36. Blink Flying Hood Catch
37. Magnetic Compass
38. Directional Gyro
39. Gyro Horizon
40. Suction Gage
41. Radio Call Plate
42. Engine Gage Unit
43. Tachometer
44. Rate of Climb Indicator
45. Bank and Turn Indicator
46. Oxygen Pressure and Flow Gage
47. Oxygen Regulator

Figure 89 — Center Rear Cockpit — AT-6D and SNJ-5 Airplanes

with tandem seats is enclosed by a full-vision enclosure and is provided with an instrument panel in both the front and rear cockpit. Quick-detachable panels in the sliding sections of the front and rear cockpit enclosure provide means for emergency escape from the airplane. A cut-out handhold is provided in each instrument panel shield to facilitate ingress and egress of the crew. A baggage compartment is located in the rear section immediately aft of the rear cockpit. Provisions are made for carrying ballast weights in this compartment when the rear cockpit is unoccupied. On later airplanes, sandbags provided with tie-down loops and 3/16 inch sash cords are installed in each baggage compartment as ballast.

b. FRONT FUSELAGE SECTION.—The front fuselage section consists of welded chrome molybdenum steel tube and steel fitting structure and includes the fire wall, front and rear cockpit, cockpit enclosure, and all of the fittings, furnishings, equipment, and controls that are attached to and carried in this structure. Longitudinal leveling brackets are located on the fuselage diagonal braces at the left side of the rear cockpit, and lateral leveling brackets are located on the fuselage cross tube immediately aft of the front cockpit seat. Two fixed steps, which are attached securely to fittings on the fuselage structure, are provided on the left side of the fuselage, one for each cockpit. The side panel assemblies which cover the bay between the upper and lower longerons of the front tubular section of the fuselage are secured to the fuselage former channels by screws and are readily detachable. The panels consist of vertical formers, made from 25ST Alclad sheet, longitudinal rolled-type 24ST stringers and .025- and .032-inch thick 24ST Alclad sheet covering. The assembly is spot-welded about the outside margins and the remaining structure is assembled by rivets or is spot-welded. On some airplanes both the front and rear cockpits are provided with wooden floor assemblies which include floor troughs, supports, and brackets constructed of spruce and 3-ply birch-poplar plywood attached to the lower fuselage structure by U-clamps and screws. On other airplanes the foot troughs are constructed of riveted aluminum sheet. A fuel hose grounding jack is located near the lower margin of both the right and left panel directly below the rear attachment of the windshield. A door serving the hydraulic fluid tank is located slightly above the center line of the left panel and below the front panel of the stationary section of the cockpit enclosure. A fire extinguisher is mounted on the inside surface of a door on the left of the rear cockpit. Two panel sections, the upper of which is fabric-base phenolic sheet, are located between the right side panel and the engine cowling. Three phenolic fabric-base panel sections are located between the left-side panel and engine cowling. These, with the windshield cowling which is made from 24SO Alclad sheet, complete the covering of the front fuselage section. The lower front panel on the right side is of 24ST Alclad sheet construction and is equipped with a hinged Dzus-fastened 24ST Alclad door that serves the front machine gun ejection chute. The middle front panel on the left side is Dzus-fastened and affords access to the fuse box mounted aft of the fire wall on the left side of the front fuselage section. The nose-over structure, which is an integral part of the front fuselage frame structure, is located aft of the front cockpit within the fixed section of the cockpit enclosure, in a position which affords the greatest protection to the occupants of the front and rear seats. The front fuselage is securely attached to the wing center section at four points of attachment. The lower frame is drilled to take two bolts at each of the two attaching points on the wing center section front spar and rear spar.

(1) FIRE WALL.—*(See figure 90.)*—The fire wall consists of a single thickness of .019 corrosion-resistant steel sheet, and is provided with an angle about its circumference which is omitted at the lower portion. The fire wall is secured to the forward end of the fuselage frame assembly by means of engine mount attachment fittings and numerous brackets and clamps. Mounted on the forward face of the fire wall is the battery, main power panel box, throttle switch, mixture and propeller bell crank support bracket and numerous smaller units used in the operation and control of the airplane. An exhaust gas analyzer is mounted on the fire wall on some airplanes

(2) CONTROL SHELF.—*(See figures 84 and 87.)* —A control shelf, attached to two brackets on the left side of the front fuselage structure and to a flange

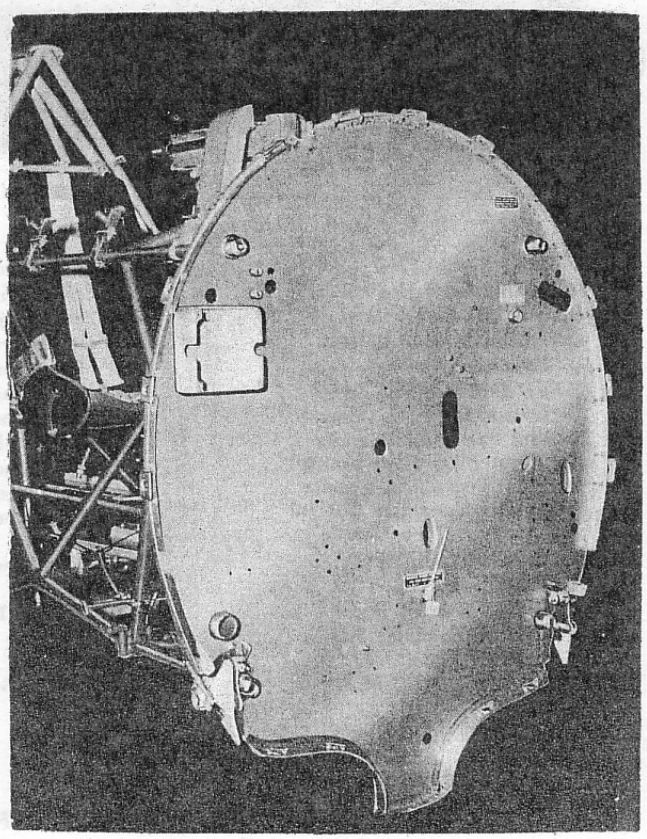


Figure 90 — Fire Wall

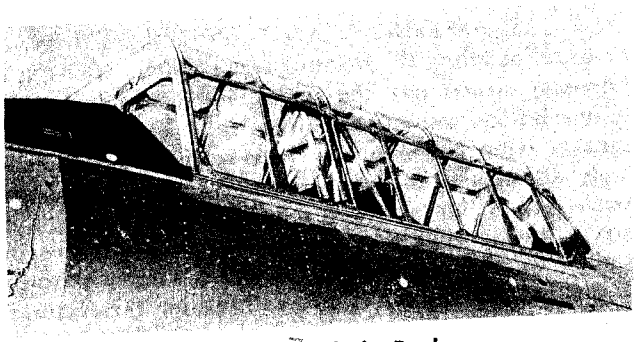


Figure 91 — Cockpit Enclosure

bracket on the front bulkhead of the rear fuselage section, provides the mounting and attachment facilities for the controls in the front and rear cockpit.

(a) FRONT COCKPIT. — The portion of the control shelf in the front cockpit contains the following units:

Hydraulic pressure gage
Landing gear position indicator
Flap position indicator
Landing gear control
Flap control
Elevator trim tab control
Rudder trim tab control
Hand fuel pump handle
Fuel selector valve control
Carburetor air temperature control
Hydraulic power control
Tail wheel lock control

(b) REAR COCKPIT.—The units mounted on the control shelf in the rear cockpit are as follows:

Landing gear control
Flap control
Elevator trim tab control
Rudder trim tab control
Hand fuel pump handle
Fuel selector valve control
Hydraulic power control
Hydraulic fluid reservoir
Hydraulic fluid filter

(3) COCKPIT ENCLOSURE.—*(See figure 91.)*— The two tandem cockpits are under one enclosure, which consists of a windshield assembly, a sliding section over the front cockpit, a stationary center section between the cockpits, a sliding section over the rear cockpit, and a rear section gunner's hood at the rear of the enclosure assembly. Later airplanes have a fixed canopy replacing the gunner's hood.

(a) WINDSHIELD ASSEMBLY.

1. DESCRIPTION.—The windshield is of 3-ply laminated glass. The central windshield panel is 1/4-inch thick glass and the smaller side panels are 3/16-inch thick glass.

2. REMOVAL AND DISASSEMBLY.—It is necessary to remove the windshield from the cowling before replacing a damaged glass panel. To do this, remove the bow and strips as one assembly by removing the eight screws that secure the assembly to the cowling. A glass panel is then easily removed and replaced, without disassembly of the windshield frame. On earlier airplanes, drilling out rivets and partial disassembly of the frame are necessary.

3. ASSEMBLY AND INSTALLATION. — The windshield assembly includes three fuselage cowling panels, one extending forward from the lower edge of the center windshield panel, and the other two extending downward from the lower edges of the side panels. An instrument panel shield is also incorporated in the windshield assembly. Place the windshield in position on the fuselage; fasten the cowl panels and instrument panel shield to the fuselage formers. Prior to replacing a windshield panel in earlier airplanes, it may be necessary, depending upon the accessibility of the attaching rivets, to remove or partially remove the section assembly affected. This is not necessary in later airplanes, since no rivets are used in windshield installation. The same rubber channels may be utilized for replacement if they are in good condition. Apply a plastic caulking compound around the outside edges of the windshield, such as Hunt's mastic caulking compound or equivalent.

(b) SLIDING ENCLOSURE SECTIONS.

1. DESCRIPTION. — *(See figure 92.)* — The side panels are 2-ply laminated glass. The top sections are provided with 1/8-inch thick non-inflammable transparent sheet. The sliding sections operate on channel tracks which are attached to the fixed enclosure section located between the cockpits. A handle and lever arrangement is located at the left side of each sliding section to provide a means of controlling the enclosure lock plungers from either inside or outside. The front and rear sliding sections can be locked at three positions; open, closed, and one intermediate position. Each sliding section is equipped with an emergency release latch assembly on both the right and left side. Each latch assembly consists of a corrosion-resistant steel, spot-welded frame in which is built a top panel release plunger, a bottom panel release plunger, and a spring lever which operates both plungers simultaneously. The lever is safety-wired when the side panel structure of the sliding section is locked in place. Raising the lever disengages both plungers and releases the entire side panel from the cockpit enclosure, providing an

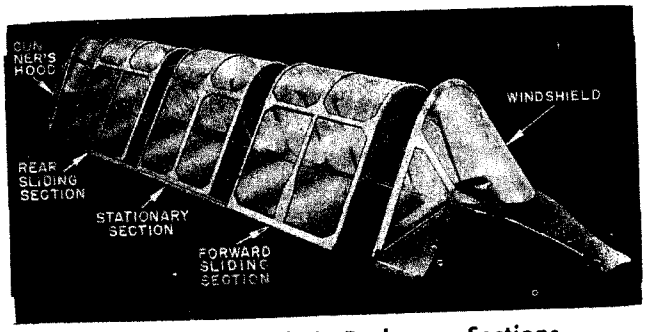


Figure 92 — Cockpit Enclosure Sections

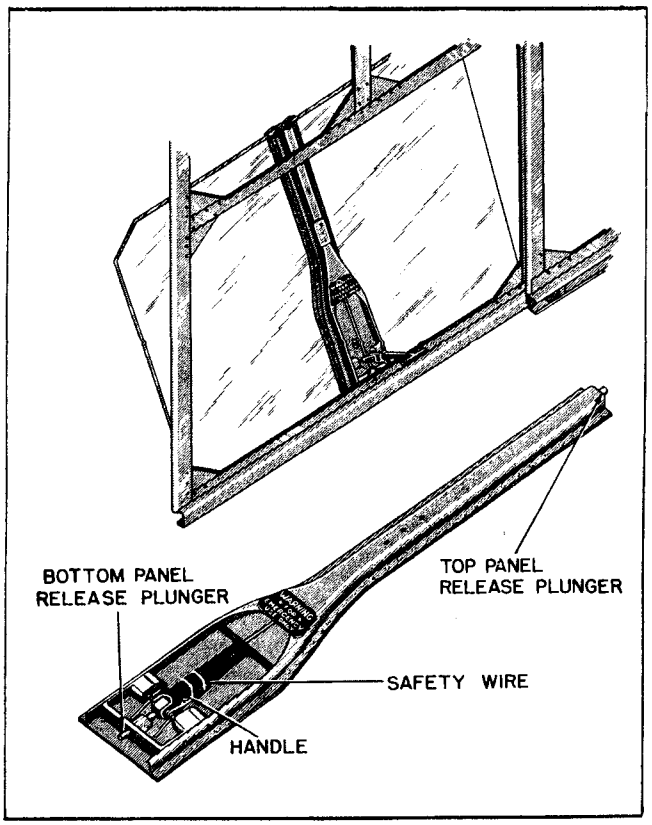


Figure 93 — Emergency Release Latch

emergency exit for the crew. (See figure 93.) The enclosure frame is constructed of 53S tempered aluminum-alloy riveted channel extrusions.

2. REMOVAL.—To remove any of the side panels in either of the sliding sections, pull the EMERGENCY RELEASE HANDLE which will release the panel section. To remove a defective panel, pull the rubber channel from the panel frame and remove the panel. To remove the forward or aft top panels of the front sliding section in earlier airplanes, it is necessary to remove the bow and corner blocks. To replace a forward top panel of the aft sliding section in the earlier airplanes, removal of the entire rear hood assembly is necessary; that is to permit the sliding section to be moved aft. To remove the aft top panel of the section it is only necessary to remove the bow and corner blocks. In later airplanes all panels are removed and replaced without removal or disassembly of the sliding sections. The panels are encased in rubber channels which are fitted into the panel frames when panels are installed or replaced. To remove a panel, the rubber channel is pulled from the panel frame allowing free removal of the panel. To remove the fixed rear enclosure of the AT-6F airplanes, remove retainer strip screws and retainer strips at edge of enclosure. Then remove enclosure. (See figure 93A.)

NOTE

No cement or caulking is needed between the rubber channel and the enclosure.

3. ASSEMBLY AND INSTALLATION.—Prior to installing the front or rear sliding sections, it is necessary to remove the windshield assembly or the gunner's hood respectively. In the latter case, it is necessary to remove the top fuselage cowl panels immediately aft of the enclosure assembly. In this case, the stationary sections may be removed by removing four screws that permit the front sliding section to be installed or removed without disturbing the windshield assembly. Care should be used in handling the enclosure sections before they are installed in order to prevent possible malfunctioning due to misalignment of the lower edges. Engaging the rollers of the sliding sections with the enclosure tracks, slide the sections into position over the front and rear cockpits. Install the roller stops at the attaching ends of the enclosure tracks in order to prevent overtravel of the sliding sections in the open position. If new panels replace damaged ones, the same rubber strips may be used if they are in good condition.

CAUTION

Ascertain that the EMERGENCY RELEASE HANDLE lockpins and safety wires are properly installed.

(c) STATIONARY ENCLOSURE SECTION.

1. DESCRIPTION.—The side panels are 3-ply laminated glass. The top sections are provided with 1/8-inch thick non-inflammable transparent sheet.

2. REMOVAL.—In earlier airplanes, remove the stationary section by removing the four block-shaped stops from the inside of both tracks. Lift the entire section clear. Remove the bow and corner blocks and remove the top or side panel as required. In later airplanes removal and disassembly is the same as described in paragraph *(b)* 2.

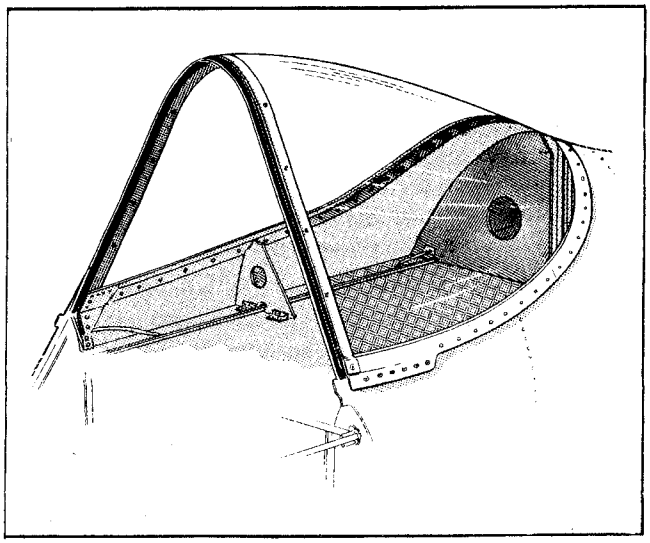


Figure 93A — Fixed Rear Enclosure

3. ASSEMBLY AND INSTALLATION. — The stationary section of the cockpit enclosure is installed between the tracks of the front and the rear sliding sections. The tracks may be installed with or without the stationary section attached. However, it is preferable to install the tracks and stationary section as a unit. Place the stationary enclosure section and tracks in position on the fuselage, and fasten the track sections to the upper fuselage side former channels.

(d) GUNNER'S HOOD.

1. DESCRIPTION.—The panels of the rear section gunner's hood are 1/8-inch thick non-inflammable transparent sheet.

2. REMOVAL. — To remove the gunner's hood, unbolt the corners of the hood from the lower rear corners of the movable rear section and disengage the roller at the lower end of the operating arm from the track.

3. INSTALLATION.—The gunner's hood is interconnected with the rear movable section in such a manner that when the section is opened the hood automatically slides and rotates in a forward and upward direction to the open position. To install the hood, engage the roller at the lower end of the operating arm with the track extending downward and forward at the right side of the rear cockpit. Bolt the corners of the hood to the lower rear corners of the movable section.

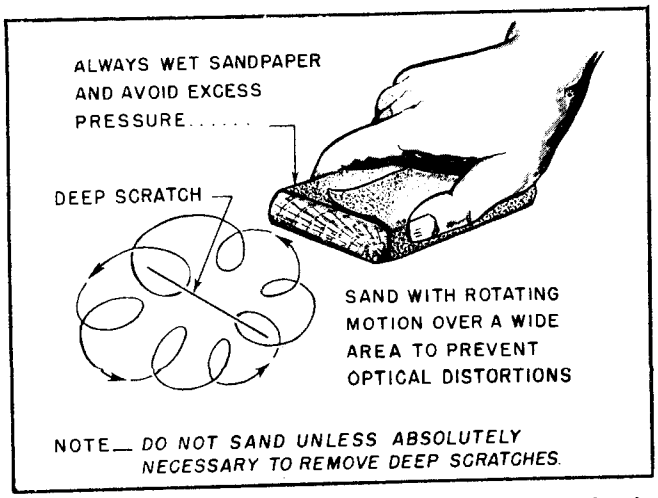


Figure 94 — Removing Deep Scratches From Plastic Panel

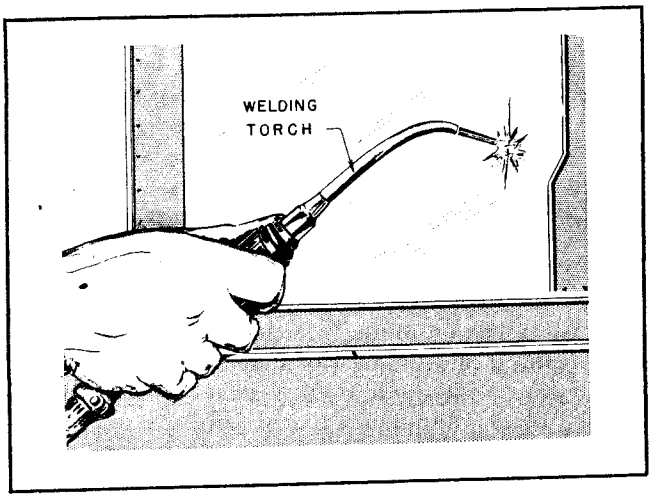


Figure 96 — Applying Torch Flame to Plastic Panel

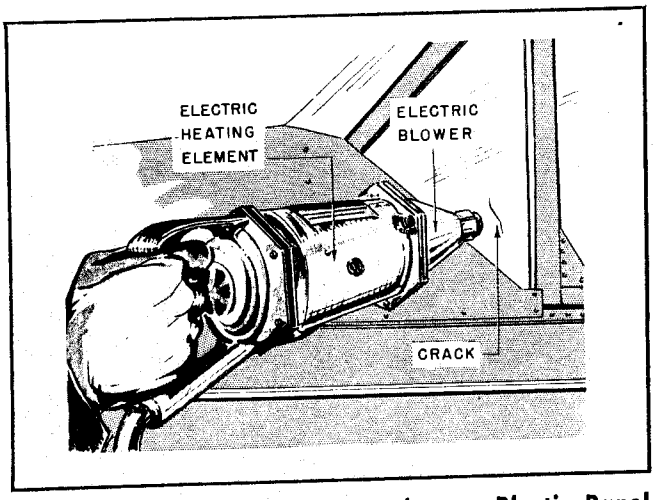


Figure 95 — Applying Hot Air Blast to Plastic Panel

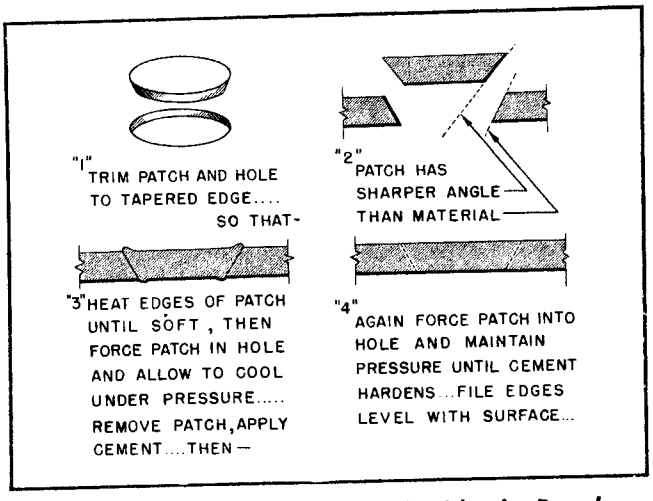


Figure 97 — Repairing Holes in Plastic Panels

NOTE

When ordering a replacement part, be sure to give the correct number. Each panel has a separate part number and is called out on its respective assembly number. Refer to pertinent illustrated parts catalog.

(e) TRANSPARENT PLASTIC PANELS. — The following instructions concern transparent plastic panels of the cockpit enclosure. These repairs, for the most part, are for temporary service only and more permanent repairs to damaged units should be effected as soon as possible. It should be borne in mind that even a carefully patched plastic panel is not optically or structurally equal to a new section.

1. CLEANING.—In order to avoid scratching the panels, it is recommended that the panels be washed with a grit-free soft cloth, chamois or sponge. Never use a dry cloth. In addition to scratching the panels, wiping with a dry cloth also builds up an electrostatic charge on the panels, which attracts dust particles. Washing with a damp chamois will remove this charge, and the dust will not scratch the surface. Soap and water or carbon tetrachloride may be used to remove grease and oil, but acetone, benzine and lacquer thinners will affect the surface. The application of a wax finish is recommended to protect the panels from undue scratching.

2. MINOR SCRATCHES. — Minor scratches may be removed by vigorously rubbing the affected area by hand, using a soft cloth moistened with a mixture of turpentine and chalk or automobile body cleaner. Rub the area both in the direction of the crack and at right angles to the crack, but do not rub too long in one place as the heat generated by friction may cause ridges.

3. DEEP SCRATCHES.—*(See figure 94.)*—If the scratches are too deep to be removed by the procedure outlined for minor scratches, it may be necessary to sand the area around the scratches. It is to be

noted, however, that the panels should not be sanded unless absolutely necessary. Wrap a sheet of 320A fine sandpaper around a block, wet the sandpaper, and sand *lightly* over a wide area with a free circular motion. Do not confine the sanding to too small an area or objectionable distortions, or "bull's eyes," will result in the transparent plastic. Wash the surface, then sand lightly with a wet sheet of 400A or finer sandpaper. When the primary deep scratches are removed, remove the fine sandpaper scratches by the procedure outlined in the paragraph on Minor Scratches. If a buffing wheel is available, a more satisfactory method is to apply a preliminary polish to the deep scratches by means of a felt disc coated with a mixture of jeweler's rouge and water. Rotate the disc at approximately 250 rpm. Apply lightly and keep moist. After the depth of the scratches has been reduced, apply a final polish of turpentine and chalk with an 8- to 10-inch diameter silk buffing wheel rotated approximately 200 rpm. Clean the area and apply a wax coat.

4. ISOLATED CRACKS.—*(See figures 95 and 96.)*—At the first sign of cracking, a hole 1/8- to 3/16-inch in diameter should be drilled at the end of the crack. This simple operation helps to prevent further splitting by distributing the strain over a large area. If the crack is small and repair facilities limited, stopping the crack with the drilled hole will usually suffice until a more permanent repair or a replacement can be made. However, if more permanent repair is to be effected, plug the hole as outlined in the following paragraph and apply Lucite Cement. H-65, (E. I. du Pont de Nemours & Co., Inc.) with a brush to both surfaces of the crack; then to the crack, apply a stream of intense hot air with a blower. Play the blower over the crack with a circular motion for approximately 5 minutes and let the material cool. If a hot-air blower is not available, a torch may be substituted. The torch should produce a soft bluish flame and should not be blowy. Hold the torch several inches from the panel. This type of repair may be regarded as permanent.

5. REPAIRING HOLES.—*(See figure 97.)*—The first step in repairing holes in transparent plastic panels is to trim the hole and surrounding cracks to a circle as soon as possible. This will prevent the development of radial cracks and will confine the damage to a minimum area. Trim the edges of the hole to a 45-degree taper. Cut a transparent plastic patch of slightly thicker material than the section to be repaired, and trim its edges to a sharper angle than that of the hole. Heat the edges of the patch over a hot-air blower or an alcohol lamp until the edges are very soft and pliable. Force the patch into the hole and allow it to cool. Remove the patch and soak the edges of the patch in Lucite Cement, H-65, (E. I. du Pont de Nemours & Co., Inc.) for 2 or 3 minutes. Reinsert the patch into the hole. Apply pressure on one surface only; since the edges are tapered, equal pressure will be applied to all edges automatically. Leave the patch under light pressure for approximately 24 hours; and after the cement has hardened, sand or file the edges level with the adjacent surface. In patching a curved or a large section where it is not possible to heat the patch, it is possible to obtain a perfect fit by cutting the patch first and using it as a template. The area to be cut out of the damaged piece is indicated by scribe lines. The operator should saw within the scribe lines and sand or file the edges to a smooth 45-degree taper. With careful workmanship it will be possible to obtain a good fit. The patch should always be oval or round in shape, never square.

c. REAR FUSELAGE SECTION.—*(See figures 98 and 99.)*

(1) The rear section of the fuselage is of all-metal, semi-monocoque construction, consisting of 24ST Alclad longerons, 24SO Alclad bulkheads and 24ST aluminum-alloy stringers, covered with 24ST Alclad sheet. The rear section is provided with drainage facilities through drain holes in the bottom of each bulkhead. The four longerons extend the entire length of the rear fuselage structure, form the upper and lower points of

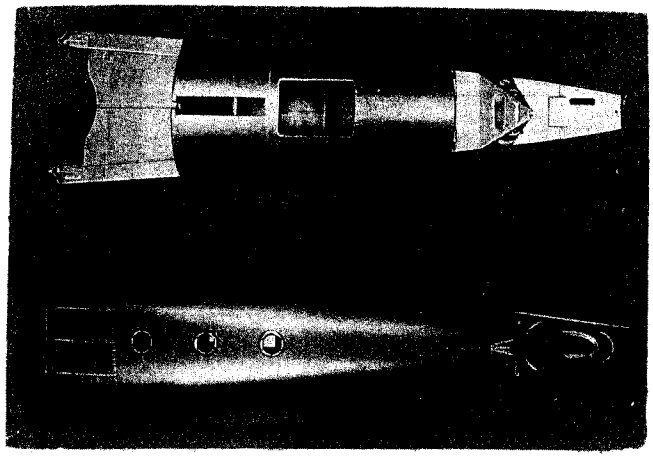


Figure 98 — Metal Monocoque

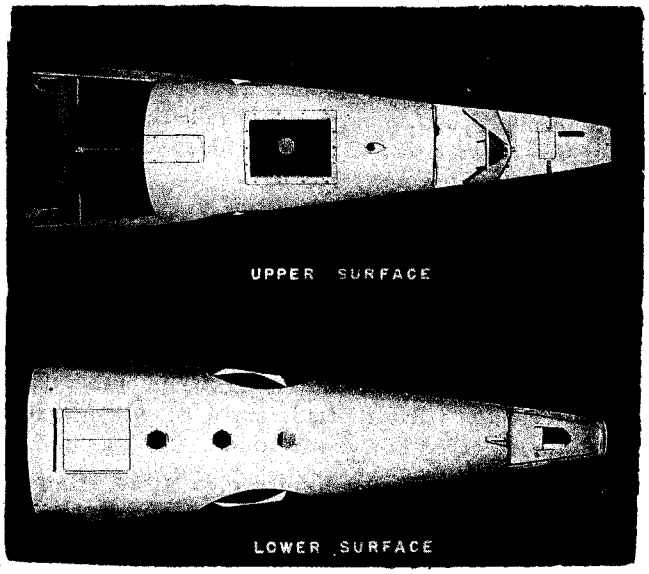


Figure 99 — Wood Monocoque

attachment to the front fuselage section, and are designed to resist the main bending loads to which the airplane is subjected. Some of the later airplanes have been equipped with wooden rear fuselage assemblies which conform in general over-all dimensions, contours, and weight to those of all-metal construction. Three-ply mahogany plywood is used for the outside skin covering, bulkheads, and shear webs. Solid spruce members serve as longerons, stringers, stiffeners, bulkhead flanges, and fillers. Maple compregwood is spliced to the spruce members at points where it is necessary to absorb excessive loads. In some locations 24ST aluminum-alloy is used to reinforce fittings. Bonding is used at all fittings. The skin panels are scarf-spliced and grain direction is laid at 45 degrees to vertical frames and bulkheads. To maintain the proper contour of the fuselage, there are eight frames spaced at approximately 21-inch intervals —some complete bulkheads, and others form ring frames. Four longerons extend the entire length of the structure and provide the points of attachment to the front fuselage section. Substitutes may be used for the woods mentioned herewith in accordance with substitution specifications.

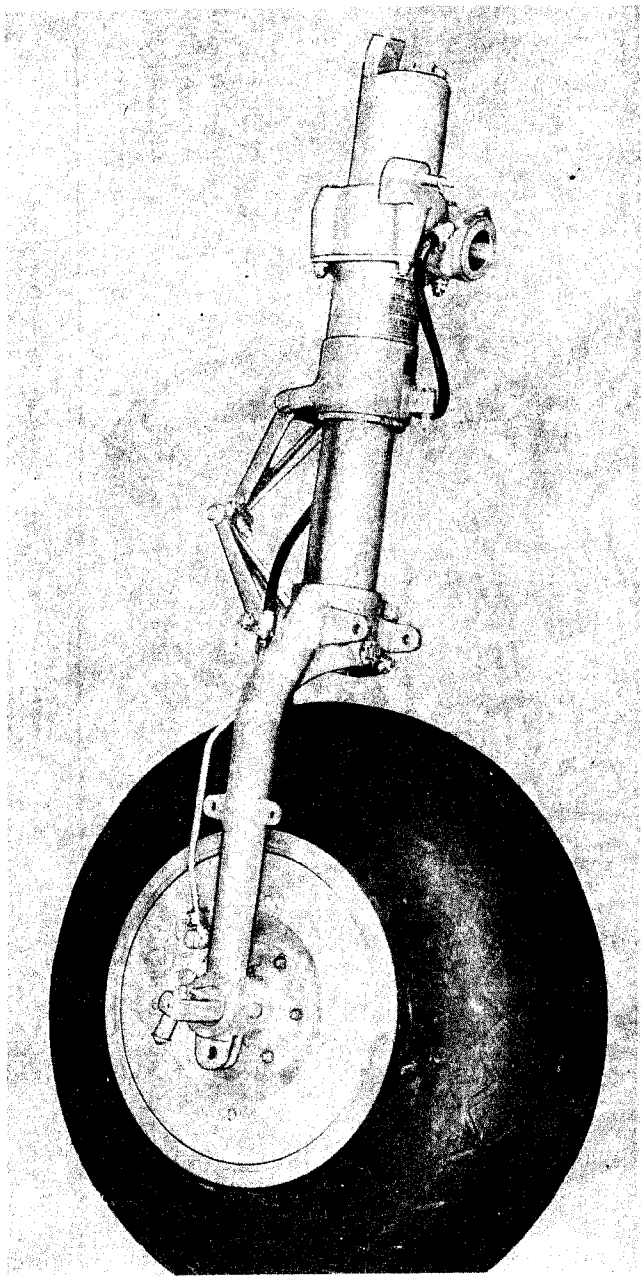


Figure 100 — Main Landing Gear Strut and Wheel Assembly

• (2) Space is provided in the fuselage rear section immediately aft of the rear cockpit for a baggage compartment. Some late airplanes allow space provisions for the installation of an auxiliary fuel tank between the compartment floor and the bottom deck. In early AT-6 and SNJ (Navy) series airplanes, space for photographic equipment is provided under the baggage compartment and provision is made aft of the rear cockpit above the baggage compartment for mounting one model M-2, .30 caliber Browning flexible machine gun except on the AT-6F. A lift-mooring tube is provided in the fuselage just forward of the tail surfaces. A bar up to 1-5/8 inch diameter may be passed through the tube in order to lift the airplane by means of personnel at each end of the bar, or by hoist. Provisions are made for the installation of the tail assembly by means of a tripod assembly mounted to the top of the fuselage and the necessary means for holding the various attaching bolts. The tail wheel is attached to the fuselage aft section at three points. Reinforcement to the bottom of the fuselage immediately forward of the tail wheel provides attachment for the auxiliary tail skid and jack pad. Three signal lights are installed in the bottom of the rear fuselage section, to be flush with fuselage surface. Access doors on each side of the rear fuselage are provided to service the upper shock strut attachment. The baggage compartment door is located on the left side of the fuselage. Camera doors are installed in the bottom of the fuselage aft of the rear cockpit on earlier airplanes. Space is provided in the deck assembly in the rear fuselage, aft of the baggage compartment upper deck and the top fuselage structure, for oxygen cylinders in earlier airplanes. In later airplanes which are equipped with a demand type oxygen system, the oxygen cylinders are mounted on the aft side of the bulkhead that forms the rear wall of the baggage compartment. The oxygen cylinder filler valve is installed on the forward face of this bulkhead, access to which is through the baggage compartment door.

4. LANDING GEAR.

a. MAIN LANDING GEAR.

(1) GENERAL. — *(See figure 101.)* — The main landing gear is of the single leg, half-fork type and is supported on the front spar of the wing center section. It is retracted inboard into the center section directly forward of the front spar by means of the main hydraulic system. Positive mechanical up-lock latches and down-lock pins are provided. Both locking mechanisms are inter-connected with the landing gear control handle

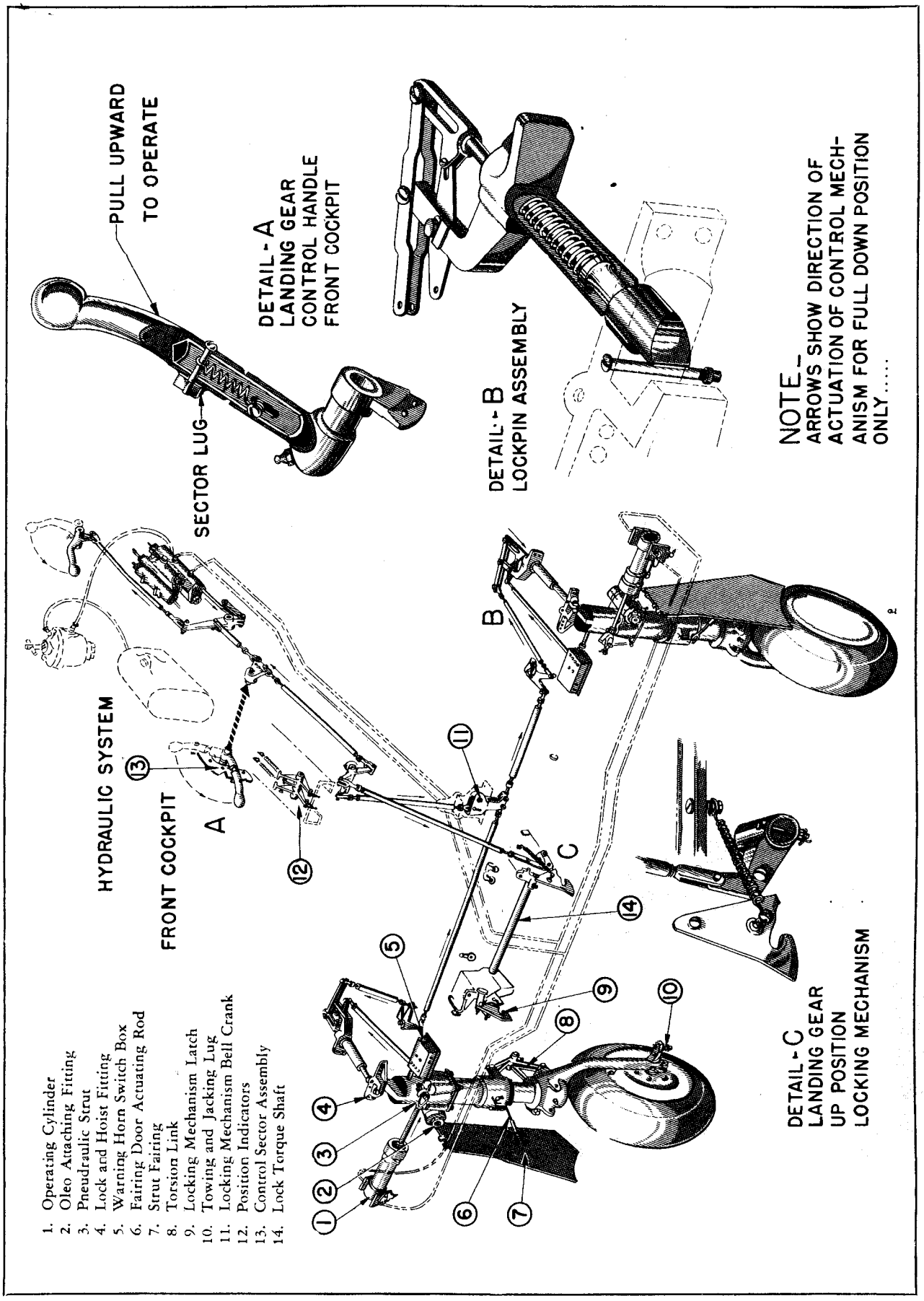


Figure 101 — Main Landing Gear Diagram

by means of lock control rod assemblies and bell cranks. Mechanical position indicators at the left side of the front cockpit on the control shelf show the approximate position of each strut at all times. These indicators should be used to determine that the landing gear is fully extended whenever it is necessary to push the lock-pins into place manually. A warning horn sounds when the throttle is closed for landing if the landing gear is not locked in the down position. Provisions are made on the landing gear wheel forks for the installation of skis. Description and instructions for the landing gear hydraulic operating system will be found in paragraph 12 of this section. For adjustment of landing gear warning horn, refer to paragraph 13.

NOTE

The landing gear of all AT-6 series airplanes is essentially smiliar. In the later models there is a shorter wing center section, which makes the landing gear tread of 102¾ inches, 7 inches shorter than earlier models. This difference does not affect the construction or maintenance of the landing gear units.

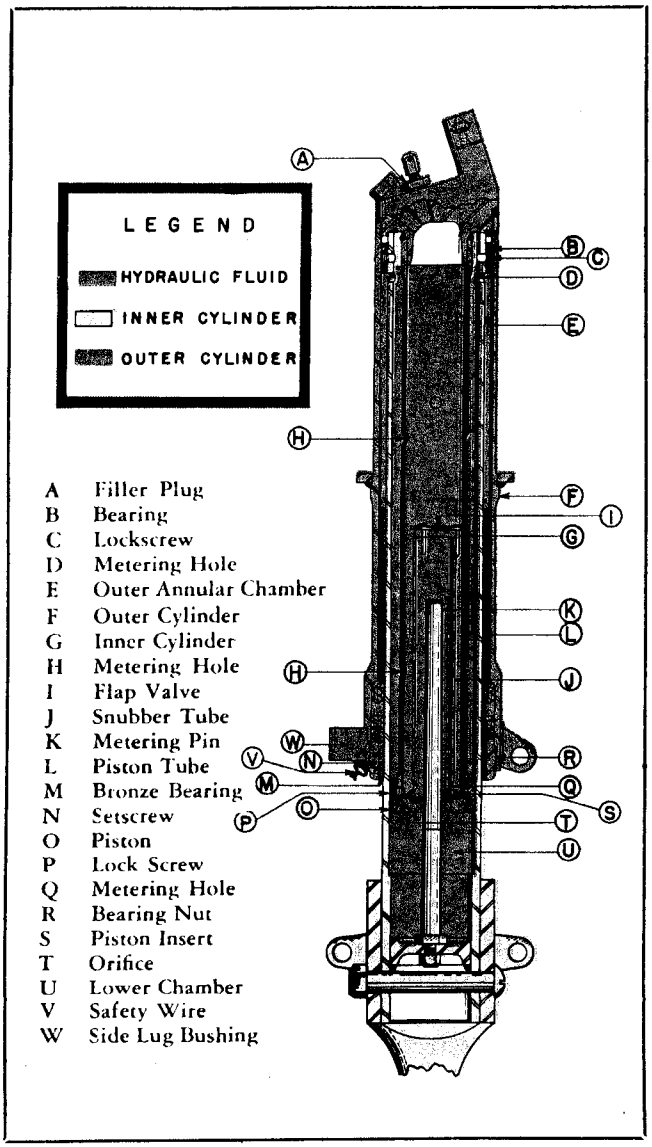


Figure 102 — Shock Strut Function Diagram

(2) SHOCK STRUTS.

(a) DESCRIPTION. — *(See figure 100.)* — A shock strut of the combined hydraulic and pneumatic type and designed in accordance with AAF Specification No. 40228 constitutes the main unit of each main landing gear leg. Torsional resistance on the strut is afforded by a torque-arm scissors arrangement which interconnects the piston and cylinder of each unit. Each strut assembly is pivoted on a polished steel pin which is pressed into a support casting bolted to the wing center section front spar and end plate.

EXPLANATION OF MAIN LANDING GEAR SHOCK STRUT FUNCTION DIAGRAM *(See figure 102.)*

CONDITION I: COMPRESSION STROKE.—Compression stroke of the strut is the initial movement and occurs when the impact load of the landing airplane is applied to the landing gear.

The lower or inner cylinder G moves farther into outer cylinder F, thus reducing the volume of lower chamber U and forcing the strut fluid to leave the lower chamber U.

The fluid leaves the lower chamber by passing through orifice T and flows into the snubber tube J.

The flow of fluid through orifice T is automatically controlled at all points of strut compression and extension by the variable section of the metering pin K attached to lower cylinder G and projecting through orifice T.

The fluid, in overcoming the resistance to its flow through orifice T, absorbs the greater portion of the impact energy of the landing airplane. The energy so absorbed by the fluid is converted into heat and dissipated.

The fluid in rising causes flap valve I attached to the end of tube J to open, and the fluid passes to the upper chamber thereby compressing the air above it.

As the compression stroke continues, the oil level continues to rise and a portion of the fluid flows through holes H and into the outer annular chamber E through hole D.

Compression of the strut stops when the entire impact load of the landing airplane has been absorbed by the fluid and by the compression of the air in the upper chamber.

CONDITION II: EXPANSION STROKE.—Expansion of the strut takes place after a sufficient compression stroke has been made to absorb the energy of impact.

The air which has been compressed above the fluid level in the upper chamber expands, causing the strut to extend.

Flap valve I is closed instantly by the returning fluid.

The fluid must then pass through the small holes Q drilled in the lower end of tube J before it can enter the lower chamber.

The extension of the strut reduces the volume of the outer annular chamber E, forcing fluid back through the small hole D, then through holes H, and finally into the lower chamber through the small holes Q.

By forcing the fluid to return through the small holes Q during the extension stroke, the expansion of the strut is slowed up because of resistance to flow created. This reduces rebound in two ways:

By actually absorbing energy.

By changing the natural period of oscillation in such a way that it damps out the tire oscillation. This is referred to as *snubbing effect.* The tail wheel shock strut operates on a similar principle.

(b) REMOVAL.—The left and right landing gear shock struts are interchangeable. The sequence necessary to remove a shock strut without removing the shock strut attachment fitting at the pivot pin is as follows:

1. Jack the airplane approximately 12 inches by means of the outer wing jacking points. (Refer to section III.)

2. Set the landing gear controls for the "UP" position of the landing gear to disengage the lockpins.

3. Completely deflate the strut by removing the hex cap on the air valve and backing the air valve filler plug not more than one turn to allow the air to escape slowly past the plug seat.

CAUTION

Do not depress air valve core to deflate strut. Do not attempt to remove filler plug past one turn until the strut is completely deflated and all hissing of air and fluid ceases.

4. Disconnect the brake line at the brake shoe operating cylinder, drain the brake system, and reconnect line.

5. Disconnect and remove the rigid brake line tubing, located between the two flexible hose sections on the strut, and plug the ends of the lines.

6. Disconnect the landing gear fairing rod from the strut.

7. Remove the four cotters and nuts from the bolts securing the strut to its attachment fitting on the strut pivot pin.

8. Lower the strut through its attachment fitting.

CAUTION

The shock strut should be well supported during removal since it is awkward to handle.

(c) DISASSEMBLY.—To disassemble the main landing gear strut, proceed as follows:

1. Ascertain that the strut is deflated and that all fluid has been drained from the strut.

2. Disconnect the upper scissor torsion arm link at the point of attachment on the strut cylinder after removing the cotter, nut, and bolt.

3. Remove the lock wire and unscrew the packing nut.

4. Pull out the piston tube assembly; if necessary, use a slight bumping action to loosen the packing rings.

5. Remove the lock screw and bearing from the upper end of the inner shock strut piston and remove the piston tube, upper packing ring spacer, packing rings, lower packing ring spacer, and lower packing retainer.

6. Remove the nut on the lower end of the metering pin in the lower end of the inner piston and then remove the metering pin. Remove the inner cylinder piston set screw and unscrew the piston. Remove the piston insert and snubber tube.

7. Remove the three nuts and bolts attaching the shock strut fork and flange assembly to the lower end of the piston tube and remove the fork.

(d) REASSEMBLY.

1. To reassembly the strut, reverse the sequence of operations outlined above.

2. For replacements of packings and gaskets, refer to applicable illustrated parts catalog. New strut packing rings should be installed in the same manner as old ones. Use only the packing specified for the strut.

CAUTION

Should the lips of the packing rings become scored or nicked, replacements are necessary because tightening down the packing nut will not stop the leakage.

3. Coat the rings with the same hydraulic fluid used in the strut before installation. A thin piece of shim stock should be placed over the threads in the cylinder while installing the packing rings to prevent the rings from being cut or scored by the threads in the cylinder. After tightening the packing gland nut down firmly, safety the gland nut with safety wire. After filling the strut with fluid, Specification No. AN-VV-O-366, at the filler port, inflate the strut with air at 60 pounds per square inch pressure and run in, provided a suitable machine is available.

(e) INSTALLATION.—*(See figure 103.)*—To reinstall the strut, reverse the sequence of removal operations outlined above. Bleed the brake system as instructed in this section, paragraph 4, *a, (11), (e).* Make certain the strut is fully extended before installing the brake line.

(3) SHOCK STRUT ATTACHMENT FITTING.

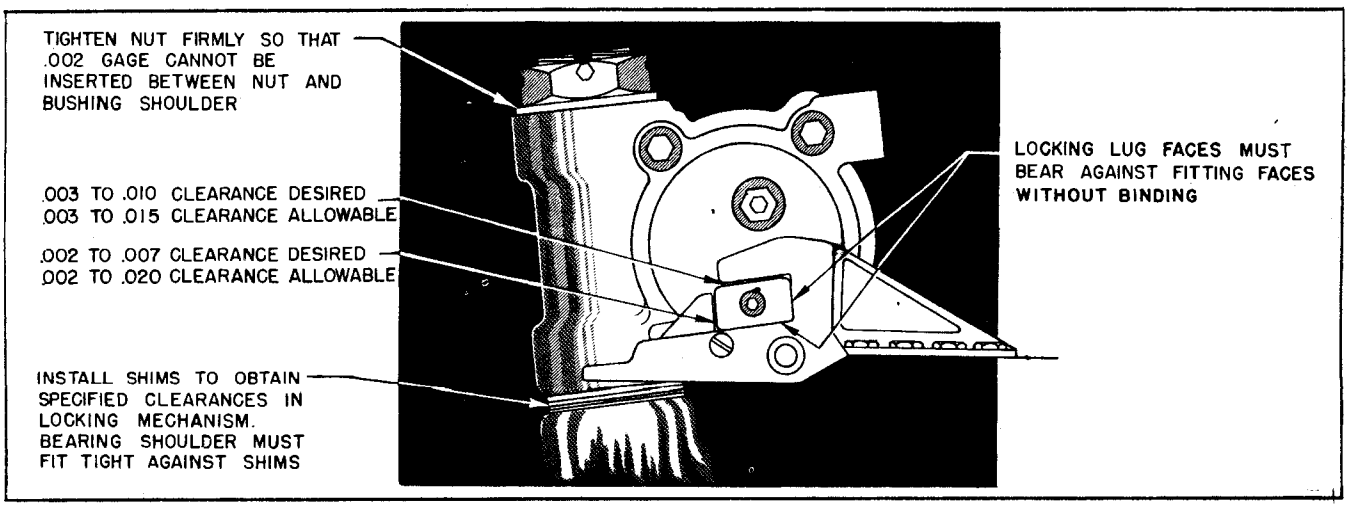


Figure 103 — Clearance for Main Landing Gear Installation

(a) REMOVAL.

1. Remove the landing gear shock strut as outlined in paragraph 4, *a, (2), (b),* this section.

2. Disconnect the flexible electric conduit from the inboard side of the center section end plate and from the center section leading edge.

3. Disconnect the cold air duct line from the wing leading edge section (left side only).

4. Remove the bolts, screws, and fairing as required, to remove the wing leading edge assembly from the center section.

5. Remove the shock strut fairing and its front hinge bolt from the wing attaching angle.

6. Disconnect the landing-gear position indicator cable from the lower rear side of the strut attaching fitting.

7. Loosen the lock nut on the operating cylinder piston rod and rotate the piston rod until it becomes disengaged from the fitting which attaches the piston rod to the oleo attaching fitting. Care should be exercised to prevent damaging the polished surface of the piston rod. (See figure 104.)

8. Disconnect the flexible brake line from the support fitting by removing the attachment bolt.

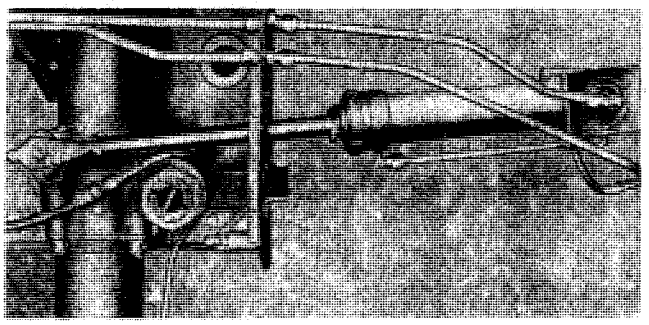


Figure 104 — Main Strut Operating Cylinder

9. Remove the pivot pin nut locking bolt and slide the strut attachment fitting from the pivot pin.

(b) ADJUSTMENT OF SHOCK STRUT AND SHOCK STRUT ATTACHMENT FITTING.

1. After installing the shock strut and attachment fitting on the pivot pin, lower the strut to the down, locked position. Slide the strut and fitting assembly forward or aft on the pivot pins in order to fit the locking lug in the lock fitting. Insert a .003 to 010 inch feeler gage between the forward face of the shock strut locking lug and the face of the lock fitting. Then determine the approximate thickness of shims that must be installed between the strut fitting and the pivot pin support casting. Normally, this thickness is approximately .030 inch. Shims, NAA standard part No. 2W1C, are available in thickness from .002 inch up.

2. Remove the shock strut and install the shims on the pivot pin. An assortment of shims varying in size from .002 to .010 inch will be required when the final adjustment is being made. Reinstall the assembly on the pivot pin and run the pivot pin nut up snugly against the strut attachment fitting. Raise and lower the strut several times to determine whether or not the strut locking lug at the top of the strut is binding in the lock fitting. If binding occurs, add or remove the required number of shims until the shock strut locking lug moves in and out of the lock fitting without binding as the strut is retracted and extended. It may be necessary to install and remove the shock strut several times, adding or removing .002 to .005 inch shims as required, before achieving a satisfactory fit. (See figure 105.)

NOTE

Do not rework the locking lug unless it is too large (see drawing for proper size) to provide proper gap tolerances, which may be the case when a new strut is installed.

3. After final adjustment, the shock strut lock-

ing lug should move in and out of the lock fitting without binding; however the aft face of the shock strut lug should fit snugly against the face of the lock fitting so that it is impossible to insert a .002 inch feeler gage between the two surfaces and a clearance of .003 to .005 inch should exist between the forward face of the strut locking lug and the face of the lock fitting. With the landing gear in the down, locked position, the inboard face of the strut locking lug should fit snugly against the face of the lock fitting so that it is impossible to insert a .002 inch feeler gage between the surfaces and a clearance of .002 to .007 inch should exist between the outboard face of the strut locking lug and the inboard face of the lockpin.

NOTE

On airplanes in service, it is permissible to allow the specified .003 to .010 inch tolerance limit between the forward face of the shock strut locking lug and the lock fitting to increase to a maximum of .015 inch, and the .002 to .007 tolerance limit between the strut locking lug and the lockpin to increase to a maximum of .020 inch before restoring the desirable specified tolerances.

The above assembly tolerances should exist after the pivot pin nut has been run up snugly against the shock strut fitting and safetied with the safety bolt. After final adjustment of the pivot pin nut has been made, the landing gear should drop of its own weight from the retracted to the extended position.

NOTE

After obtaining a satisfactory fit of the strut locking lug in the lock fitting, it may be impossible to safety the pivot pin nut with the safety bolt. When the nut is run up tight enough to permit the insertion of the safety bolt through the pivot pin nut, the strut attachment fitting may bind on the pivot pin or the pivot pin nut may be too loose when backed off to the next castellation. Should this trouble occur, the pivot pin nut may be ground down to permit the nut to be run up snugly against the strut attachment fitting and safetied. It should be impossible to insert a .002 inch feeler gage between the nut and the shock strut attachment fitting bushing.

(c) INSTALLATION.—To reinstall the shock strut attachment fitting, reverse the removal procedure.

(d) ADJUSTMENT.—See paragraph 12, *b, (5), (e)* for adjustment of landing gear operating cylinder piston rod stroke.

(4) LOCKING MECHANISM.

(a) DESCRIPTION.

1. RETRACTED POSITION LATCHES.—*(See figure 106.)*—The landing gear is held in the "UP" or retracted position by means of triangular-shaped, spring-loaded latches located on the right and left side of the fuselage, immediately outboard of each lower engine mount fire wall attaching fitting. These latches are controlled by a linkage mechanism attached to the landing-gear control lever at the left side of each cockpit. The landing-gear jack pin, which is on the inboard side of the landing-gear strut, is locked in position by the "UP" latch when the landing gear swings "UP" into its fully retracted position. The latch is so designed that when the strut jack pin comes in contact with a

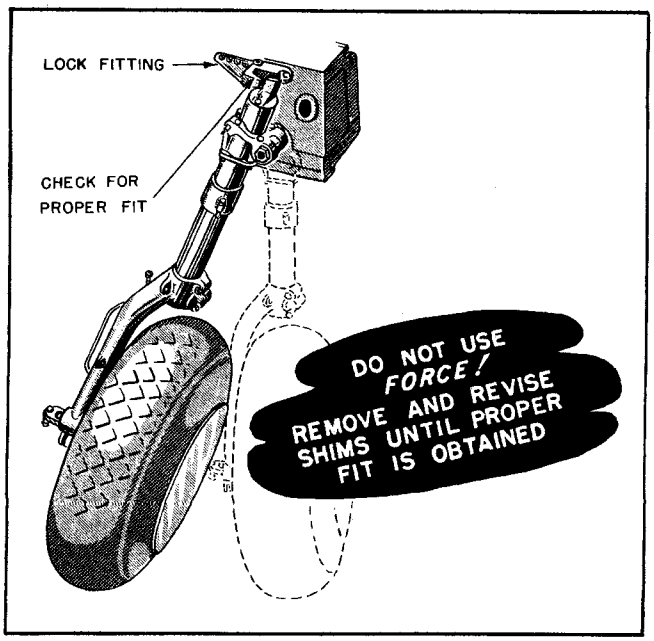


Figure 105—Installing Shock Strut on Pivot Shaft

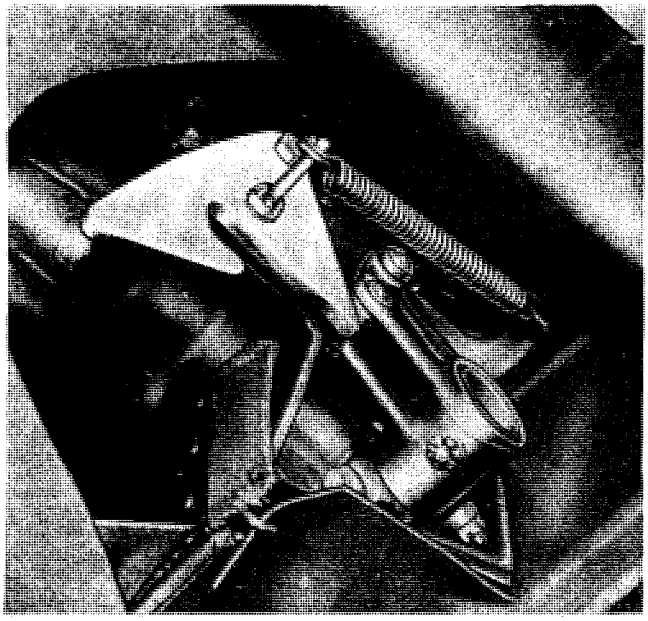


Figure 106—Retracted Position Latch

roller on the latch, the latch moves forward allowing the jack pin to continue upward until it slips into the cam-shaped cut-out in the latch. To release the latches, move the landing gear control handle to the "DOWN" position.

2. EXTENDED POSITION LOCK MECHANISM.—As the landing gear reaches the "DOWN" position, a boss at the top of the shock strut slides into the slot of a steel lock fitting which is bolted to the landing-gear support casting. When the landing-gear strut has reached its fully extended position, the spring-loaded lockpin snaps into place behind the boss, thus securely locking the landing gear in the "DOWN" position. Should the springs behind the lockpins fail to move the pin forward to the locked position, the lockpins can be manually forced into place by moving the front cockpit landing-gear control handle down to the extreme end of the sector to the "EMERGENCY" position. The lockpins are released when the landing gear control handle is moved to the "UP" position.

(b) REMOVAL.—Disconnect landing-gear down position lock control rod and landing-gear position indicator actuating rod from lockpin actuating mechanism, located at rear of landing-gear support casting. Remove the two bolts attaching mechanism support to landing-gear support casting, and remove assembly.

(c) INSTALLATION.—The surfaces of the lock fitting slots and lockpins should be lubricated with light oil before installation, and all grease fittings should be greased with high pressure grease after installation. All nuts should be safetied with cotters and lock wire as required. The lockpin linkage control rods should have sufficient clearance at all points to allow free movement of the rods and bell cranks.

NOTE

Do not grease the zerk fitting in the top of the top of the locking lug located on top of the shock strut.

(d) ADJUSTMENT.—The landing-gear down position lock mechanism should be adjusted to obtain a total movement of 11/16 inch of the lockpins. (See figure 107.) An access door to the lock mechanism is located on the lower surface of the center section immediately aft of each landing gear shock strut. Ascertain that the lock assemblies are properly installed and that the landing gear rod from the control shelf to the vertical bell crank in the center section is disconnected.

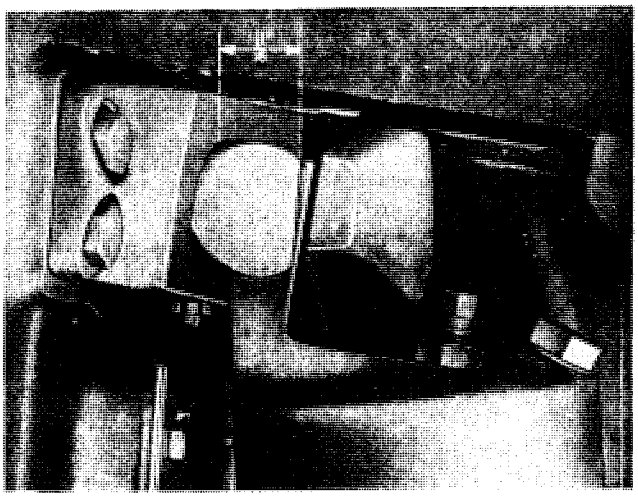


Figure 107—Landing Gear Lockpin Adjustment

1. Adjust the push rod attached to the aft end of the lockpins to obtain at least 3/16 inch between the aft face of the push rod support fitting and the shoulder on the push rod. This should allow 1 inch movement of the lockpins. (See figure 108.)

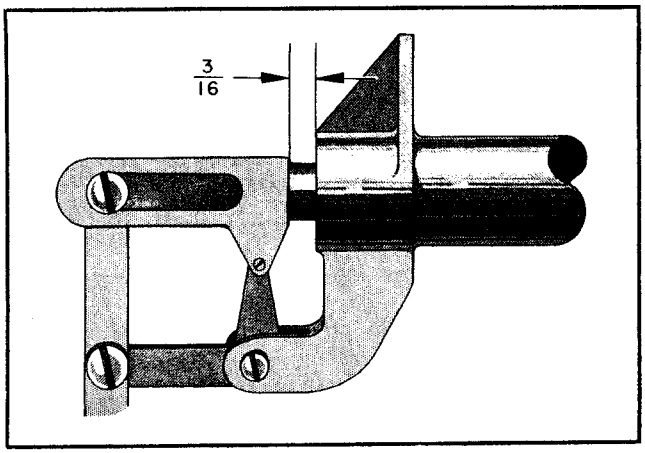


Figure 108—Lockpin Push Rod Adjustment

2. Connect the aft arm of the lock mechanism to the slot in the lockpin push rod by means of an AN24-14 bolt, B414-R4-12 spacer, AN320-4 nut, a washer, and a cotter pin.

3. Obtain a distance of approximately 11-1/64 inches between the control rod end fitting attachment hole centers on the left outboard control rod. (See figure 109.)

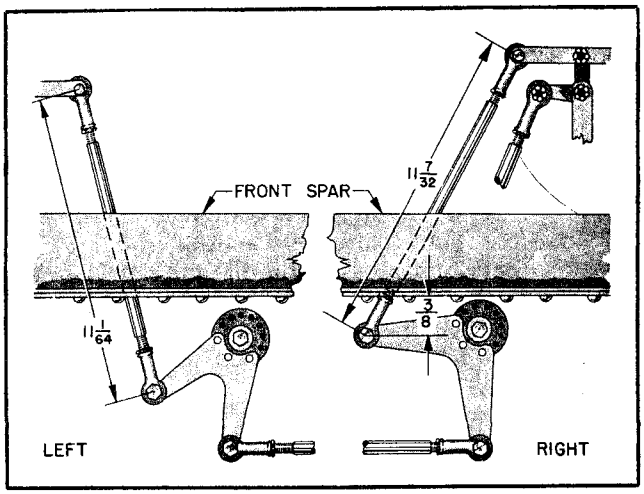


Figure 109—Lockpin Outboard Control Rod Adjustment

4. With the lock mechanism in the extreme unlocked or "UP" position, ascertain that there is a clearance of approximately 1/8 inch between the left outboard control rod and the edge of the front hole in the center section spar.

5. Adjust the right outboard control rod so that a dimension of approximately 11-7/32 inches exists between the control rod end fitting attachment hole centers. Check for a measurement of approximately 3/8 inch between the center of the forward rod-end fitting hole of the right outboard control rod and the front face of the center section spar, with the lock mechanism in the extreme "EMERGENCY" position.

6. Adjust the left inboard control rod so that a dimension of approximately 22-1/4 inches exists between the control rod end fitting attachment hole centers. Connect the inboard end of the left inboard control rod to the bell crank in the wheel well. Obtain a dimension of approximately 61-1/2 inches between the rod end fitting attachment hole centers on the right inboard control rod. (See figure 110.)

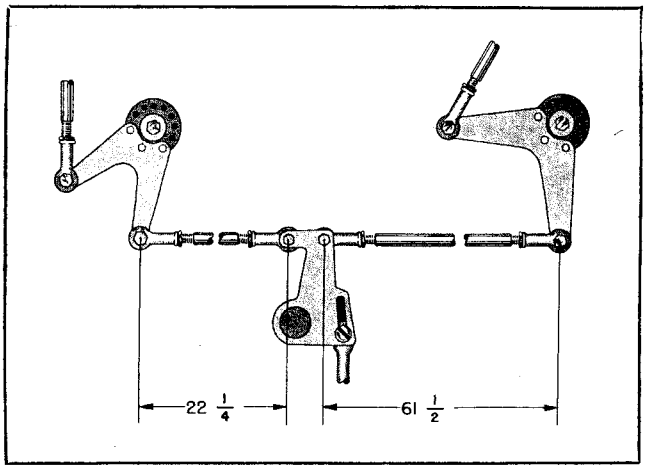


Figure 110—Lockpin Inboard Control Rod Adjustment

7. Before connecting the right inboard control rod to the vertical bell crank, move the control rods to the "EMERGENCY" position.

8. Make the necessary adjustment on the right inboard control rod to line up the rod-end fitting hole with the vertical bell crank.

9. Before installing the bell crank and control rod attaching bolt, move the control rods to the "DOWN" position, and ascertain that the right inboard control rod-end fitting hole still lines up with the hole in the vertical bell crank. If this is not the case it will be necessary to readjust the right outboard and inboard control rods as follows:

a. If the right inboard rod is long, let out one turn on the right outboard control rod and either let out or take up one or two turns, as required, on the right inboard rod to line up the attachment holes.

b. If the right inboard control rod is short, take up one turn on the right outboard rod and either take up or let out one or two turns on the right inboard rod to line up the attachment holes.

c. Connect the right inboard control rod to the vertical bell crank.

d. Move the control rods to the "UP" position. The lockpins must release the landing-gear struts simultaneously. If this is not the case, proceed as follows:

(1) Disconnect the right inboard rod from the vertical bell crank.

(2) With the rods in the full "UP" position, adjust the right outboard and inboard rods to synchronize the lockpins. Line up the right inboard rod and vertical bell crank attachment holes, repeating foregoing procedures 7. through d.

NOTE

It may be necessary to make adjustments on the left inboard and outboard rods to obtain the proper adjustment; however, this should be avoided if possible.

10. With the front cockpit landing-gear control lever in the "EMERGENCY" position, adjust the control rod which connects the cockpit control lever to the bell crank on the forward end of the control shelf and the vertical control rod which connects the forward control shelf bell crank with the vertical bell crank in the center section so that the clevis bolt on the lower end of the vertical control rod is positioned in the lower end of the slot in the vertical bell crank. When the control lever is in the "EMERGENCY" and "DOWN" positions, the lockpins should engage the shock strut lug and extend 1/16 inch beyond the face of the lock fittings. Move the cockpit control lever to the "UP" position and ascertain that the lockpins are fully disengaged from the shock strut lugs. If the lockpins do not fully disengage the shock strut lugs and retract into the lock fitting at least 1/8 inch when the control lever is moved to the "UP" position, readjust the vertical control rod.

11. Check the backlash in the landing gear control lever with the vertical control rod disconnected from the vertical bell crank in the center section. If backlash is present when the control lever is placed in the "EMERGENCY" position, shorten the vertical control rod. That is, shorten the vertical control rod if the control lever tends to move up from the "EMERGENCY" position at the lower end of the quadrant. A maximum backlash of 1/8 inch is permissible with the control lever in the "EMERGENCY" position. If backlash is present when the control lever is placed in the "UP" position or if the control lever lug moves out of the "UP" position notch on the upper end of the quadrant, lengthen the vertical control rod. No backlash in the control lever is permissible with the landing gear in the "UP" position. Adjust the "UP" position lock-latch rod so that the roller in the release arm just clears the lock-latch when the landing gear is in the

"UP", locked position with the jack pins on the struts resting on the "UP" latches. With the landing gear control lever in the "EMERGENCY" position it should be impossible to push the lockpins back into the lock fitting. No movement of the lockpins is permissible.

12. After rigging the "UP" and "DOWN" lock mechanism so that the lockpins are properly synchronized, check the action of the lockpins and landing gear struts by raising the gear to the "UP" position and permitting it to fall to the "DOWN", locked position. The landing gear struts should fall to the extended position due to their own weight and the spring loaded lockpins should snap into place behind the strut lugs. Adjust the landing gear indicator cables so that the two landing gear indicator arms on the forward end of the control shelf indicate the correct position of the landing gear struts. With the landing gear in the "UP" position, adjust the landing gear selector valve plunger control rod so that a dimension of 13/16 inch exists between the center of the clevis bolt on the aft end of the strap linkage and the forward face of the selector valve body. It is very important that this adjustment be made as specified to prevent the hydraulic power from reaching the landing gear operating cylinders before the lockpins are completely retracted free of the landing gear strut lock lugs.

(5) POSITION INDICATOR.—When installing the landing gear position indicator, connect the landing gear position indicator cable to the strut attachment fitting; adjust the clevis end of the cable at indicator arms to obtain the correct indication.

(6) FAIRING INSTALLATION. — Attach the upper end of the landing gear fairing to the hinge brackets located on the wing center section, just forward of the front spar and inboard of the end plate, using two bolts. Interconnect fairing with landing gear by means of rod assembly, and set for trial at approximately 6-3/4 inches, measured between pin centers. Adjust rod so that fairing contacts lower surface of center section snugly when gear is in the retracted position, and safety one end of rod only with wire.

(7) TROUBLE SHOOTING.

LANDING GEAR

Trouble	*Possible Cause*	*Remedy*
GEAR FAILS TO FALL INTO "DOWN", LOCKED POSITION OF ITS OWN WEIGHT.	Pivot pin nut too tight. Shock strut lug not in alignment with lock fitting. Operating cylinder piston rod packing nut too tight.	Readjust nut and shims. Readjust attachment fitting and refit strut lug if necessary. Loosen packing nut.
GEAR FAILS TO EXTEND OR RETRACT PROPERLY.	Defective operating cylinder.	Check alignment of cylinder. Check for internal leakage.
	Leak in hand pump one-way check valve in selector valve.	Reseat valve.
	Excessive leakage around plunger control valve in selector valve.	Refit plunger control valve or replace selector valve.
FAILURE OF LANDING GEAR TO RETRACT AFTER PRESSURE HAS BUILT UP TO 1200 POUNDS PER SQUARE INCH.	Internal leakage in landing gear operating cylinder.	Replace packing.
	DOWN position lockpins do not completely disengage strut lug.	Readjust lock mechanism to synchronize lockpins.
	Hydraulic power cutting in too soon.	Readjust control rod to position center line of selector valve plunger rod clevis bolt 13/16 inch from forward face of selector valve body with landing gear in UP position.
LANDING GEAR DOES NOT EXTEND WHEN CONTROL HANDLE IS MOVED TO "DOWN" POSITION.	Hydraulic power cuts in too late due to improperly adjusted selector valve plunger.	Adjust stroke of selector valve plunger.

Trouble	*Possible Cause*	*Remedy*
LANDING GEAR FAILS TO RETRACT AFTER LANDING GEAR CONTROL LEVER IS MOVED TO "UP" POSITION.	Selector valve relief valve set too low.	Adjust to relieve at 1000 pounds per square inch.
CONTROL LEVER MOVES TOO FREELY.	Loose selector valve plunger rod packing nut.	Tighten packing nut.
STIFFNESS IN "UP" and "DOWN" MOVEMENT OF CONTROL HANDLE.	Tight selector valve plunger rod packing nut. NOTE: This condition often hides evidence of backlash in control handle due to improperly adjusted lockpin mechanism.	Loosen packing nut.
	Lockpin mechanism control rod rubbing on fairlead on rib in landing gear bay.	Rework fairlead to free control rod.
	Uplatch linkage clevis bolt fouling control shelf.	Adjust bolt.
	Uplatch rod fouling casting in center section.	Align rod.
CONTROL LEVER SLIDES OUT OF "UP" POSITION NOTCH IN QUADRANT WHEN HANDLE IS TESTED FOR BACKLASH.	Improper rigging of vertical control rod.	Lengthen vertical control rod.
	Center section bell crank casting boot clamp too high on rod.	Lower boot clamp.
CONTROL HANDLE SLIDES UP FROM "EMERGENCY" POSITION ON QUADRANT BEYOND 1/8 INCH PERMISSIBLE MAXIMUM TOLERANCE.	Improperly adjusted vertical control rod.	Shorten vertical control rod.
LANDING GEAR INDICATOR ARMS SET TOO HIGH OR TOO LOW WITH GEAR IN "UP" OR "DOWN" POSITION.	Improper rigging of indicator arm cables.	Rig cables properly.
	Indicator arm linkage fouling end of control shelf.	Readjust linkage.
IRREGULAR MOVEMENT OF INDICATOR ARMS FROM "UP" TO "DOWN" POSITION OR VICE VERSA.	On right gear only—cotter pin in turnbuckle on indicator cable fouling control shelf.	Readjust turnbuckle and cotter pins.
	Indicator cable binding on pulley.	Align pulley.
LAGGING INDICATOR ARM.	Indicator cable fouling side of control shelf.	Align cable.
INDICATOR ARMS TRAVEL TOGETHER FROM "UP" TO "DOWN" POSITION AT TOO RAPID RATE.	Defective restrictor valve.	Replace restrictor valve.
SHOCK STRUT PISTON FREEZES IN CYLINDER IN HOT PART OF DAY.	Packing nut too tight.	Loosen packing nut and retighten nut sufficiently to prevent appreciable leakage during hot part of day.
	Strut piston caked with foreign matter. Strut piston corroded.	Clean strut piston and wipe with cloth saturated in oil, Spec. AN-VV-O-366.

Trouble	*Possible Cause*	*Remedy*
FLUID LEAK AT STRUT PACKING GLAND IN COLD PART OF DAY.	Dry packing rings. Packing nut improperly adjusted. (See figure 111.)	Place airplane on ramp so that the struts may become thoroughly chilled to atmospheric temperature, then adjust the packing gland nut so that there is only a very slight seepage of fluid past the packing glands. This adjustment must be made in the coldest part of the day. In extreme climates, a maximum leakage of approximately one drop in five minutes is permissible. Clean the shock strut piston and gland nuts with a cloth frequently during the day, especially before take-off and after landing. If leak persists, replace strut.

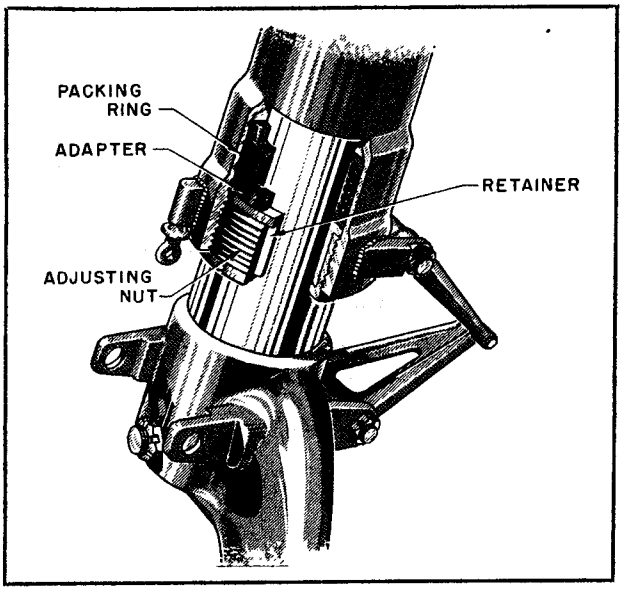


Figure 111 — Main Landing Gear Shock Strut Packing Adjustment

(8) SKIS.—Provisions are made for the installation of X37G772, type H-1 non-retractable skis, each one of which should be installed as follows:

(a) Remove fairing and attaching parts.

(b) Jack complete airplane according to instruction in Section II, to a level flight position.

(c) Install axle extension 34A5 which should have a minimum length of 6-1/8 inches and outside diameter of 1.0925 plus .000 minus .001 on the inboard end of the wheel axle.

(d) Attach aft fitting on ski to end of landing leg fork by means of an AN10-15 bolt, an AN310-10 nut, and an AN380-4-4 cotter pin. Attach aft fitting on ski to end of landing gear leg fork and extension by means of AN10-14 bolt and the above nuts and cotters.

(e) Attach end of retainer 33B867 opposite piston rod end to forward fitting on ski with an AN6-12 bolt, AN310-6 nut, and AN380-3-3 cotter pin.

(f) Adjust length of retainer piston rod by means of clevis fork until an angle of 2 degrees is obtained between the forward lower side of the ski and the ground, with the airplane in the level flight position.

(g) Attach retainer piston rod end to fitting on landing leg fork by means of an AN6-11 bolt, and AN310-6 nut, and AN380-3-3 cotter pin.

WARNING

Landing gear control handle in the front cockpit must be fastened with wire in the "EMERGENCY DOWN" position to prevent unintentional retraction of gear.

(9) WHEELS.

(a) DESCRIPTION. — The landing-gear wheel assembly (AAF No. 25258, 27 inch, type II) is of the one-piece cast aluminum alloy drop-center type. The wheel is machined to permit installation of the steel brake drum liner, bearing cups, and tire. The wheel access fairing is of stamped aluminum alloy, and is easily removed to inflate the tire and inspect the Timken roller bearings and internal bracing ribs of the wheel.

(b) REMOVAL.—To remove the main wheels place an outer wing jacking stand under the outer wing jacking points and extend the jack until the wheel is free to rotate. (The tank doors must be installed before jacking the airplane at the outer wing jacking points.) An alternate method of jacking is accomplished by placing a small hydraulic jack in a main alighting gear wheel jack cradle and placing the center of the jack

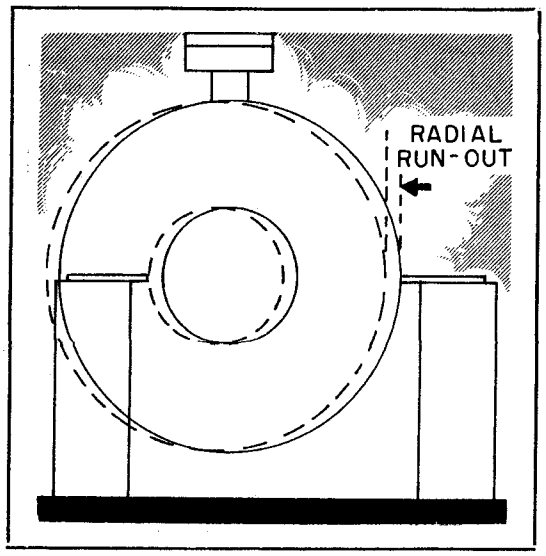


Figure 111A — Radial Run-Out

under each alighting gear strut at the jacking point provided. Extend the jack until the wheel is free to rotate. Remove the Dzus-fastened access fairing plate. Remove the hub nut cap retaining spring and the hub nut cap. Extract the cotter key and unscrew the large hex nut on the axle. Remove the bearing washer and the Timken bearing cone. Remove the wheel from the landing-gear strut axle.

(c) INSTALLATION. — When installing the wheels, ascertain that the bearing cups are pressed squarely into the wheel castings and that the wheel bearing cones are in good condition and properly lubricated. No grease should be packed in the wheel hub or in the cap, but all parts of the bearing cone and inboard and outboard axle bearing surface should be coated with a thin layer of grease.

(d) ADJUSTMENT.—After replacing the main landing-gear wheel, check to see that there is no brake drag. To adjust the wheel bearing, turn the adjusting nut counterclockwise while revolving the wheel; then, with the wheel spinning, tighten the adjusting nut slowly until a bearing drag on the wheel is noticed. Back off the adjusting nut to the next castellation; safety with a cotter. Do not confuse *brake drag* with *bearing tightness* while rotating the wheel during bearing adjustment.

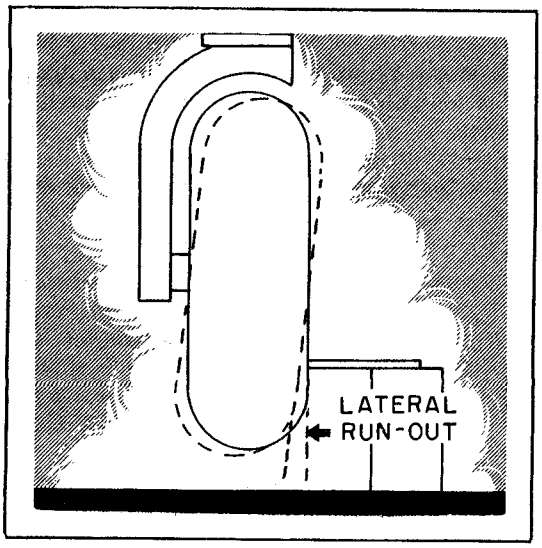


Figure 111B — Lateral Run-Out

(e) WHEEL ALIGNMENT.

1. RADIAL RUN-OUT: *(See figure 111A.)*— First check tire for radial run-out; if radial run-out is excessive, then check the wheel rim to determine if error is in the wheel and or tire. A condition of radial run-out must not be excessive or the wheel will oscillate in a vertical direction at high speed. Error can be corrected only by changing the tire and/or wheel.

2. LATERAL RUN-OUT. *(See figure 111B.)* —Check for lateral run-out; if excessive, determine if error is in tire and or wheel. Lateral wheel or tire run-out can sometimes be corrected by replacement of worn, distorted, or maladjusted wheel bearings. Usually lateral run-out is due to a distorted tire.

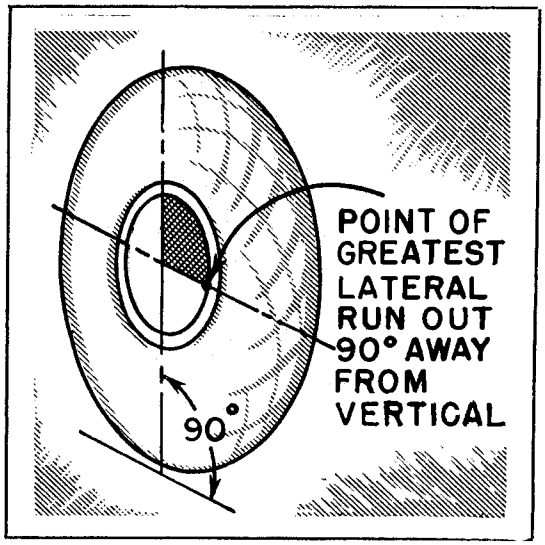


Figure 111C — Measurement of Camber

NOTE

After determining lateral run-out and before allowing the weight of the airplane to rest on the wheels for measurement of camber, turn the wheel so the point of greatest lateral run-out is 90 degrees from vertical. This procedure permits a more accurate measurement of camber. *(See figure 111C.)*

3. TOE-IN OR TOE-OUT. *(See figure 111D.)* —Always check for radial and lateral run-out before determining toe-in or toe-out. Toe-in or toe-out tolerance is limited to 3/16 inch. Any degree of toe-out is undesirable and should be eliminated.

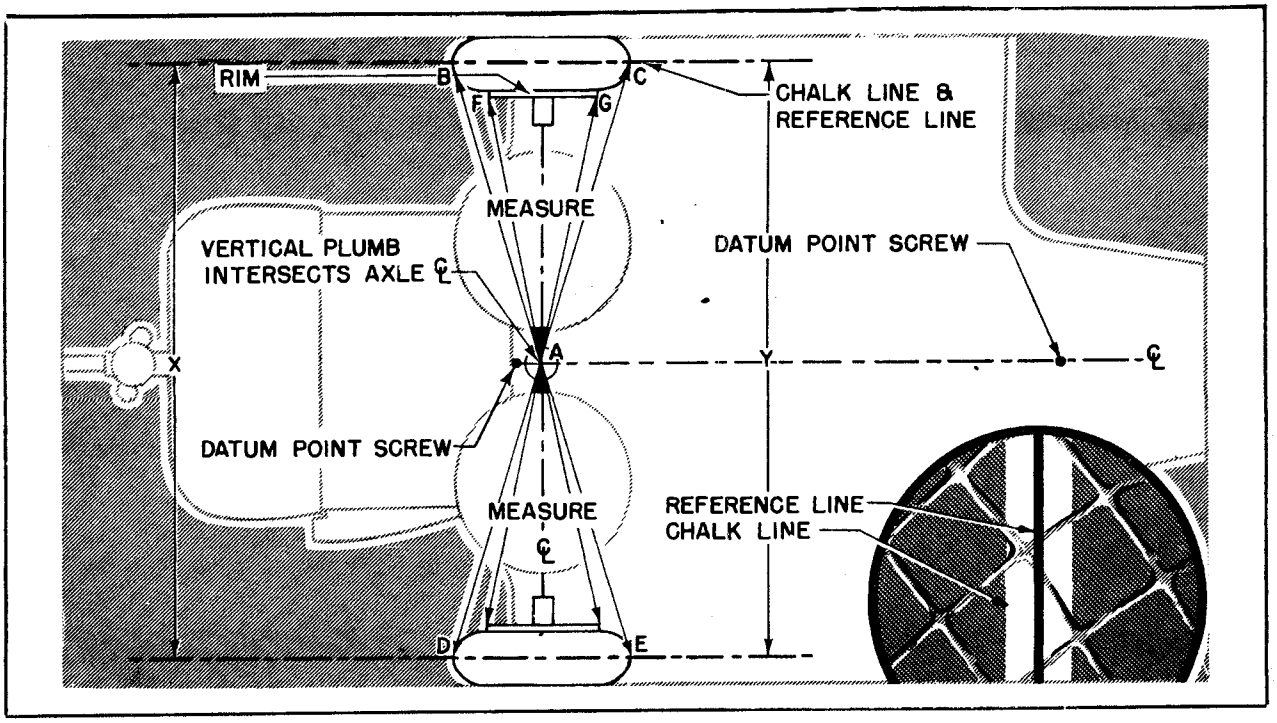


Figure 111D — Location of Measurement Points for Toe-In and Toe-Out

a. Mark a chalk line on the tire as indicated, using a steady support to hold the chalk. Inscribe a narrow line in the center of the chalk line to establish a reference line for accurate measurements.

b. To establish a center plumb line, stretch a line between the two center line datum point screws located on the lower surface of the wing center section and the lower surface of the fuselage aft section just forward of the camera doors. (See figure 111E.) Suspend a plumb line from the forward end of the center line so that the plumb line intersects a reference line temporarily strung between the lathe spindle center holes in the inboard ends of the landing gear jack and towing lugs.

c. Measure dimensions from "A" to "B" and "A" to "C". This distance must not vary more than 3/16 inch.

d. Measure the distance from "A" to "F" and "A" to "G". This distance must not vary more than 3/16 inch.

.e. An additional check is suggested. Check points "X" and "Y". "Y" may be 3/16 inch greater than "X".

NOTE

Excessive toe-in or toe-out may result from improperly adjusted or twisted shock strut torsion link assembly, sprung axle fork, bent pivot pin, or distorted wing center section.

4. CAMBER.—For measurement of camber, the airplane must be level and the *weight of the airplane must be on the wheels.* It is essential that the point of greatest lateral run-out be 90 degrees from vertical.

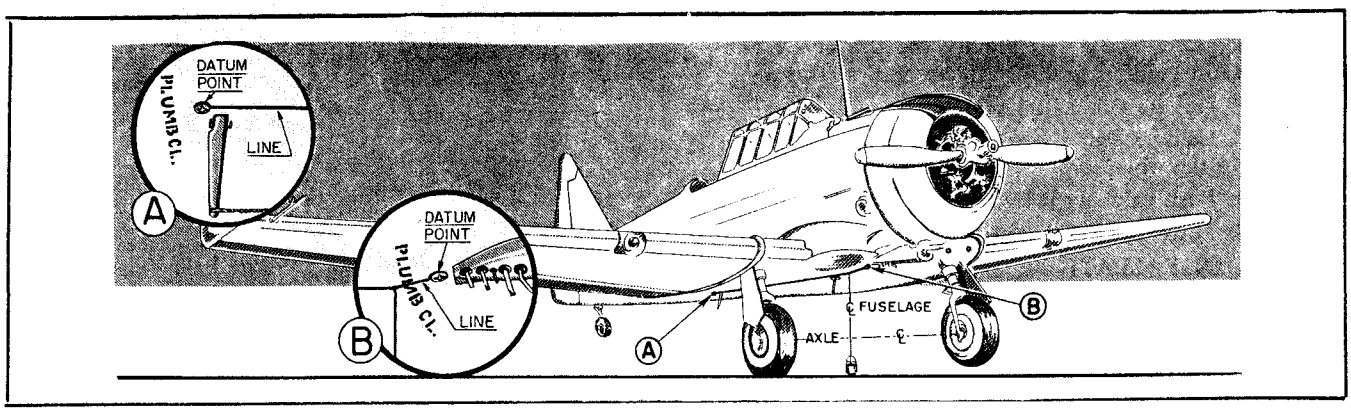


Figure 111E — Locating the Plumb Line

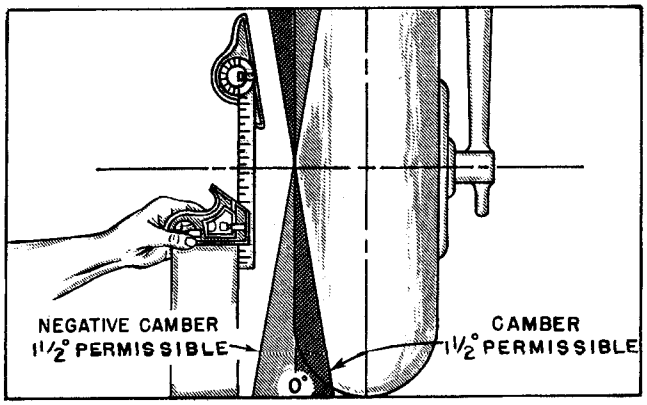


Figure 111F — Determining Camber or Negative Camber

a. Ascertain that both shock struts are equally inflated to the 1-½ inch dimension shown on the shock strut cylinder.

b. Level the airplane laterally by jacking up one of the shock struts and placing a straight edge and spirit level on the lateral leveling brackets located in the front cockpit just aft of the pilot's seat.

c. Place a board or block under the raised wheel and remove the jack. The airplane should now be laterally level with full weight on the wheels.

d. Place a straight edge, equipped with a bevel protractor, vertically against the wheel rim. Determine the camber angle by reading the scale. Zero angle is desired; however plus or minus 1-½ degree is permissible. (See figure 111F.)

NOTE

Excessive camber usually is caused by a bent axle fork, worn pivot pins, distorted wheel, or worn pivot pin support casting and attachment fittings. Replace defective parts or assemblies to correct.

(10) TIRES AND TUBES.

(a) DESCRIPTION.—The landing gear wheels are provided with 27-inch smooth contour tires (AAF No. 26545). Small raised inflation seams running around the outside circumference on each side of the casing are provided to aid in maintaining proper inflation. Each tire has an inner tube (AAF No. 26546) equipped with a flexible, molded rubber valve stem.

(b) REMOVAL.—To remove the tire and tube from the main landing gear wheel, proceed as follows:

1. Deflate tire completely.

2. Using a flat tire iron, force the top bead of the tire over the wheel rim.

3. Push valve stem into tire and pull tube out.

4. Force tire off the wheel.

(c) INSTALLATION.

1. Before mounting the tire and tube on the main wheel ascertain that all of the metal tools to be used have rounded edges and are free from burs. Check the inside of the tire casing for breaks in the fabric and presence of foreign objects. Mount the tire and tube on the main wheel in the following manner:

a. Place a tire on a main wheel so that the lower bead of the tire is partially on the rim of the wheel. Hook a tire clip on each side of the wheel rim so the tire cannot slip off the rim, and then force the tire bead over the wheel rim with a flat tire iron.

b. Apply talc to the tube with a piece of cheesecloth.

c. Insert tube into the tire.

d. Push valve stem through hole provided in the wheel and tie a string to it. Tie string to one of the spokes of the wheel so that the valve stem will not slip back into the tire.

e. Line the heavy mark on the tire with the light mark on the tube if the tube has been balanced.

f. Force the top bead of the tire over the wheel rim with a flat tire iron. Keep pushing the tire bead down into the wheel well as the tire bead becomes harder to stretch.

g. When the tire bead is almost on the wheel rim, it may be forced entirely on by pounding it with a rubber mallet.

h. A mark 1 inch wide by 2 inches long should be painted across the tire sidewall and wheel rim. This mark will extend 1 inch on the tire sidewall and 1 inch on the wheel rim. (See figure 112.) Use red enamel to make this mark. If the markings on the wheel and tire do not coincide, slippage is evident. If this has happened, the tube must be deflated and the tire realigned to its original position on the wheel.

CAUTION

Do not operate the airplane until this realignment is accomplished.

i. Inflate the tire to approximately 32 pounds pressure and then release the air so that the tire can adjust itself to the wheel and the valve stem

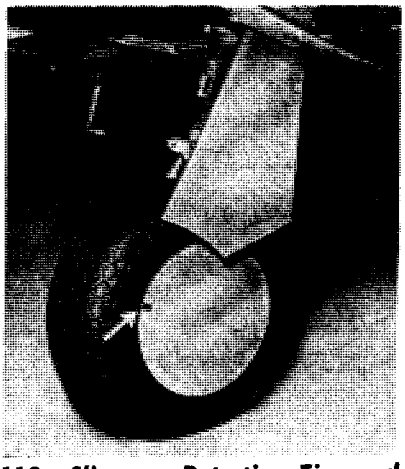


Figure 112 — Slippage Detection Tire and Wheel Rim Mark

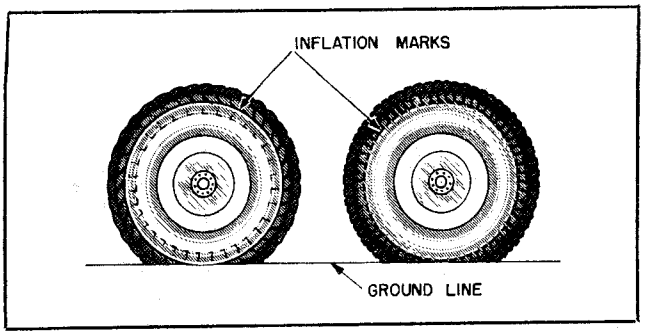


Figure 113—Inflation Marks and Lines on Tire Sidewalls

may straighten up. Reinflate the tire to approximately 32 pounds pressure.

2. The proper degree of inflation for tires which are not equipped with inflation marks or lines may be obtained by using inflation check templates. A check template must be made for each different size tire. With the airplane loaded for flight and the tire resting on a smooth, flat surface, place the inflation check template in such a position that the straight side rests on the same flat surface that the tire is resting on and the upper point formed by the intersection of the two curved sides contacts the lowest point on the wheel rim, as shown in the accompanying illustration. The vertical distance from the ground to the lowest point on the rim should not be less than 3.91 inches for the 27 inch main landing gear wheel tire. (See figures 113, 114, 115.)

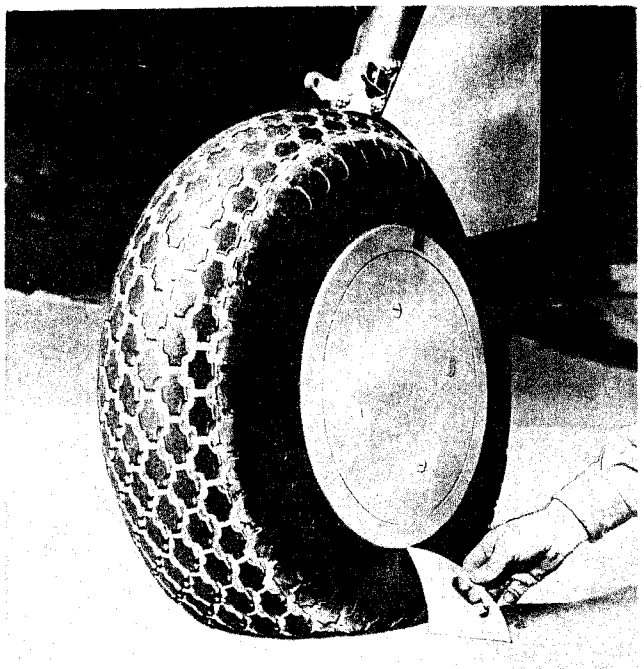


Figure 114—Check Template Applied to Tire

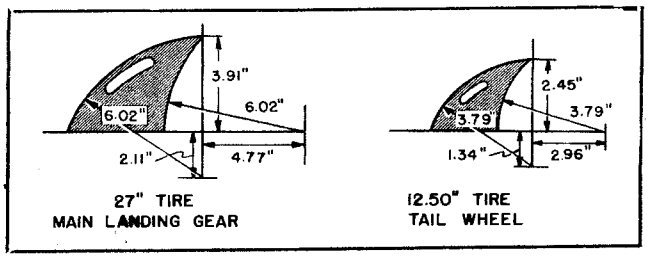


Figure 115—Tire Inflation Check Templates

(11) BRAKES.

(a) DESCRIPTION.—*(See figure 116.)*—The hydraulically operated brakes are of the reversible Hayes internal expanding "Servo" type, using a one-piece, Lynite brake band and molded brake shoes. Due to the large braking surface used, the brakes require very little attention other than checking and adjusting the radial clearances between the brake shoes and the brake drum. A separate hydraulic system, consisting of a master brake cylinder installed on the lower fuselage cross tube immediately aft of the fire wall, a small brake cylinder in each main landing gear wheel, and the necessary lines, is employed for operating the brakes of the airplane. Instructions on the hydraulic units of the brake system are given under "Hydraulic Systems," paragraph 12 of this section.

(b) REMOVAL.—To remove the brake assembly from the main landing gear shock strut for replacement or repairs, follow the instructions below:

1. Drain the brake line and brake shoe operating cylinder at the bleeder port of the brake shoe operating cylinder.

2. Remove the main landing gear wheel from the axle.

3. Disconnect the brake line at the brake shoe operating cylinder inlet fitting.

4. Plug the ends of the brake line and the brake shoe operating cylinder port.

5. Remove the six nuts, bolts, and washers which attach the brake assembly support plate to the landing gear strut flange; remove the brake shoe assembly from the strut.

CAUTION

Care should be exercised in the removal and installation of the brake shoes to see that they are not damaged or cracked by pulling the ends apart. When replacing the brake shoe return springs, see that the hooks have not been straightened out to the point where they may work loose in service.

(c) DISASSEMBLY.—*(See figure 117.)*—Disassembly of the brakes can readily be accomplished after first making a visual inspection and proceeding as follows:

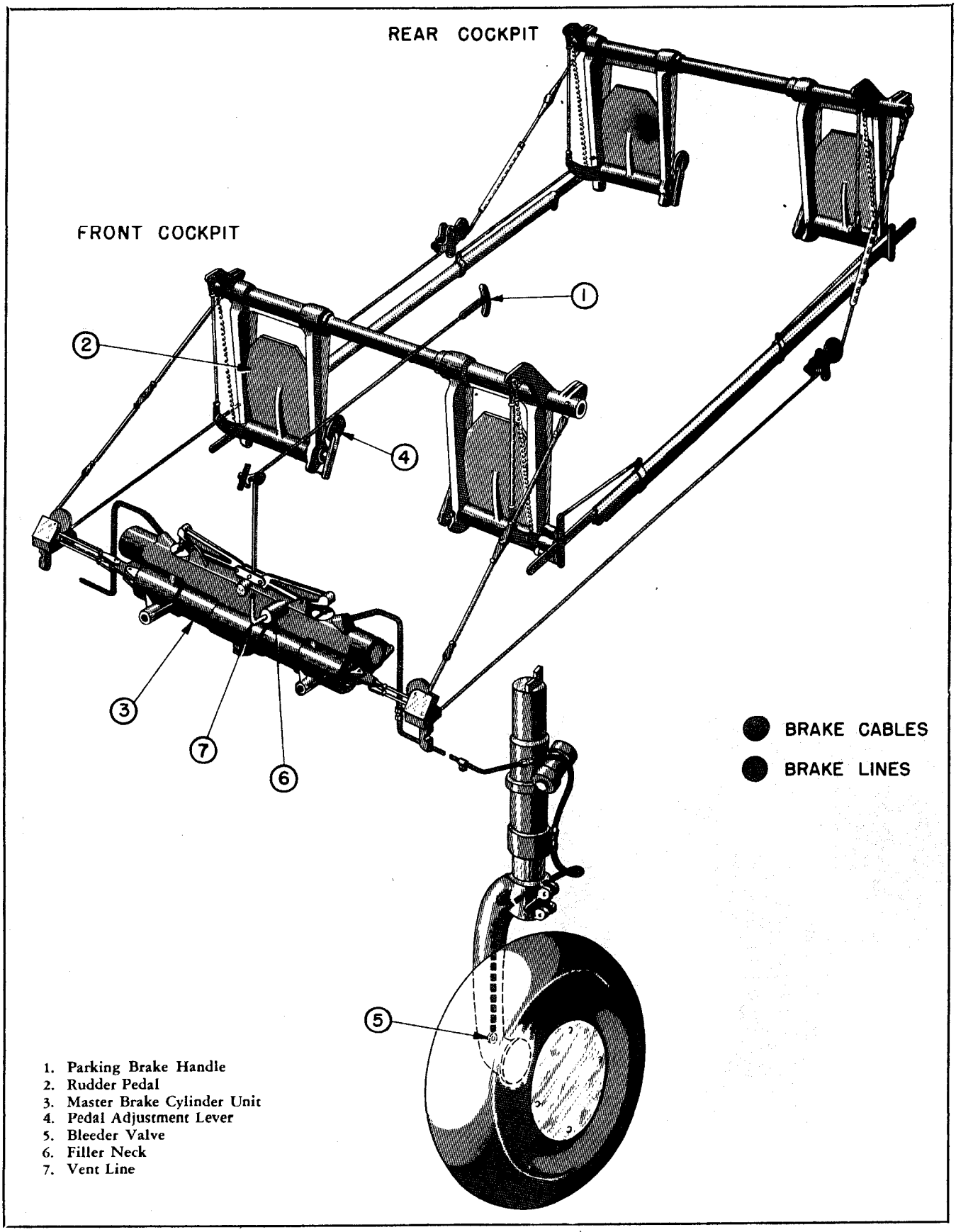


Figure 116 — Brake System Diagram

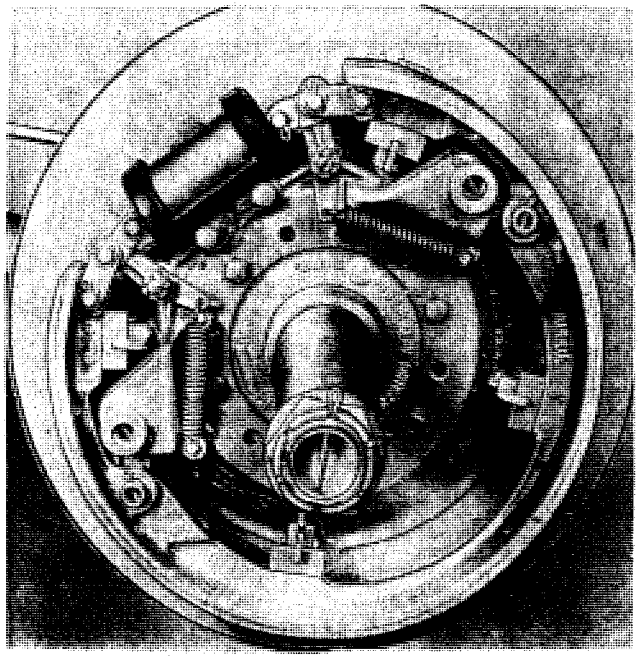


Figure 117— Brake Shoe and Operating Cylinder

1. Remove the six screws which attach the brake shoe assembly backing plate to the brake assembly support plate.

2. Remove the cotters and washers which hold the brake shoe retracting springs in place; remove the spring from the assembly.

3. Remove the cotters from the tubular clevis pins which attach the brake shoes to the brake assembly support plate link bars.

4. Remove the cotters and clevis pins which attach the ends of the brake shoe to the operating cylinder rod linkage.

5. Rotate the brake shoe either clockwise or counterclockwise; detach it from the assembly.

NOTE

New brake lining must be ground after installation on the brake shoe to insure concentricity of the brake shoe, drum, and wheel. The wheel bearings should have no appreciable shake or side play.

(d) ASSEMBLY AND INSTALLATION.—Assembly and installation of the brakes is generally the reverse of the removal and disassembly procedure. After installation, bleed brake system as instructed below. Ascertain that there is no interference between flexible brake line and torsion links.

(e) ADJUSTMENT.

1. GENERAL.—Bleeding the brake hydraulic system is not necessary before each brake adjustment unless there is an indication of air in the system. A spongy brake pedal usually indicates that there is air in the system. Jack the main landing gear wheels clear of the ground, utilizing the jacking point on the inboard side of each wheel axle. Before attempting to adjust the brakes, remove each wheel and inspect the brakes for damaged or worn parts. Examine the brake lining for grease; if the lining is greasy, it should be replaced with new lining. Ascertain that the brake shoe retracting springs have a good initial tension. If the initial tension is weak they should be replaced. After replacing the wheel and brake drum assembly, make sure that there is no brake drag. Do not confuse *brake drag* with *bearing tightness.* Adjust the wheel bearings as directed in paragraph (9), *(d), 4.* All mechanical linkage and hydraulic units must also be adjusted properly.

2. ADJUSTMENT OF MECHANICAL LINKAGE.—*(See figure 118, A and B.)*

a. Place the front and rear rudder pedals in the center adjustment hole in the rudder connect bar.

b. Ascertain that both master brake cylinder pistons are held in the retracted position by the retraction spring on the aft side of the master brake cylinder unit.

c. Adjust the turnbuckles on each brake cable assembly so that the perpendicular distance between the center of the brake-cable attachment bolt on the aft end of the front cockpit rudder pedal bell crank and the top of the forward end of the rudder pedal connect bars is 10-1/8 inches.

d. The turnbuckles on the brake cables in the rear cockpit should be adjusted so that the perpendicular distance between the center of the cable attachment bolt on the aft rudder pedal bell crank and the top of the aft end of the rudder pedal connect bar is 9-7/8 inches.

e. Adjust the link rod located forward of the rudder pedal fork which connects the forward bell crank with the lower bell crank on the rudder pedal so that the forward face of the rudder pedal is approximately 1/2 inch forward of the rudder pedal fork.

f. Ascertain that a dimension of 3-16 inch exists between the forward end of the parking brake handle and the aft face of the support bracket. (See figure 118,C.)

3. ADJUSTMENT OF MASTER BRAKE CYLINDER.—*(See figure 118,D.)*

a. Remove the filler-plug at the forward side of the fire wall and ascertain that the fluid level in the master brake cylinder unit is parallel with the top of the filler port.

b. Ascertain that both master cylinder pistons bottom against the stop in the retracted position when the brakes are released.

c. Ascertain that a dimension of 3/16 inch exists between the end of the master cylinder housing and the end of the compensator-spool adjustment plug.

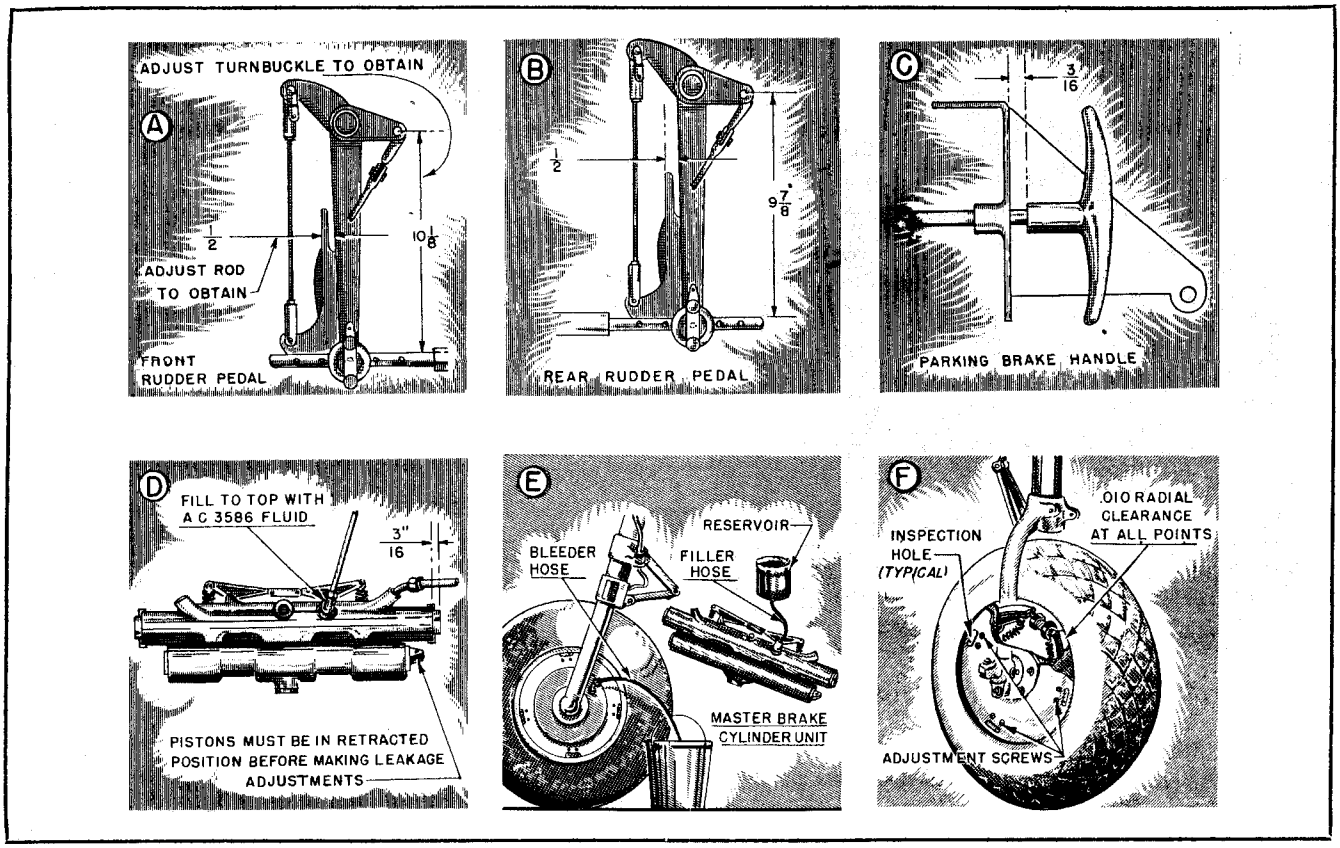


Figure 118 — Brake Adjustment Procedure

4. BLEEDING BRAKE HYDRAULIC SYSTEM.—*(See figure 118,E.)*

a. Remove the master cylinder filler plug and attach a line to the filler port. The opposite end of the line should be connected to a reservoir containing at least one pint of hydraulic fluid. Position the reservoir above the master cylinder unit so that the fluid in the reservoir is free to flow into the master cylinder filler port.

b. Remove the bleeder plug from the inboard side of the brake torque plate and attach a bleeder hose to the bleeder port. Submerge the opposite end of the line in hydraulic fluid contained in a suitable container placed at approximately ground level.

c. Pump the brake pedals several times and note whether air bubbles are present in the fluid in the bleeder tube container. When air bubbles cease to appear in the fluid, remove the bleeder hose and install the bleeder plug. Disconnect the upper reservoir line from the master cylinder filler port and install the filler plug. If a spongy brake pedal is still evident, check all hydraulic line joints for leaks and repeat the above bleeding procedure.

5. ADJUSTMENT OF BRAKE SHOE CLEARANCE.—*(See figure 118,F.)*

a. Place a jack under the shock strut jack pins and jack the airplane so that the main landing-gear wheels are free of the ground.

b. Remove the landing-gear wheel and ascertain that the brake lining is not glazed or covered with grease. The brake shoe and linkage should operate freely when the hydraulic operating cylinder pistons expand.

CAUTION

Do not apply the brakes while the wheel and brake drum are removed.

The brake drum should be free of deep scores and cracks. Examine the ends of the brake shoe operating cylinder for evidence of fluid leakage. Replace the wheel and adjust the bearings so that all bearing drag and play is eliminated. Ascertain that the wheel does not drag on the rim of the torque plate.

c. Uncover the four inspection holes located on the inboard side of the torque plate by rotating the covers aside. The radial clearance between the brake lining and drum should be .010 inch.

d. Insert a .010 inch thickness gage through the upper inspection hole adjacent to the adjusting screw and turn the adjustment screw clockwise to decrease the radial clearance or counterclockwise to increase the clearance. There should be a small amount of drag on the thickness gage as it is withdrawn from the inspection hole while the wheel is turning.

e. Follow the above procedure with the in-

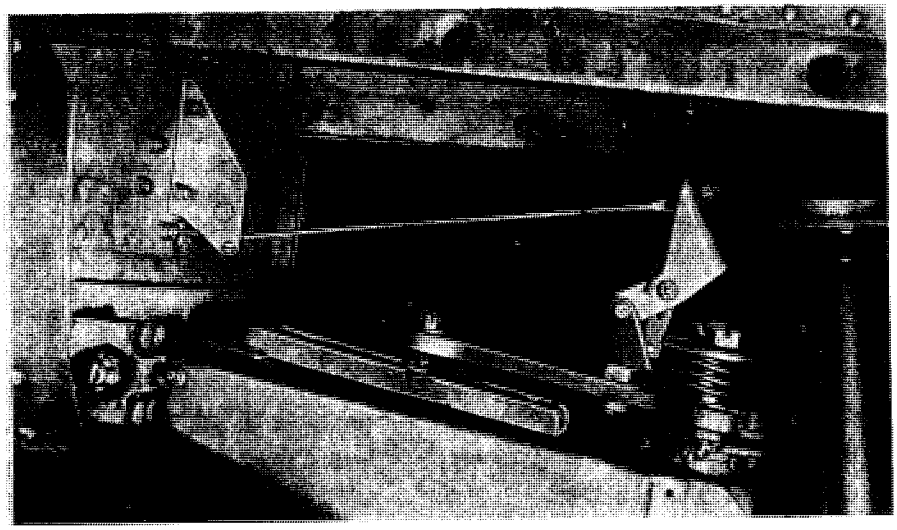


Figure 119—Installation of Declutching Head

spection hole and adjustment screw at the lower front portion of the torque plate and then at the lower and upper rear portion of the torque plate.

f. The drag exerted on the brake drum by the presence of the thickness gage should be approximately the same at all inspection holes.

g. Rotate the wheel to see that the brake lining does not drag on the brake drum. If the drag on the .010 inch thickness gage does not remain constant as the wheel is rotated, the brake drum will probably be found to be distorted. If a slight high spot is found on the drum, the radial clearance between the brake lining and the drum must be adjusted to .010 inch at the high spot even though the clearance between the lining and the drum at other points is greater than .010 inch.

h. Spin the wheels rapidly and apply the brakes; both wheels should stop simultaneously. Apply the parking brakes and ascertain that both wheels are locked. Release the brakes and ascertain that both wheels turn freely without drag.

i. If the brakes drag when the weight of the airplane is put on the wheels, the radial clearance between the high spot on the drum and the lining should be readjusted to .010 inch while the wheels are resting on the ground. Normally the radial clearance at the top of the drum will increase and the radial clearance at the bottom of the drum will decrease when the weight of the airplane is put on the wheels due to the fact that a small amount of clearance is taken up in the wheel bearings. The foot pressure on each rudder pedal necessary to apply the brakes should be equal and when both brakes are applied together, they should hold the airplane at full throttle.

j. When aircraft on which brakes nave been newly installed are exposed to inclement weather before brakes have been worn in, a recheck will be made of the brakes to ascertain that the brake clearance remain at .010 inch. This recheck will be made prior to any further flight or taxiing of the aircraft.

b. TAIL WHEEL ASSEMBLY.

(1) GENERAL.—The tail wheel assembly is a single-leg, half-fork, full cantilever structure, supported by an aluminum alloy casting. The forward end of the casting is attached to the fuselage aft section by means of two trunnions. The aft end of the casting is supported by a pneudraulic type shock strut. The upper end of the shock strut is attached to the aft end of the fuselage by means of a universal assembly and the lower end of the strut is attached to the extreme aft end of the support casting. Most airplanes have a boot assembly attached to the top end of the shock strut. Some earlier airplanes have a canvas dust cover. A short steering mast is attached to the upper end of the knuckle pivot shaft. The intermediate steering mast is attached to the lower end of a vertical pivot shaft mounted on the support casting and an adjustable bell

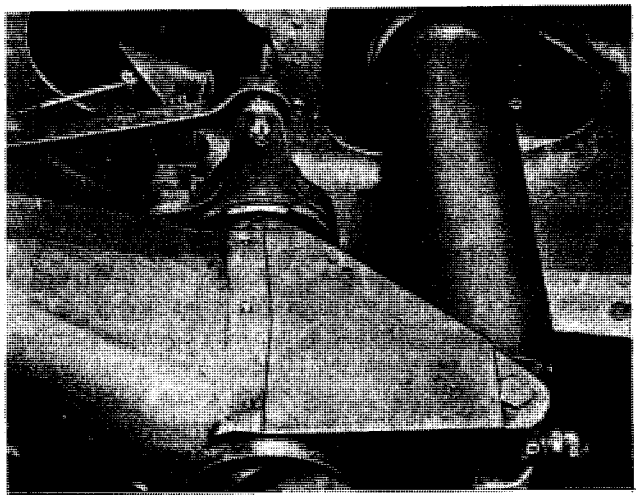


Figure 120—Tail Wheel Assembly

crank is attached to the upper end of the pivot shaft. An adjustable link arm connects the bell crank with the steering knuckle steering mast. The tail wheel is steerable through an arc of 30 degrees. The tail wheel locking mechanism is controlled by the tail wheel control lock in the front cockpit. Unlocking the control causes the lock pin to disengage from the declutching head plate and allows full swivel of the tail wheel. The tail wheel assembly is not retractable.

(2) SHOCK STRUT.

(a) DESCRIPTION.—The tail wheel assembly is provided with a shock absorber strut of the pneudraulic type, and it is designed to absorb shock transmitted to the tail landing gear assembly. Early airplanes are equipped with Bendix struts, and later airplanes are equipped with Gladden struts. The shock strut is attached to the aft section of the fuselage and to the aft end of the aluminum alloy casting support.

(b) REMOVAL. — To remove the tail wheel shock strut, follow the instructions below:

1. Jack up the airplane approximately 6 inches at the rear fuselage jacking point, and remove the tail wheel cowling and tail wheel housing fairing.

2. Ascertain that the brakes are applied.

3. Remove the bolt which attaches the knuckle support casting to the tail wheel shock strut.

4. Remove the nut and washer from the bolt connecting the strut to the universal joint, and knock out the bolt, thus freeing the strut.

(c) DISASSEMBLY. — Completely deflate the strut, by removing hex cap and backing off filler plug one turn only. When fizzing stops, remove the filler plug, drain all fluid, and proceed as follows:

1. On the Gladden-type strut, remove the lock wire and four nuts on the studs which hold the packing gland flange in place. On the Bendix-type strut, remove the set screw lock wire and the packing nut set screw and unscrew the packing nut on the upper end.

2. Remove the piston from the tube assembly.

3. Visual inspection will readily determine the procedure to follow in removing the packing rings.

(d) REPLACEMENT OF PACKING.

1. To replace packing in the tail wheel shock strut, follow instructions given for main gear struts, paragraph 4, *a, (2), (d).*

2. After new packing rings have been installed and the tail wheel strut reassembled, tighten the packing gland cap on the Bendix strut just tight enough to prevent leakage. The four nuts which hold the packing gland flange in place on the Gladden-type strut should be tightened down just enough to prevent leakage past the packing rings. Take care that the nuts on the studs are drawn down evenly to prevent uneven pressure on the packing rings and to prevent the packing gland from binding on the inside of the cylinder.

(e) TEST BEFORE INSTALLATION. — Test Bendix tail wheel strut, using procedure recommended for main landing gear struts. (Refer to paragraph 4, *a, (2), (c).)* Test Gladden-type strut as follows:

1. Inflate the strut to 225 pounds per square inch air pressure and run in the strut, provided a suitable testing machine is available. If available, run the strut in after replacing the packing. This should be accomplished by a machine that will move the piston in and out through at least one-half of its total stroke, a minimum of 750 cycles. There should be no appreciable loss of fluid or air.

NOTE

The strut should be serviced with oil and air before the running in is accomplished.

2. Inflate the strut to 225 pounds per square inch air pressure and leave it in a *horizontal* position for ½ hour. There should be no loss of air.

3. Inflate the strut to 225 pounds per square inch air pressure and leave it in a *vertical* position for ½ hour. There should be no loss of air.

4. Inflate the strut to 1688 pounds per square inch air pressure and leave for 15 minutes. There should be no loss of air.

(f) INSTALLATION.—With an AN6-17 bolt, secure the piston end of the shock strut to the lug provided directly between and below the horizontal stabilizer attaching blocks. The lower end of the shock strut is attached to the tail wheel housing at a point just aft of the tail wheel swivel fork, with an AN6-35 bolt and washers as required. For shock strut service instructions, refer to paragraph 3, section III.

(3) WHEEL.

(a) DESCRIPTION.—A 12-½ inch diameter tail wheel is mounted on the axle at the lower end of the tail wheel fork on late models A 10 inch wheel is used on early models. The cast aluminum alloy wheel is fitted with Timken roller bearings and cups on early airplanes and with plain bearings on later airplanes.

(b) REMOVAL. — To remove the tail wheel, place a jack under the tail jacking point located at station 215-⅝; extend the jack until the wheel is free to rotate. Remove the three screws from the wheel fairing, if installed. Remove the cotter, nut, washer, and bearing cone. Remove the wheel from the knuckle axle.

CAUTION

Care should be exercised not to drop the tail wheel bearings.

(c) INSTALLATION.—To reassemble and install the tail wheel, reverse the procedure outlined under "Removal." See that the bearing cups and bearing cones are correctly installed and properly greased. See that the bearings are not too tight and that there is no appreciable end play. Refer to paragraph 4, *a, (9), c* and *(e)* for further instructions.

(4) TAIL WHEEL TIRE AND TUBE.

(a) DESCRIPTION.—A 12-1/2 inch, smooth contour, static-conducting tire (AAF Specification No. 26547) is mounted on the tail wheel. Small raised inflation seams, located around the outside circumference on each side of the tire, are provided to aid in maintaining proper inflation. The inner tube (AAF Specification No. 26550) is equipped with a flexible valve stem. Earlier model airplanes, equipped with a 10-inch diameter wheel, are equipped with a 10-inch tire.

(b) REMOVAL.

1. Deflate the tire completely.

2. Remove the nuts holding the two halves of the hub together.

3. Remove the two halves of the hub from the tire.

4. Remove the tube from the tire.

(c) INSTALLATION.

1. Apply talc to the tube with a piece of cheesecloth.

2. Inflate the tube slightly to round it out.

3. Remove lock ring from the wheel hub. Take flange off the hub.

4. Push tire and tube over the wheel hub and guide valve stem through hole provided in the hub.

5. Place flange back on the hub and then install the lock ring.

6. Inflate tire to approximately 38 pounds pressure and then release the air so that the tire can adjust itself to the contour of the wheel hub and the valve stem may straighten up. Reinflate tire to approximately 38 pounds pressure.

NOTE

The vertical distance from the ground to the lowest point on the wheel rim should not be less than 2.45 inches for the 12-1/2 inch tail wheel tire and 1.94 inches for the 10 inch tail wheel tire, as measured by the inflation check templates.

(5) TAIL WHEEL KNUCKLE.

(a) REMOVAL.—Remove the tail wheel assembly cowling, tail wheel housing fairing, if installed, and the damper spring cover. Proceed as follows:

1. Remove the cotter, nut, washer spring, declutching head assembly, cotter, nut, cup, washer, bearing cone washer, and bearing cone, in that order.

2. Remove the knuckle from the housing.

(b) INSTALLATION.—When reinstalling the tail wheel knuckle shaft within the knuckle housing, see that the shaft bearing cone within the knuckle housing is not drawn up too tightly. The nut on the end of the tapered spindle shaft should be tightened just enough to eliminate any appreciable shake or end play.

(6) TAIL WHEEL KNUCKLE HOUSING.

(a) REMOVAL.—Remove the right and left cotters, hex nuts, washers, and bolts from the knuckle housing and fuselage attachment fittings. Remove the housing from the fuselage attachment fittings.

(b) INSTALLATION.—Reverse the procedure of removal.

(7) TAIL WHEEL STEERING MECHANISM.

(a) REMOVAL.

1. Remove the two bolts from the ends of the bell crank and short steering mast link rod and remove the link rod.

2. Remove the nut on top of the knuckle pivot shaft and remove the spring cap, spring, and declutching head.

3. Remove the two clevis bolts which attach the aft ends of the tail wheel cables to the intermediate steering mast.

4. Remove the four bolts attaching the vertical intermediate pivot shaft support to the support casting and remove the steering mast and pivot shaft assembly.

5. Remove the nut on the upper end of the intermediate pivot shaft and remove the bell crank.

6. Remove the eight screws which attach the lower steering mast cam slot plate to the support casting and remove the cap.

(b) INSTALLATION. — When installing the link rod, be sure to place the serrated washer on the lower side of the bell crank. On late model airplanes equipped with intermediate steering mast, be sure to install the correct cap with the large cam slots. Early model airplanes are equipped with caps with narrow slots, approximately the same width as the cams on the short steering mast. To eliminate tail wheel shimmying, install spring, part No. 88-34026.

(c) ADJUSTMENT.—Refer to paragraph 11, *c, (3), (c),* 10.

5. COWLING AND AIR INDUCTION SYSTEM

a. COWLING.

(1) DESCRIPTION.

(a) ENGINE RING COWL.—The engine ring cowling consists of three easily detachable sections. The sections are joined together by means of hooks and Dzus-type fasteners. The three sections are pulled securely around the engine assembly by means of three bolts at the lower left cowling joint.

CAUTION

Do not tighten the bolts excessively; permit cowling to have just a snug fit to provide sufficient expansion and retraction.

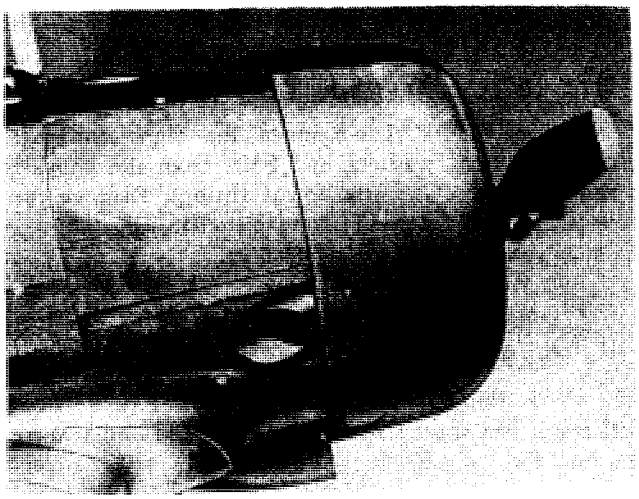


Figure 121 — Engine Cowling Installed

Access to the two forward bolts, located inside the leading edge of the cowling, is gained through the front of the engine ring cowling. The rear bolt is readily accessible on the outside of the cowling.

(b) ENGINE COMPARTMENT COWLING. —The engine compartment cowling consists of a top and bottom section, and two right -and two left-side sections. These sections are attached together and to the fire wall and engine fixed ring cowl by means of Dzus-type fasteners.

b. AIR INDUCTION SYSTEM.

(1) DESCRIPTION.—*(See figures 123, 124, 125.)*

(a) Cold air is introduced at the left side of the engine compartment cowling through a screened air scoop, which contains an easily removable carburetor air intake filter. This filter prevents dirt, dust, and grit from entering the induction system. The filter is of the wire mesh "Air-Maze" type. A rubber-lined frame holds the filter secure in a diagonal position across the air intake duct. The cold air passes through a duct assembly to the carburetor air mixing chamber. This chamber is bolted to the lower inner portion of the engine fixed ring cowling and is interconnected with the cold air inlet duct and the carburetor by means of slip-type joint assemblies. In order to provide a chamber for preheating air before it enters the mixing chamber, the exhaust collector ring is jacketed with a Dzus-fastened shroud. The air as it circulates around the exhaust collector ring is heated and then conducted through the duct to the carburetor air mixing chamber.

(b) A control handle, mounted on the forward end of the control shelf at the left side of the front cockpit, is pulled back to admit hot air, and pushed forward to admit cold air to the carburetor mixing chamber. Intermediate positions of the control will position the valves to allow varying amounts of hot and cold air to enter the mixing chamber.

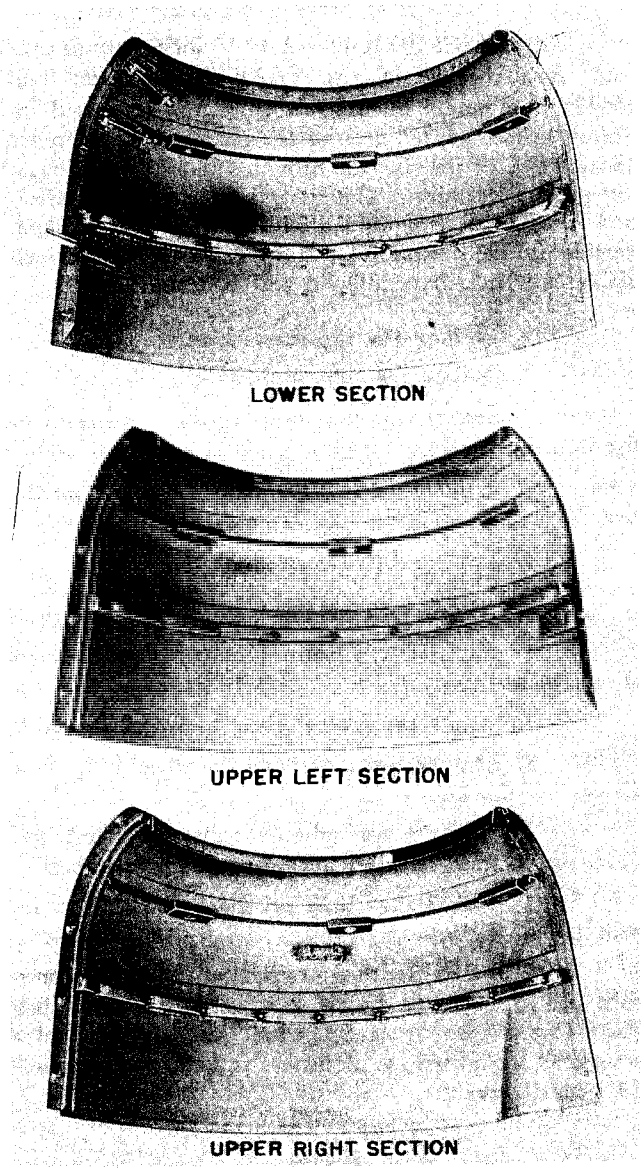


Figure 122 — Engine Cowling Sections

(c) A carburetor temperature indicator, actuated by a thermometer inserted in the duct assembly above the carburetor, is mounted on the main instrument panel of the front cockpit.

(2) REMOVAL.

(a) CARBURETOR AIR SCOOP. — The carburetor air scoop may be removed by removing the two bolts at the forward points of attachment to the engine fixed cowl.

(b) CARBURETOR AIR FILTER.—To remove the carburetor air filter from the airplane, remove the left power plant compartment side panel over carburetor air duct, release Dzus fastener at top, and lift filter out of duct.

(3) MAINTENANCE.—Cleaning the carburetor air filter is accomplished in the following manner:

(a) Wash in gasoline or other volatile cleaning fluid by immersing the filter element in the proper size container; shake the container vigorously to insure removal of any foreign substances from the innermost parts of the element.

(b) Thoroughly dry the filter element.

(c) Then immerse the filter in a mixture composed of one part corrosion preventive compound, Specification No. AN-VV-C-576, and three parts lubricating oil, Specification No. AN-VV-O-446, Grade 1120, from 2 to 5 minutes.

(d) Drain the filter from 2 to 4 hours to remove excessive oil prior to reinstallation.

(4) INSTALLATION.—To install the carburetor air filter, ascertain that the mounting frame is clean, place filter in air duct, secure Dzus fastener at top, and reinstall the side panel over carburetor air duct. A spring-loaded cam arrangement is incorporated in the mounting frame to automatically hold the lower end of the filter secure when it is pushed down into position.

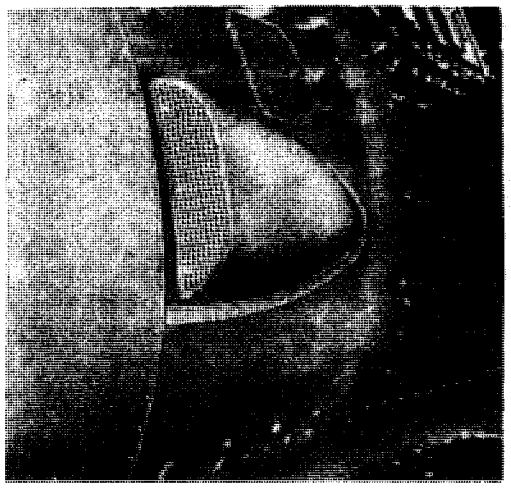


Figure 123 — Carburetor Air Scoop

6. POWER PLANT.

a. GENERAL.—*(See figure 126.)*

(1) The airplane is powered with a single Pratt and Whitney, model R-1340-AN-1, nine-cylinder, air-cooled, radial engine. The blower ratio is 10:1; compression ratio is 6.03:1. For take-off at sea level, the engine rating is 600 brake horsepower at 2250 rpm, with 36 inches Hg manifold pressure for 5 minutes (maximum); normal rating at 5000 feet is 550 brake horsepower at 2200 rpm, with 32.5 inches Hg manifold pressure. The engine is to be serviced with 87 octane fuel.

NOTE

Model AT-6 airplanes are equipped with R-1340-49 engines. These engines are similar to the R-1340-AN-1 except for normal brake horsepower at sea level (2200 rpm) which, for

1. Air Temperature Gage
2. Air Control Quadrant
3. Cold Air Scoop
4. Air Scoop Filter Screen
5. Exhaust Manifold Shroud
6. Cold Air Duct
7. Control Linkage and Bell Cranks
8. Air Mixing Chamber
9. Air Mixing Chamber Gate
10. Air Filter Fastener
11. Air Filter Bracket

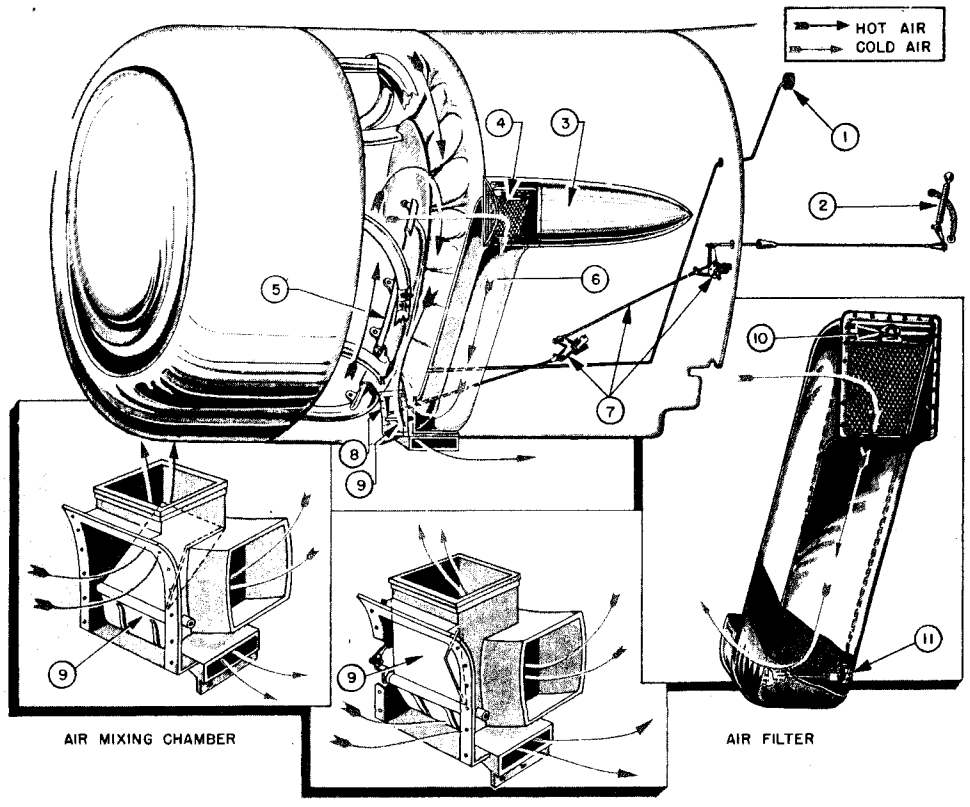


Figure 124 — Carburetor Air Induction System

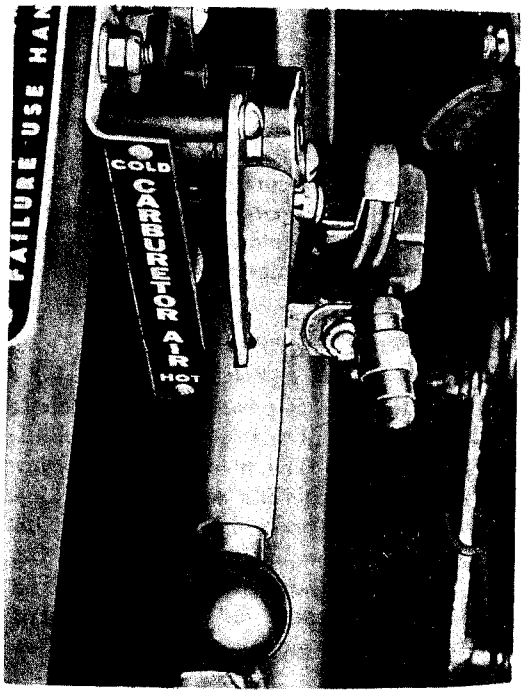


Figure 125 — Carburetor Air Control

the R-1340-49 is 501 brake horsepower, while for the R-1340-AN-1 it is 550 brake horsepower. For other engine characteristics, refer to section I.

(2) Engine equipment consists of two Scintilla model SB9RN magnetos (AT-6D and SNJ-5 airplanes) or two Scintilla model SB9R magnetos (earlier airplanes), a Stromberg model NA-Y9EI carburetor fitted with an idle cut-off device, an integral oil pump, and the following:

Fuel pump (Chandler-Evans or equivalent)	Type F-10
Hydraulic pump (Pesco)	263-E
Vacuum pump (Pesco)	Type B-12
Starter (Eclipse)	Type G-5 or H-5 (earlier airplanes)
Generator (Eclipse)	Type M-3 or E-5 (earlier airplanes)
Gun synchronizer (Pratt and Whitney)	Type E-4 or E-3 (earlier airplanes
Tachometer generator (Weston)	Type E-12
Propeller governor (Hamilton Standard)	Model 1M12-A

NOTE

For complete instructions on operating the engine, refer to Pilot's Flight Operating Instructions for the airplane.

b. ENGINE. *(See figures 127 and 128.)*

(1) DESCRIPTION.—The engine is divided into five major groups: front section, main crankcase, cylinders, blower section, and rear section. The main crankcase, cylinders, and front section are usually referred to as the *power section,* while the blower and rear sections are called the *accessory section.* The engine may be split between the blower and the main crankcase to facilitate work on either or both halves of the engine.

(a) FRONT SECTION.—The front section of the crankcase is an aluminum forging and supports a deep groove ball bearing which transmits the thrust of the propeller from the crankshaft to the engine mounting via the crankcase. Provision is made for a governor drive on the top of the front section.

(b) MAIN CRANKCASE.—The main crankcase is divided into two sections in the plane of the cylinders and united by nine through bolts between the cylinders, as well as by the cylinder flanges which are secured to the studs on the crankcase. With this type of construction the explosion forces are equally distributed between the two main bearings, one of which is carried in each section of the case. The two sections of the main crankcase are machined together. A rubber seal is used between each cylinder flange and the main crankcase. The front main crankcase carries the cam supported on a shelf forged integrally with the case forging. The tappets and tappet guides are also mounted in an integral shoulder.

(c) CYLINDERS.—The cylinders are of steel and aluminum construction. The cylinder barrels are machined from steel forgings and have integral cooling fins. The head is made from aluminum and has closely spaced cooling fins cast integrally. The cylinder has one inlet and one exhaust valve, the inlet seating on a bronze insert, and the exhaust seating on a steel insert, both of which are shrunk into the head casting. Fins are concentrated on the top and exhaust side of the hemispherical head and around the exhaust port where the greatest heat dissipation is essential. Horizontal fins surround the lower portion with a heavy shrink band at the bottom. The cylinder pressure-type baffles force cooling air through and over the cylinder fins.

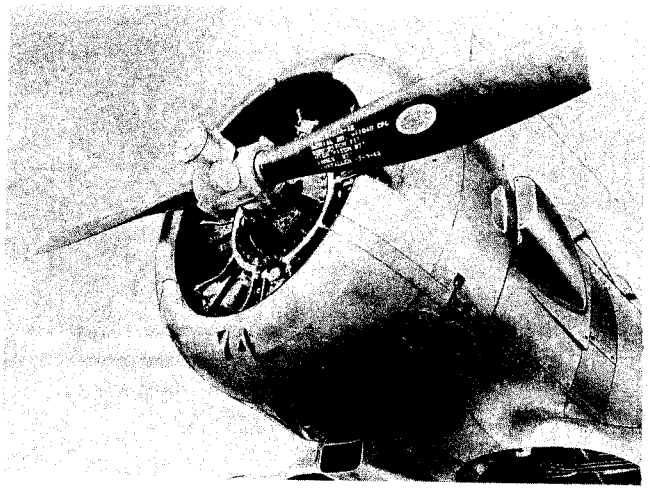
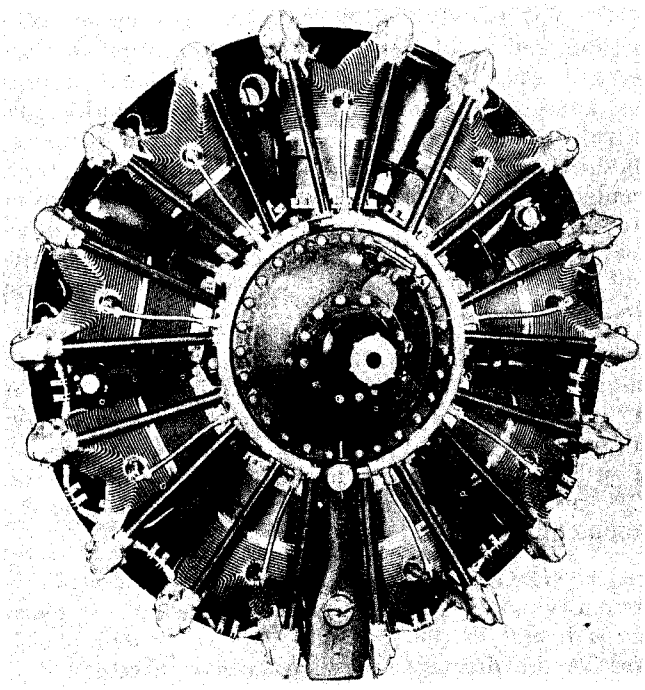


Figure 126 — Power Plant



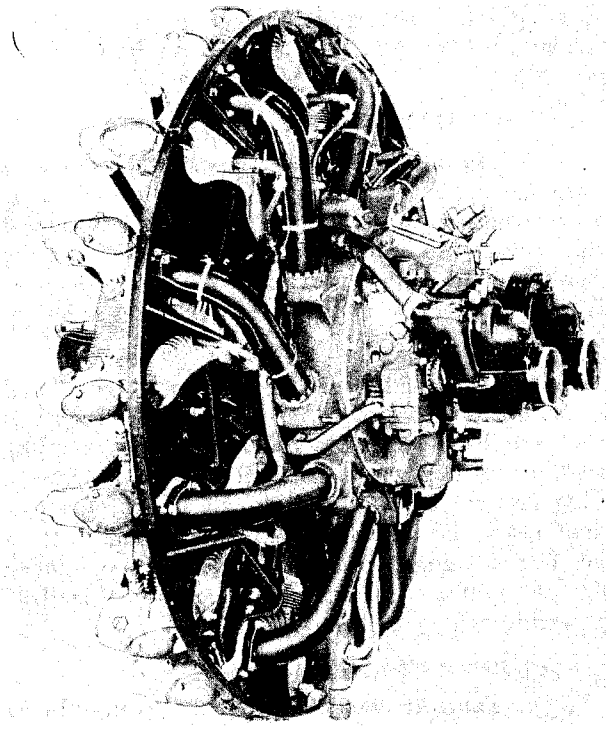


Figure 127 — Engine — Front and Side Views

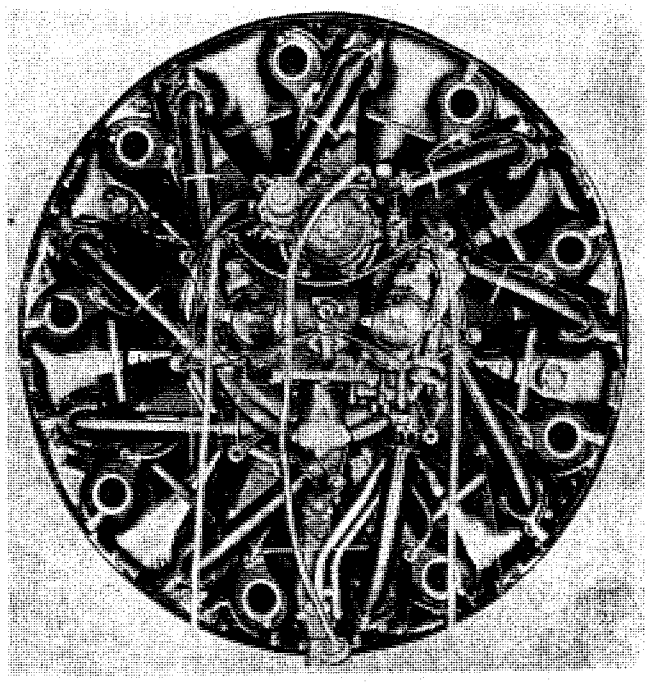


Figure 128 — Engine — Rear View

(d) VALVE MECHANISM.

1. All valve operating parts are enclosed. The rocker arms are supported by double row ball bearings in the rockers. Eighteen tappets located in the front main crankcase actuate the rocker arms through tubular push rods which have hardened steel ball ends. These rods are enclosed by removable oiltight cover tubes held in place by a nut and packing at the top and bottom. Rocker box covers are secured by studs and stop nuts. The valve clearance adjusting screw is in the end of the rocker arm over the valve. A half ball is used between the adjusting screw and valve stem to minimize friction at this point.

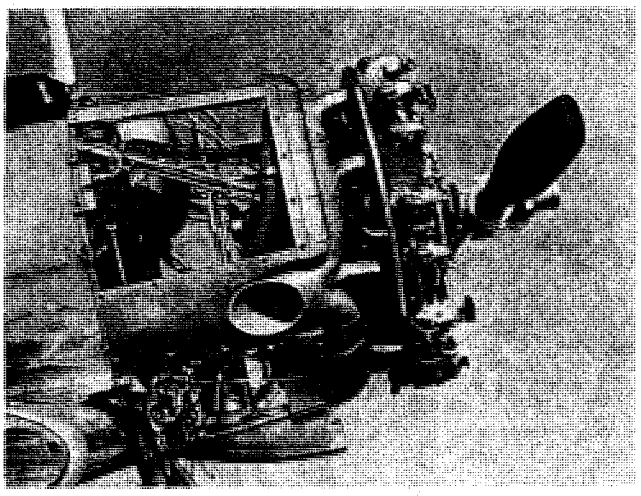
2. Two concentric valve springs are used and are secured to the valve stem by a split cone and washer. Inlet and exhaust valve springs are interchangeable and can be removed without taking out the rocker arms. To prevent possibility of valves being dropped into the cylinders while the split cones are being installed or removed, a safety ring is installed on each valve. The exhaust valves, made of a high-heat-resisting austenitic steel, are sodium-filled and stellite-faced on the seats.

3. The entire valve mechanism is pressure-lubricated; oil enters the tappets through the guides, then flows through the push rods and rockers. The rocker boxes, below the horizontal center line of the engine, are interconnected and drain into a separate compartment of the sump. Oil from the cylinders above the horizontal center line drains from the rocker box down the push rod covers through a passage in the tappet guides in the crankcase. An additional scavenge stage in the oil pump completes the circulating system. This full automatic lubrication makes possible greatly extended operating periods without any attention to the valve mechanism and practically eliminates all wear.

(e) TIMING GEAR.

1. By means of a train of spur gears and internal teeth in the cam ring forging, the cam is driven at 1/8 crankshaft speed in the opposite direction to the crankshaft rotation.

2. The cam, which actuates all valves through two four-lobed tracks, rotates on a bronze bushing mounted on a shelf, forged integral with the front main



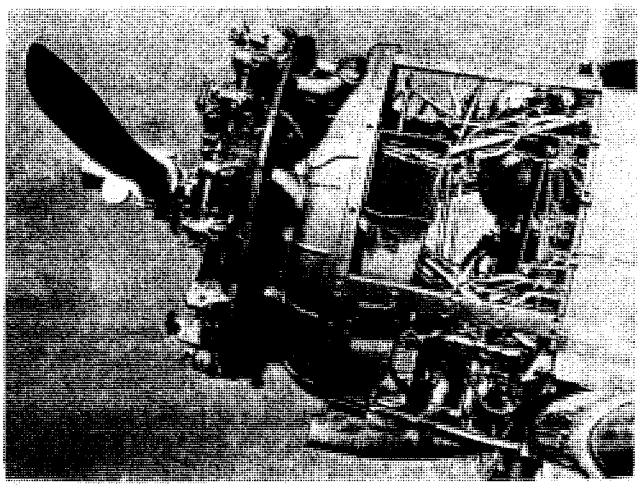


Figure 129—Power Plant Installation

crankcase. The cam reduction gear is mounted with a bearing on each side, one in the main case and the other in the nose section, assuring correct alignment.

(f) CRANKSHAFT.

1. The crankshaft is a single throw, two-piece split pin type supported on three bearings. There is a roller bearing on each side of the throw supported in the main crankcase, and a ball bearing in the front section which takes the propeller thrust as well as the radial load.

2. Two oil jets, one located in the front section rear plug and the other on the top of the rear cheek, furnish lubrication to the pistons, piston pins, and cylinders, in addition to the oil thrown off the master rod and knuckle pin bushings.

3. The weights of reciprocating and rotating parts connected to the crankshaft are counterbalanced by weights which are riveted to the cheeks of the crankshaft. The crankshaft is balanced statically and dynamically against a master balance weight. This insures a crankshaft that will operate without vibration at all speeds, and provides interchangeability of crankshaft between engines of a similar type.

(g) CONNECTING RODS.—The master connecting rod is solid and incorporates a shrunk-in steel backed lead-silver bearing. Eight "I" section link rods are attached to the master rod by means of knuckle pins fitted tightly in the master rod. Each link rod is bronze-bushed for the piston and knuckle pins. Oil, carried under pressure to the crankpin, lubricates the master rod bearings and also the knuckle pins through drilled passages. The piston pin bushings are lubricated by the oil thrown off by the master rod bearing, knuckle pin bushings, and oil jets.

(h) PISTONS.—Each piston, machined from an aluminum-alloy forging, has five ring grooves and is of the full-skirt type. The piston carries compression rings in the three top grooves, a dual oil ring in the fourth, and a scraper ring in the fifth, or bottom groove. The piston pin floats in the piston bosses as well as the connecting rod bushing.

(i) OIL SUMP.—The oil sump is located between cylinders No. 5 and No. 6. This sump is fastened at each end to the front and blower sections, which receive the drainage from the main crankcase. Oil is scavenged by the first stage of the oil pump. An oil pipe, supported in the upper part of the sump, carries oil under pressure from the rear to the front of the engine.

(j) BLOWER SECTION.

1. The blower section supports the engine in the airplane and is attached to the rear of the main case. The supercharger, together with its gearing, is carried in this section. An annulus in this section receives the mixture from the impeller through a diffuser chamber and delivers it to the cylinders through tangential intake pipes.

2. The supercharger is a high-speed centrifugal type having a 10:1 blower ratio. The supercharger is driven from the crankshaft by means of a spring coupling located inside the rear crankshaft gear and drives a floating gear in the lower section. By means of a pair of spur gears, the impeller is driven at a high rate of speed. The coupling relieves the blower gears of sudden strains of rapid acceleration and deceleration. Antifriction bearings are used throughout.

(k) REAR CRANKCASE.

1. The rear crankcase, attached to the blower section, is the accessory section. It carries all the auxiliaries; two Scintilla magnetos, a Stromberg carburetor, a hand-electric starter, a fuel pump, an oil pump, an oil strainer, tachometer drive, and two gun-synchronizer drives. Provision is made for mounting and driving a generator and two or three accessory pumps.

2. The rear section has blades in the elbow above the carburetor to direct the mixture evenly to the impeller, and vanes on the diffuser section which lead the mixture into the annulus in the blower section from which it is drawn through the intake pipes into the cylinders.

3. A check valve is provided in the oil pressure strainer to prevent seepage of oil from the tank into the engine when it is not in use.

(l) ACCESSORY DRIVES.—The accessories are grouped at the rear of the engine and are driven by three lay shafts which extend entirely through the blower and rear sections. Each shaft carries a spur gear at its forward end, which engages a gear attached to the rear of the crankshaft. The upper shaft provides a drive for the starter and generator. Each of the two lower shafts drives a magneto at its rear end by means of a readily adjustable flexible coupling. Besides this, four vertical drives are provided for a bevel gear on each shaft. The upper drives are for two gun synchronizers and two tachometers. The lower vertical shafts drive an oil pump on the right side and a fuel pump on the left.

(m) LUBRICATION.

1. Oil circulation is actuated by a three-section oil pump mounted on the right side of the rear section. The lower section supplies oil under pressure to the various moving parts of the engine. Oil is taken from the tank to the pump through the oil inlet connection. After passing through the pressure section, the oil flows from the outside to the inside of the pressure strainer located in the rear section just forward of the carburetor. From the inside of the pressure chamber, the oil flows forward through the blower section to the sump. A branch line feeds the accessory drive bushings in the rear section. An additional branch from the pressure chamber feeds the accessories on the right-hand side of the rear section through a series of drilled passages, and also leads directly to the main oil pressure relief valve located on the right-hand side of the rear section.

2. After the oil reaches the sump, it is passed through the top of the sump where it divides into two additional lines. One line directs oil to the top of the nose where it is available for the hydro-controllable propeller. The other line feeds directly to the front oil feed bracket and the oil is transferred to the cam drive gear sleeve by means of a bearing with oil seal rings and thence into the crankshaft. This pressure line also provides lubrication for the cam through a branch which leads to a groove around the shelf on which the cam is mounted.

3. Oil is fed to an annular groove machined around the front main cranckcase and thence to the tappets through a series of drilled passages in the crankcase. This provides full pressure lubrication for the valve mechanism via the push rods.

4. Oil fed into the crankshaft lubricates the master rod bearing and knuckle pin bushings. Two No. 55 oil jets, one in the rear of the front section and the other on top of the rear cheek, furnish additional lubrication to the power section. The supercharger gearing and accessory shafts are lubricated by drilled passages from the oil strainer chamber and by an oil jet in the main oil feed line.

5. The surplus oil in the engine proper drains into the main sump. The surplus oil in the rocker boxes drains by gravity through the push rod cover tubes to the crankcase or through a system of intercylinder drain pipes to an additional compartment on the bottom of the sump, whence it is pumped to the engine oil outlet by the center stage of the oil pump.

6. Excess oil from the relief valve is routed to the inlet side of the pressure pump.

(2) ENGINE TROUBLE SHOOTING.

(a) FAILURE OF ENGINE TO START.

1. LACK OF FUEL AT CARBURETOR.—Check carburetor strainer and airplane fuel strainer.

2. UNDERPRIMING OR OVERPRIMING.

a. Underpriming is sometimes caused by leaky primer line connections or primer pump packing. It is also well to check the fuel supply to the primer pump.

b. It is necessary to learn by trial the correct amount of priming necessary. Overpriming can be determined by wet spark plugs and gasoline being present at the exhaust stacks or in the collector ring, which is a dangerous fire hazard as well as a detriment to the oil film on the cylinder walls, causing scored pistons and cylinders.

3. INCORRECT THROTTLE OPENING.

a. The throttle should be set at about one-tenth open until the engine starts to fire; then it should be opened slowly until the engine turns between 600-800 rpm.

b. Check mixture control lever to insure its being in "Full Rich" position.

4. DEFECTIVE IGNITION.

a. Examine ignition wiring for broken wires and burned or chafed insulation.

b. Check spark plugs for correct gap setting, fouled or leaded condition, and proper functioning.

c. Check magneto breaker points for opening, pitted condition, and cleanliness. (Over-oiled breakers can cause misfiring.)

d. Check insulation on high tension wire, the ground connection, and the switch.

e. Check magneto timing.

5. FAULTY VALVE ACTION.

a. Check valves for freedom of action and broken valve springs.

b. Check for bent or worn push rods.

c. Check for correct valve adjustment clearance.

6. COLD OIL.

a. Turn propeller over by hand to insure engine being free.

b. During extremely cold weather, arrangements should be made to heat the oil before starting the engine.

7. AIR LEAKS.

a. Check intake pipes and carburetor gaskets for air leaks.

b. Check intake pipes for holes or cracks, particularly around the head end flange.

c. Check carburetor to see that it is tight.

d. Check tightness of plugs in cylinder primer connection holes (all cylinders).

e. Check intake packing nuts for tightness.

8. CARBURETOR FLOODING.

a. When using wobble pump, work slowly, never exceeding a pressure of 5 pounds.

b. The carburetor should be checked for leakage, externally and internally, by noting whether fuel comes out of the air intake. If there is a leakage, no attempt should be made to start the engine, because of the fire hazard involved. All external leaks should be corrected if possible; but in no case should the carburetor be dismantled to correct any internal leaks. The carburetor should be replaced instead.

(b) LOW OIL PRESSURE.

1. Determine quantity of oil in tank. Check oil pressure gage for correct recording.

2. Inspect all oil lines and connections from tank to inlet side of oil pump for tight connections, and determine if there are any air leaks. Check oil pressure connection to engine for correct location.

3. Check oil relief plunger for proper seating. Be sure there are no foreign particles on valve seat.

4. Check oil relief valve spring for length and pressure.

5. Check oil pump for excessive wear and proper functioning.

6. Remove oil pressure screen to see if it is partially clogged, or if the oil pressure screen plug has any metal particles present. If metal particles of appreciable size or quantity are found, the cause should be determined and the engine cleaned out before further operation.

7. The oil sump should be removed and inspected for metal particles. The oil pressure pipes in the sump should be checked for proper tightness.

8. After the above has been accomplished, if low oil pressure still persists, a cylinder should be removed, other than the master rod cylinder, and the master rod bearings checked for excessive wear or end clearance. This condition is almost always accompanied by the telltale of heavy deposits of metal particles in the oil pressure strainer cover. The same holds true if a bearing, bushing, or a cam bearing becomes scored or starts to "pick up."

9. Excessive clearance between the oil seal rings and ring carriers, or the cam and cam bearing liner, will also cause low oil pressure.

(c) LOW POWER.

1. Check valve mechanism for operation and timing.

2. Check magnetos for operation and timing.

3. Check spark plugs.

4. Check throttle throw to determine whether carburetor throttle valve is opening fully.

5. Check magnetos with switch to determine drop in rpm on each magneto individually. A drop of more than 100 rpm generally indicates faulty ignition, such as poor spark plugs, broken or damaged ignition wires, or malfunctioning of magnetos.

6. Check carburetor for proper setting and functioning.

7. Check fuel lines and strainers for restrictions to flow.

8. Check air intake system for restrictions or induction of exhaust gas.

9. Check preheater shut-off valve for hot-air leakage when in the cold-air position.

10. Check for air leaks in intake pipes, carburetor mounting flange, and carburetor body gasket.

11. Be sure the correct grade of fuel is being used. On engines of high power output, this is extremely important.

12. Check for ice formation in carburetor venturi.

13. Check propeller for correct design and setting.

(d) ROUGH RUNNING.

1. Check spark plugs and plug shields.

2. Check magneto timing and operation. Check ignition harness for broken wires, poor connections, and damaged insulation.

3. Check valve mechanism operation and timing.

4. Check propeller by installing a propeller from another engine which is known to run smoothly.

5. Check propeller hub nut, being sure it is tight.

6. Check propeller balance and track.

7. Check thrust nut to insure its tightness. Check propeller hub rear cone for galling.

8. Check engine mounting bolts for tightness.

9. Check engine mount for cracked or broken members.

10. Check running engine with hot air on to determine if poor distribution or ice formation in carburetor is causing roughness.

11. Check carburetor setting and operation to be sure it is functioning properly.

(e) HIGH OIL TEMPERATURES.

1. Check oil cooling system, particularly installations which have oil coolers with bypass valves.

2. Check valve timing and adjustment.

3. Check magneto timing.

4. Check compression for burned or scored pistons and weak piston rings.

5. Check oil strainer for metal particles, particularly master rod bearing and bushing metal.

6. Check carburetor for lean mixture.

7. Check cowling and intercylinder baffles when used, being sure that they are not interfering with correct air flow over engine.

8. Check to see that oil tank has sufficient air flow around it and that it has not been decreased by cowling alterations or changes.

(3) REPLACEMENT OF ENGINE PARTS.

(a) GENERAL.—This section will be limited to instructions for engine top overhaul. Discretion will be used in determining which parts should be removed, repaired, and replaced. If there are indications that internal engine parts have been damaged, the engine will be reported to the Area Air Service Command for disposition. Before complying with the following instructions, house the airplane indoors, if possible, to protect the engine from dust and moisture.

(b) REMOVAL OF PARTS.

1. PROPELLER.—For instructions on removing the propeller, refer to paragraph *7a, (2)* of this section.

2. COWLING. — All sections of cowling which would interfere with the necessary work on the engine will be removed.

3. SPARK PLUGS.—Refer to paragraph *d. (5)* for instructions on removing spark plugs.

4. EXHAUST PIPING.—Unscrew nuts which fasten exhaust stacks or exhaust manifold pipes to the cylinder heads, and remove the piping.

5. CYLINDER DEFLECTORS.—R-1340 series engines have been equipped with two different types of intercylinder deflectors. The names of these deflectors and the order in which they have been furnished are as follows: (1) "Bolted Type;" (2) "Latch Type." Both types of deflectors are attached to the cylinder barrels by means of a butterfly clamp and are also secured to adjacent cylinder head deflectors.

a. BOLTED TYPE.

(1) Remove all primer lines which fit through the rubber grommets in the deflectors and are connected to the cylinders.

(2) Remove bolts which attach intercylinder deflectors to the adjacent cylinder head deflectors.

(3) Unscrew wing nuts which fasten intercylinder deflectors to butterfly clamps; remove these parts.

(4) Remove nuts or screws which attach cylinder head deflectors to the top of the cylinders; lift off the deflectors.

b. LATCH TYPE.—Comply with the instructions outlined under "Bolted Type," with this exception: Detach the intercylinder deflectors from the cylinder head deflectors by compressing the latches which secure these parts together.

6. PUSH RODS AND COVERS.

a. The rocker box covers will be removed after the nuts which fasten them to the cylinder heads have been unscrewed.

b. Unscrew push rod cover packing nuts at top and bottom, using PWA-439 wrench.

c. Turn crankshaft until each valve, which is actuated by push rod to be removed, is fully closed.

d. Depress rocker arms with PWA-455 depressor; remove push rods and covers.

7. INTAKE PIPES.

a. Remove all primer lines, oil pipes, etc., which are fastened to the intake pipes.

b. Unscrew intake pipe gland nuts at blower section, using PWA-144 wrench.

c. Unscrew nuts and cap screws holding intake pipe flanges to the cylinders; remove pipes.

CAUTION

These pipes are made of thin gage aluminum and are easily damaged if dropped.

8. CYLINDERS AND PISTONS.

a. Remove spark plugs, exhaust piping, cylinder deflectors, push rods, push rod covers, and intake pipes, in accordance with the previous instructions.

b. Loosen clamps or wrap locks which fasten hose connections on intercylinder drain pipes. Slip the connections to one side so that the pipes between the cylinders are no longer connected.

c. Observe the following instructions before removing cylinders:

(1) The master rod cylinder (No. 5) will be the last removed, should its removal with one or more cylinders become necessary.

(2) Upon removal of the master rod cylinder, the rod will be centered rigidly in the crankcase opening by suitable blocking or wiring, and rotation of the crankshaft will be avoided. If these instructions are not complied with, the master rod may move sufficiently to permit the piston scraper rings to withdraw from the remaining cylinders, thereby causing damage to the pistons and cylinder skirts.

(3) After removal, the cylinders will be placed on wood or in some appropriate carrier to prevent mutilation at the bottom ends of the barrels. Also, the crankcase openings will be covered to prevent dust or grit from entering the crankcase.

(4) If difficulty is experienced in pushing out a piston pin, slightly heat the head of the piston and then lightly tap the pin, using PWA-12 drift. When using the drift to drive out a piston pin, support the connecting rod in which the pin is fitted to prevent it from striking the crankcase.

d. Turn crankshaft until piston within cylinder to be removed is at the top of the stroke.

e. Remove cylinder hold-down nuts, using PWA-186 wrench. Pull off each cylinder.

f. Push the piston pin out of each piston (after its respective cylinder has been pulled from the crankcase), and remove the latter.

9. VALVE SPRINGS AND ROCKER ARMS.

a. Remove rocker box covers, push rods, and push rod covers, as previously specified.

b. If the cylinders have been removed before the valve springs are withdrawn, place a block (having the same contour as the inside of the head) against the dome of the combustion chamber to prevent the valve stems from descending in the guides when the springs are compressed for removal.

c. Compress each valve spring, using PWA-459 compressor. Remove the split lock, upper washer, valve springs, and lower washer.

d. Unscrew the castellated nuts from the ends of the rocker shafts.

e. Drive out the rocker arms shafts, using a suitable drift. Remove the rocker arm assemblies.

10. VALVES.

a. Remove cylinders, pistons, rocker arms, and valve springs, as previously specified.

b. Remove safety circlets on the valve stems. Withdraw the valves from the guides and through the cylinder barrels.

(c) REPLACEMENT OF PARTS.

1. PUSH ROD COVER PACKING GLANDS.

a. Remove the push rod and cover in accordance with previous instructions.

b. Replace the push rod cover gland with a .004-inch oversize gland.

c. Rotate crankshaft until tappet, which actuates push rod to be installed, has fully descended in its respective guide.

d. The number etched on the tappet end of each push rod should correspond with the number of the cylinder to which the rod is assembled. The rod will be fitted to the tappet and rocker arm for the exhaust or intake valve, depending on the designation (that is, "Ex." or "In.") etched on the tappet end of the rod.

e. Insert push rod in cover.

f. Depress rocker arm with PWA-455 depressor, and fit push rod and cover into proper position.

g. Tighten packing nuts on each end of the cover, using PWA-439 wrench. The packing nut at the tappet end of the cover will be tightened first.

2. INTAKE PIPE GASKET.

a. Loosen intake pipe gland nut at the blower section, using PWA-144 wrench.

b. Remove nuts and cap screw holding the intake pipe flange to the cylinder head.

c. Remove gasket, after the necessary clearance is obtained for its removal, by a slight backward pull on the intake pipe.

d. Replace gasket. Fasten flanged end of pipe to cylinder head with nuts and cap screw.

e. Tighen gland nut of pipe at blower section, using PWA-237 wrench.

3. INTAKE PIPE PACKING.

a. Remove intake pipe in accordance with previous instructions.

b. Fit the flange, gland nut, and rubber packing over the blower end of each intake pipe.

c. Place pipe in position; screw gland nut loosely into the blower.

d. Locate copper gasket in proper position; fasten flange on pipe to cylinder head with cap screw and nuts.

e. Tighten gland nut at blower end of pipe, using PWA-237 wrench.

4. EXHAUST MANIFOLD PIPE GASKET.

a. Remove nuts holding flange of exhaust manifold pipe to cylinder head.

b. Remove gasket, after the necessary clearance is obtained for its removal, by a slight backward pull on the exhaust manifold pipe.

c. Replace gasket. Fasten flanged end of pipe to cylinder head with the necessary nuts.

NOTE

Replacement of gaskets and packing will be made when there is evidence of leakage at their respective locations, despite the fact that the nuts, screws, or gland nuts are snug.

5. ROCKER ARM BEARINGS.

a. Press bearing out of rocker arm with PWA-614 drift and base or its equivalent, using arbor press.

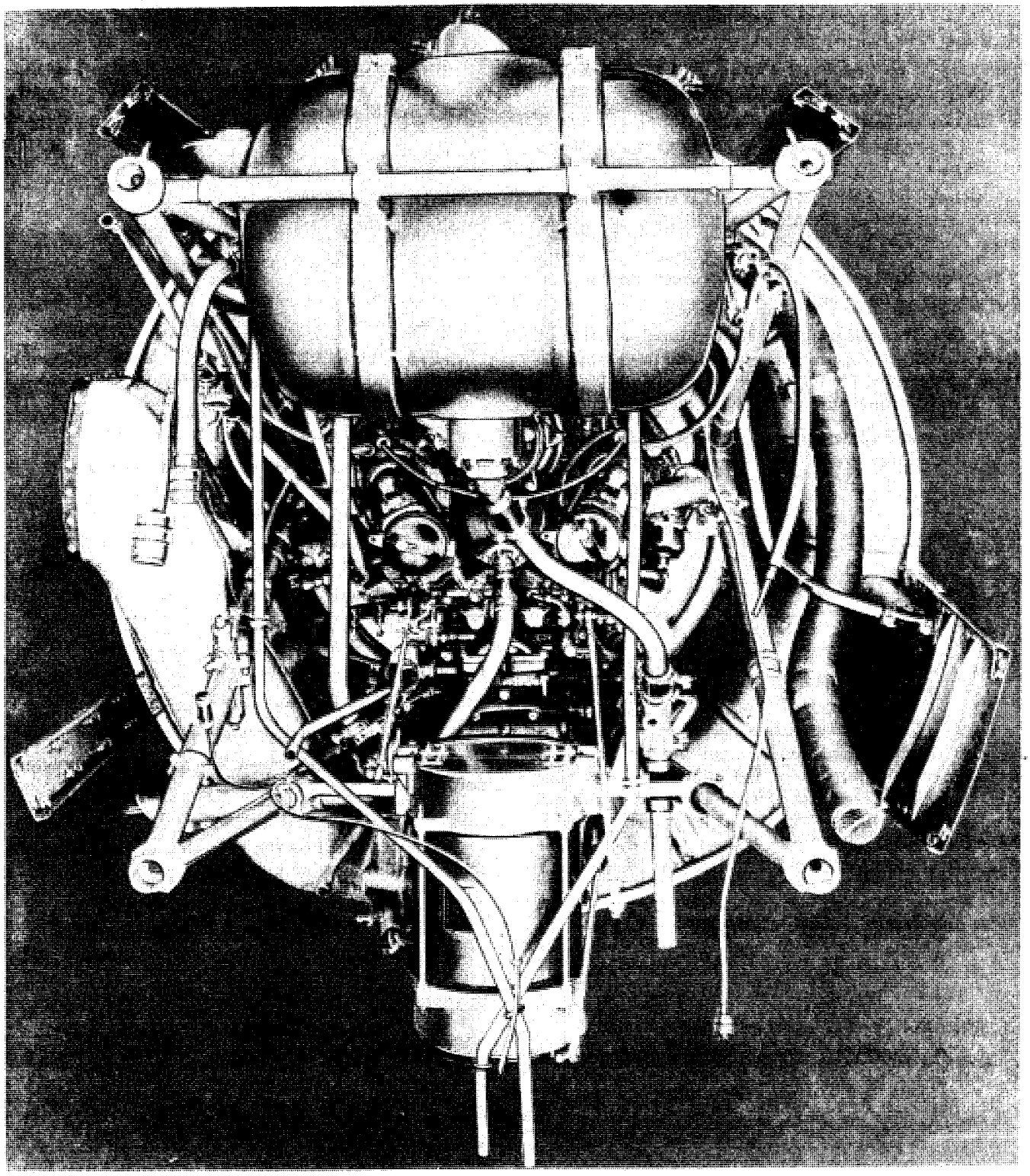


Figure 130 — Power Plant Assembly — Rear View

b. Observe the following instructions before installing new bearing in rocker arm: The two holes drilled through the outer race of the new bearing will be aligned as close as possible to the drilled passages in the rocker arm.

c. Press new bearing into rocker arm, using arbor press.

(4) ADJUSTMENT OF VALVE CLEARANCES.—To adjust valves, perform the following operations when the engine is cool:

(a) Remove the rocker box covers and the front spark plugs of all cylinders.

(b) Turn the propeller in the normal direction of rotation until the required piston is at top dead center of its exhaust stroke. (Refer to the table below.) Back off the valve adjusting screws to insure sufficient clearance.

Set Piston at Top Center of its Exhaust Stroke	*Adjust Valve Clearances to .040 in.*	
	Inlet	Exhaust
1	5	6
3	7	8
5	9	1
7	2	3
9	4	5
2	6	7
4	8	9
6	1	2
8	3	4

(c) Insert a .040-inch feeler of gage, PWA672, between the No. 5 inlet valve stem and the adjusting screw insert and turn down the adjusting screw until there is a slight drag on the feeler. Tighten the lock nut to a torque of 300 to 350 inch-pounds, using wrench PWA2835. Adjust the No. 6 exhaust valve to the same clearance adjustments in the same manner in the order of their listing.

(d) Install the rocker box covers and gaskets. Replace gaskets that are in poor condition, otherwise serious oil leakage may result. Tighten the rocker box cover nuts to a torque of 70 to 82 inch-pounds.

(5) REMOVAL. *(See figures 130 and 131.)*

(a) GENERAL.—Before removing the engine or the complete power plant as a unit, drain the fuel and oil systems; remove the engine cowling and propeller. To disconnect the lines and engine mount at the fire wall, reverse the sequence of operations contained under installation of the power plant. Make certain that all lines, rods, wiring, etc., have been disconnected and are free from clamps and that nothing will interfere with the removal of the complete power plant or engine, as the case may be. When disconnecting lines, plug the ends to prevent the loss of fluid.

NOTE

When the ignition plug is disconnected, the engine ignition is on. Do not rotate the engine.

(b) ENGINE REMOVAL. — The following sequence of operations should be adhered to in removing the engine from the engine mount.

1. Remove the outer muff assemblies.

2. Remove starter crank extention and starter hand engaging ring and cable, located at the left side of the engine compartment.

3. Disconnect all electrical wiring and conduits at the respective engine units.

4. Disconnect the following lines from the engine and respective engine units, as noted:

a. Exhaust gas analyzer cell lines at right rear side of exhaust collector ring.

b. Oil pressure lines at pump.

c. Manifold pressure lines at top of engine.

d. Engine primer line at primer distribution unit.

e. Hydraulic pressure and return lines.

5. Disconnect the following control rods from their respective engine units:

Throttle	Carburetor air heat
Mixture	Propeller

6. Disconnect the cockpit heating and ventilating system hot air duct at the hot air muff, located at the upper right side of the exhaust collector ring.

7. Remove the magneto blast tubes.

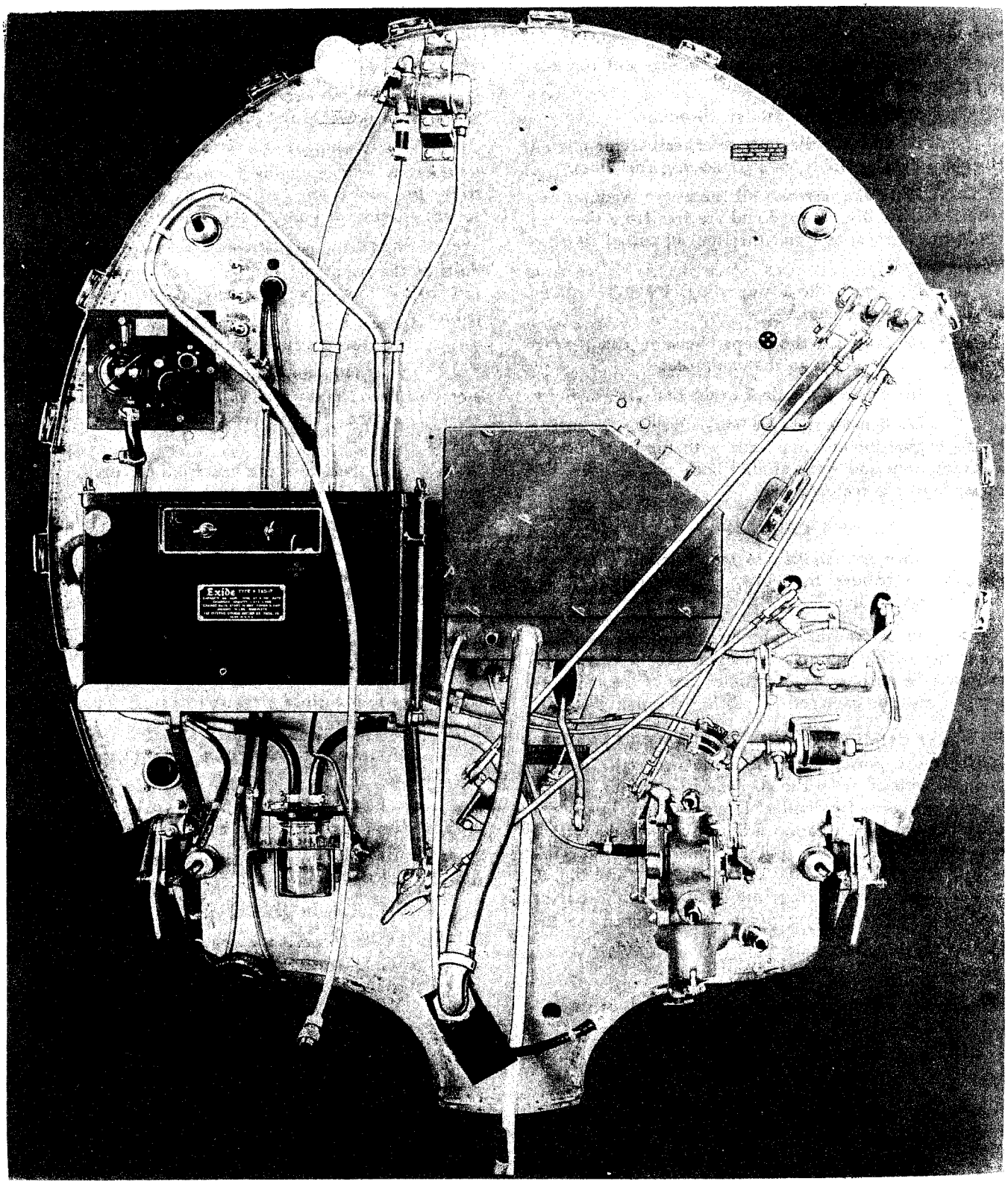


Figure 131 — Fire Wall Assembly

8. Remove the generator.

9. Remove the vacuum pump and connecting vacuum lines.

10. Remove the hydraulic pump and connecting hydraulic lines.

11. Remove the gun synchronizer.

12. Remove the carburetor, carburetor mixing chamber, duct assembly, and connecting fuel lines.

13. Make certain all necessary rods, lines, wires, etc., are disconnected and are free from tie-down cords and clamps, and that they are supported clear, as required.

14. Attach the lifting sling, PWA-37, to the lifting eyes on the engine.

15. Maintain the proper hoisting chain clearances to avoid damage to the equipment.

16. Take up the slack in the chain fall or hoist.

17. Remove the nine bolts attaching the engine to the engine mount ring. Start with the bolts located at the bottom and work around both sides, so that the upper bolts are removed last.

CAUTION

Two men are required to remove the engine: one to remove the bolts, and the other to operate the hoist.

18. After the bolts are removed, carefully guide the engine through the engine mount ring. Take care that the magnetos, or any other part of the accessory section, are not damaged in passing through the ring.

(c) COMPLETE POWER PLANT REMOVAL.—The entire power plant from the fire wall forward may be removed from the airplane in one unit. Engine mount fittings and individual line disconnect blocks are conveniently located and easily disconnected. Lifting eyes are provided on the engine assembly, between cylinders No. 1 and No. 2, and cylinders No. 1 and No. 9. Power plant hoisting lugs are located on the engine mount at the two upper points of attachment to the fuselage.

CAUTION

Do not use the power plant hoisting lugs on the engine mount to hoist the airplane.

1. Remove the propeller.

2. Remove the engine ring cowl and the engine compartment cowling, which is secured by conventional Dzus type fasteners.

3. Remove the oil cooler air scoop and duct mounted below the engine compartment.

4. Disconnect the cowling formers at their point of attachment to the fire wall.

5. Disconnect the following control rods from their respective bell cranks at the fire wall:

Throttle
Mixture
Propeller pitch
Carburetor air heat

6. Disconnect all electrical wiring and conduits at the main power panel junction box on the fire wall.

7. Disconnect the cylinder head temperature thermocouple line running from engine cylinder No. 5 to the fire wall fitting just below the right upper engine mount attachment point at the fire wall.

8. Disconnect all magneto wiring and conduits at the connector fitting, located on the fire wall just below the upper left engine mount attachment point.

9. Disconnect the following lines as noted:

a. Oil temperature capillary line at thermometer well on oil tank to drain cock line located at right side of engine compartment, and remove attaching clamps.

b. Fuel pressure line from carburetor at fire wall disconnect block.

c. Vacuum line at fitting at upper left corner of fire wall.

d. Hydraulic pressure and suction lines from engine-driven hydraulic pump at connector fitting located at left side of fire wall.

e. Oil pressure line from oil pump at disconnect fitting on fire wall.

f. Manifold pressure line from top of engine to disconnect fitting on fire wall.

g. Engine primer line at lower right side of fire wall.

h. Fuel line from engine-driven fuel pump at "tee" fitting at bottom of hand fuel pump.

i. Fuel line from carburetor to relief valve at top of hand fuel pump.

j. Exhaust gas analyzer and oil dilution lines and tachometer shafts.

10. Disconnect the cabin ventilating system hot air duct at the lower right side of the fire wall.

11. Disconnect the machine gun impulse tube at the gun trigger motor, if a gun has been installed in the airplane.

(6) ASSEMBLY AND INSTALLATION.

(a) GENERAL.—The entire power plant, including all accessory units forward of the fire wall and with the cowl panels removed, may be installed on the airplane in one complete unit; or, the engine may be installed on the engine mount after the mount, oil tank, oil cooler, fixed engine ring cowling, and other power plant units are installed on the airplane. The sequence of operations required for both methods is outlined in following paragraphs. The engine mount attachment

fittings, line-connecting blocks, control rods, etc., are conveniently located and easily connected. Lifting eyes are mounted between the top three cylinders. Hoisting lugs are located on the engine mount at the two upper points of attachment to the fuselage.

(b) PREPARATION FOR COMPLETE POWER PLANT INSTALLATION. — After the following instructions have been complied with, proceed with the complete installation, as outlined in paragraph *(c)*. Disconnect (or attachment) points are marked in the accompanying chart.

1. Make certain that all lines, conduits, etc., are secured properly with suitable clips and clamps. Connect the heating system pipes.

2. Ascertain that all control rods are properly adjusted and safetied; that all line connections are sufficiently tightened; and that all lines, conduits, controls, etc., are bonded and protected against chafing.

3. Make certain complete exhaust-collector ring and muff assemblies are installed. Install engine compartment cowling formers and oil cooler air scoop, inserting the ends of the oil filler neck drain line, oil

MARKINGS CHART: ENGINE DISCONNECT POINTS

Item No.	*Part No. Engine Side*	*Part No. Fire Wall Side*	*Designation*	*Appropriate Position of Connection*
1.	77-48812	Type D-3 fuel unit	Fuel line from carburetor to hand fuel pump	Lower left side of fire wall
2.	77-48810 *88-48810	Type D-3 fuel unit	Fuel line from engine-driven fuel pump to hand fuel pump.	Lower left side of fire wall
3.	77-51825	Type C-2 Spec. 94-32175 fuel press. signal	Fuel pressure line from carburetor to fire wall	Lower left side of fire wall
4.	55-48827	55-48827	Engine primer line at fire wall	Upper right side of fire wall
5.	77-51821	77-51822	Manifold pressure line from top of engine to fire wall	Upper right side of fire wall
6.	77-51829	77-51830	Oil pressure line from oil pump to fire wall	Upper right side of fire wall
7.	55-58507 *77-58507	55-58508 *77-58508	Hydraulic pressure line from engine-driven hydraulic pump to connectors at left lower tube of engine mount	Left lower side of fire wall
8.	55-58503 *77-58503	55-58505 *77-58505	Hydraulic return line from engine-driven hydraulic pump to connectors at left lower tube of engine mount	Left lower side of fire wall
9.	77-51081 *88-51081	77-51081	Thermocouple line from cylinder No. 5 to connector on fire wall	Upper right side of fire wall
10.	77-51805 *88-51805	AC 882-10-10	Vacuum line to fire wall	Upper left corner of fire wall
11.	U1050-B1	B-2 Spec. 27943	Front and rear oil temperature lines to capillary bulbs in "Y" valve	Lower right side of engine
12.	55-51845 88-51845	A-7 Spec. 27992	Outlet exhaust gas sampling line to exhaust gas analyzer unit	Right side of fire wall
13.	77-51844 *88-51844	A-7 Spec. 27992	Inlet exhaust gas sampling line to exhaust gas analyzer unit	Right side of fire wall
14.	U1050-B1	77-47810	Oil dilution line to "Y" valve	Lower right side of fire wall
15.	88-43802	28-43014	Throttle control rod to bell crank at fire wall	Lower left side of fire wall
16.	55-43804 *88-43804	55-43012	Mixture control rod to bell crank at fire wall	Lower center of fire wall
17.	88-43805	77-43030	Carburetor-air control rod to bell crank at fire wall	Bottom side of fire wall
18.	88-44801	55-44011	Propeller control rod to bell crank at fire wall	Upper left side of fire wall
19.	Type E-12 Tachometer Generator	25-54080-2AB-370	Tachometer conduit to tachometer generator	Rear right side of motor
20.	25-54080-2BB-500	88-54072	Gun solenoid and gun sights conduit to box assembly	Center of fire wall
21.	NA-Y9E1 Carburetor	25-54080-2AB-214	Carburetor mixture temperature conduit to carburetor	Rear center of motor
22.	25-54080-8DG-330	88-54072	Starter conduit to box assembly	Center of fire wall
23.	25-54080-6AB-394	88-54072	Generator conduit to box assembly	Center of fire wall
24.	25-54080-3EG-290	55-54139	Ignition conduit to box assembly	Upper left side of fire wall
25.	Type E-4 Gun Synchronizer	77-61004	Impulse tube unit, tube to synchronizer	Rear center of engine
26.	55-53308	55-53338	Ventilating system hot air duct to fire wall	Lower right side of fire wall
27.	77-31901	88-31104	Four engine mount nacelle attachment points	Outside edge of fire wall

*Used on later airplanes.

a. The above disconnect points are marked by means of "International orange" lacquer.

b. Both units of separation are marked.

c. Markings consist of a daub of paint at least 1/4" wide.

separator outlet line, battery vent line, and fuel pump flange drain line through the scoop.

4. Install the mechanical starter engaging cable assembly.

5. Install battery on shelf at the right side of the fire wall, and attach vent hose and conduit. Make certain that rubber padding is provided between battery base and the shelf.

6. Install engine ring cowling and engine compartment cowling.

7. Install propeller.

(c) COMPLETE POWER PLANT INSTALLATION.—The sequence of operations necessary to install the complete power plant, including all units forward of the fire wall, is as follows:

1. Because of the snug fit, it is recommended that the four engine mount attachment fittings and attachment bolts, AN8-13, be cleaned and coated with graphite grease prior to installation.

2. When proper lifting sling arrangements and clearances have been obtained, take up slack in the chain hoist and raise the power plant into position, engaging the two upper points of attachment to the fuselage. Then, connect the two lower points of attachment.

3. Secure each engine mount attachment fitting to its respective fuselage attachment bolt with an AN960-816 washer, AN310-8 nut and AN380-3-3 cotter.

4. Lower the hoisting chains and disconnect the sling.

5. Connect and secure all lines and rods at their points of attachment as noted:

a. FUEL LINES.

(1) Connect fuel unit at fuel pump at forward end of fuel unit.

(2) Connect carburetor to fuel unit at top of fuel unit.

(3) Primer line to engine at upper right side of fire wall.

b. OIL LINES.—Connect oil dilution line at top of oil "Y" drain and dilution cock.

c. HYDRAULIC LINES.

(1) Connect pressure line to upper connector at lower left side of fire wall.

(2) Connect suction line to lower connector at lower left side of fire wall.

d. INSTRUMENT LINES.

(1) Connect fuel pressure line to fitting at signal switch of fire wall.

(2) Manifold pressure line to upper right side of fire wall.

(3) Oil pressure line to upper right side of fire wall.

(4) Vacuum line from check valve to upper left side of fire wall.

(5) Thermocouple to upper right side of fire wall.

(6) Connect oil temperature capillary. Insert bulbs in oil dilution and drain valve, short conduit in rear part.

(7) Secure long conduit to lower left engine mount tube.

(8) Exhaust gas analyzer inlet to fuel mixture cell on fire wall. Secure to fire wall.

e. ELECTRICAL CONDUITS.

(1) Connect the engine ignition to connector at upper left side of fire wall.

(2) Magneto boosters to right side of power control box.

(3) Engine starter to left side of power control box.

(4) Engine generator to left side of power control box.

(5) Tachometer generator to upper right side of fire wall (connect at tachometer junction box).

(6) Carburetor mixture temperature to lower right side of power control box.

(7) Gun synchronizing to lower right side of power control box.

(8) Secure conduit loop of exhaust gas analyzer to upper right engine mount tube.

f. CONTROL RODS.

(1) Adjust engine controls, as in paragraph 6., *e.*

(2) Connect throttle inboard of bell crank, at lower left side of fire wall.

(3) Mixture at upper side of bell crank, at lower center of fire wall.

(4) Carburetor air at upper side of bell crank, at lower left side of fire wall.

(d) INSTALLING ENGINE TO ENGINE-MOUNT RING.—The sequence of operations for installing the engine on the engine mount is as follows:

1. Prior to installation, in order to allow the engine accessory section to pass through the engine mounting ring, it is necessary to remove the carburetor, generator, vacuum pump, tachometer generator, and hydraulic pump from rear of the engine.

2. Install two B1144-2 rubber vibration absorber cushions in each of the nine engine mounting lugs, except in the rear side of the upper mounting lug between cylinders No. 1 and No. 2 which require one 36-31912 cushion.

3. Place an AN960-716 washer on each of the eight AN7-57 bolts and on the 49-42006 clevis bolt. Place a 55-31911 washer on the clevis bolt, and install through the rear side of the lug located between engine cylinders No. 1 and No. 2. Place washers, 55-31916 and

55-31919, on two of the AN7-57 bolts, and install these bolts in the lugs between engine cylinders No. 2 and No. 3, and No. 1 and No. 9, respectively. Place 2W3 washers on the remaining bolts; insert same in lugs; and place 2W3 washer over the end of all nine bolts.

4. Install the engine-fixed baffle assembly around the engine accessory section.

5. If oil tank and/or oil regulator are not installed on the engine mount assembly, install them before making any other installation.

6. Connect the two metal straps (65-42063) from the oil cooler to the rear connecting flange of the carburetor air-mixing chamber.

7. Attach lifting sling to engine lifting eyes.

NOTE

Provide ample chain clearances to avoid damage to equipment. See hoisting instructions.

8. Take up the slack in the chain hoist; raise the engine to the level of the mounting ring.

9. Carefully guide the engine through the mounting ring. Take care that the magnetos, engine ignition flexible conduit, and other attached accessories are not damaged when passing them through the mounting ring.

10. Install bonding braid (19-54079) on the mounting bolt at engine cylinders No. 2 and No. 7; fasten the engine to the mounting ring with AN960-716 washers, eight AN310-7 and one AN320-7 nuts. Safety with lock wire.

CAUTION

Tighten all bolts evenly to obtain maximum absorbing characteristics and to insure proper alignment of the engine with mounting ring. The proper tension of the 7/16-inch engine mount bolts is 300- to 500-inch pounds.

11. Lower the hoisting chain and remove the engine sling.

12. If the two halves of the engine fixed cowling rings have not been installed, they should be installed at this point. Attach the carburetor air-mixing chamber to the cowling ring, and install the assembly on the engine mounting ring. Install the carburetor cold-air intake duct at the left side of the power plant compartment with one attachment to the cowling ring; secure with three bolts and link.

13. Install carburetor and upper and lower duct assemblies between the carburetor and mixture chamber.

14. Install engine generator, hydraulic pump, vacuum pump, and tachometer generator.

15. Insert flexible end of each magneto blast tube assembly through the fiber fair-leads in engine-fixed baffle assembly, and secure the end of each assembly to its respective air scoop. Adjust the leather chafing collar so as to protect the tube at the fair-lead.

16. Check and secure the following lines and rods at the attachment points as noted:

a. FUEL LINES.

(1) Fuel line to carburetor at outboard side of pump to T-fitting at left rear corner of carburetor.

(2) Fuel pump drain line at rear of fuel pump flange.

(3) Primer line to fuel outlet distributor at top of engine.

(4) Hand pump to carburetor at the fitting on left rear corner of the carburetor.

(5) Hand pump to fuel pump on inboard side of fuel pump.

b. OIL LINES.

(1) Engine breather at top of engine crankcase.

(2) Oil inlet connects below oil pump.

(3) Oil outlet at center of engine case.

(4) Tank vents (2) to left and right sides of engine case.

(5) Ascertain that T-fitting is installed at end of right line for installation of vacuum line to oil separator.

c. HYDRAULIC LINES.

(1) Pressure line to inboard port of hydraulic pump.

(2) Suction line to outboard port of hydraulic pump.

d. INSTRUMENT LINES.

(1) Oil pressure to upper left side of engine case.

(2) Manifold pressure at elbow fitting above crankcase and aft of cylinder No. 1.

(3) Vacuum pump discharge to lower port on vacuum pump.

(4) Vacuum to upper port on vacuum pump.

(5) Connect oil separator vacuum to engine at T-fitting at the right oil tank vent line attachment to engine.

(6) Thermocouple to attachment fittings at rear of cylinder No. 5.

(7) Exhaust gas analyzer inlet to intake duct above carburetor.

e. ELECTRICAL CONDUIT.

(1) Engine ignition to left magneto.

(2) Magneto booster to right magneto, center plug.

(3) Engine starter to left side of power control box.

(4) Secure to upper left diagonal engine mount tube.

(5) Connect tachometer generator at generator on top of engine case.

(6) Carburetor mixture temperature at intake duct above carburetor rear side.

(7) Gun synchronizing to gun synchronizer at right side of engine case.

f. CONTROL RODS.

(1) Adjust the engine controls, as instructed in paragraph *e.* (2).

(2) Connect the throttle, mixture, propeller, and carburetor air control rods to their respective units.

c. CARBURETOR.—*(See figure 132.)*—The Stromberg carburetor, type NA-Y9E1, is a double-barrel updraft type. This type carburetor has a Y-type float mechanism, needle valve economizer, back suction-type mixture control, and an accelerating pump. The carburetor is also equipped with an idle cut-off device. The settings for cruising and full throttle have been determined by the manufacturer; therefore, no adjustment will be necessary. An idle adjustment is provided to take care of production variations. Two small levers at the rear of the throttle valve body may be moved to control the richness of the mixture at idling speeds. After the carburetor is properly installed and the idle adjustments are made, very little attention is required in service. A fuel strainer is located at the rear of the carburetor and may be removed by the removal of the large square head plug at the top of the main body. The strainer should be removed frequently to dispose of any dirt or water which may have accumulated in the strainer chamber.

WARNING

Because of the fire hazard involved, the engine must not be run if the carburetor leaks fuel excessively. In no case will the carburetor be disassembled to correct any leakage. Replace the carburetor instead.

CAUTION

When removing the carburetor, cover the engine intake passage with heavy cardboard or other material to prevent the entry of foreign matter.

(1) AUTOMATIC MIXTURE CONTROL ADJUSTMENT.—Since the automatic mixture control is set at the factory when new and at the depots during overhaul, where special equipment is used, no change will be made in the setting by operating personnel. If there is any malfunctioning or evidence that the adjustment has been changed, the complete automatic mixture control unit will be replaced. When replacing the automatic mixture control assembly, care will be taken to insure that the new assembly is the proper type and assembly number required for the particular carburetor.

d. IGNITION SYSTEM.

(1) GENERAL.—The ignition system consists of two magnetos, an ignition switch, a booster coil, 18 spark plugs, and the required wiring and radio-shielded ignition harness.

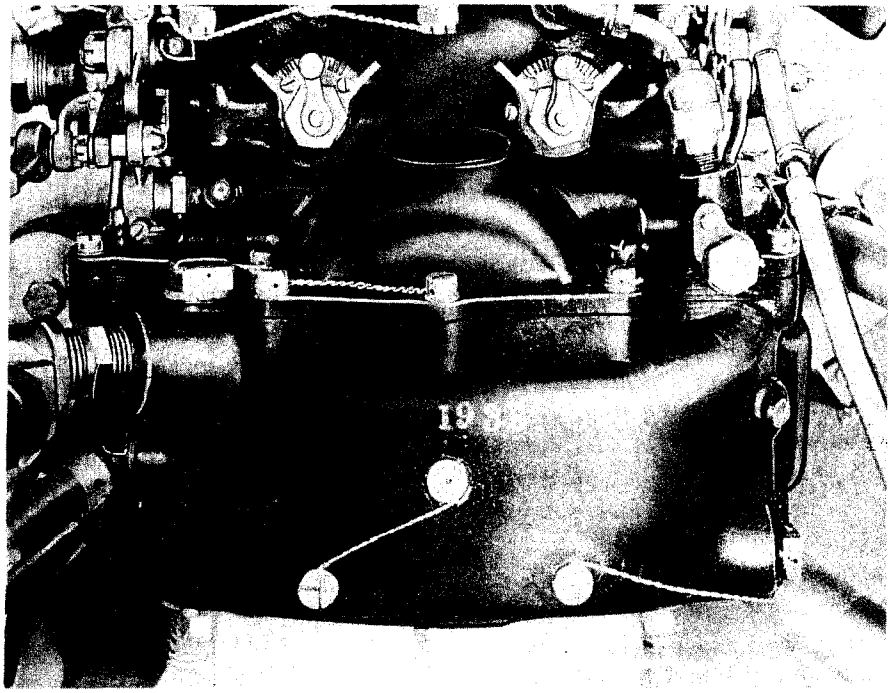


Figure 132—Carburetor

(2) TROUBLE SHOOTING.

Trouble	*Possible Cause*	*Remedy*
ENGINE MISSES OR FAILS TO START	Excessive lubricant in magneto.	Clean magneto breaker assembly and adjust magneto.
	Open circuit or short in ignition circuit.	Repair and replace defective part.
	Defective spark plugs.	Replace defective spark plugs.
	Fouled spark plugs.	Clean and adjust spark plugs.
	Defective booster coil.	Repair or replace booster coil.
	Defective ignition switch.	Repair or replace ignition switch.

(3) MAGNETOS.

(a) DESCRIPTION.—*(See figure 133.)*—Two Bendix-Scintilla SB-9RN (or SB-9R) magnetos are mounted on the rear of the engine, one at each side of the starter. Their function is to generate the current to furnish the spark to the spark plug. A pivotless-type breaker is employed. Other features are a cobalt magnet, rubber encased coil, flat-type condenser mounted on top of the coil, and a distributor cylinder with replaceable segments. A magneto can be installed on either side of the engine by using the proper radio shields. A four pole magnet is used and the magneto is driven at 1-1/8 engine crankshaft speed.

(b) TIMING MAGNETOS TO ENGINE.

1. Timing of the magnetos will be checked as follows:

a. Attach a template made up in accordance with figure 134 to the nose section of the engine at the two top holes which are provided for attaching cowling brackets.

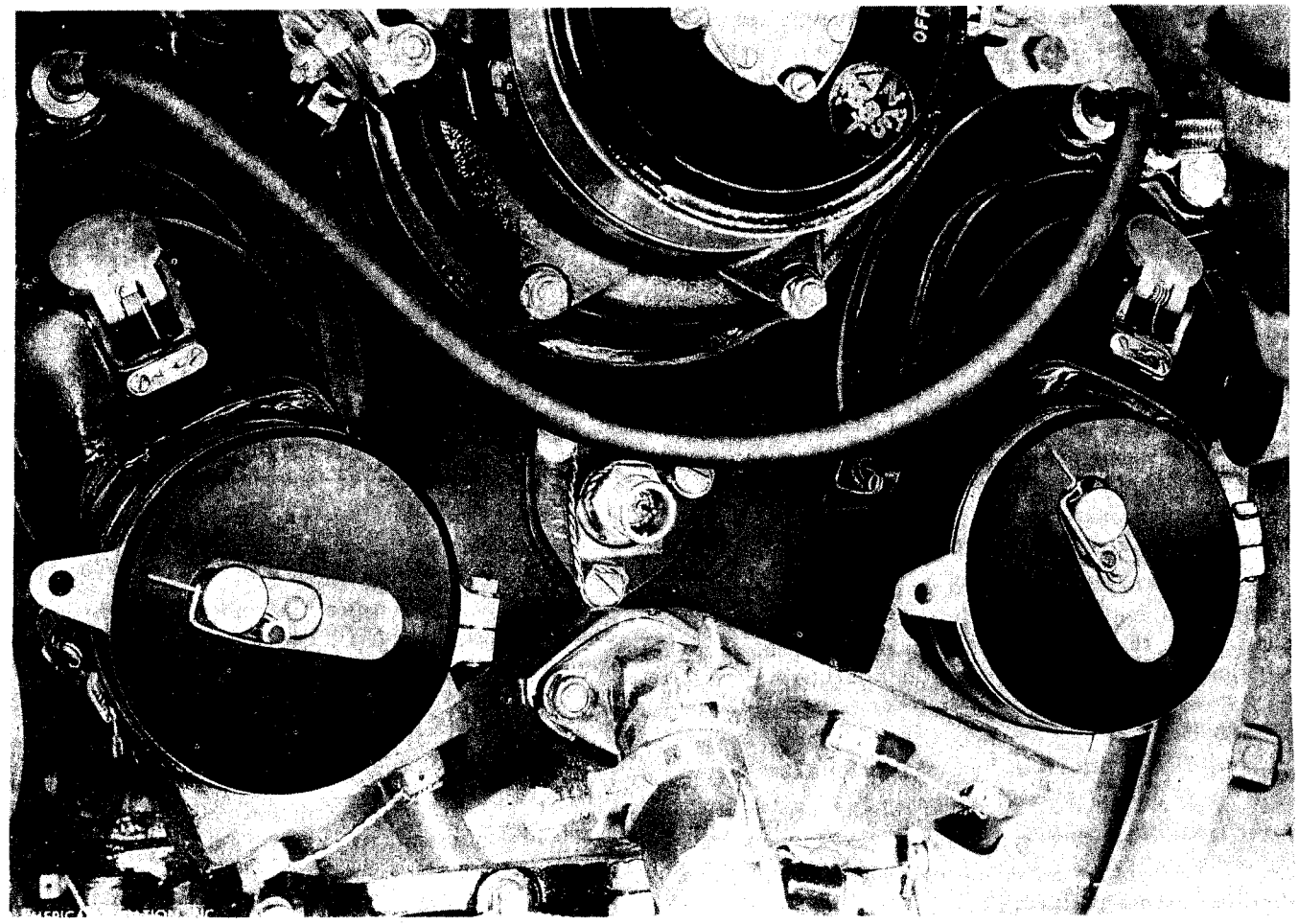
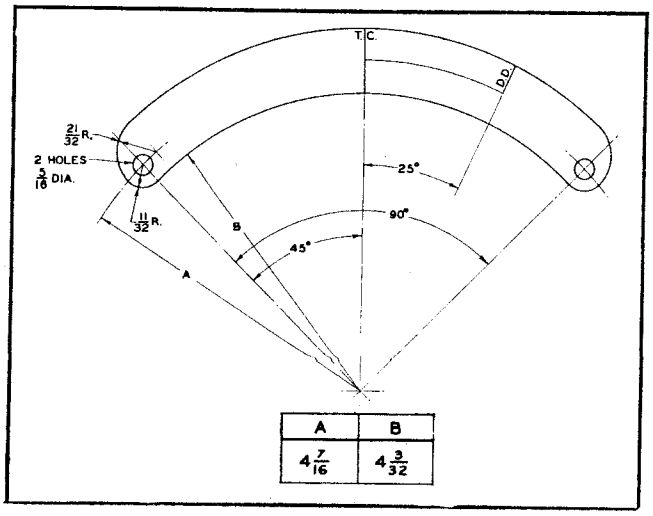


Figure 133—Magnetos



A	B
$4\frac{7}{16}$	$4\frac{3}{32}$

Figure 134 — Diagram for Timing and Synchronizing Magnetos

b. Improvise a timing pointer by fastening a stiff piece of wire securely to the propeller hub, and line up its end with the top center mark on the template when No. 1 piston is at top center of its compression stroke.

c. Connect the timing light (Abbott Type A-100, AF Stock No. 8043-273875) across the breaker points. If a timing light is not available, a .0015-inch feeler gage may be used.

d. Turn the propeller shaft clockwise approximately 90 degrees, after which it should be returned gradually in a counterclockwise direction by jarring the propeller with the hand, until the points just start to open. Then note the position of the timing pointer (wire) with respect to the "specified advance" mark on the template.

(1) The contacts in both magnetos should break simultaneously when the timing pointer is aligned with the "specified advance" mark.

(2) If it is found that the timing of both magnetos is improperly synchronized or at an incorrect relation to the engine, each magneto will be properly timed as outlined below. No timing adjustment will be necessary on a magneto which is correctly timed with the engine.

2. Magnetos will be timed as follows:

a. Remove distributor blocks and breaker cover from the magneto.

b. Move spark advance lever (if used) to the full advance position.

c. Disengage magneto drive coupling and adjust relation of the magneto mechanism to the engine as follows.

(1) Remove cap screws which fasten magneto to engine rear section.

(2) Remove magneto from dowel pins in mounting pad.

(3) Turn magneto shaft until timing marks on the large distributor gear align with the timing marks on the inside of the front end plate. The running segment on the distributor rotor will now be in a position opposite the No. 1 distributor block electrode, and the breaker contacts should be just opening.

(4) Turn magneto shaft slightly until the breaker contacts begin to open.

(5) Place a steel scale on the step of the cam. Observe how close the straight edge of the scale is in relation to the timing marks on the rim of the breaker housing. If this distance is greater than $\frac{1}{8}$ inch, adjust the breaker contact points as follows: See figure 135.)

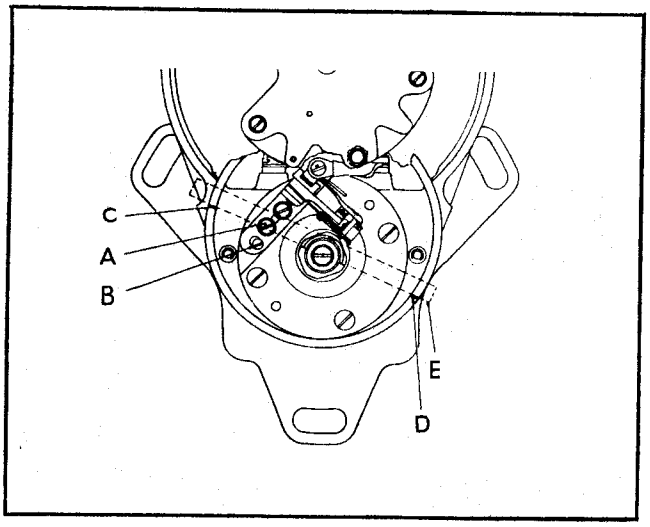


Figure 135 — Magneto Timing Diagram

(a) Loosen the two screws (A).

(b) Adjust the contact points by means of the eccentric screw (B) so that the points just begin to open on the No. 1 lobe when the straight edge (E) coincides with the timing marks (C) and (D).

(c) Tighten the screws (A) when the setting has been made, and recheck the adjujstment.

(6) Use the timing light, Abbott Type A-100 or equivalent, to determine the position where the contacts open. If the timing light is not available, the opening can be determined by placing a strip of .0015-inch shim stock between the points and pulling against it slightly. When the .0015-inch shim stock can be released with a slight pull as the crankshaft is turned slightly, the contact points are just beginning to open.

CAUTION

When inspecting the contact points for any reason, do not raise the breaker main spring beyond a point giving 1/16-inch clearance between the contact points. Any further tension on the main spring caused by raising it beyond this point will weaken it and cause unsatisfactory magneto performance.

(7) Turn crankshaft counterclockwise until the piston in No. 1 cylinder is on the compression stroke (both valves closed) and the timing pointer aligns with the "specified advance" mark on the front section.

(8) Turn magneto drive coupling until it can be engaged in both coupling drive gears without causing the magneto shaft to turn.

(9) Engage coupling by fitting magneto over dowel pins in mounting pad; fasten magneto to engine rear section with the necessary cap screws.

(10) Turn crankshaft 90 degrees in a clockwise direction; then reverse rotation. Note the position of the timing pointer with respect to the "specified advance" mark on the front section. (The contacts of both magnetos should break simultaneously when the aligning pointer aligns with the timing mark on the front section. If the contacts do not break at this point, adjustment will be made in accordance with the instructions in the next paragraph.

(11) If the contacts break before the pointer aligns with the timing mark on the front section, remove magneto; turn coupling clockwise one or two notches; refasten magneto to engine rear section; recheck timing as previously outlined. If the contacts break after the pointer aligns with the timing mark on the front section, the above procedure will be followed except that the coupling will be turned counterclockwise one or two notches. Due to the fact that the coupling has 19 notches on one side and 20 notches on the other side, a rather fine adjustment can be made.

(12) After the magneto is properly timed, insure that cap screws which hold it in place are tight. Then secure screws with safety wire; fasten distributor blocks in position with spring clamps, and secure clamps with wire clips. Attach breaker cover to magneto with knurled screw, and secure screw with a wire clip.

(13) Remove timing pointer from the propeller hub.

(4) BOOSTER COIL.—(See description in "Electrical System", paragraph 13.) The booster coil is mounted in a shielded case with flexible conduit shielding the leads to the magneto and is controlled by the engine's starter meshing switches. Its function is to aid in starting the engine by intensifying the spark.

(5) SPARK PLUGS.

(a) GENERAL.—Spark plugs recommended for the engine are listed below:

AT-6 SERIES

Manufacturer	*Type*
Champion	C-26S
Autolite	SH-21

SNJ SERIES

Aero	RS-4AB-1
Bendix	6S-11A
BG	SS-485A
Champion	C-26S

(b) REMOVAL AND INSTALLATION.

1. Remove ignition cables, first loosening all elbow nuts with proper elbow wrench. Gently pull cable connectors straight out. *Do not jerk them.*

2. Apply proper size (7/8-inch) hexagon socket wrench to spark plug shell.

NOTE

If threads of both plug and bushings are in proper condition, the plug can be inserted the full length of the shell threads until it seats firmly against the socket by screwing with the fingers.

3. Tighten all spark plugs with a torque of not more than 360 inch-pounds nor less than 300 inch-pounds, using a torque indicating handle. If a torque wrench is not available, a wrench handle approximately 8 inches long may be used.

4. Spark plug shell threads may be lightly lubricated with anti-seize compound, Specification AN-C-147. Should thread lubricant become deposited on the electrodes, remove it before installing plug in an engine.

5. Replace ignition cables, inserting the cable connectors straight into the spark plug shield, not at an angle. When each connector is in place, start its elbow nut by hand, making sure that it turns freely before tightening.

6. Whenever checking the installation of shielded plugs, always check the terminals and elbows to see that they are securely tightened. Use elbow wrenches for tightening terminal elbows.

(c) GAP SETTING.

1. Initial gap setting by manufacturer: Short reach plugs .016 inch +.002 −.001.

2. All later gap settings will be confined to *decreasing* the gap dimension.

e. ENGINE CONTROLS. *(See figures 136 and 137.)*

(1) GENERAL.—The engine controls are of the steel tube, push-pull type, with bell cranks and rod ends mounted on ball bearings. The throttle, mixture, and propeller control levers are all assembled in a single quadrant located on the left side of each cockpit. Front and rear cockpit control levers are interconnected by means of rods. The engine controls are equipped with a friction lock to prevent the controls from creeping after setting. The lock is located in the front cockpit on

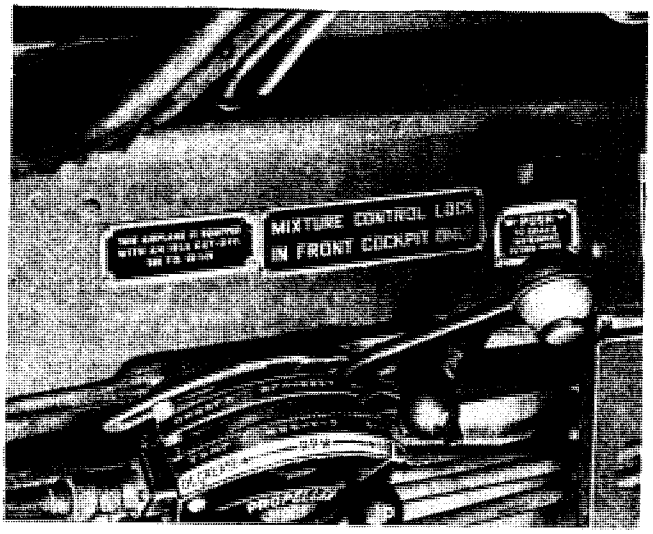


Figure 136 — Engine Control Quadrant — Front Cockpit

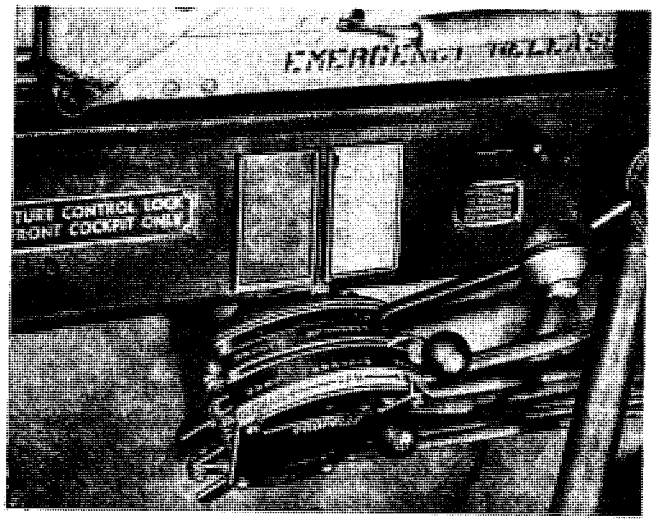


Figure 137 — Engine Control Quadrant — Rear Cockpit

the face of the quadrant and may be actuated at will by the pilot or occupant in the front cockpit. The controls may be set or tightened by screwing the small disc inward or loosened by screwing outward. The function and operation of the controls are as follows.

(a) THROTTLE CONTROL. — The forward position of the throttle control lever is "OPEN" and the rearward position "CLOSED," as indicated on the quadrant. The throttle in the front cockpit is provided with a joggle-type stop that should be adjusted to limit the travel of the control lever so that 36 inches Hg manifold pressure at 2250 rpm is not exceeded at sea level take-off. The throttle may be advanced beyond the stop for maximum power; however, this position is utilized only in case of an emergency and must not be used normally. The throttle lever is wired to two toggle switches in the wheel wells that operate the landing-gear warning horn. If the throttle is retarded within 7/16 inch of the "CLOSED" position, the warning horn will sound, indicating that the landing gear is not down or locked in its extended position. Located in the knob-type handle on the throttle control lever is a radio button for British throat-type microphones, serving the same purpose as the switch on U. S. hand-type microphones.

(b) MIXTURE CONTROL.—The front cockpit mixture control lever is equipped with a spring-loaded lock and ratchet. When the controls are moved forward toward the "RICH" position, the lock is ineffective; however, in moving the control to the "LEAN" position, it is necessary to press forward on lock lever attached to the control handle. When this is done, the lock is disengaged from the ratchet and allows the control to be pulled back toward the "LEAN" position. This feature enables the occupant in the rear cockpit to enrich readily, but prevents him from leaning out the mixture. This is done because the engine instruments are in the front cockpit and cannot be checked visually from the rear cockpit. An idle cut-off device is provided and becomes effective when the mixture control handle is in the extreme rear or "LEAN" position.

(c) PROPELLER CONTROL.—The propeller control handle is mounted on the engine control quadrant. Control levers are interconnected by a rod and connected to the constant speed governor by means of push-pull rods and bell cranks. As indicated on the quadrant, the forward position of the propeller control lever results in "INCREASE RPM" and the rearward position results in "DECREASE RPM." Between these two positions is the constant speed control range within which the governor can automatically adjust the propeller pitch for the desired rpm. For take-off, climb, and landing, set the control for "INCREASE RPM." For cruising, high speed, and prior to starting and stopping engine, set control for "DECREASE RPM."

(2) ADJUSTMENTS.

(a) THROTTLE STOP.—*(See figure 138.)*— Loosen screws securing the throttle stop to the mounting in order that it can slide fore and aft. With the

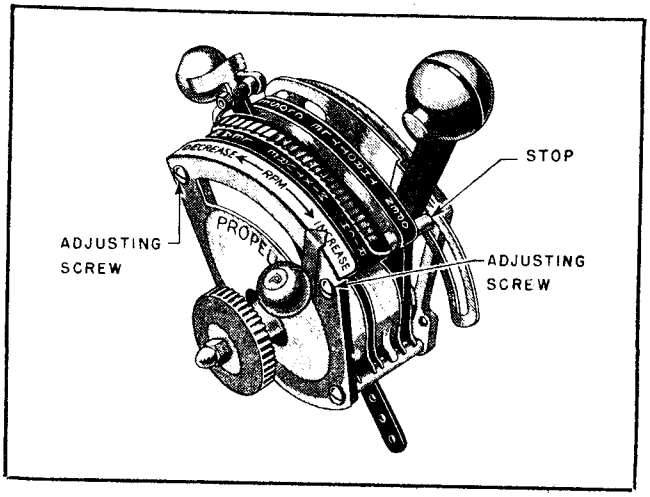


Figure 138 — Throttle Stop Adjustment

engine running, set the throttle for 36 inches Hg manifold pressure and 2250 rpm at sea level, and slide the stop against the throttle control for the proper setting. Then tighten the throttle stop mounting screws.

(b) ENGINE CONTROLS.—*(See figure 139.)* It is of extreme importance that the engine controls be properly adjusted to provide smooth and correct operation for the pilot. Each control quadrant should be at an angle of 46 degrees to the vertical axis. See paragraph 13, in this section for adjustment of the throttle switch actuating rod. With the propeller governor and the carburetor at proper settings, the length of the control rods from center to center should be as follows: Rods not listed will be lengthened or shortened as required for proper adjustment.

Name	*Number*		*Length*
Throttle	54-43053		32-9/16
	*88-43053		
	55-43802	(2 Req.)	23-7/8
	*88-43802		
	55-54177		8
Mixture	54-43053		32-9/16
	*88-43053		
	55-43806		27-11/16
	*88-43806		
	55-43804		21-15/16
	*88-43804		21-7/8
Propeller	55-44802		32-5/8
	*88-44802		
	55-44801		23-7/16
	*88-44801		
	55-44803		27-1/2
	*88-44803		27-3/8
Carburetor Air	84-43807		21-1/2
	55-43801		21-15/16
	*88-43801		
	65-43805		28-3/16

*Used on later airplanes.

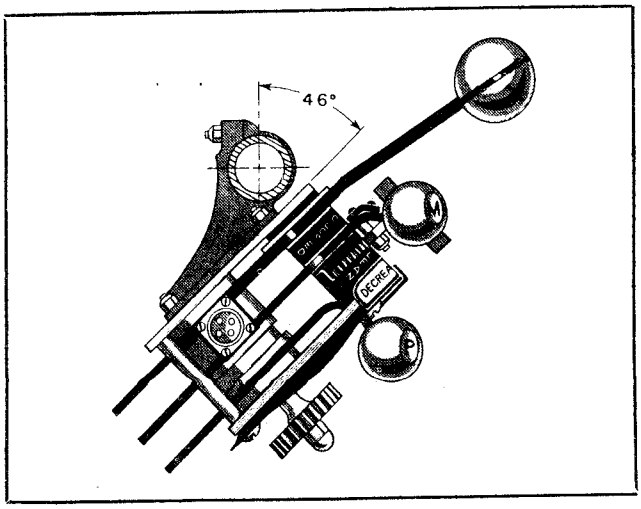


Figure 139—Engine Control Quadrant Angle

After the rod adjustment is made, check the controls at the quadrant for 1/8-inch spring back in the full forward and aft positions. Make any slight adjustment in the rods, if necessary, for proper spring back; then tighten the lock nuts and install cotter pins in the end bolts.

IMPORTANT

Bearing housing must be held in the correct position while tightening the lock nut to permit the rod end to be free at attachment to the bell crank or the operating arm. Distance from the lock nut to the shoulder of the rod should be approximately $\frac{5}{16}$ inch at each end. At completion of an adjustment, operate the controls and check for play and binding. Play may be eliminated by making sure that all bolts, lock nuts, shaft bolts, and mounting bolts are tight. If ball bearing rod ends or bell crank bearings are causing play in the system, they should be replaced.

(c) PROPELLER GOVERNOR STOP.—The propeller governor stop is set at 40 degrees counterclockwise from top center for 2250 rpm. For instructions on adjustment of propeller governor control, see paragraph 7. *c.* (2).

f. EXHAUST SYSTEM.—*(See figures 140 and 141.)* —The engine exhaust is collected by an exhaust collector ring and discharged at the right side of the engine cowling. The exhaust collector ring assembly, consisting

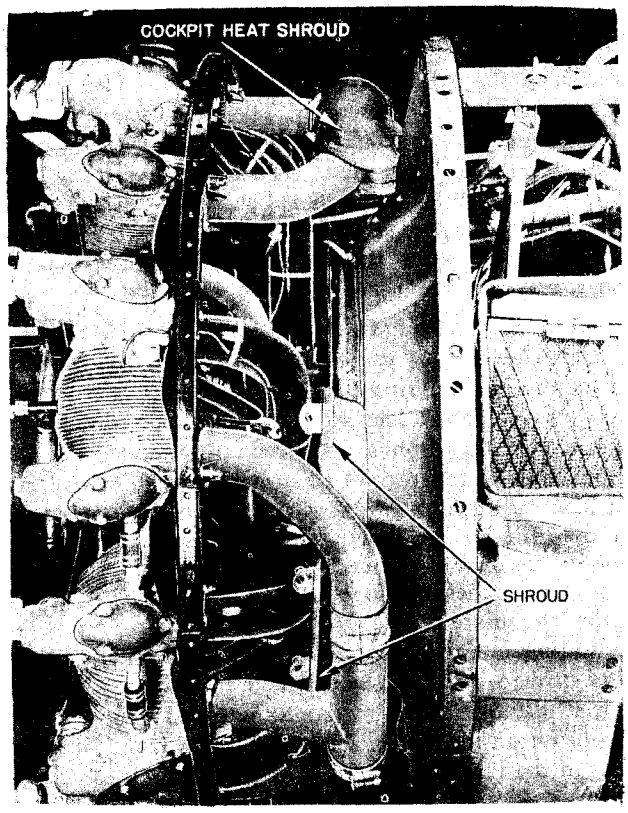


Figure 140—Exhaust Manifold—Left

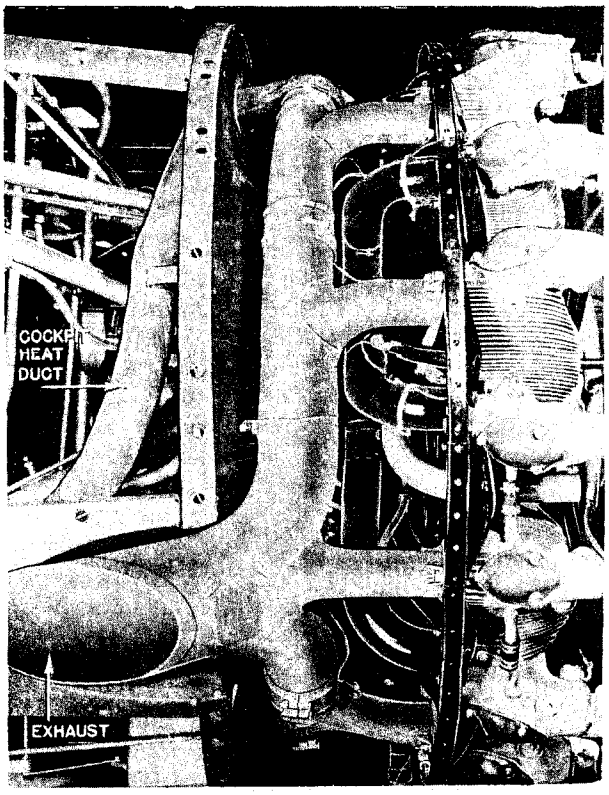


Figure 141 — Exhaust Manifold — Right

of seven sections, is constructed of corrosion- and heat-resisting stainless steel. All sections are interconnected by clamp-type or slip-type joints that provide for expansion and contraction of the engine and manifold. This arrangement also makes it possible to remove any section of the exhaust collector ring without disturbing other sections of the assembly. The exhaust outlet joints are designed to prevent leakage of the exhaust gases and fouling of the airplane. The exhaust collector ring is jacketed with a Dzus-fastened shroud, which provides a chamber for preheating air before it enters the carburetor air mixing chamber. For details of exhaust heating system, refer to paragraph 14, section IV.

(1) EXHAUST GAS ANALYZER.—*(See figure 143.)*—The exhaust gas analyzer indicates fuel-air ratio of the mixture entering the engine by electrically analyzing exhaust gases. The indicator normally responds in about 5 to 60 seconds after mixture change. Reading should not be taken until this time has elapsed. Correct fuel-air ratio indication does not lessen the importance of the cylinder head temperature indicator. Should detonation occur, the points of mixture indicator will move eratically, generally toward the "RICH" end of the scale. The mixture indicator cannot be relied upon when indicating less than .072. The exhaust gas analyzer consists primarily of an analysis cell located on the right side of the fire wall just above the battery and an indicator unit on the instrument panel. Lines from the manifold to the inlet and outlet sides of the analysis cell are copper. Airplanes of late SNJ-4 and SNJ-5 (Navy) models are not equipped with exhaust gas analyzers.

g. ENGINE MOUNT.—*(See figure 144.)*—The engine mount is of welded chrome-molybdenum steel tubing construction, with the exception of the upper rear cross tube, which is of 24ST aluminum-alloy secured by four bolts to the welded structure. This tube supports the rear of the oil tank. Suitable mounting lugs and fittings are used for attachment of the engine to the mount and the mount to the fire wall. Two lugs at the upper fire wall attachment points provide for hoisting the power plant.

7. PROPELLER AND PROPELLER CONTROLS.

a. PROPELLER.

(1) DESCRIPTION.—*(See figure 145.)*—The engine is equipped with a two-blade, nine-foot, one-inch nominal diameter, Hamilton Standard, constant-speed, counterweight-type propeller. The propeller hub assembly basic model number is 12D40; the propeller blade assembly model number is 6101A-12, and the constant speed propeller governor model number is 1M12-G. On later airplanes a sheet steel, dust-proof propeller spinner is installed over the hub assembly. The blade angle settings at the 42 inch station are 13 degrees minimum and 28 degrees maximum and 28 degrees index. Oil pressure is used to move the blades to the

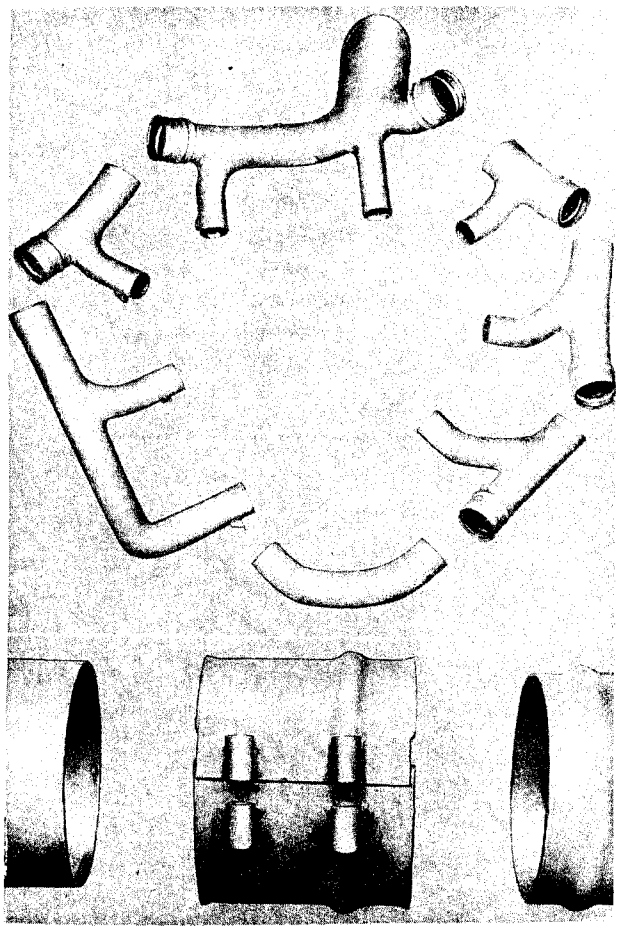


Figure 142 — Exhaust Manifold Sections and Slip Joint

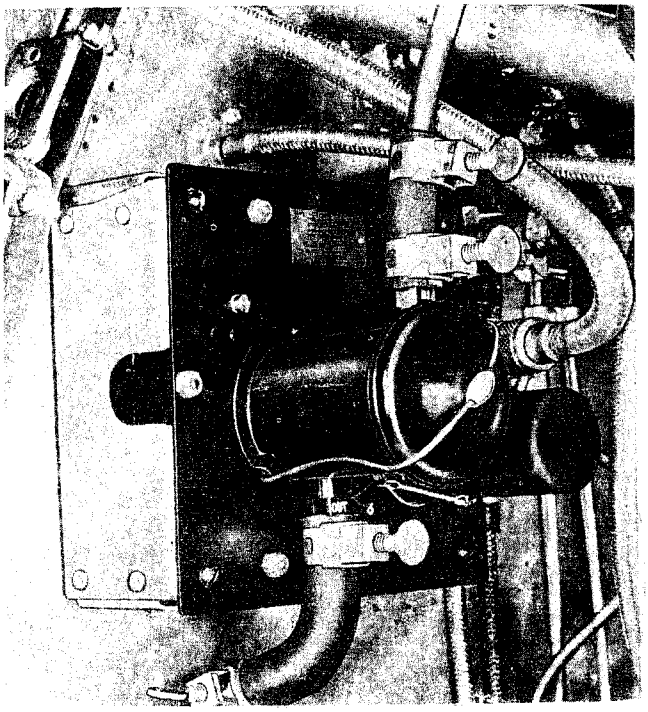


Figure 143 — Exhaust Gas Analyzer

high rpm (low pitch) position. The blades are moved toward the low rpm (high pitch) position by centrifugal force acting on the counterweights attached to the blade brackets. The oil supply is obtained from the engine, and the flow of oil is controlled by a governor located on the top side of the engine nose casting, which automatically regulates the flow of oil to and from the cylinder of the propeller.

(2) REMOVAL.

(a) Before removing the propeller from the engine shaft, place the blades in the low rpm (high pitch) position.

NOTE

At no time should a hammer or mallet be used on the blades, counterweight brackets, or cylinder to change the blade angle from low to high position. To change the position of the blade angles when the engine is not running, use a beam on each blade of the propeller assembly. Care should be exercised to insure that both blades are moved at the same time.

(b) Remove the front propeller spinner shell, if installed, in the following manner:

1. Break the safety wires and remove the 12 front fillister-head screws attaching the front shell half to the brackets.

2. Lift off the front shell.

(c) Disengage the cylinder head lock wire and remove the cylinder head. Have a pail handy to catch the oil from the cylinder.

(d) Disengage piston lock ring by removing cotter pins. It is a good practice to slide the lock ring up on the piston.

(e) Unscrew the piston. This will start the propeller off the engine shaft.

(f) Slide the propeller slowly forward on the engine shaft, and remove. Take care not to damage the engine shaft threads. Use thread protectors.

(g) Remove the rear propeller spinner shell and brackets, if installed:

1. Remove the 12 rear fillister-head screws.

2. Slip the rear shell off the propeller shaft.

3. Remove the four bolts that attach the bracket assembly to the propeller.

4. Remove the bracket assemblies.

(3) MINOR REPAIR.

(a) GENERAL.—The types of damage described below can be repaired locally by any activity having the facilities and personnel familiar with the work.

1. NICKS AND DENTS.—*(See figure 146.)*—Small nicks or dents in the leading edges, trailing edges, or tips will be removed by reworking the blade locally with a curved or "riffle" file. In urgent cases, this can be done while the propeller is on the airplane if the nicks are not too large; however, most desirable results are obtained if the propeller is rebalanced. When a nick is removed from a blade with the propeller on the airplane, balance can be attempted by weighing or calculating the weight of removed metal and installing weight to provide an equal moment on the same side of the hub, or removing weight to provide an equal moment on the opposite side of the hub. Care will be taken to remove the sharp base of the nicks, as these act as stress concentration points. The reworked surface will then be polished with a fine emery or crocus cloth.

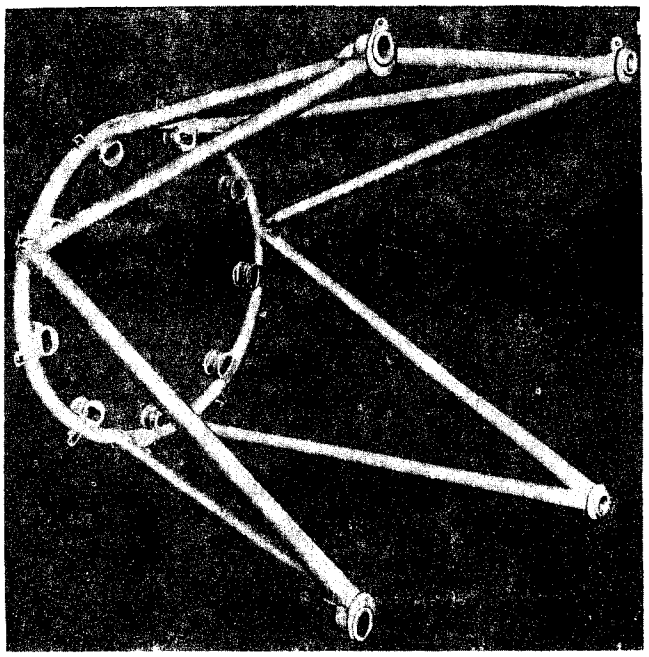


Figure 144 — Engine Mount

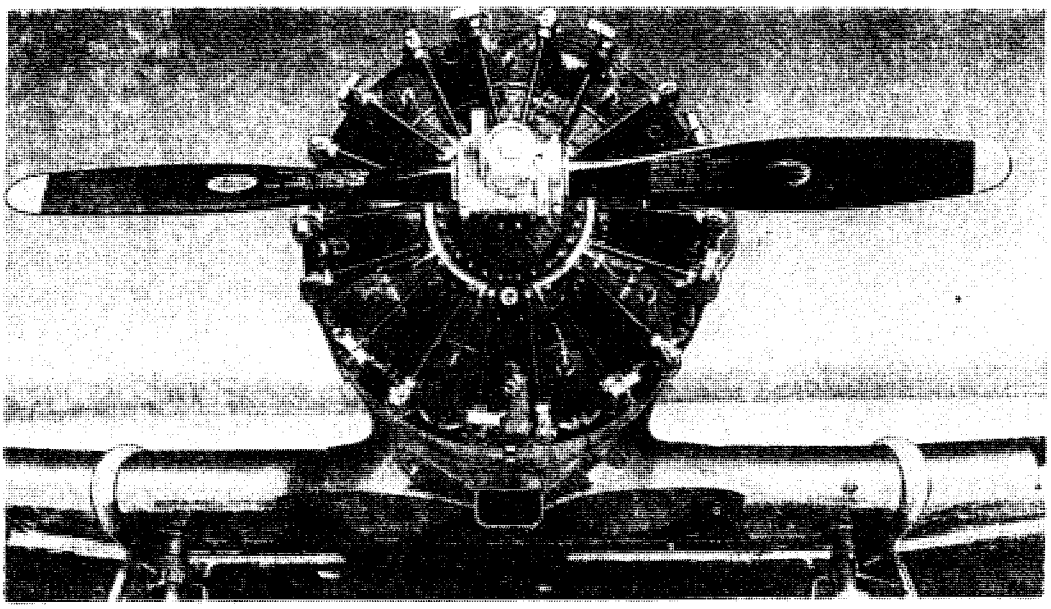


Figure 145 — Propeller

2. CUTS AND SCRATCHES.—Longitudinal surface cuts or scratches which are located beyond the 50 percent radius may be reworked to form saucer-shaped depressions whose length, width, and depth do not exceed 1 inch, 3/8 inch, and 1/8 inch respectively. More than one of these defects is permitted provided they do not form a continuous line, or are not located nearer than 1 inch of one another in a transverse direction. Here again, in urgent cases, repair can be made while the propeller is on the airplane; however, an attempt should be made to secure balance by the method mentioned in *1.* (This reoperation is shown in figure 146.) Severe cuts or indentations which can be removed within the limitations of bullet damage can be treated the same as bullet damage.

3. BULLET HOLES.

a. In all cases where a bullet has entered a blade without going through the blade, but has resulted in damage beyond the limits of cuts or scratches given in paragraphs *1., 2.,* preceding, the blade will be drilled through and the damage treated as for a bullet hole.

b. No holes will be allowed outside 15 inches of the tip of the blade, and no holes are permitted inside the 21-1/2 inch station.

c. All holes must be cleaned out and blended into the blade surface with generous radii (at least 1/4 inch). (See figure 147.)

d. The nearest edge of a clean hole must be at least 3/4 inch from the leading or trailing edge of the blade.

e. The width of a cleaned hole (measured along the chord) must not be greater than 1/7 of the chord at that station.

f. The surface width of the blended hole (including radii) must not be greater than 2 inches, or 1/4 of the chord at that station, whichever is smaller.

g. There must not be more than one hole in any 6 inches length of the blade.

h. Bullet damage to the leading and trailing edges must be repaired in accordance with the present procedure for "nicks" and "cuts" as shown in figure 146.

i. Bullet damage to the tip portion will be treated the same as for cracks in the tips of the blades.

j. To insure that all cracks have been removed upon completion of repair of bullet holes, the vicinity of the repair will be etched and carefully examined. If cracks are found to persist, the blades will be condemned.

k. Blades damaged by bullet holes will be grouped and assembled in propellers in such a manner that the damage to each blade of the assembly is as nearly as possible identical.

(b) LOCAL ETCHING.

1. Caustic solutions for local etching will be prepared locally by adding to the required quantity of water as much commercial caustic soda as the water will dissolve at room temperature. The quantity of solution will depend on the amount of etching to be done. Glass or earthenware containers will be used for such solutions.

2. With No. 00 sandpaper, clean and smooth off the area being reworked. With a small swab or stick, apply to the area a small quantity of caustic solution heated to 160°-180° F.

3. After the area is well darkened, thoroughly wipe it off with a clean cloth dampened with clean water. Too much water may remove the solution from a defect and thereby spoil the etch.

4. If a crack or other defect extending into the metal exists, it will appear as a dark line or other mark; with the aid of a magnifying glass, small bubbles may be seen forming in the dark line or mark.

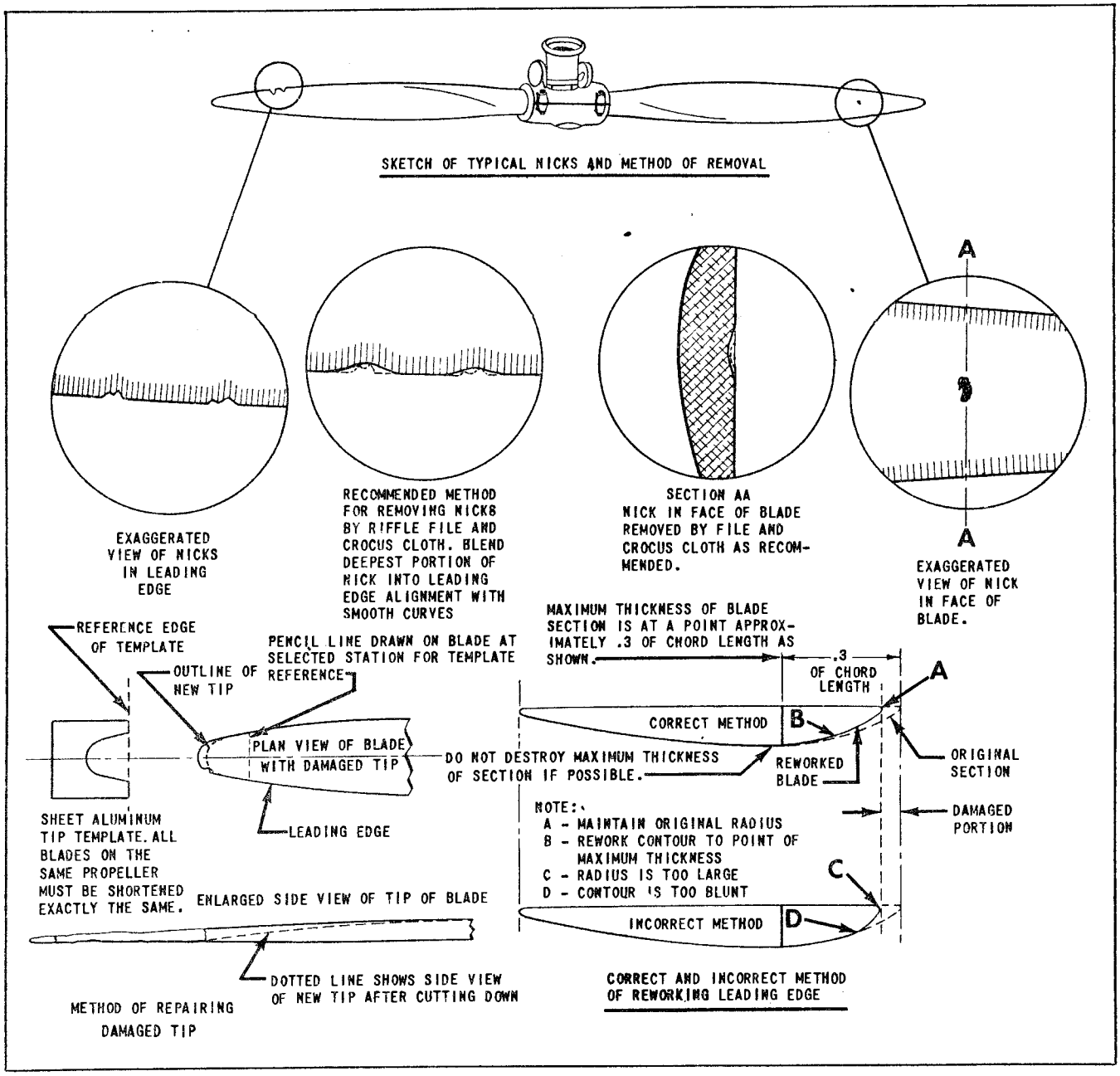


Figure 146 — Method of Propeller Repair

5. Several applications of the caustic solution may be necessary to determine when all the shallow cracks have been removed. Immediately on the completion of the final check, all traces of the caustic solution will be removed with nitric acid solution (20 percent by volume) which, in turn, will be thoroughly rinsed off with clean water. After completion of etching, the surface will be polished with fine emery or crocus cloth to remove all traces of the etch.

NOTE

The repair of damage other than that covered above requires special equipment. Damaged blades will be forwarded to the respective Area Air Service Command for repair or disposition.

(4) INSTALLATION.

(a) PRELIMINARY INSTRUCTIONS.—Before installing a propeller, examine all parts for defects and damage, and check for proper fitting. All corrosion and all raised points of nicks, burrs, galls, scores, etc., on joining surfaces of the attaching parts, hubs, and crankshaft end will be carefully dressed off and the parts thoroughly cleaned before the propeller is installed on the shaft. In addition, the splines, front cones, front cone seats, etc., will be coated with clean engine oil to

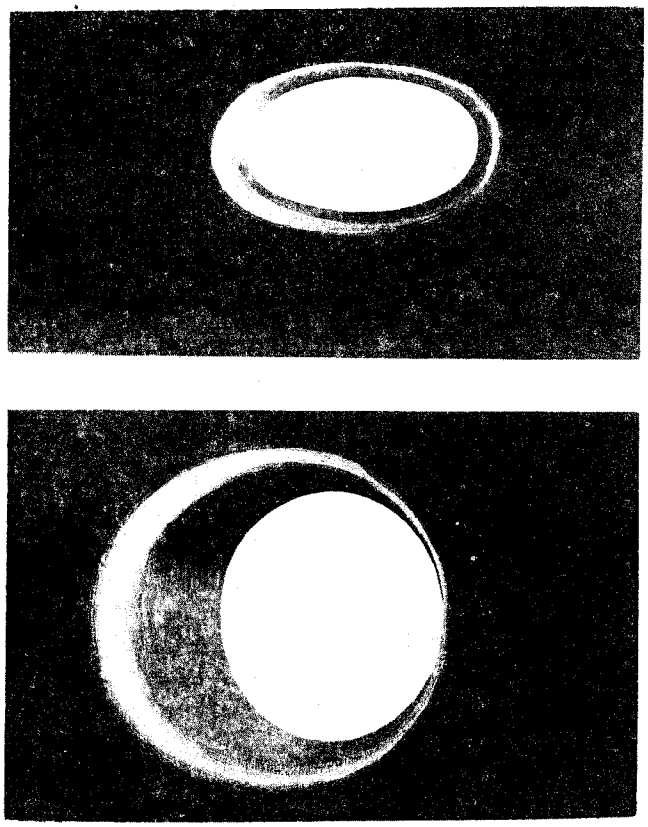


Figure 147 — Bullet Damage to Aluminum Alloy Blades

provide lubrication and prevent corrosion. Rear cones and rear cone seats will be installed dry. Cup grease or semifluid oils will not be used for this purpose. The threads in the propeller hub piston will be thoroughly coated with compound, thread, Specification No. AN-C-53.

(b) ATTACHING PARTS.—Special attaching parts will be furnished with each propeller and will be kept securely attached thereto. Standard attaching parts (nut, cones, snap ring, etc.) with each engine that are not required when a controllable propeller is installed will be returned to stock. When the propeller is removed, the special attaching parts will also be removed and kept with the propeller.

(c) INSTALLATION PROCEDURE.—The propeller is installed in the following steps, in order:

1. Thoroughly clean out the inside of the front portion of the crankshaft.

2. Remove the screw plug from inside the crankshaft.

3. Install bronze rear cone and rear cone spacer (if used) on engine shaft against the thrust nut.

4. Remove the propeller cylinder head lock wire; unscrew the cylinder head. Remove the lock ring from the hexagon portion of the piston.

5. Be sure that thread protectors are in place.

6. Place the propeller on the crankshaft. Make sure that the piston and crankshaft threads are in perfect alignment. In no case should force be used to tighten the piston if there is binding or indication that the threads are not properly started, otherwise serious damage may result.

7. When it is discovered that, due to handling or reassembling without proper adapters, the piston and shaft are not in alignment, the counterweights should be disassembled and the bearing shafts removed. This frees the cylinder and piston to permit easy starting of the threads and proper tightening of the propeller on the shaft. The counterweights may then be reassambled. Care should also be taken in tightening the piston to see that the front cone packing washer, when one is required, does not bind, but is pulled properly into place. As an aid in assembly, it is suggested that the piston be tightened a few turns and then the hub jarred slightly by hand. This will help prevent jamming the washer into the shaft threads.

8. Insert the proper wrench and tighten the piston, using a bar approximately 4 feet long. Apply a force at the end of the bar of approximately 175 pounds. One man of average weight (175 pounds) using a bar of this length can generally tighten the piston sufficiently without the need of additional leverage or the use of a hammer on the bar.

CAUTION

Do not, in any case, attempt to tighten the hub by hammering on the end of the bar.

9. Secure piston with lock ring. Cotter the lock ring, using 3/32-inch steel cotter pins (2 or 3, as required). The heads of these cotters should be toward the crankshaft.

10. Check to see that the piston gasket nut is cottered.

11. Install cylinder head gasket on the cylinder head.

NOTE

In order to avoid the possibility of the gasket becoming damaged during assembly, care should be taken to insure that it is properly held in place on the pilot of the cylinder head.

12. Before installing the cylinder head, thoroughly coat the threads on the cylinder head and in the cylinder with lubricant, thread, Specification No. AN-C-53. Extreme care must be exercised in installing the cylinder head to insure that the threads are properly started. Tighten cylinder head sufficiently to prevent oil leaks, using the proper size wrench with a leverage of not more than 18 inches.

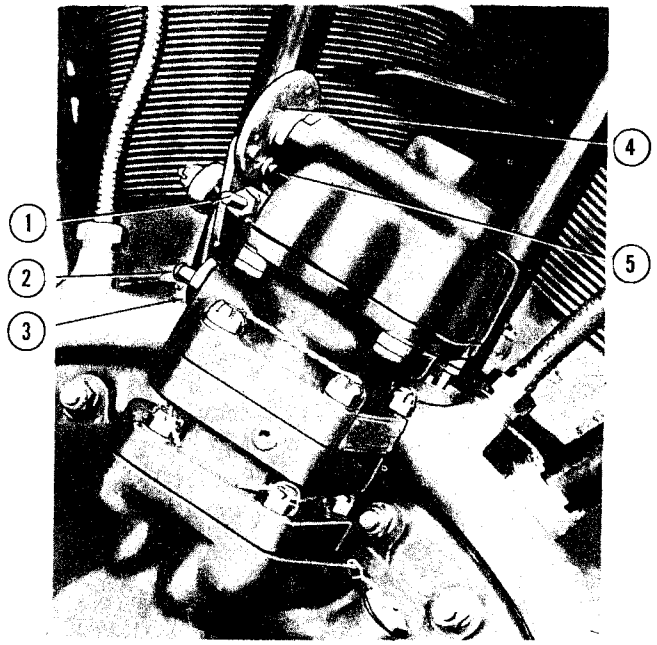
(d) ELIMINATING THE BOTTOMING OF FRONT CONES AGAINST SPLINES.—Due to manufacturing tolerance of crankshafts, propeller hubs, and attaching parts, it is possible that in some cases the front cone bottoms against the outer end of the splines

and therefore cannot be tightened against the cone seat in the hub. Whenever this condition is found, a steel spacer approximately 1/8 inch in thickness will be manufactured locally and installed between the thrust bearing retaining nut and the rear cone, or rear cone spacer when one is used. If the rear cone is found to bottom against the spline ends in the hub, either replace the cone with a new one, or rework the unsatisfactory cone by removing sufficient metal from the small end to eliminate bottoming.

b. PROPELLER CONTROLS.—The propeller control handles are mounted on the engine control quadrants in the front and rear cockpits. Control levers are interconnected by a rod and connected to the constant speed governor by means of push-pull rods and bell cranks. As indicated on the quadrant, the forward position of the propeller control lever results in "INCREASE RPM," and the rearward position results in "DECREASE RPM." Between these two positions is the constant speed control range which permits the governor to automatically adjust the propeller pitch for the desired rpm.

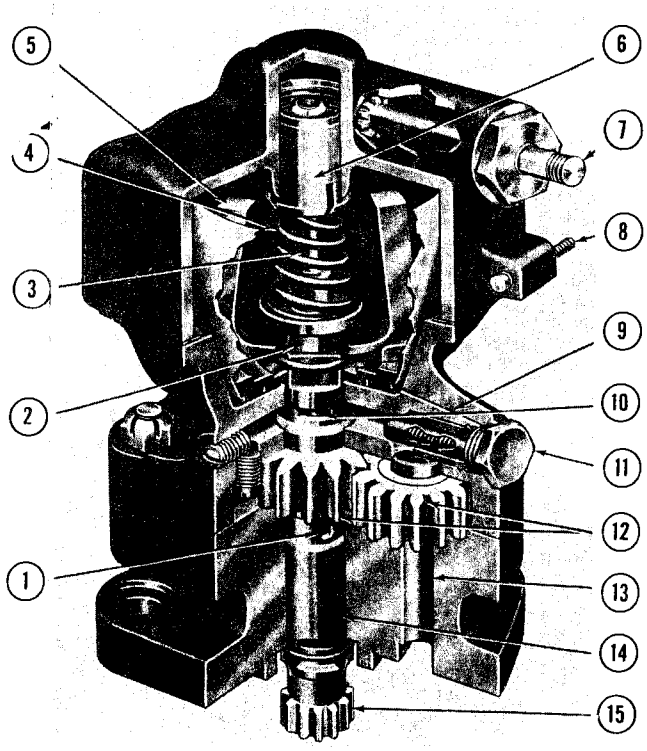
c. PROPELLER GOVERNOR.

(1) DESCRIPTION.—*(See figure 148.)*—The propeller governor, model 1 M12-G, is mounted on the top of the engine nose casting. The governor is controlled by means of interconnected push-pull rods and bell cranks from the control quadrant in both front and rear cockpits. The purpose of the governor is to control the flow of oil to the propeller cylinder which will automatically adjust the propeller pitch for the desired rpm. Since it is the oil in the propeller cylinder that holds the blades at low pitch and prevents the pull of centrifugal force on the counterweights from rotating them to high pitch, it is apparent that they will move toward high pitch, low engine rpm, as soon as the oil is released. The hydraulic and centrifugal forces are such that when the revolutions are below normal, extra force is available for movement toward low pitch. When revolutions are above normal, extra force is available for movement toward high pitch.



1. High rpm Adjusting Screw
2. Bell Crank Stop
3. Pressure Relief Valve Plug
4. Control Wheel
5. Stop Pin

Figure 148—Propeller Governor Installed



1. Lower Drive Gear Shaft Port
2. Pilot Valve Ball Bearing
3. Pilot Valve Shaft
4. Speeder Spring
5. Flyball Assembly
6. Speeder Spring Adjusting Rack
7. Control Shaft
8. High rpm Adjusting Screw
9. Oil Pressure Relief Valve Drain Channel
10. Upper Drive Gear Shaft Port
11. Oil Pressure Relief Valve
12. Booster Gear Pump
13. Idler Gear Shaft
14. Hollow Drive Gear Shaft
15. Drive Gear

Figure 149—Propeller Governor

(2) INSTALLATION.—Place the governor on the mounting pad. Install washers and the four stainless steel self-locking attaching nuts. Tighten the attaching nuts evenly to approximately 100 to 150 inch-pounds torque. Excessive tightening will displace the gasket material around the mounting studs and warp the governor base.

(3) ADJUSTMENTS. —*(See figure 149.)*—It is important that the control system between the governor and the cockpit be adjusted to set the unit for rated rpm. In case governor adjustment has not been accomplished on a suitable test stand and it is necessary to adjust or readjujst for take-off rpm, the following procedure will be adhered to: For trial setting, place the cockpit lever in the extreme rear position. Turn the pulley attached to the governor control shaft in a clockwise direction until the rack bottoms in the head. Connect control rod extending from the cockpit control lever to the pulley attached to the governor shaft. Start engine and operate on ground until desired take-off rpm is obtained, moving the governor lever in cockpit forward. If necessary, shift the position of the stop screw on the governor head to permit sufficient travel of the control. Stop engine, exercising care to insure that the setting of the governor lever in the cockpit is not disturbed. Adjust stop screw on governor head until it bottoms against pulley stop. Make flight test to insure that the governor is adjusted properly. If during flight the rated rpm cannot be obtained, or if excessive rpm is encountered, readjustment of the controls is necessary. Make a trial flight, adjusting cockpit control lever until rated rpm is obtained, marking the quadrant at this position. After landing and stopping the engine, adjust cockpit control lever to marking on the quadrant and reset governor stop. After the proper adjustment of the governor stop is obtained, rig the controls so that the cockpit lever is 1/8 inch from its extreme forward position when the governor is in the maximum rpm position.

CAUTION

If difficulty is experienced in obtaining take-off rpm with the airplane stationary on the ground, care must be taken not to adjust the governor when the cause of difficulty is lack of engine power, improper blade angle setting, etc. Adjustment of the governor under these conditions will not increase the rpm and may lead to overspeeding in flight. If take-off rpm is not obtained at take-off manifold pressure, check by reducing manifold pressure slightly. If the rpm remains constant, the governor is controlling the propeller, but is set incorrectly. If, however, the rpm drops when the manifold pressure is reduced with the propeller blades in the extreme high rpm (low pitch) position, then the speed is not being controlled by the governor. Check the minimum blade angle, and check the engine for any defect causing loss of power.

(4) TROUBLE SHOOTING.—Although improper use of the engine and propeller controls may cause runaway propellers, mechanical malfunction may be the sole cause or add to the unsatisfactory condition. Runaway propellers resulting from mechanical causes can be traced to several sources. The first of these is the malfunctioning of the governor oil pressure relief valve which sometimes sticks in the closed position due to deposits of sludge and dirt. Should this occur, oil is prevented from passing through the relief valve. Since the booster gear pumps is still operating, oil pressure increases at the faulty relief valve. In seeking an outlet, the oil overcomes the normal function of the governor flyballs to raise the pilot valve above the propeller ports. The increasing oil pressure forces the pilot valve down, thus preventing the oil in the propeller cylinder from entering the governor and draining into the engine sump. When oil is forced to remain in the propeller cylinder, the propeller cannot change blade angle from low pitch to high pitch. When the blade angle cannot be changed from low pitch to meet new flight conditions, such as putting the airplane into a glide or dive, a runaway propeller may result.

The second mechanical malfunction is the incorrect tension of the propeller governor speeder spring which withstands the efforts of the flyballs to raise it and thus allow the pilot valve to open the propeller ports. In this instance, as in the preceding condition, the oil in the propeller cylinder is again unable to enter the governor and drain into the engine sump. The propeller is therefore obliged to remain in low pitch.

Foreign matter in the propeller governor or in the cored passage in the nose section of the engine is the third cause of mechanical malfunction. Such a restriction, preventing the ready flow of oil through the governor, is usually responsible when the propeller moves to high pitch and exhibits no tendency to change pitch at various throttle settings. Likewise, this condition might interfere with the proper drainage of oil from the propeller cylinder when the propeller is in low pitch. In this latter instance, retarded oil drainage from the propeller cylinder could also result in a runaway propeller.

The symptoms accompanying these conditions and the instructions for correcting each of them follows:

(a) SYMPTOMS. — If the oil pressure relief valve or the speeder spring is at fault, a common indication of this fact is usually evident when, with the propeller control set for 2250 rpm on the ground, the stop on the bell crank of the governor control shaft does not touch the high rpm adjusting screw on the governor housing. Even when the screw has been turned in as far as it will go, there is still no contact with the stop on the bell crank. If all attaching linkage has *first* passed inspection, this usually indicates that the oil pressure being produced by the booster gear pump is above the 180 to 200 pound normal setting. This increased oil pressure upsets the normal balance between the pressure and the propeller counterweights. As a result, less spring tension on the governor flyballs is necessary in order to scavenge enough of the high pressure oil to keep the balance within control.

(b) CLEANING PROPELLER GOVERNOR OIL PRESSURE RELIEF VALVE.

1. Remove the oil pressure relief valve in the propeller governor and check for sludge, dirt, or metal filings.

NOTE

If an abnormal amount of foreign matter is found, the entire governor should be removed, disassembled and cleaned.

2. Wash the entire floating piston assembly in carbon tetrachloride.

3. Check the piston for freedom of movement.

4. Reinstall the relief valve.

5. Without making any adjustments, run-up the engine to 2250 rpm.

If the relief valve was at fault, the bell crank stop will again hit the high rpm adjusting screw on the propeller governor indicating that the necessary balance for proper constant speed control is again present.

(c) ADJUSTING PROPELLER GOVERNOR SPEEDER SPRING.—In cases where the preceding check of the propeller governor oil pressure relief valve does not remedy the trouble, observe the following instructions:

1. Remove the governor cover.

2. Remove the self-locking nut on top of the pilot valve shaft, unscrew the pilot valve nut completely off the shaft, and remove the speeder spring adjusting rack completely off the end of the shaft.

3. Remove the special lock clip holding the castellated nut inside the speeder spring adjusting rack in position.

4. Turn castellated nut counterclockwise (when viewed from above) about a quarter turn per 25 rpm of propeller overspeed until the approximate position desired has been determined. This action decreases speeder spring tension.

5. Reinstall the lock clip; replace the speeder spring adjusting rack on the pilot valve shaft.

6. Replace the selflocking nut and pilot valve nut.

7. Replace the governor cap.

8. Move the high rpm adjusting screw on the outside of the governor to a neutral position.

9. Run-up the engine; adjust the screw for 2250 rpm.

(d) CHECKING FOR FOREIGN MATTER IN PROPELLER GOVERNOR OR ENGINE NOSE SECTION.—When the propeller moves to high pitch and remains unchanged at various throttle settings, this check is necessary.

1. Remove the propeller piston cap and the propeller governor.

2. Blow about 30 pounds air pressure through cored passage in the nose section of the engine and check for any restriction to the free passage of air.

3. Remove the governor oil pressure relief valve; check the inner piston for freedom of movement.

NOTE

If this piston is frozen or binds in an open position, it is a positive indication that not enough oil pressure is being produced by the oil booster pump to actuate the propeller into low pitch against the opposing force of the propeller counterweights.

4. If the oil pressure relief valve is defective, repair the valve and reinstall it on the governor.

5. Reinstall the governor on the engine and replace the propeller piston cap.

6. Run-up the engine and check for proper functioning of the propeller.

7. Malfunction of the propeller after the above check has been made is an indication that the oil seal rings on the crankshaft adapter, just behind the thrust bearing in the nose section of the engin , are failing to seal the governor oil pressure from leaking back into the engine. This involves an engine change.

8. OIL SYSTEM

a. GENERAL.—*(See figures 150 and 151.)*—The oil system consists of an oil tank, an oil cooler, an engine-driven oil pump, an oil Y-drain valve, pressure and temperature indicators, oil dilution system, and the necessary piping to carry the oil to and from the engine. The oil in the system flows from the bottom of the oil tank to the engine pressure pump. After oil circulates through the engine, the engine scavenger pump forces it back to the tank, either directly or through the oil temperature regulator, depending upon its temperature. The return flow of the oil to the tank is determined by a thermostatically controlled bypass valve at the oil temperature regulator. Oil system lines, including oil pressure lines, are identified with a *bright yellow band* about ¾ inch wide. (Refer to section III, paragraph 3 for servicing instructions.)

b. OIL TANK.

(1) DESCRIPTION. *(See figure 152.)*—The oil tank consists of front and rear halves of formed aluminum sheet welded together. A cylindrical hopper, providing accelerated warming of the oil, is installed in the tank and has a capacity of approximately 1.5 U.S. (1.2 Imperial) gallons. A sump and standpipe are located at the bottom of the hopper to which is attached the oil line going to the engine attachment. On late airplanes the oil tank sump is provided with a drain cock in lieu of a drain plug. Access to the bottom of the hopper is gained by removing the oil line and eight nuts securing the standpipe to the sump. When reinstalling the standpipe, seal the gasket with sealing compound, AAF Specification No. 3597. The oil tank has a service capacity of 10.2 U.S. (8.5 Imperial) gallons, plus a foaming space of 2 U.S. (1.7 Imperial) gallons.

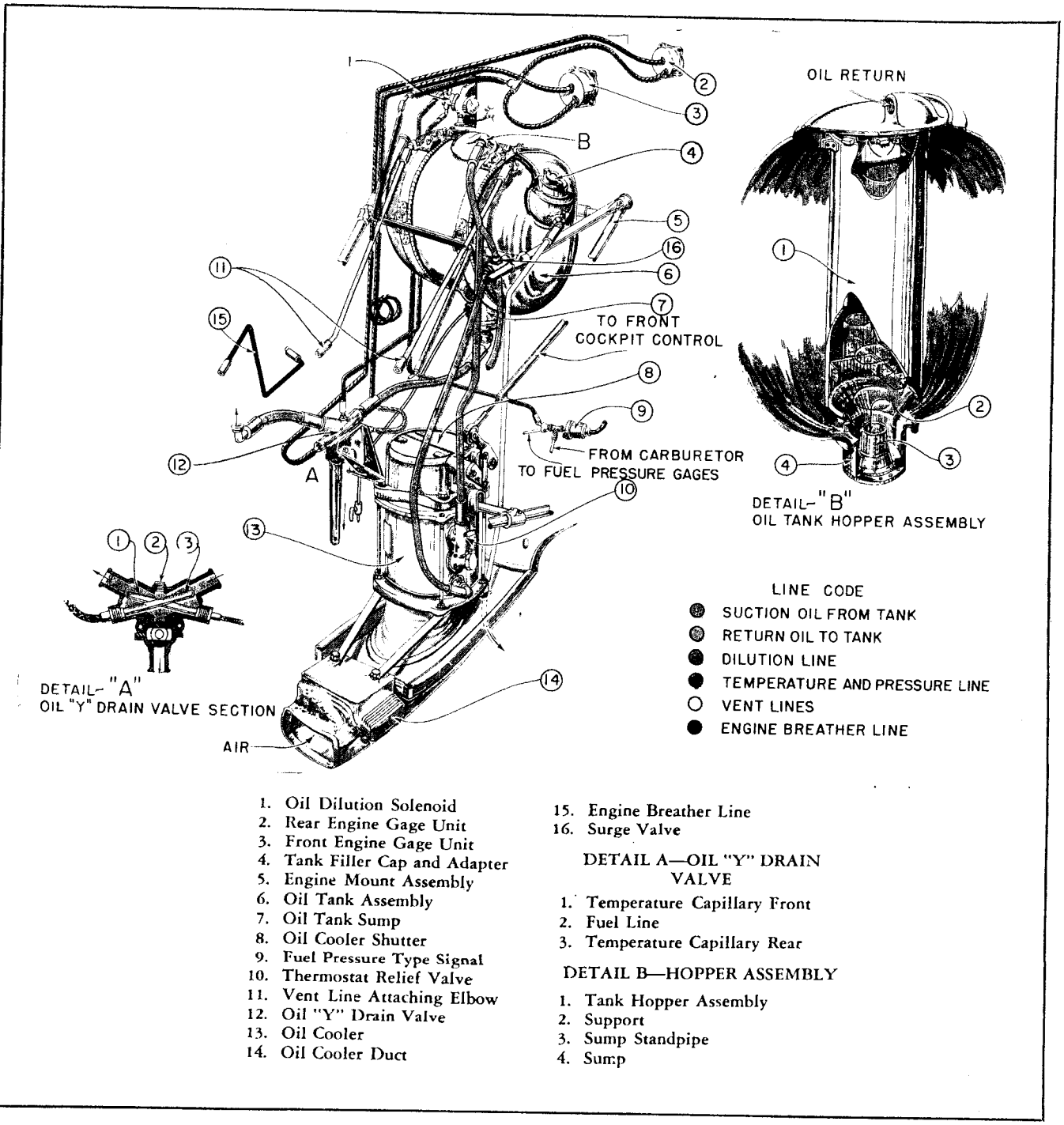
NOTE

AT-6 airplanes have a normal tank capacity of 10.8 U.S. (9 Imperial) gallons, with an overload total capacity of 15.5 U.S. (12.9 Imperial)

gallons. A cock on the left side of the tank indicates the oil level of the normal capacity.

(2) REMOVAL.—Drain oil by opening the Y-drain valve on the lower right side of the engine compartment. Disconnect all bonding ribbons and the filler neck drain line. Disconnect the drain cock line at the bottom of the tank sump. Disconnect the oil return line and the two oil tank vent lines at the top of the oil tank. Remove the two tank bonding braids. Unhinge the upper straps over the top of the tank, and disconnect turnbuckles. Unfasten the ends of the upper and lower straps from fittings on the cross tubes, and lift out the tank.

(3) (Deleted)



1. Oil Dilution Solenoid
2. Rear Engine Gage Unit
3. Front Engine Gage Unit
4. Tank Filler Cap and Adapter
5. Engine Mount Assembly
6. Oil Tank Assembly
7. Oil Tank Sump
8. Oil Cooler Shutter
9. Fuel Pressure Type Signal
10. Thermostat Relief Valve
11. Vent Line Attaching Elbow
12. Oil "Y" Drain Valve
13. Oil Cooler
14. Oil Cooler Duct
15. Engine Breather Line
16. Surge Valve

DETAIL A—OIL "Y" DRAIN VALVE

1. Temperature Capillary Front
2. Fuel Line
3. Temperature Capillary Rear

DETAIL B—HOPPER ASSEMBLY

1. Tank Hopper Assembly
2. Support
3. Sump Standpipe
4. Sump

Figure 150 — Oil System Diagram

(4) (Deleted)

(5) INSTALLATION. — *(See figure 153.)* — The oil tank is mounted by means of padded metal straps to the two upper cross tubes attached to the engine mount structure. The strap padding consists of soft felt, covered by mercerized cotton cloth dipped in varnish, with the excess removed. The padding may be cemented to the straps for easier handling at assembly and must be

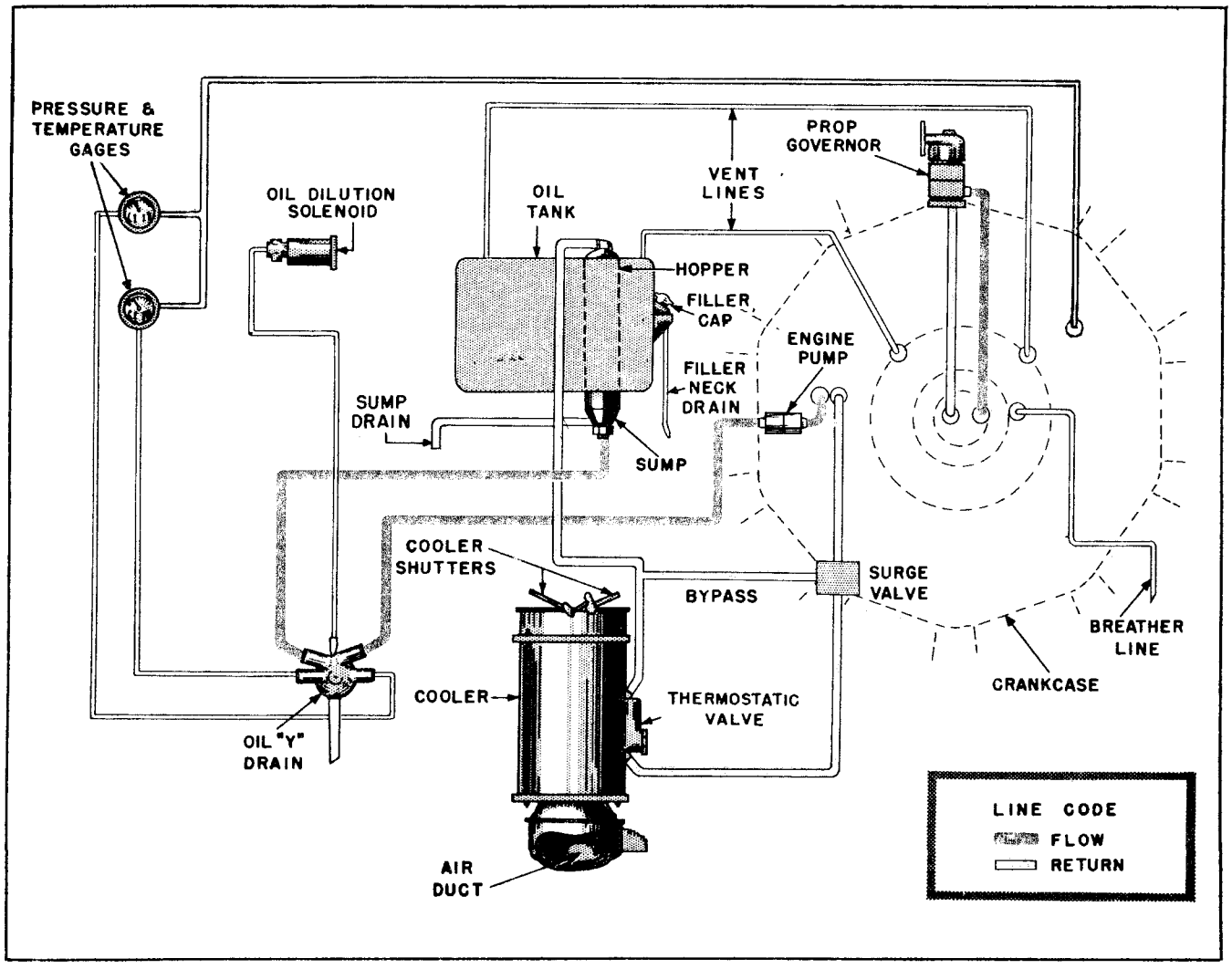


Figure 151 — Oil System Flow Diagram

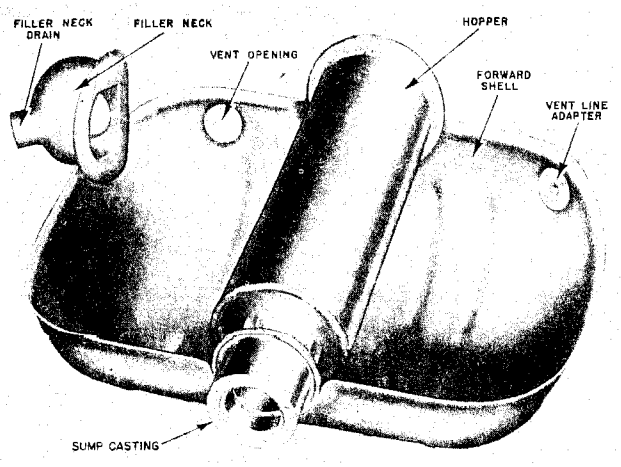


Figure 152—Oil Tank

secured to the straps with waxed linen cord wrappings at intervals of approximately 6 inches. Secure the ends of the upper and lower straps to fittings on the cross tubes and position the oil tank on the lower straps with the filler cap on the left side. Hinge the upper straps over the top of the tank, and connect turnbuckles. When proper alignment of the straps is obtained, tighten the turnbuckles and safety with wire. Attach the two tank bonding braids. Connect the oil return and the oil tank vent line to the top of the oil tank. Connect tank to the drain cock line at the bottom of the tank sump. Install filler neck drain line. Use suitable rubber hose connections and clamps in making the above oil line connections. Make certain all bonding ribbons are wrapped around rubber between clamps, wherever bonding is required.

c. OIL TEMPERATURE REGULATOR.

(1) DESCRIPTION.—*(See figure 154.)*—An 8-inch diameter vertical temperature regulator, type C-5, is supported at the bottom of the engine mount structure. Cooling air is provided by means of a scoop forming the lower portion of the engine compartment cowling and fitted at the bottom of the regulator. Automatic temperature control depends on a thermostatic relief valve, type D-5, which allows the oil, when cold, to pass through the outside jacket, and, when hot, to flow through the radiator. A plug is provided for drainage when the unit is removed from the airplane. Shutters are provided on the top side of the oil temperature regulator with a ratchet-type control located in the front cockpit, below the switch panel, just forward of the control stick. The shutters may be opened, closed, or set in various intermediate positions to regulate the flow of air through the oil temperature regulator radiator.

(2) REMOVAL.—Detach all bonding ribbons and remove the engine-to-regulator and regulator-to-tank oil lines. Disconnect the two aluminum straps extending from the regulator to the carburetor mixing chamber; remove the two attaching bolts, and remove the regulator.

(3) CLEANING.

(a) Clean the oil temperature regulator at each normal engine change or before making any solder repairs.

NOTE

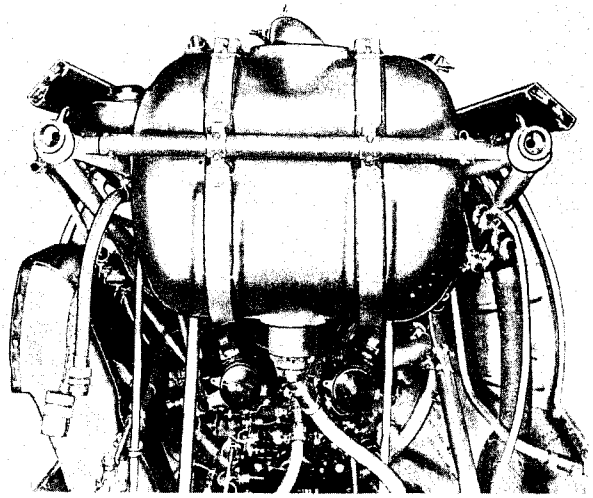
When the engine is changed due to an internal failure which releases metal particles into the oil system, *the oil temperature regulator must be rebuilt.* In such a case, remove the regulator, tag with AAF Form No. 50 marked "Metal-Rebuild," and forward it to the control depot.

(b) Prepare a cleaning solution from the following items:

Cleic acid, stock No. 8500-050000
7 parts by volume

Triethanolamine, stock No. 8500-407600
3 parts by volume

Aromatic naphtha, stock No. 8500-617700
90 parts by volume



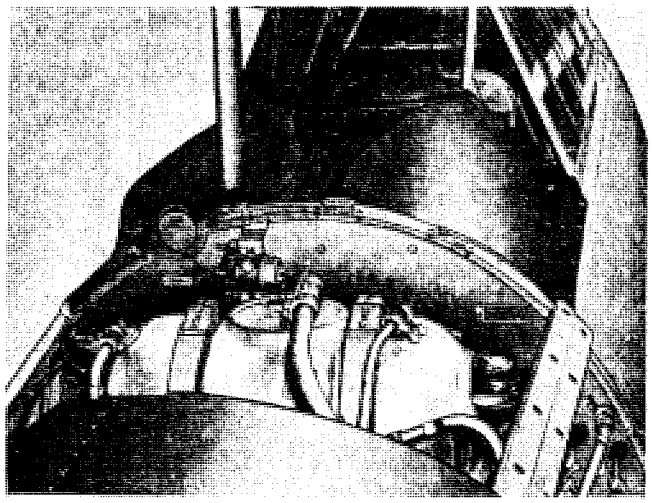


Figure 153—Oil Tank Installation

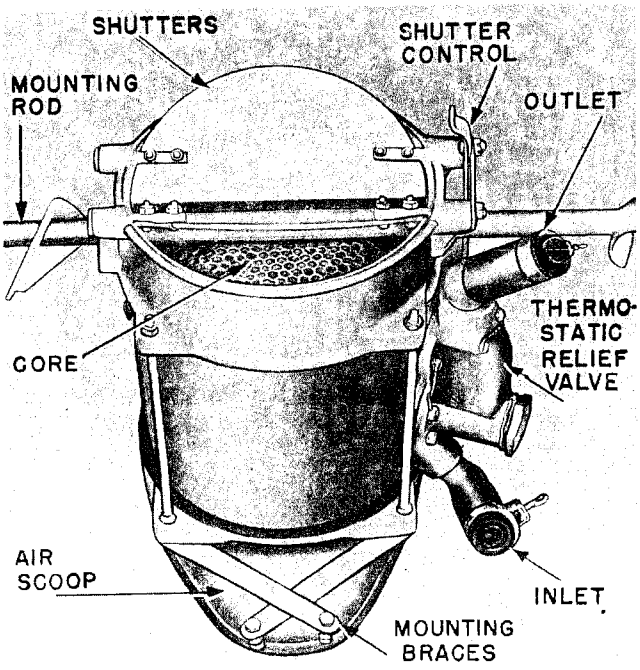


Figure 154 — Oil Temperature Regulator

CAUTION

This fluid is highly inflammable.

(c) Fill the regulator three-quarters full of the cleaning solution and close all openings. Shake and rotate the regulator vigorously for 4 minutes and then drain. Perform this operation two additional times, using a fresh cleaning solution each time. Drain the regulator and apply a compressed air blast for at least 15 minutes to dry it out for testing. Test the regulator for leaks at 100 pounds pressure while submerged in warm water.

(4) REPAIR.

NOTE

Repair of oil temperature regulators is an operation requiring trained personnel, and permanent or major repairs will be made only by depots or depot groups. Exercise care to prevent mechanical damage to any equipment.

(a) Individual leaky tubes, up to 3 percent of the total number of tubes, may be repaired by plugging their ends with loosely packed copper wire and solder, Federal Specification No. QQ-S-571. Make sure soldering is thorough.

(b) If over 3 percent of the tubes are defective, the core should be replaced. If no core replacements are available, individual tubes may be replaced as follows.

1. Use two special soldering irons, AC Drawing 076707. Insert the tip of one heated iron in each end of the tube to be removed. (Corresponding tube ends can be identified by pushing a wire through the tube.) Push on the tube with one iron; and, while holding the other iron in place, apply a slight twisting motion to both irons. If the irons are hot enough, the tube will break loose and may be pulled out through the core with a pair of pliers. Be careful not to deform the ends of the adjacent tubes.

2. Flux each end of the replacement tube, and tin it with soft solder on the hexagon ends only.

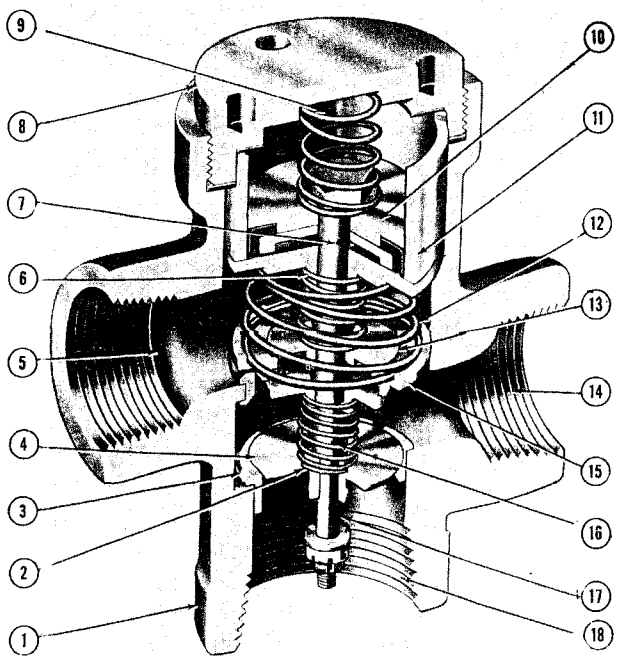
3. Install the replacement tube with a minimum of soft solder, Federal Specification No. QQ-S-571 and a standard type soldering iron. (A radiator torch may be used if extreme care is exercised not to anneal the tubes.)

4. After final testing, flush the oil temperature regulator inside and out with hot running water and then steam for ½ hour. Thoroughly dry the regulator by heating it in an oven for approximately 1 hour at 121°-135°C (250°-275°F) to evaporate all moisture. If an oven is not available, immerse regulator in a tank of clean, light, neutral lubricating oil, SAE 20, Federal Specification No. VV-9-496, at approximately 121°C (250°F); shake the regulator until all bubbling ceases; drain the regulator, and reinstall it in the airplane.

(5) INSTALLATION.—The oil temperature regulator assembly is supported by means of a bracket extending from the top of the regulator, and is attached to the two lower engine mount tubes with rubber hose cushioning. Insulator AC-294-30 (N. A. standard part) is required at the attachments of the oil temperature regulator to the upper bracket and the lower duct. Fit the regulator over the air intake scoop, if installed, and attach the two aluminum-alloy straps extending from the regulator to the carburetor mixing chamber. Ascertain that the edge of the regulator lower duct, lined with C-297-32-0 (N. A. standard part) extruded neoprene, fits snugly around the opening in the air intake scoop. Connect the engine to the regulator, and the regulator to the tank oil lines. Use suitable rubber hose connections and clamps; attach bonding braid, as required.

d. OIL SURGE VALVE.

(1) DESCRIPTION. — *(See figure 155.)* — A United Aircraft Products surge valve, type UB-4400-1, designed to protect the oil temperature regulator from high oil pressure when the engine is started in cold weather, is installed on later model airplanes. The valve is in the oil return line leading from the engine to the oil temperature regulator. A bypass line connected to the valve joins the oil return line from the oil temperature regulator to the tank. The valve has three ports: one is for the oil return line from the engine to the valve; the second is for the oil return line leading from the valve to the regulator; the third connects with the bypass line. This last port is fitted with a spring actuated check valve set to open at 85 pounds per square inch pressure. When oil pressure induced by congelation of oil in the regulator reaches the necessary pressure, the check valve opens and permits the flow of oil through the bypass line into the tank. Meanwhile, the increasingly warm oil coming from the engine will gradually



1. Valve Housing
2. Lower Check Valve Spring
3. Valve Seat
4. Valve Face
5. Port—to Tank
6. Upper Check Valve Spring
7. Hollow Shaft Outlet
8. Valve Cap
9. Piston Spring
10. Expansion Chamber Valve
11. Expansion Chamber Cylinder
12. Heavy Check Valve Spring
13. Upper Check Valve
14. Port—from Engine
15. Primary Check Valve
16. Hollow Shaft Inlet
17. Hollow Shaft
18. Port—to Cooler

Figure 155 — Surge Valve

melt the oil in the regulator, permitting flow through it at pressures less than 85 pounds per square inch. The check valve again closes and all return oil from the engine is routed through the regulator line to the tank.

(2) REMOVAL.—To remove the valve, unscrew the clamps, disconenct the hose from the three port fittings, and unscrew the two clamps securing the valve to the engine mount.

e. OIL PRESSURE AND TEMPERATURE INDICATORS.—*(See figure 156.)*—Oil pressure and temperature indicators are included in the engine gage unit mounted on the instrument panel of each cockpit. The oil temperature indicators are actuated by thermometers, which are inserted in wells located in the oil system drain cock assembly. (For further information refer to section IV, paragraph 10.)

f. OIL DILUTION SYSTEM.

(1) GENERAL.—*(See figure 157.)*—An oil dilution system is provided to admit small quantities of fuel into the oil system to reduce the viscosity of the oil in cold weather. An AC37D6210 oil dilution solenoid valve is mounted above the oil tank, connected in the fuel line from the fuel pressure signal to the oil "Y" drain valve, and controlled by a switch on the front cockpit electrical control panel. When the switch is "ON," the sole-

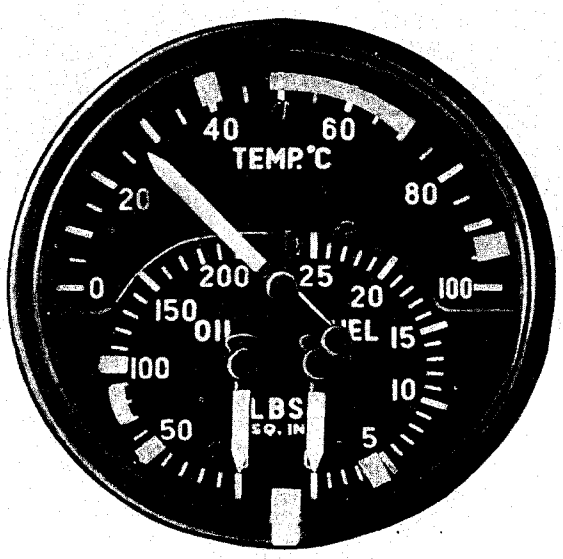


Figure 156 — Engine Gage Unit

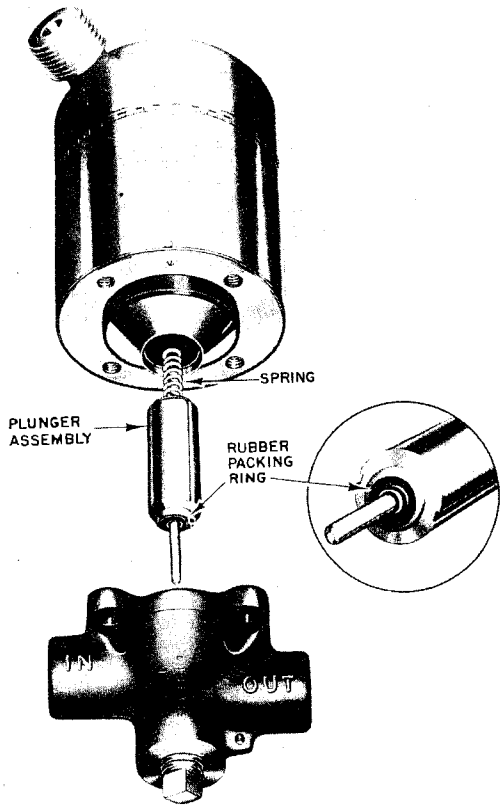


Figure 157 — Oil Dilution Solenoid

noid valve unseats and pressure from the engine-driven fuel pump sends fuel through the valve.

(2) OPERATION. — Refer to section III, paragraph 4.

(3) REMOVAL.

(a) Loosen the hose clamps connecting the inlet and outlet lines to the solenoid and disconnect the lines.

(b) Disconnect electrical conduit to the solenoid.

(c) Unscrew the nuts from the two bolts directly below and above the solenoid to loosen the clamp holding the unit.

(d) Remove the solenoid.

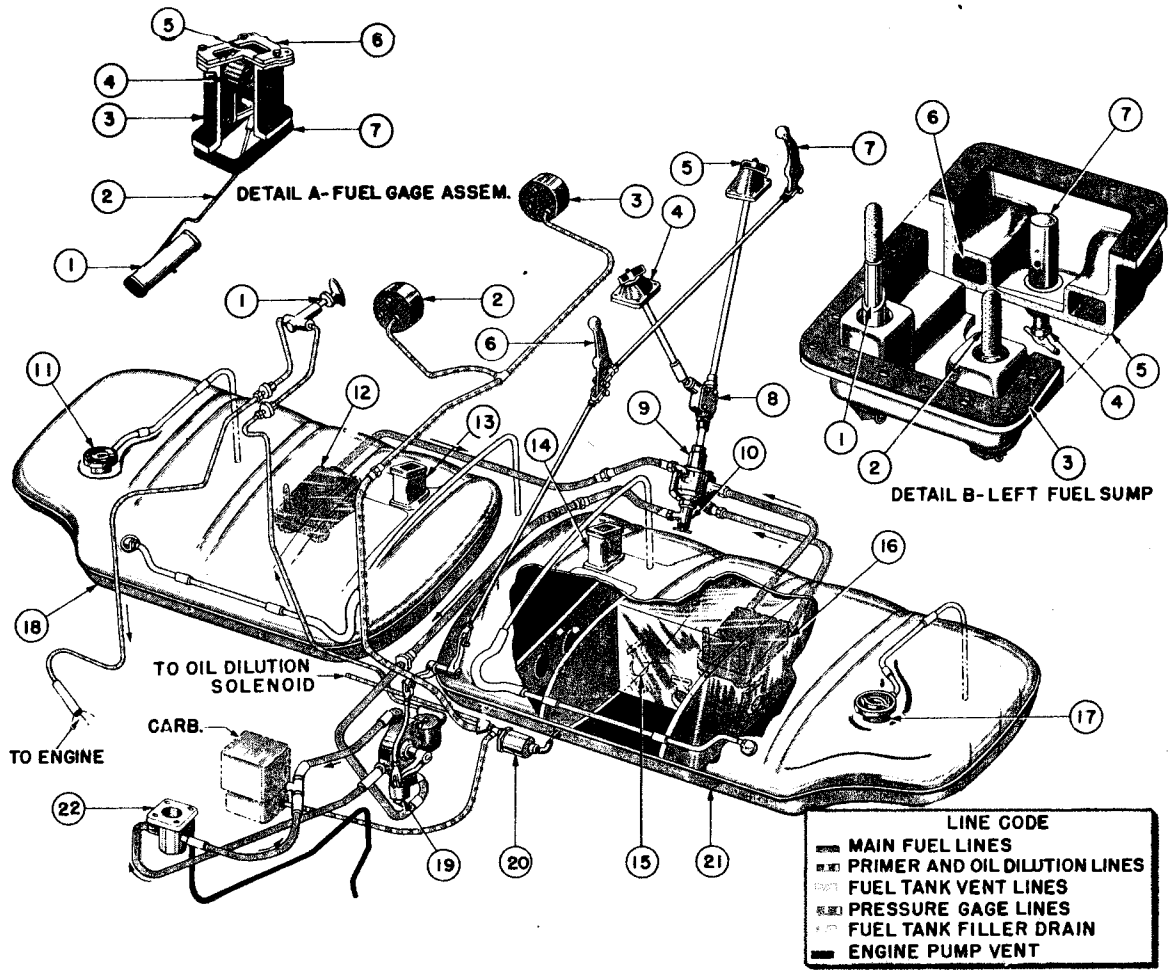
(4) TESTING.—Test the oil dilution valve at each 25-hour inspection according to the following instructions:

(a) Remove the plug in the end of the solenoid valve.

(b) Start the engine, and check for fuel leakage through the plug opening.

(c) If leakage is less than 10 drops a minute, the valve is satisfactory. Stop the engine and reinstall the plug.

(d) If fuel leakage is more than 10 drops a minute, stop the engine and reinstall the plug. Start the



1. Primer
2. Engine Front Gage
3. Engine Rear Gage
4. Front Fuel Selector Dial
5. Rear Fuel Selector Dial
6. Front Fuel Pump Handle
7. Rear Fuel Pump Handle
8. Selector Valve Gear
9. Fuel Selector Valve
10. Selector Valve Drain Cock
11. Right Tank Filler Cap
12. Right Fuel Tank Sump
13. Right Fuel Tank Gage Assembly
14. Left Fuel Tank Gage Assembly
15. Flapper Valve
16. Left Fuel Tank Sump
17. Left Tank Filler Cap
18. Right Fuel Tank
19. Fuel Unit
20. Fuel Pressure Signal
21. Left Fuel Tank
22. Engine-Driven Pump

DETAIL A—FUEL GAGE ASSEMBLY

1. Float
2. Float Rod Assembly
3. Housing
4. Dial Assembly
5. Plexiglas
6. Retainer Plate
7. Gasket

DETAIL B—LEFT FUEL SUMP

1. Standpipe (Long)
2. Standpipe (Short-Reserve)
3. Gasket
4. Drain Cock
5. Reserve Outlet
6. Outlet
7. Anti-Corrosion Capsule

Figure 158—Fuel System Diagram

engine and turn the oil dilution switch "ON" and "OFF" for 10 five-second periods. Stop the engine and remove the plug. Start the engine and if leakage is now less than 10 drops a minute, the valve is satisfactory. Stop the engine and reinstall the plug.

(e) If leakage is more than 10 drops a minute, install a new solenoid.

(5) INSTALLATION. — Installation of the oil dilution solenoid valve is the reverse of "Removal."

9. FUEL SYSTEM

a. GENERAL.—*(See figures 158 and 159.)*—The fuel system consists of two removable tanks, housed within the center section structure, a type F-10 engine-driven fuel pump mounted on the engine accessory housing, a fuel unit (combination hand pump and strainer) on the forward side of the fire wall with a fuel cock at the bottom of the fuel unit, and a fuel selector valve. Two float-type fuel quantity gages, a fuel pressure signal, a carburetor mixture temperature indicator, engine priming system, and the necessary piping, fittings, controls, etc., are provided. Fuel is inducted into the engine from either the left or right tank by means of the fuel tank selector valve, through the combination fuel unit to the engine-driven pump and into the carburetor. In the event that the engine-driven fuel pump fails, fuel is supplied to the carburetor by the fuel unit, with pressure being applied by the hand pump. Fuel system lines are identified by a *red* band. Late airplanes are made suitable for use of aromatic fuels.

NOTE

In the AT-6 only, there are two fixed fuel compartments as integral parts of the wing structure. Each compartment has a capacity of 89 U.S. (74 Imperial) gallons. A standpipe provides a reserve of 20 U.S. (16.7 Imperial) gallons of the total capacity.

b. REMOVABLE FUEL TANKS.

(1) DESCRIPTION.—*(See figure 160.)*—The two pressed sheet aluminum fuel tanks, constructed of a top section and a bottom section which are welded together, are installed between the front and rear spars in the center section structure and are not interconnected. Each tank has a total capacity of 55.2 U.S. (46 Imperial) gallons. An extended standpipe has been provided in the left tank which prevents taking fuel from below the level of its tops, thus creating a reserve supply. Access to the fuel tanks for draining and inspection purposes is gained through several access doors on the lower surface of the center section. The fuel tank sumps located on the bottom side of the tank have incorporated in them the main fuel outlets to the engine and the reserve supply outlet. The sumps are equipped with anti-

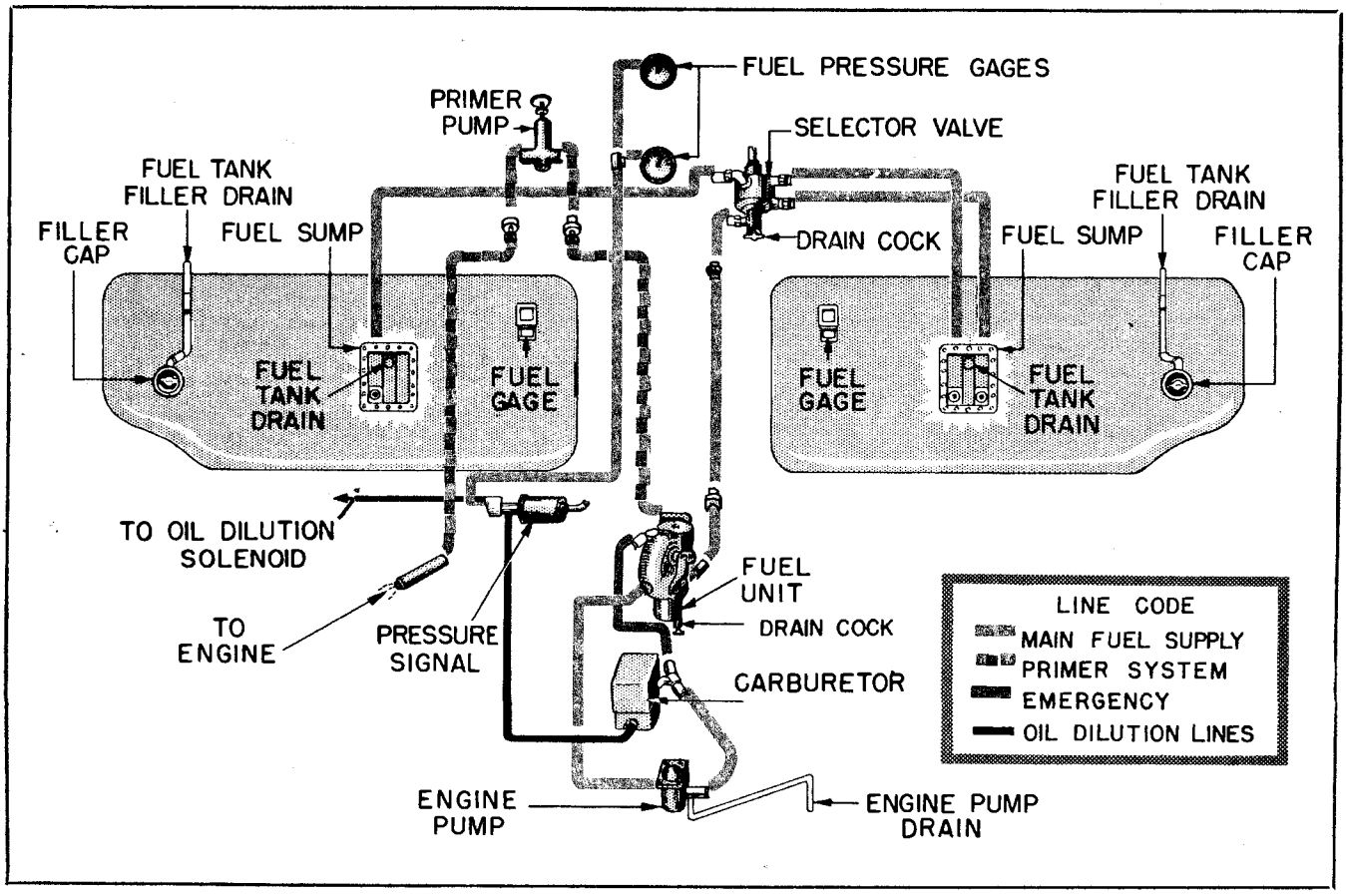


Figure 159 — Fuel System Flow Diagram

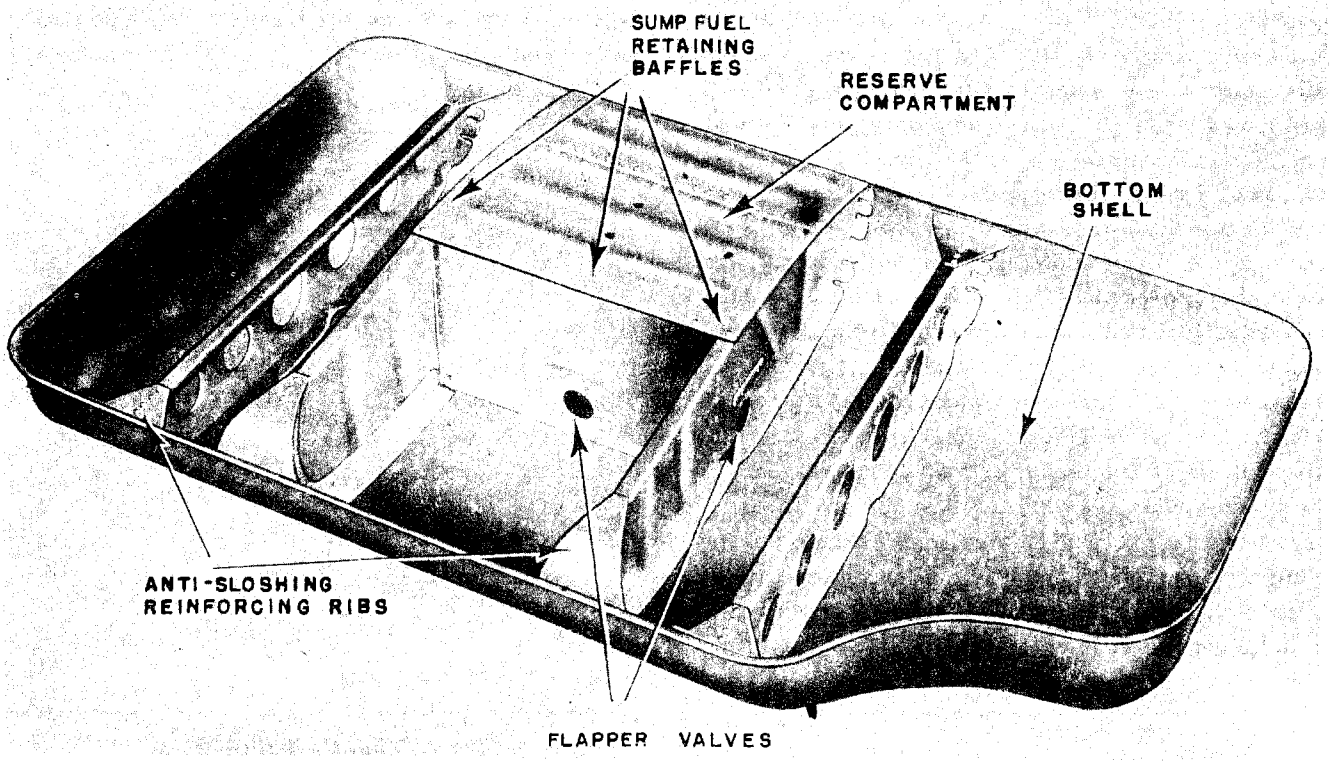


Figure 160 — Fuel Tank

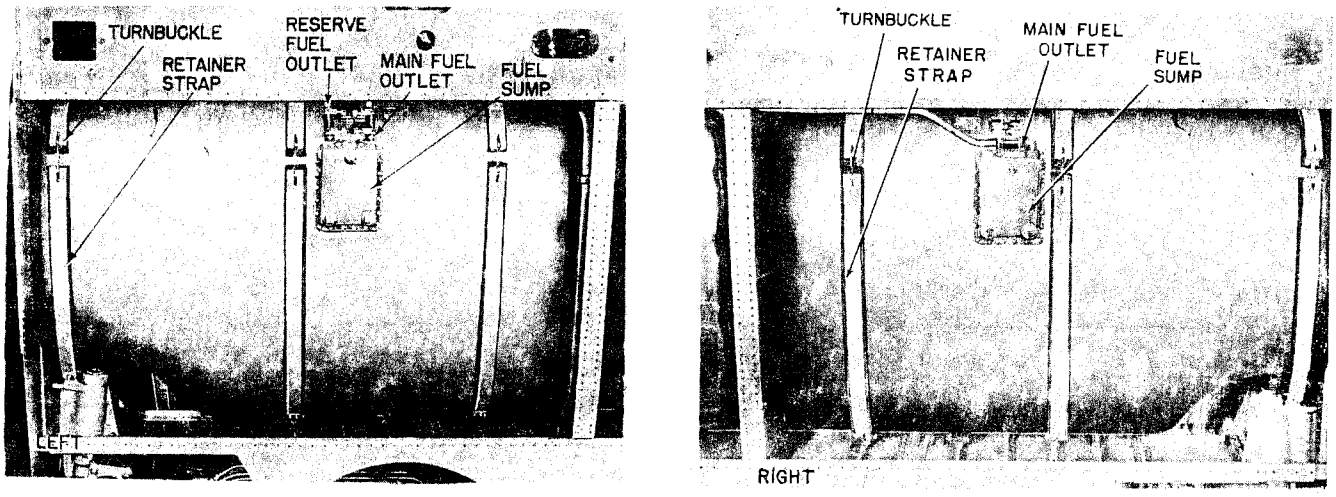


Figure 161 — Fuel Tanks Installed — Left and Right

corrosion capsules. The standpipes are covered with screens for the purpose of filtering the fuel as it is taken from the tank. A drain cock is located in the bottom of each sump for draining the fuel tanks. A chamber located around the tank sump is equipped with flapper valves which allow fuel to enter the sump compartment, but restrict it from leaving, thereby preventing exposure of the fuel outlets when the airplane is maneuvering. The fuel tanks installed in later AT-6D and SNJ-5 (Navy) airplanes differ from those used on earlier airplanes in that the filler cap has been enlarged from two inches to three inches. This change necessitated the redesign of the tank area around the filler cap and enlargement of the opening in the center section top skin to accommodate the larger filler cap assembly.

NOTE

The 20 gallons reserve fuel should not be relied upon after exhausing left main fuel supply.

(2) REMOVAL.— *(See figure 161.)*—Drain the fuel system. (Refer to section III, paragraph 3.) Place padded supports under the outer wing panel tips prior to removing the fuel tank doors. These supports should remain under the tips until the fuel tank doors are reinstalled. *Do not* rock the airplane. Remove the fuel

tank doors on the lower surface of the wing by first removing the bolts securing the door attaching angles to the outer wing panel attaching angles. Access to the bolts is provided by removing the bolting angle cover. Then remove the screws and bolts securing the doors to the center section spars and the bulkhead. Remove the cover plate from the upper surface of the center section above each tank to be removed, and disconnect the fuel tank vent lines. Remove the light assembly from the fuel gage and the cover plates located around the gage. Disconnect the fuel tank bonding braids. Remove the fuel lines at the sump. Unscrew the tank strap turnbuckles and remove the tanks, using one man to support the tank and another to guide the fuel gage through the upper surface of the center section. In preparation for storing the tanks, *do not* seal them as the air inside has a tendency to expand or contract under changing atmospheric conditions, resulting in possible warping of the tank. Vent the tanks for storage by plugging the holes for the vent lines with a soft wooden plug; drill a small hole through the plug. The fibers of the soft wood will prevent dirt from entering through the drilled hole.

(3) and (4) (Deleted)

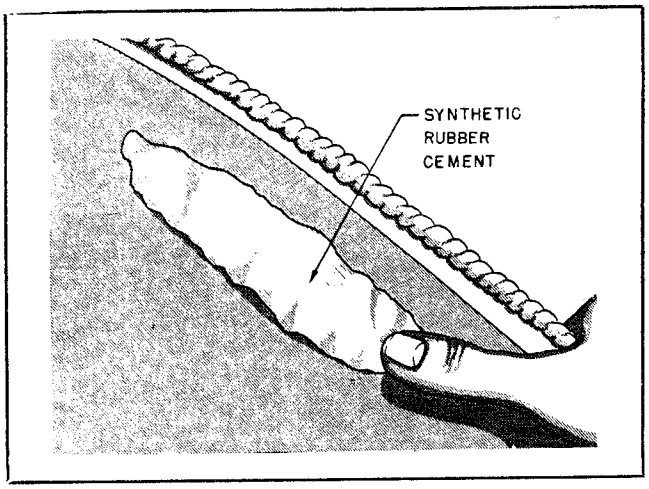


Figure 162 — Sealing Small Cracks

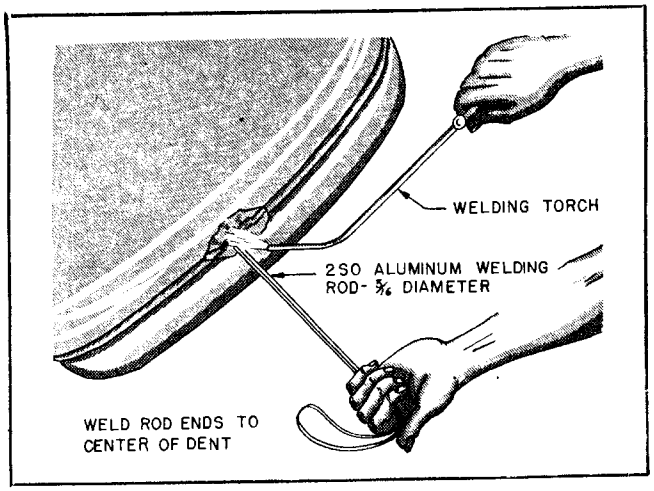


Figure 164 — Removing Dents

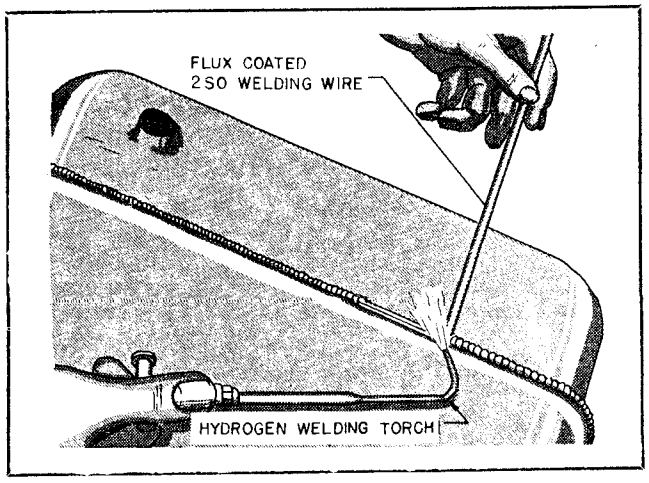


Figure 163 — Welding Split Seams

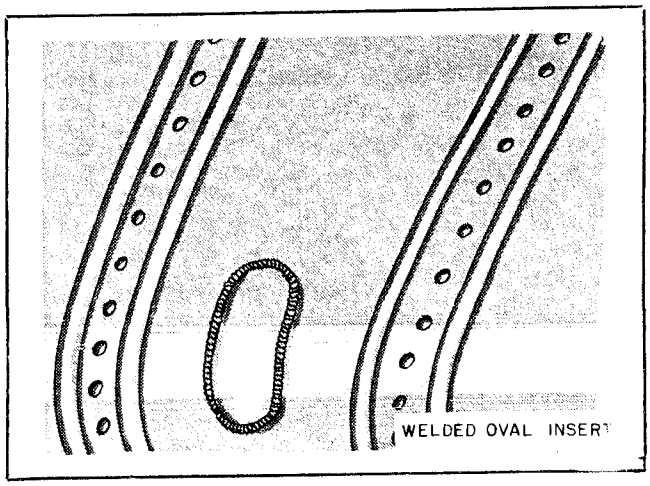


Figure 165 — Welding Inserts

(5) INSTALLATION.—To install a fuel tank, adhere to the following procedure:

(a) Ascertain that the fuel tank pads are properly cemented to the tank's former ribs and tank straps. Use du Pont "Cavalprene" cement or the equivalent for this purpose.

(b) Make certain that the sections of the fuel tank vent line are properly installed in the tank bay with the necessary rubber hose guards.

(c) See that the overflow line is connected to the tank filler neck flange and is spaced from the tank by means of two rubber hose guards. Position the clamps so that they will not chafe the tank or the wing structure. Tighten securely by hand only. Tubing, at each end of all rubber hose guards, should be wrapped with friction tape and shellacked over tape. Also, wrap the line-to-neck attachment and shellac.

(d) See that bonding braids are properly bonded to the lugs on the tank and that the rubber ring is secured to the filler neck casting with cement.

(e) Check the fuel gage readings in level and inverted tank positions for empty and full positions. When properly installed, approximately ½-inch clearance will be present between the float rod and the tank baffle.

(f) Raise the tank into the bay, having a man positioned to guide the gage through the center section opening.

(g) Connect the tank straps, but do not tighten.

(h) Connect the tank vent line.

(i) Ascertain that tank filler neck is centrally located and that tank straps are positioned in the tank grooves.

(j) Tighten the tank straps by means of turnbuckles. It is exceedingly important that the straps be tightened the correct amount, as excess tightening may damage the tank and any looseness may cause the tank to shift. Straps are properly tightened when they can be moved with force into the tank groove.

(k) Safety the strap turnbuckles and connect the bonding braids.

(l) Clean the fuel lines and install as required, using Parker "Sealube" on the line connections.

(m) Test the tank for leaks, using 4 pounds per square inch air pressure connected to the tank sump drain cock.

(n) Install the tank doors.

(o) Install the tank gage covers, bonding, and lights.

c. FIXED TYPE TANKS (AT-6 ONLY)

(1) CLEANING.—Flush the tank with hot water, admitted at the bottom and allowed to overflow from the top. Continue this flushing until there is no trace of fuel adhering to the inside surfaces of the tank.

CAUTION

Precautions must be taken to protect the wing and accessories from the overflow.

(2) SEALING.

(a) In the repair and replacement of parts of the fuel compartments, all seams should be joined and seals should be covered with AAF 3596 sealing compound, and AAF 3595 slushing compound. AAF 3596 may be applied by hand and AAF 3595, by applicator (paint pressure pot type) or stiff brush. Apply compound to interior of compartments only; faying surface coats *must* be uniform with no overlapping coats. In general, leaks occurring from crevices, gaps, slots, etc., can be stopped by use of AAF 3596 compound, and AAF 3595 compound shall be used only on faying surfaces; i.e., only when fittings or parts have been removed and require recoating prior to reassembling. AAF 3596 should be used on compartment interior to completely cover heads of all through bolts and nuts of elastic stop nut plates on seals; also plates, castings, and fuselage attaching bolts. Edges of compound must be spread out to give a "feather" edge all around; approximate thickness of compound applied should be $\frac{1}{8}$ inch minimum to $\frac{1}{2}$ inch. The compartment may then be filled with fuel immediately as no drying time is necessary.

(b) TW1063 wash thinner or equivalent should be used in cleaning seams, backing plates, and faying surfaces prior to applying zinc chromate compounds. Avoid excessive handling of parts after cleaning. Ethyl acetate may be used in removing excess zinc chromate compounds in areas ISOLATED from seams and retainers. Remove excess compound.

CAUTION

A natural solvent, ethyl acetate must not be allowed to stand in contact with zinc chromate. Massage hands after using cleaning solvents with AAF Specification No. 18000 hand protective cream.

(c) All components of the sealed structure must be fitted and drilled to size and then disassembled and cleaned of chips. The methods of repairing parts of fuel compartments are as follows:

1. SKIN LAPS AND ANGLES, FLANGES TO PLATE, SKIN OR WEB, AND ALL FITTINGS.—Slight leaks can be repaired by wiping-in and leaving a small fillet of AAF 3596 compound, and excessively large leaks will require removal of angles, etc., and coating of seam components with AAF 3595 compound. Allow to dry at least 1 hour before reassembly. Cover plates and/or rivets and seam around through fittings with AAF 3596 compound.

NOTE

Do not apply compound to nuts and bolts in compartment interior at access doors, sump casting, or drain flange.

2. BACKING PLATE SEALS.—Permanently remove any metal retainers present at leak, and replace with backing plates where necessary. Before attaching backing plates, clean all members with TW1063 or equivalent wash thinner. Reassemble, using AAF 3595 compound on all faying surfaces, and then AAF 3596 where necessary.

3. THROUGH-BOLTS.—Remove bolts, thoroughly clean with ethyl acetate, apply AAF 3596 compound to countersunk recesses, and reassemble.

4. GASKETS.—Coat both sides of all vellumoid gaskets with AAF 3595 compound and allow to dry 1 hour before reassembly. Dip bolts in AAF 3595 compound on assembly. Assemble fuselage attaching forgings and sump fairing attaching brackets, using AAF 3596 compound.

(3) TESTING.—Stop off vent lines and filler necks with rubber expanding plugs, and connect manometer and air line through control valve to fuel-tight compartment. Interconnect the two compartments. Special access doors must be made for attaching test lines to compartments. Test compartments when interconnected; then test one separately at a minimum pressure of 3 pounds per square inch, all tests lasting for a duration of 15 minutes.

WARNING

Do not apply more than 3 pounds per square inch pressure.

If only single compartment test fails or when high "leg" of mercury in manometer drops more than 3/32-inch, remove access doors and reseal center bulkhead. If leakage occurs when compartments are interconnected, adjust air control valve to 2 pounds per square inch and check the following in the order given. Use liquid soap, with glycerin added, to detect leaks.

Drain plugs	Tube seals
Fuel lines	Corner and stringer seals
Vent lines	
Filler neck cap	Seams
Access doors	Rivets, bolts, screws

After leak has been repaired, apply test pressure of 3 pounds per square inch once more.

d. ENGINE-DRIVE FUEL PUMP.

(1) DESCRIPTION.—*(See figure 166.)*—The engine-driven fuel pump, type F-10, is of the rotary positive displacement type. The pump consists of an aluminum housing in which a rotor with four vanes is driven by means of a drive shaft incorporating a spline gear mating with a gear on the accessory drive section of the engine housing. The fuel pump is located on the lower left side of the accessory section to the left of the carburetor.

(2) INSTALLATION. — Before mounting the pump on the engine, note carefully the direction of rotation of the drive gear. Place the gasket in position over the mounting studs, and mount the pump in position for the necessary connections. Take care to tighten the mounting nuts evenly; see that they are properly safetied. Connect intake and discharge lines to the proper pump ports. The discharge port for either direction of rotation is designated by arrows on the name plate fastened to the end of the body. Connections must be tightened carefully, and all tubing must be properly supported. Connect drain line to the drain hole provided in the pump body next to the mounting plate. This line is to carry away the slight amount of fuel that may work past the seal. See that the relief valve housing is mounted on the body with the intake side next to the pump intake port, as indicated on the instruction plate secured to the valve housing.

e. FUEL UNIT.—*(See figure 167.)*—The type D-3 fuel unit is installed on the lower forward side of the fire wall. This unit combines a hand fuel pump, fuel strainer, sump, drain cock, and a fuel pressure relief valve in one housing. The housing has three mounting posts, and pressure and primer connections are provided.

(1) RELIEF VALVE.

(a) DESCRIPTION.—The balanced pressure relief valve, of the bellows type, is provided with a dash pot to damp out flutter and high-frequency pulsations.

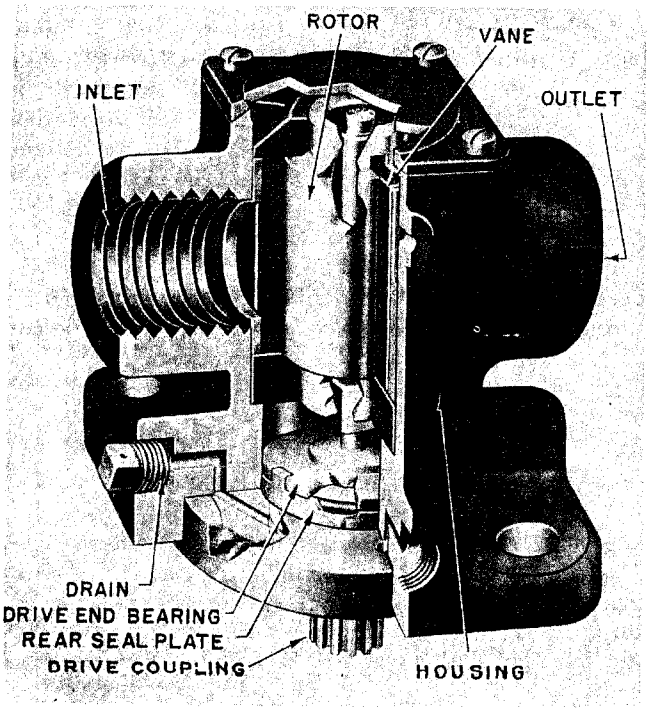


Figure 166 — Engine-Driven Fuel Pump

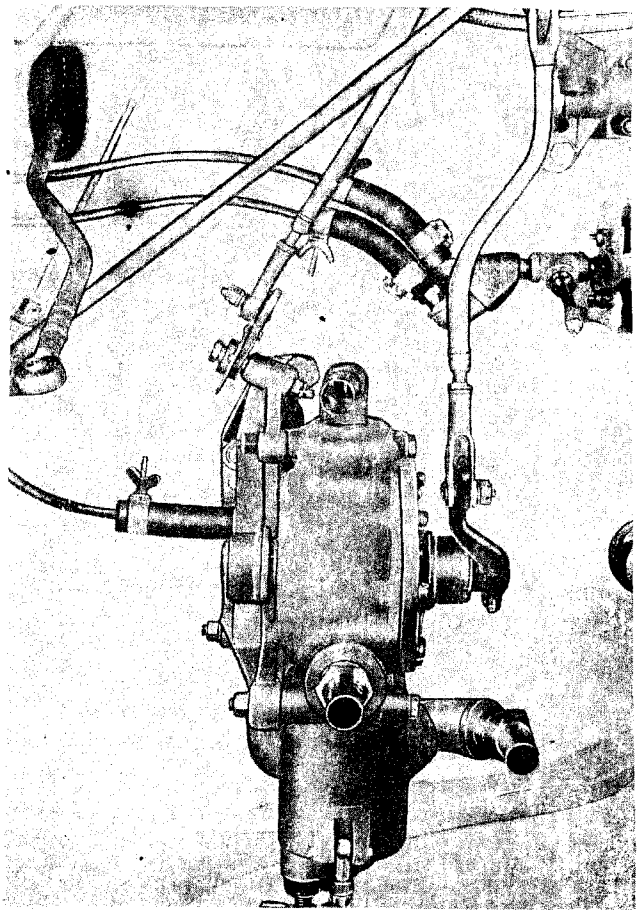


Figure 167 — Fuel Unit Installed

Care should be taken to keep the vent hole free from obstructions.

(b) ADJUSTMENT.—The pressure relief valve on the fuel unit should be set for a discharge pressure of 4 pounds per square inch with a flow of 128 U. S. (106.6 Imperial) gallons per hour through the relief valve. If it is desired to remove the rotor from the unit, the rotor and valve cages should be removed simultaneously and reinstalled in the same manner by entering all three parts grouped together and pressing them into place by means of the cover plate, as otherwise the unit may be damaged by chafing.

(2) HAND PUMP.

(a) DESCRIPTION. — *(See figure 168.)* — The hand fuel pump, being an integral part of the type D-3 fuel unit, is installed on the lower forward side of the fire wall. The handle for operating the hand fuel pump is located on the control shelf at the left side of each cockpit, between the rudder and elevator trim tab control wheels. The control levers are interconnected

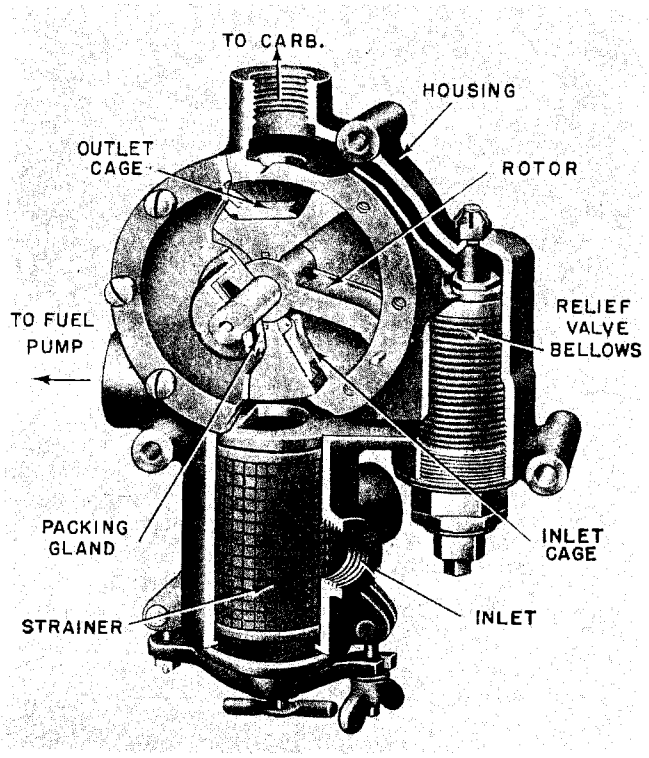


Figure 168 — Fuel Unit

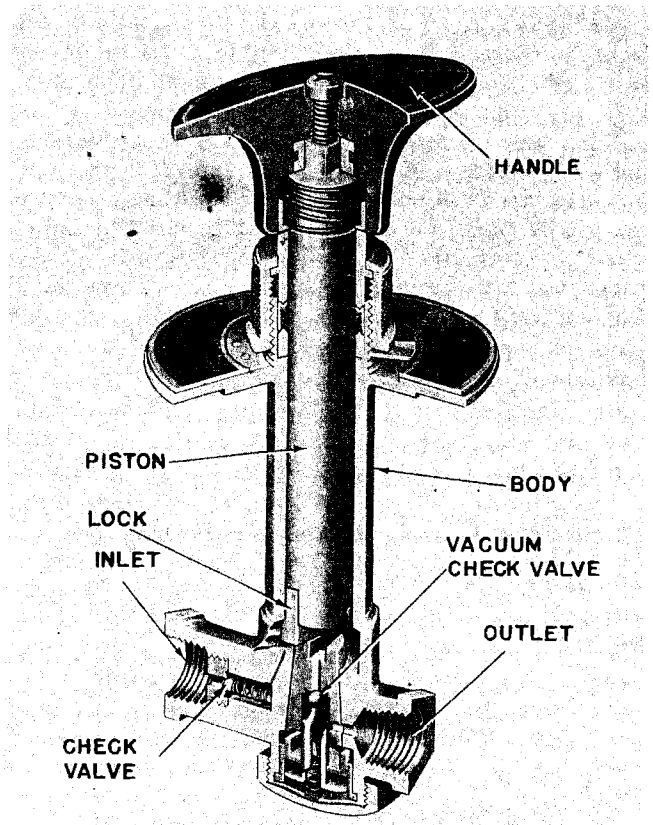


Figure 169 — Engine Primer

by a rod and are connected to the hand pump arm by means of a push-pull rod and bell crank mounted on ball bearings. The function of the hand fuel pump is to obtain fuel pressure when the engine is not running, and it may be used in the event of failure of the engine-driven fuel pump. Insufficient operation of the hand pump will be indicated by the fuel pressure warning light.

(b) ADJUSTMENT.—Adjustment of the hand fuel pump fire wall bell crank should be such as to prevent the fuel pump from traveling the complete amount in either direction. To check for proper adjustment, place the cockpit control handles approximately 1/16 inch short of their full forward position. With the handles in this position, the fire wall bell crank adjustment bolt should be positioned against its stop. Remove the clevis bolt securing the control rod to the fuel pump handle, and check to make certain the pump handle is 1/8 inch into the control rod clevis. Move the cockpit handles to their full aft position, and check for the above distance between maximum pump handle travel and the control rod clevis. If the travel of the pump handle is not restricted as specified above, reposition it on its spline shaft and adjust the stops on the fire wall bell crank as required. It is desirable, if the linkage permits, to have the cockpit control handles fall 1/16 inch short of contact with their full forward stops when the fire wall bell crank stop is engaged.

f. ENGINE PRIMER.—*(See figure 169.)*—The engine primer pump and the operating handle, Parker type 401, is installed on the sub-panel directly below the instrument panel in the front cockpit. The Parker primer is of the displacement plunger type. It is an entirely self-contained unit with no auxiliary valves or other parts. Distribution and shut-off are effected by the single pump handle. In the "OFF" position, the handle is positively locked against vibration. A special vacuum check valve prevents suction of fuel into the engine should the primer accidentally be left in the "ON" position. The fuel is pumped by means of the primer pump from the discharge side of the fuel unit to the engine fuel outlet distributor on cylinder No. 1 intake port. From the primer distributing inlet fuel diffuses through jets in the cylinder intake ports of cylinders 8, 9, 1, 2, and 3.

NOTE

Make certain the handle is pushed in and turned clockwise to the "OFF" position when the priming operations are completed.

g. FUEL SELECTOR VALVE.—*(See figures 170, 171, 172.)*—The fuel selector valve is a cork-seated cock-type G-2A valve, with dial-type selectors. The fuel selector valve is located in the center section structure aft of the left fuel tank gage assembly and is connected by means of rod linkage to the dial selectors located on the control shelf. Fuel tank dial selectors are provided in both front and rear cockpits forward of the trim tab controls in the rear cockpit and aft of trim tab controls in front cockpit. Fuel may be taken from either the right

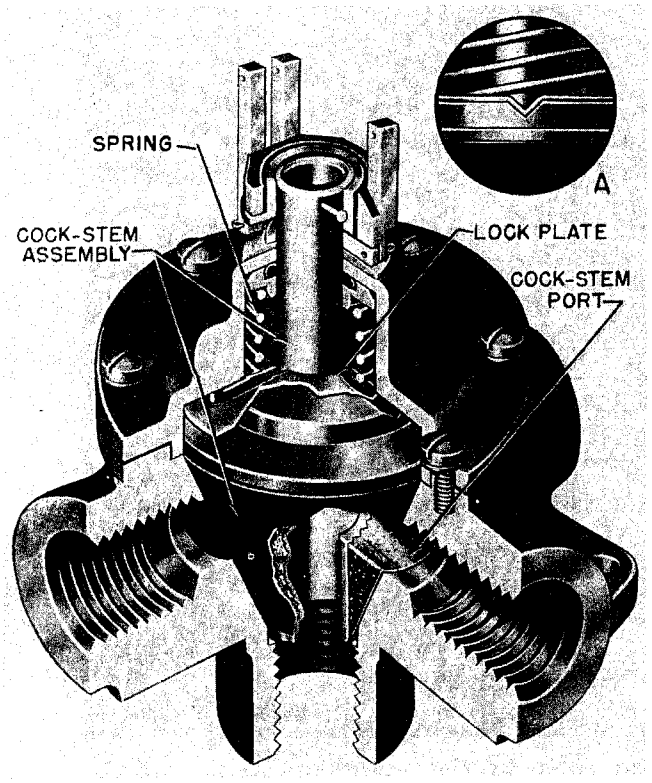


Figure 170 — Fuel Selector Valve

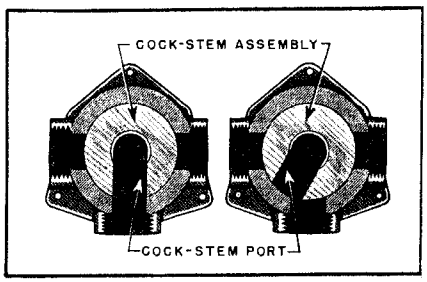


Figure 171 — Alignment of Fuel Selector Valve

tank, left tank, or the reserve supply by turning the dial selector to any one of these three positions, as indicated on the dial selector face place. By turning the selector, the rod linkage revolves a cock-seated core in the selector valve, thus aligning an opening in the core with the passage connected to the fuel line from the selected fuel compartment. The fuel will then flow from the tank through the selector valve and on to the fuel unit. To shut off the flow of fuel to the engine, turn the fuel selector to the "OFF" position.

b. FUEL SWITCH-OVER SIGNAL.—A type C-2 or C-3 fuel switch-over signal assembly is installed on the lower left forward side of the fire wall. This unit operates a fuel signal lamp assembly which is installed on the right side of the instrument panel in the front cockpit. When the carburetor fuel pressure is above 3 pounds per square inch (plus or minus 1/4 pound per square inch), enough pressure is exerted on the bellows and the spring within the signal assembly to maintain an open circuit. Upon reduction of the pressure, the bellows extend, allowing the electrical contacts which are located in a separate compartment to complete the circuit and operate the signal lamp. When the fuel supply in the compartment from which the engine is being operated is exhausted, the fuel pressure will drop and cause the signal lamp to operate for approximately 10 seconds before engine failure. Also, when hand fuel pump operation is insufficient to maintain the required fuel pressure, the signal will operate.

c. FUEL COMPARTMENT SUMP.—To remove fuel compartment sump, remove the fuel lines fore and aft of the sump. Remove the bolts attaching sump to wing center section, and remove.

10. INSTRUMENTS.

a. GENERAL. *(See figures 173, 174, 175.)*

(1) DESCRIPTION.—The instrument panels, installed in the conventional position in each cockpit, are mounted on rubber shock absorber mountings to prevent damage to the instruments from engine vibration, hard landings, etc. Fluorescent lights are provided in each cockpit for lighting the instrument panels, and all instrument dials have fluorescent or fluorescent radioactive markings. The lights may be adjusted to give either ultra-violet and white light or ultra-violet. The compasses on the instrument panels on most airplanes and the fuel gages are individually lighted. The fluorescent lights, compass lights, and fuel gage lights are controlled by switches on the control panel in each cockpit. In general, the same kind of instruments are mounted on the instrument panels in both 12-volt and 24-volt airplanes. Instruments indicating fuel air ratio, carburetor mixture temperature, and cylinder temperature are on the front cockpit instrument panels only. The instruments mounted on the instrument panel in both cockpits are: a manifold pressure gage (AT-6F only), a compass, an altimeter, an air speed indicator, a suction gage, a clock, an engine gage, a rate of climb indicator, a tachometer, and three gyro-controlled instruments: bank-and-turn indicator, gyro horizon, and directional gyro. An accelerometer is mounted below the center of the instrument panel in the front cockpit on AT-6C, SNJ-4, and some AT-6D and SNJ-5 airplanes.

A hydraulic pressure gage, two fuel contents gages, a free air temperature indicator, a generator voltmeter (not installed on AT-6D, F, and SNJ-5 (Navy) airplanes), and an ammeter are also mounted in the front cockpit. These instruments may be classified under four headings: vacuum operated instruments, pitot-static instruments, engine indicating instruments, and miscellaneous instruments. AT-6F airplanes embody standardized instrument panels. (See figures 174A and 175A.)

(2) TROUBLE SHOOTING.—No attempt at disassembly and repair of the instruments themselves should be attempted except at properly equipped depots, with personnel trained for such work. Malfunctioning of the instruments is more often due to some external trouble, such as shorts, grounds, open circuits, or faulty electrical connections, leaking or clogged air lines, etc. Refer to

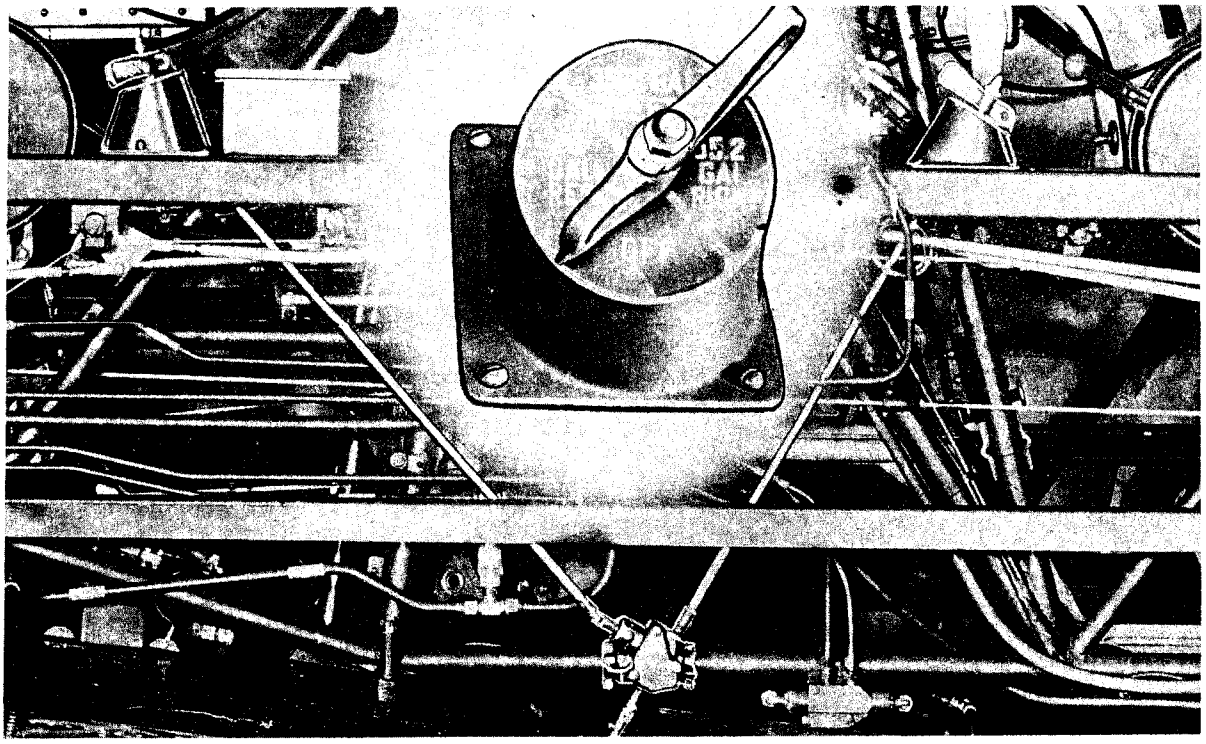
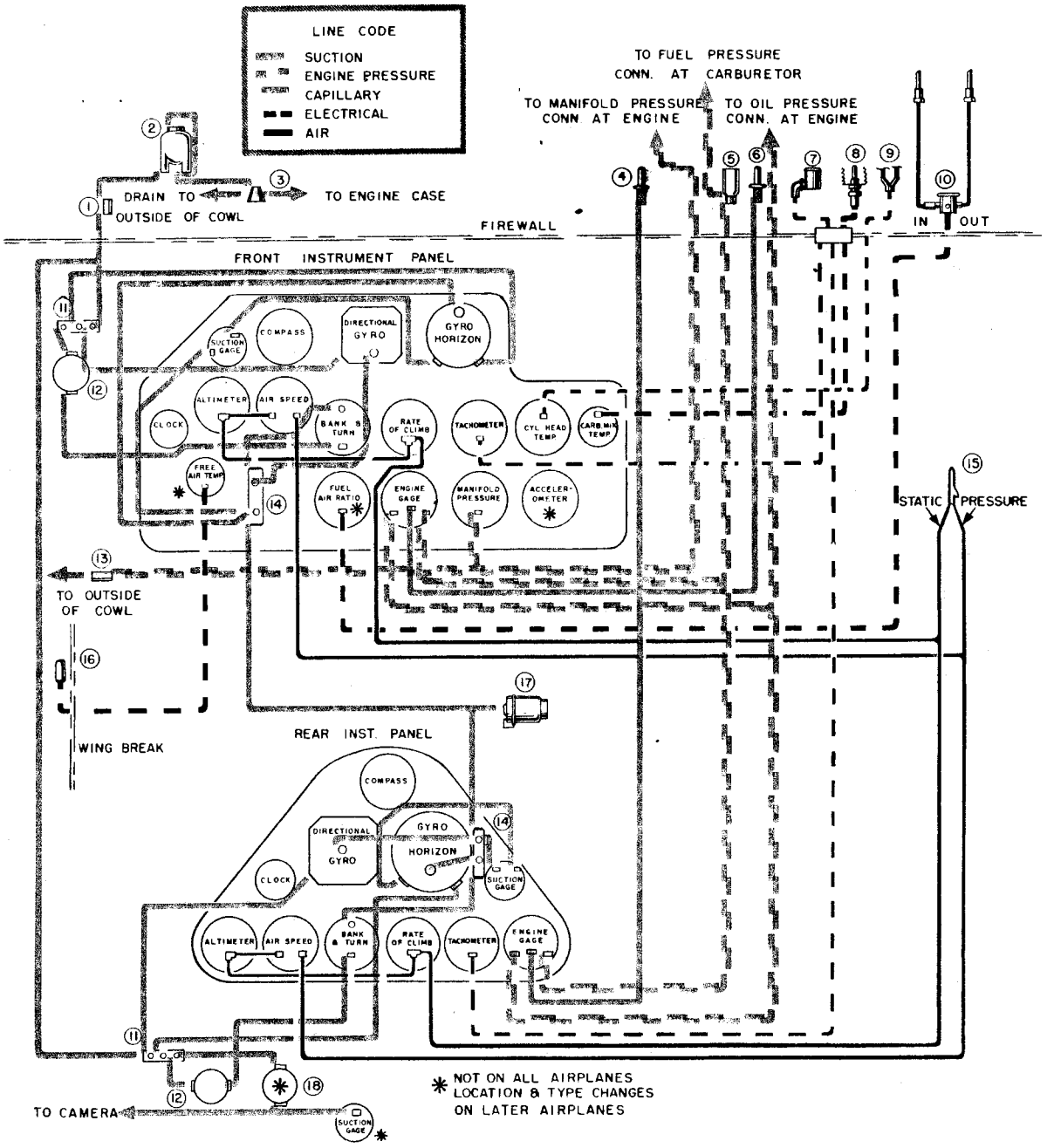


Figure 172—Fuel Selector Valve Controls

INSTRUMENT INSTALLATIONS

	AT-6F	*AT-6D and SNJ-5*	*AT-6C and SNJ-4*	*AT-6A, AT-6B, and SNJ-3*	*AT-6*
Accelerometer	None	94-27960*‡	94-27960*¶	None	None
Altimeter	AN5760-2	C-13	C-13	C-13	C-11
Ammeter	F-1*	F-1*	F-1*	F-1*	F-1*
Air Speed Indic.	C-14	C-14	C-14	C-14	C-7
Bank and Turn Indic.	AN5820-1	A-11	A-8	A-8	A-5
Carburetor Mix Temp.	AN5790-6*	AN5790-6*	F-9*	F-9*	F-2*
Clock	AN5743-1	A-11	A-11	A-11	A-9
Compass	None	B-16	B-16	B-16	B-16
Cylinder Temp Indic.	B-9*	B-9*	B-9*	B-9*	B-7*
Directional Gyro	AN5735-1	AN5735-1	A-5	A-5	A-3
Engine Gage Unit	AN5773-1	B-7	B-7	B-7	B-2
Fuel Level Gages	55-51010*	55-51010*	36-51010*	36-51010*	36-51010*
Fuel—Air Ratio Indic.	None	B-5**	A-7*†	A-7*	A-2*
Free Air Temp Indic.	C-13A*	C-13A*	C-12*	C-12*	C-6*
Gyro Horizon	AN5736-1	AN5736	C-7	C-7	C-5
Hydraulic Press. Gage	E-4*	E-4*	E-4*	E-4*	E-3*
Manifold Press. Gage	AN5770-1	D-10*	D-9*	D-9*	D-2*
Rate of Climb Indic.	AN5825-3	C-2	A-7	A-7	A-6
Radio Compass	None	None	None	None	165-B*
Remote Compass	AN5730-2A*	None	None	None	None
Signal, Fuel Press	C-2*	C-2*	C-2*	C-2*	C-2*
Standby Compass	B-21	None	None	None	None
Suction Gage	AN5771-5	F-4	F-3	F-3	F-2
Tachometer	E-12	E-12	E-12	C-9	C-7
Voltmeter	None	None	B-1*	B-1*	B-1*

* Front Cockpit only
** AT-6D Airplane only
† Early SNJ-4 and all AT-6C
¶ Late AT-6C and SNJ-4
‡ Early AT-6D and SNJ-5



1. Vacuum Relief Valve
2. Vacuum Pump
3. Oil Separator
4. Oil Temperature Bulb—Rear
5. Fuel Pressure Signal
6. Oil Temperature Bulb—Front
7. Tachometer Generator
8. Carburetor Mixture Temp Bulb
9. Thermocouple
10. Exhaust Gas Analyzer
11. Vacuum Distribution Blocks
12. Vacuum Regulators
13. Manifold Pressure Gage Drain
14. Vacuum Distribution Blocks
15. Pitot Head
16. Free Air Temp Bulb
17. Air Filter
18. Camera Valve

Figure 173 — Instrument System Diagram

the troubles, possible causes, and remedies listed for individual instruments.

(3) MAINTENANCE.

(a) Work on aircraft instruments which may be performed by the first echelon of maintenance (squadron, operating unit, etc.) will consist of routine inspections and checking of installed instruments, cleaning of glass covers, tightening of connections, checking installed instruments suspected of malfunctioning, the removal of instruments that require base or depot in-

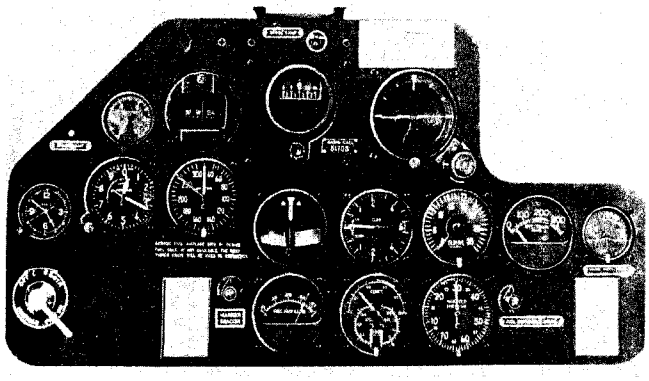


Figure 174 — Front Cockpit — Instrument Panel

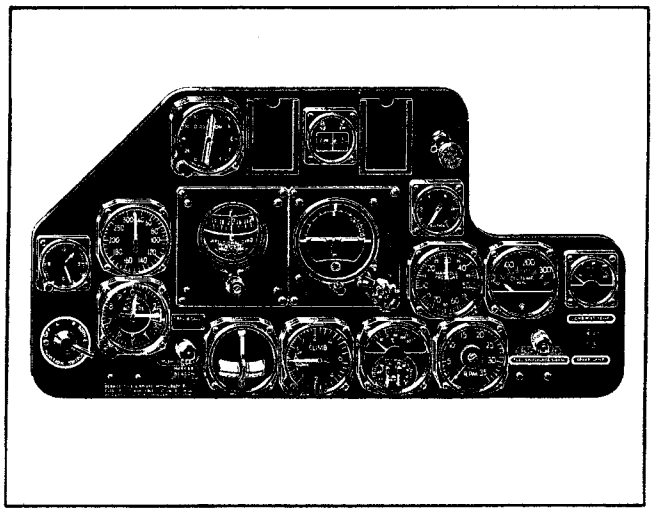


Figure 174A — Front Cockpit Instrument Panel (AT-6F)

spections and repairs, and the reinstallation of serviceable ones.

(b) Periodic inspection requiring the use of type C-1 portable testing equipment may be accomplished if the necessary facilities and trained personnel are available.

(c) An instrument reported as functioning improperly or otherwise suspected of being defective will, whenever practicable, first be checked to determine whether or not the defect is in the instrument or the installation. If the instrument is found to be defective, it will be removed and replaced, the defective instrument being turned into stock in exchange for the serviceable one. However, if the defective instruments requires only the replacement of the cover glass (except electrical instruments) or minor calibration which can be accomplished without disassembling the mechanism, these repairs may be accomplished, if practicable, by the base (3rd echelon) instrument unit, and the instrument reinstalled in the airplane from which it was removed.

(d) Cover glass sealing on flight instruments can be accomplished most successfully by use of "Dux-seal" sealing compound, produced by Johns-Manville Company. This compound will not harden with age, is not harmful to rubber, and is insoluble in water.

(4) REMOVAL.—With few exceptions the instruments have obvious means of removal. Care should be taken, however, to see that upon removal of any instrument all connections are carefully marked. This is to prevent any damage to either the instrument or to the connecting system, and to insure correct operation of the reinstalled instrument. Instruments may be removed from the panel by removing the four screws attaching each instrument case to panel. All instruments except those which are connected to a capillary tube may be detached from their respective lines.

(5) INSTALLATION. — At installation of the shock-mounted panels, take care to adjust the supporting mounts so that panels, complete with instruments, controls, tubing, and wires balance with the face of the panel vertical when the airplane is in the level flight position. Then adjust the steady mount connecting rods so that there is no load in the rods. Instruments may be installed on the panel by attaching instrument case to panel with screws. Lines are easily attached to their respective instruments by means of fittings provided.

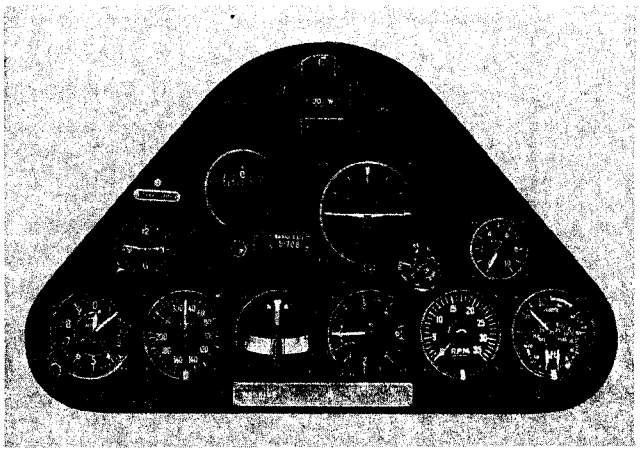


Figure 175 — Rear Cockpit — Instrument Panel

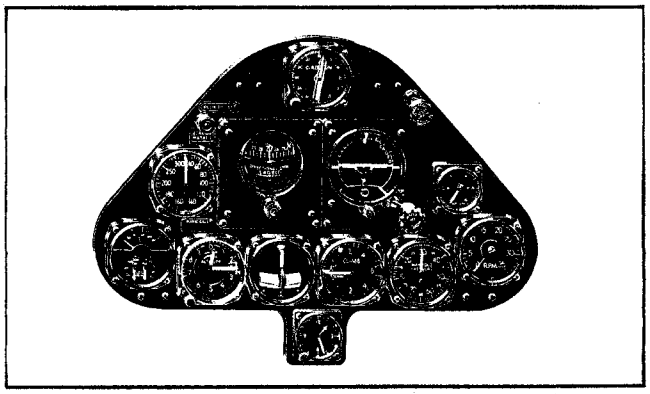
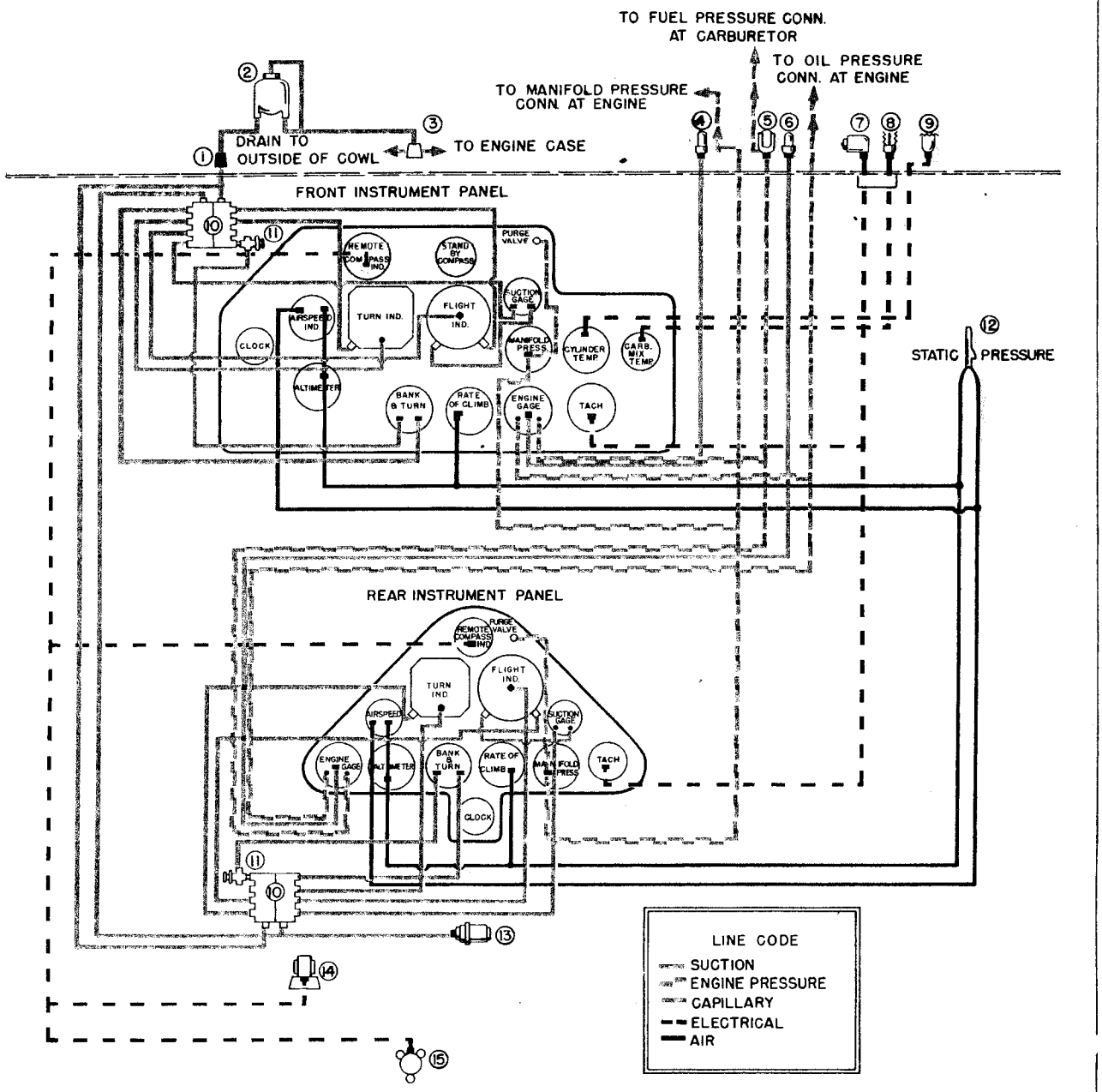


Figure 175A — Rear Cockpit Instrument Panel (AT-6F)



1. Vacuum Relief Valve
2. Vacuum Pump
3. Oil Separator
4. Oil Temperature Bulb—Rear
5. Fuel Pressure Signal
6. Oil Temperature Bulb—Front
7. Tachometer Generator
8. Carburetor Mixture Temp Bulb
9. Thermocouple
10. Vacuum Filter Manifold Block
11. Instrument Vacuum Control Valve
12. Pitot Head
13. Air Filter
14. Remote Compass Inverter
15. Compass Transmitter

Figure 173A — Instrument System Diagram, AT-6F Airplanes

(6) (Deleted in revision dated 5 May 1945.)

(7) FUSELAGE DEMAGNETIZATION. — Excessive compass deviation may be caused by magnetized metal parts of the airplane's structure or by current-carrying wires. The underlying cause may be determined by heading the airplane to magnetic north and east, with all electrical switches off. If the compass is approximately correct under these conditions, but deviation occurs when the switches are turned on, the trouble is obviously in the electrical wiring. If the deviation is approximately the same with the switches off, the trouble is caused by magnetized structure or other parts. If the trouble seems to be in the wiring, locate the offending circuit by turning on the switches one at a time, and relocate the wire to correct the trouble. If the deviation is caused by magnetized structure, demagnetization may be accomplished as follows:

(a) When starting the demagnetizing process, locate the magnetism by means of a pocket compass. In order of their greatest density, flux concentrations will be found in the "X" frames forward of either instrument panel, in the nose-over truss, and occasionally in the longerons. It has been found that only the high fields near the compass need be demagnetized to obtain the desired results.

(b) Adjust the compass compensating screws to neutral.

(c) Place the airplane in a position so that the structure to be demagnetized will have its major axis perpendicular to the earth's magnetic field.

(d) To demagnetize members in which strong fields are found, it is necessary to use a choke coil similar to that shown in figure 177 in series with a variable resistance of 100 ohms. To construct such a coil, refer to paragraph (8).

(e) With the variable resistance set at zero, apply 110 volts ac to the coil. Bring the legs of the coil in contact with the part to be demagnetized and move the sliding contact of the resistor until the full amount of resistance is in the circuit. Disconnect the voltage supply. This should demagnetize that part of the structure between the legs of the coil.

(f) Set the resistance back to zero; repeat this procedure until all suspected parts have been demagnetized.

(g) Test the region again with a compass; go over with the demagnetizing coil any parts that show appreciable magnetization.

NOTE

If it is necessary to use the demagnetizing coil in a region near instruments containing permanent magnets, the instruments should be removed first. If magnetic shields are to be demagnetized, they should first be removed from the instrument case.

(8) CHOKE COIL.—*(See figure 177.)*—Use 67 laminations stamped in the shape of a square "C" having dimensions as given in specifications following. Clamp the laminations together and cut the feet of the "C" in a V-shape to a depth of 1 inch. After milling, completely cover each lamination with two coats of clear lacquer and allow them to dry 8 hours. Clamp laminations together and bind the arc with three layers of friction tape. Give each layer of tape a heavy coat of shellac, and allow it to dry thoroughly. Wrap empire cloth of .020-inch thickness over the tape; hold it in place by another layer of friction tape. Apply two coats of shellac to the arc; allow it to dry thoroughly. Use friction tape, applied lengthwise in strips around the core, to secure the magnet wire. Wind three layers of magnet wire 100

(Figure 176 Deleted in Revision 30 October 1944)

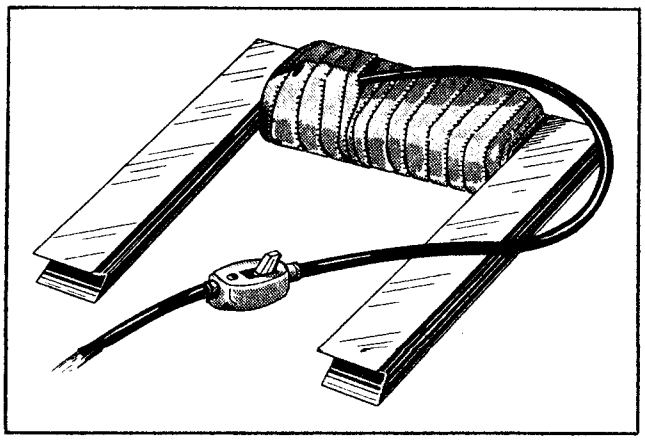


Figure 177 — Choke Coil

turns to each layer; secure the wire and tape in the usual manner. Give each layer of wire two coats of shellac and two layers of friction tape, wrapping the last layer of wire with friction tape while the shellac is *still wet.* Bake the assembly at 66°C (150°F) for 24 hours. Solder the cord, with the switch in series, to the coil leads; secure the cord by taping it to the laminations.

SPECIFICATIONS

Amperes	10
Cycles	60
Inductance, millihenries	39
Volts	110

LAMINATIONS

Type of material	Electric Core Steel
Thickness of material	0.015 inch
Total number of laminations	67
Number of turns	300
Wire number	12 (double cotton covered copper magnet wire)

DIMENSIONS EXCLUSIVE OF COIL

Length	12 inches
Legs (from back)	10 inches
Legs (width)	2 inches
Legs (thickness)	1 inch
Arc (to support coil)	2 inches

b. VACUUM OPERATED INSTRUMENTS.

(1) BANK AND TURN INDICATOR.

(a) DESCRIPTION.—The bank and turn indicator is used as an aid in indicating the flight of an airplane under conditions of poor visibility. This instrument enables the pilot to maintain a laterally level attitude while flying straight and to make a properly banked turn. There are actually two instruments combined in the one case. The turn indicator shows whether the airplane is flying straight, as when the pointer is centered, or when it is turning, and shows the direction of that turn, disregarding drift, bank, or pitch. It contains an air-driven gyroscope which precesses when its plane of spin is disturbed. The bank indicator, or inclinometer, is an encased ball which is affected by centrifugal force against the force of gravity, making the movements nil on a correctly banked turn. The turn indicator consists of a gyroscope, with the case acting as the outside gimbal ring, transmitting mechanism, a damping device, and an adjustable calibrated spring to restrain the precession. The stream of air is directed against the buckets of the rotor, driving it at a speed of approximately 9000 rpm. The gyro rotates about the lateral axis in the frame and is not affected by rolling or pitching. Displacement is transmitted through the balance plate to the fork of the staff into pointer movement proportionate to the rate of turn of the airplane. The rotor is limited by stops of about 45 degrees each side of the vertical. A spring attached to the inner gimbal ring serves the double purpose of creating a force which balances the gyroscopic reaction during a turn centralizes the assembly immediately after a turn.

(b) TROUBLE SHOOTING.

BANK AND TURN INDICATOR TYPES A-8 AND A-11

Trouble	*Possible Cause*	*Remedy*
POINTER FAILS TO RESPOND CORRECTLY.	No vacuum supplied to the instrument.	Check vacuum control valve for leaks and stoppage. Examine tubing for leaks and stoppage. Check vacuum at instrument and through the lines.
	Air inlet cap or screen clogged.	Remove cap or screen, clean and replace. Remove filter assembly and replace.
	Foreign matter in rotor bearings.	Remove instrument, forward to repair depot.
	Foreign matter in damping cylinder.	Remove instrument, forward to repair depot.
	Excessive friction in rotor bearings.	Replace instrument.

Trouble	*Possible Cause*	*Remedy*
INCORRECT SENSITIVITY.	Incorrect vacuum.	See remedies under "Pointer fails to respond." Adjust the adjustable restriction.
	Air inlet cap or screen clogged.	Remove cap or screen, clean and replace.
	Misadjustment of sensitivity spring	Remove instrument and forward to maintenance activity for adjustment.
POINTER DOES NOT SET AT ZERO.	Gimbal and rotor assembly out of balance.	Remove instrument and forward to repair depot.
	Pointer incorrectly set on its staff	Remove instrument and forward to repair depot.
	Sensitivity adjustment pulls pointer off zero.	Remove instrument and forward to repair depot.
VIBRATING POINTER.	Excessive vibration.	If vibration is not apparent, forward instrument to repair depot, giving part number of the board and type of airplane, together with particulars of the instrument board mounting.
	Damping screw misadjustment.	Unscrew damping adjustment screw to the right until corrected.
	Gimbal and rotor assembly out of balance.	Remove instrument and forward to repair depot.
	Pitted or worn pivots or bearings.	Remove instrument and forward to repair depot.
IN LOW TEMPERATURE, POINTER FAILS TO RESPOND OR DOES SO SLUGGISHLY AND WITH AN INSUFFICIENT DEFLECTION.	Oil becomes too thick.	Remove instrument and forward to repair depot.
	Insufficient bearing clearance.	Remove instrument and forward to repair depot.
	Air inlet screen or cap clogged with ice crystals.	Clean the screen or cap with an absorbing pad.
POINTER SLUGGISH IN RETURNING TO ZERO AND DOES NOT SET ON ZERO WHEN STATIONARY.	Oil or dirt between damping pistons and cylinder.	Remove instrument and forward to repair depot.
	Excessive clearance between rotor and rotor pivots.	Remove instrument and forward to repair depot.
BROKEN INCLINOMETER TUBE.	Excessive vibration; rough handling.	Replace instrument.
BALL IN INCLINOMETER DOES NOT CENTER.	Instrument out of alignment on panel.	Correct alignment.

(2) GYRO HORIZON INDICATOR.

(a) DESCRIPTION.—This instrument is used as a definite means of ascertaining the true attitude of the airplane relative to the earth. It is particularly valuable when the earth's horizon is not visible. The gyro is mounted in the flight indicator so that its plane of spin can assume any position in space. Obeying the gyroscopic principle of "rigidity" the gyro, when spinning, maintains its spinning axis upright, irrespective of the movements of the airplane, establishing a horizontal flight reference. Attitude positions are actuated through linkage by means of a pin protruding from the gyro housing through a slot in the outer gimbal ring. Diametrically balanced vanes are provided to exhaust the air and to maintain an upright position when the gyro attempts deviation. When the deviation occurs, one vane opens its port while the diametrically opposite vane closes its port, causing a torque which precesses the gyro

to its normal position. In view of the operating limits of 60-degree dives or climbs and 100-degree vertical banks, a caging knob is installed on the front of the instrument. This instrument will be UNCAGED at ALL times except during maneuvers in the air which exceed the operating limits given above.

NOTE

If the horizon bar is not level after engines are started, cage and immediately uncage the gyro at least 5 minutes before take-off.

Another knob for adjustment of the miniature airplane is also on the front of the instrument.

NOTE

When a solo flight or series of solo flights is planned, cage the unused gyro horizon indicator before take-off and uncage when solo flight or flights is completed.

(b) TROUBLE SHOOTING.

GYRO HORIZON TYPE AN5736

Trouble	*Possible Cause*	*Remedy*
BAR FAILS TO RESPOND.	Instrument caged.	Uncage.
	Air filter dirty.	Clean or replace filter element.
	Insufficient vacuum: Suction regulator. Incorrect suction gage reading. Pump failure. Insufficient lubrication in pump. Vacuum line kinked, leaking.	Correct as follows: Adjust properly. Check calibration of gage. Repair and replace pump. Provide proper lubrication. Locate and repair—check flexible hose.
	Defective mechanism.	Remove instrument and forward to repair depot.
BAR DOES NOT SETTLE.	Defective mechanism.	Remove instrument and forward to repair depot.
	Insufficient vacuum.	Correct for insufficient vacuum.
	Excessive vibration.	Test panel with vibrometer, examine shock mount and connections.
BAR OSCILLATES.	Gyro not completely uncaged.	Uncage.
	Excessive vacuum: Dirty air filters. Suction regulator misadjusted. Incorrect suction gage reading.	Correct: Examine and clean or replace. Adjust. Check calibration of gage.
	Defective mechanism.	Replace instrument.
	Excessive vibration.	Test panel with vibrometer, examine shock mount and connections.
	Instrument out of alignment on panel.	Correct alignment.
HORIZON BAR DOES NOT AGREE WITH FLIGHT ATTITUDE.	Defective mechanism.	Remove instrument and forward to repair depot.
BAR AND BANKING INDICATOR NOT PERPENDICULAR TO EACH OTHER.	Mechanism out of alignment.	Replace instrument.
INSTRUMENT FAILS ON BENCH TEST.	Defective internal mechanism.	Replace instrument.

(3) DIRECTIONAL GYRO INDICATOR.

(a) DESCRIPTION.—This instrument is used to supplement the magnetic compass in maintaining a straight course. It also measures the degree of a turn made by the airplane. The rotor spins about the horizontal axis at approximately 10,000 rpm and is mounted in an inner and outer gimbal ring. The circular card which is attached to the outer ring is observed through

an opening in the case. Due to the rigidity of the gyro, this card remains fixed in azimuth. The instrument is fitted with a caging knob used to set the gyro with the compass. The air jets which spin the rotor also serve to keep it upright. The air is divided into two parallel jets which strike the buckets at points equidistant from the center. If the rotor tilts, the air from the jets on one side strikes against the rim instead of the bucket, while the air from the other jet strikes against the sides of the buckets. Part of the force of the jets continues to spin the rotor, but part of the force acts to apply a torque on the outer ring, which precesses the rotor back to the orthogonal. The directional gyro is limited to 55 degree, climb, dive, or bank. When the knob is pulled out, the gyro is uncaged; pushed in completely, the gyro is caged. The knob is also used in IN position and rotated to set the gyro with the magnetic compass. This instrument should be UNCAGED at all times, except during maneuvers which exceed the operating limits given above. On later airplanes, the rigid connecting tubing has been supplanted by flexible tubing.

NOTE

When a solo flight or series of solo flights is planned, cage the unused directional gyro indicator before take-off and uncage when the flight or flights is completed.

(b) TROUBLE SHOOTING.

DIRECTIONAL GYRO TYPE AN5735-1

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE DRIFT.	Excessive vibration.	Test with vibrometer.
	Insufficient vacuum: Regulator misadjusted. Incorrect suction gage reading. Pump failure. Insufficient lubrication of vacuum pump.	Correct as follows: Adjust suction regulator. Check calibration of gage. Repair and replace pump. Provide proper lubrication.
	Vacuum line kinked.	Locate and remove for repair—check flexible hose.
	Defective mechanism.	Remove and send for repair.
DIAL SPINS CONTINUOUSLY IN ONE DIRECTION.	Defective mechanism.	Remove instrument. Inspect. If defective, send to repair depot.
CAGING MECHANISM WORKS HARD.	Lack of lubrication; corrosion.	Lubricate external part of shaft.
INSTRUMENT LACKS SENSITIVITY.	Insufficient speed for gyro rotor, dirty screens.	Clean screens and check suction.
LOOSE OR BROKEN COVER GLASS.	Excessive vibration.	Replace instrument and forward to repair depot.
INSTRUMENT FAILS ON BENCH TEST.	Defective internal mechanism.	Replace instrument and forward to repair depot.

(4) SUCTION GAGE.

(a) DESCRIPTION.—In the suction gage a diaphragm is mounted on a bracket which is screwed to the case. The movements of the diaphragm are transmitted to the pointer by means of a rocking shaft assembly sector assembly, and pinion. The pointer staff is provided with a hairspring to eliminate backlash. A bimetallic lever compensates the instrument for changes in temperature.

(b) TROUBLE SHOOTING.

SUCTION GAGE

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE ERROR AT ZERO.	Loose pointer.	Return to maintenance activity to reset pointer.
	Seasoning of diaphragm.	Replace instrument and forward to repair depot.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE SCALE ERROR.	Improper calibration.	Return to instrument maintenance activity for calibration.
EXCESSIVE POINTER OSCILLATION.	Rough relief val·· seat.	Adjust or replace relief valve.

(5) VACUUM SYSTEM.

(a) GENERAL.—*(See figure 178.)*—The vacuum system employed to operate the gyro instruments is comprised of an engine-driven vacuum pump, air-oil separator, vacuum regulator, relief valve, air filter, tubing and distributor blocks necessary to complete the connections. A suction gage is installed in each cockpit to give indication of the vacuum in the system. On early models a camera valve is also provided. Air drawn by the pump into the system through the air filter is directed against the gyro rotor buckets, causing the rotors to spin. A partial vacuum is created in the air-tight instrument cases, offering less resistance to rotor rotation. Lubricating oil, used to seal vacuum compartments in the pump, is expelled with the air into an air-oil separator from which it is returned to the crankcase, and the air is expelled outside the engine cowl. A pressure relief valve is installed in the main vacuum line near the pump to regulate vacuum pressure at 3.75 to 4.25 inches of mercury. It also prevents damage to the instruments in the event of line closure. A vacuum regulator is installed in each bank and turn-to-pump line to reduce the vacuum to 1.8 to 2.05 inches of mercury for operation of the bank and turn indicator.

(b) VACUUM PUMP.

1. DESCRIPTION.—The type B-12 engine-driven vacuum pump, located at the lower rear crankcase, is of rotary, four vane, positive displacement type, and is connected directly to the main vacuum line. The pump is divided into four compartments of unequal volume by an eccentrically mounted rotor with four vanes moving in a tempered sleeve. Suction is created as each compartment moves successively past the intake port.

2. REMOVAL.

a. Disconnect line to oil separator and plug line.

b. Disconnect main vacuum line.

c. Remove safety wire and the four lock nuts at the pump base, then remove pump.

3. MAINTENANCE AND REPAIR.—Maintenance and repair is to be undertaken only at regular overhaul depots.

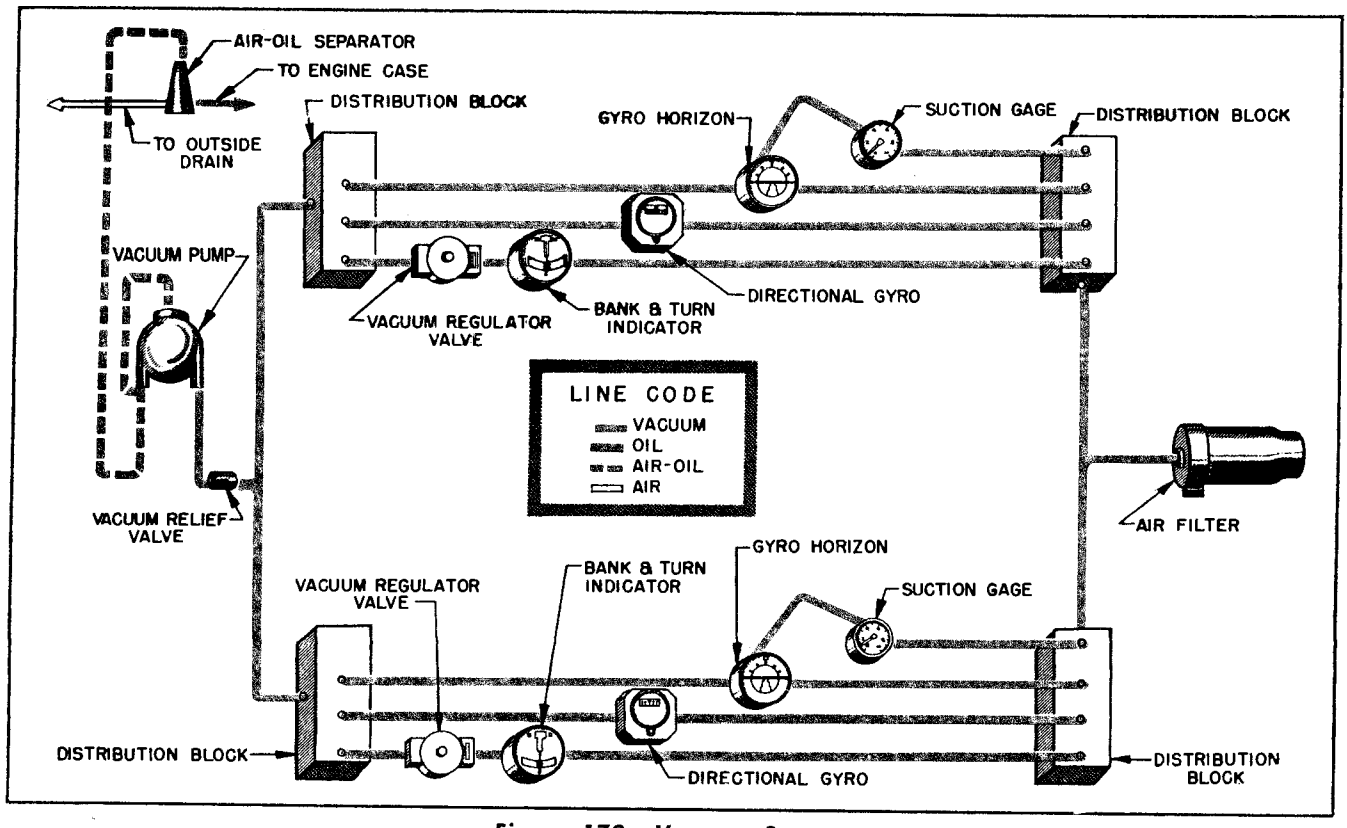


Figure 178—Vacuum System

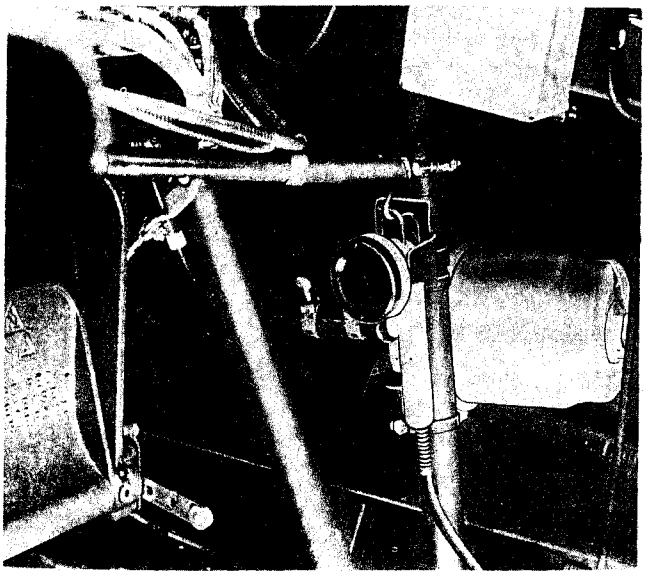


Figure 179 — Vacuum Air Filter Installation — Rear Cockpit

4. INSTALLATION.

a. In installing a new pump, note direction of rotation of engine drive gear.

b. Remove shipping plugs from the two ports, and test for freedom of operation by turning coupling with fingers.

c. If rotation is difficult, bump the assembly on a wooden bench to free its parts.

d. Mount the pump and secure mounting nuts.

e. Connect suction and discharge lines.

(c) AIR FILTER.

1. DESCRIPTION.—*(See figure 179.)*—A 10 CMF air filter, located on the right side of rear cockpit, provides original entrance of air into the vacuum system and removes all solid impurities from the air. The filter installed may be one of three types: Purolator PA-11, Purolator PA-12, or Skinner 27300. The primary difference of the three filters is in the filtering element; each requires different maintenance.

2. REMOVAL.

a. Disconnect main vacuum line by removing hose and clamp.

b. Remove the two bolts and nuts securing the mounting bracket assembly to the fuselage structure and remove filter.

3. DISASSEMBLY.

a. Remove bolt opposite outlet port.

b. Remove filter bowl from filter head.

c. Remove diffuser and filter element.

4. MAINTENANCE. — Use long thin-nosed pliers to remove the snap ring and screen from the inlet hole in the filter. Submerge filter screen in clear gasoline, and scrub with a stiff brush. Do not use a wire brush.

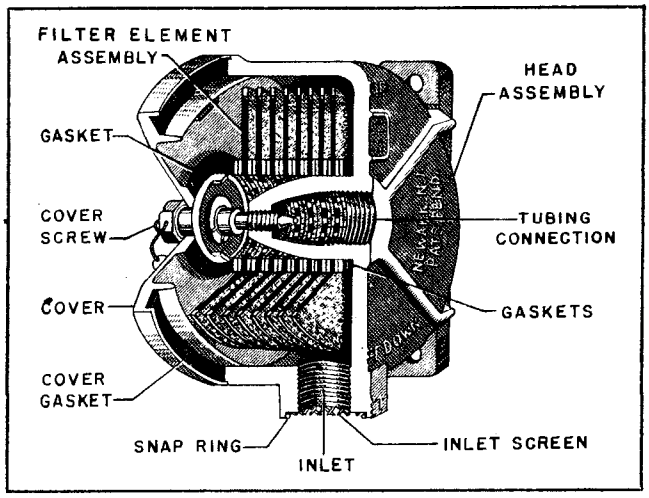


Figure 180 — Type PA-12 Air Filter

a. TYPE PA-12.—*(See figure 180.)*—To remove the filtering element, the safety wire must be removed. Using a 13/16-inch wrench, unscrew cover screw. The element assembly which will pull away with the cover must be carefully removed with a turning motion to free element from the cover.

(1) Brush element with a soft, dry, hair brush. Use masking tape to cover the holes in each end of the element to prevent dirt from entering while brushing. Replace element when it shows signs of wear, holes, or if discs are separated. *Do not use water or gasoline to clean element.*

(2) Clean inside of filter case thoroughly with gasoline and a soft, lint-free cloth.

(3) Replace cover gasket when crimped or stuck to cover.

b. TYPE PA-11.—*(See figure 181.)*—The filtering element can be cleaned or changed without disturbing installation of the filter by first removing the safety wire from case clamp nut; then using a 1-5/16-inch wrench, unscrew the case clamp nut until case assembly is released from head assembly. Element assembly will pull away from head assembly with case assembly, and element assembly may then be pulled out of the case assembly. *Do not use water or gasoline to clean element.*

(1) Brush filter with a soft, dry, hair brush. Cover the holes in each end of the element with masking tape to prevent dirt from entering while brushing.

(2) Clean inside of filter case thoroughly with clear gasoline and a soft, lint-free cloth.

(3) Replace element sealing gasket if damaged Remove the dried cement from the head assembly with alcohol and apply thin coat of orange shellac to one side of new gasket before placing in position.

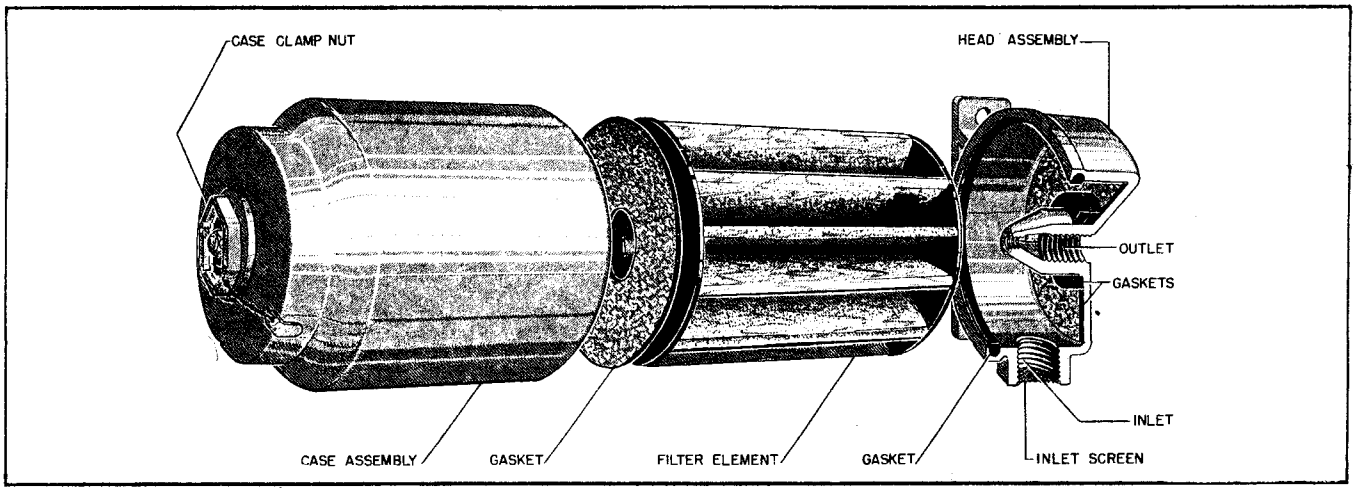


Figure 181 — Type PA-11 Air Filter

c. SKINNER TYPE 27300. — *(See figure 182.)*—To clean this filter, remove locking wire, disengage bolt, and remove filter bowl. Remove diffuser and filter element from the bowl by holding bolt and removing element nut and its lock nut from bolt. Remove diffuser from filter element by force.

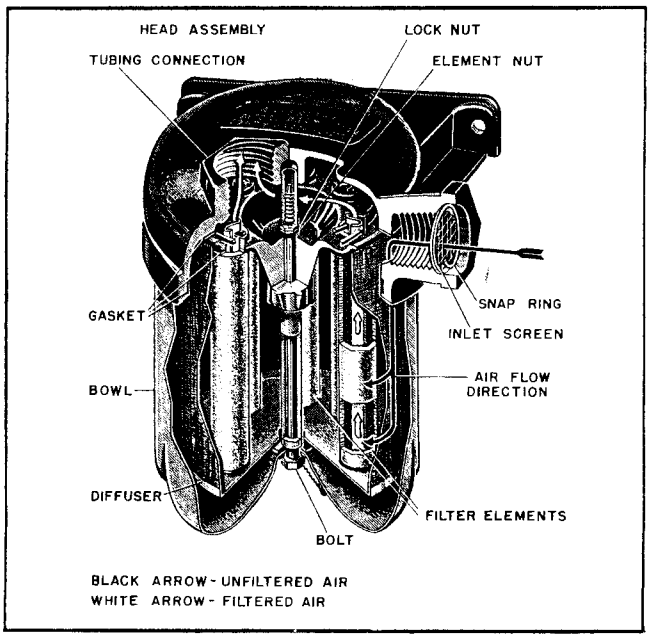


Figure 182 — Skinner Type 27300 Air Filter

(1) Use compressed air, applying first to the open ends of the tubular filter element. This reverses the normal flow and loosens any surface deposit. The dust and impurities then can be blown off by directing the compressed air along the elements from either end. *Do not apply air in right angles to the elements.* Wipe off any dust with a clean cloth.

(2) Where compressed air is not available, the element may be cleaned by brushing with a stiff bristle brush and wiping with a clean cloth.

(3) The filter may be cleaned by rinsing in gasoline or by flushing with water under pressure. In either case, it should then be wiped with a clean cloth and allowed to dry thoroughly before reinstalling.

(4) Clean interior of case, outlet port, and gaskets with a clean, soft, lintless cloth.

5. ASSEMBLY.—Reverse the disassembly procedure.

6. INSTALLATION.—Reverse the removal procedure.

(d) VACUUM REGULATORS.

1. DESCRIPTION. — *(See figure 183.)* — A vacuum regulator, installed in the line to each bank and turn indicator, restricts the suction exerted on the bank and turn indicators to 1.8 to 2.05 inches of mercury. On the AT-6F, vacuum control valves are installed in the plastic manifold vacuum block behind each instrument panel.

2. REMOVAL.

a. FRONT VACUUM REGULATOR.

(1) Detach vacuum line leading from bank and turn indicator.

(2) Detach vacuum line leading to distribution block.

(3) Remove the four bolts securing regulator to windshield-and-front-instrument-panel bracket brace.

(4) Remove regulator.

b. REAR VACUUM REGULATOR.

(1) Disconnect vacuum line leading from bank and turn indicator.

(2) Disconnect vacuum line leading to distribution block.

(3) With Phillips-head screw driver, remove four screws securing regulator to mounting bracket.

(4) Remove regulator.

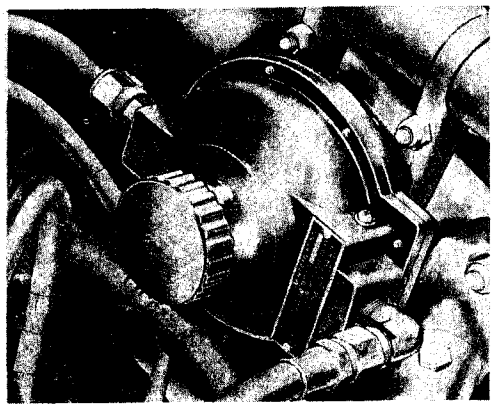


Figure 183 — Vacuum Regulator

c. VACUUM CONTROL VALVE (AT-6F) *(See figure 183A.)*

(1) Detach vacuum line leading from bank and turn indicator.

(2) Remove control valve by unscrewing from manifold vacuum block.

3. MAINTENANCE AND REPAIR.—Maintenance and repair will not be attempted by other than skilled personnel at properly equipped overhaul depots. Remove unservicable units, attach a "reparable parts" tag, and forward to the repair depot.

4. ADJUSTMENTS.—If suction on the bank and turn indicator is not within the limits given above, remove valve adjustment cap, loosen set screw, and revolve disk to regulate suction.

5. INSTALLATION. — Reverse removal procedure.

(e) VACUUM RELIEF VALVE.

1. DESCRIPTION.—The vacuum relief valve, regulating the suction on the entire system to 3.75 to 4.25 inches of mercury, is a spring-loaded disc type valve housed in cast aluminum. If suction becomes excessive the valve disc is unseated, allowing air to enter the vacuum system through a screened port. The valve is located in the engine compartment on the left side, forward and below the oil tank.

2. REMOVAL.

a. Disconnect line to vacuum pump.

b. Disconnect main line from instruments.

c. Loosen the two bolts securing valve to engine mount.

d. Remove vacuum relief valve.

3. MAINTENANCE AND REPAIR.—Inspect valve screen. If dirty, remove the valve, and then the screen. Clean the screen with gasoline and replace.

4. ADJUSTMENTS. — If necessary to alter adjustments of the valve, loosen the lock nut and turn the adjusting nut to regulate suction.

5. INSTALLATION.—Using a short piece of tubing, connect the valve to the pump with the necessary rubber hose connections and pipe nipples. Always mount the unit so that the screen faces downward or to one side—never upward.

(f) OIL-AIR SEPARATOR.

1. DESCRIPTION.—A type B-12 air-oil separator is incorporated in the system, forward of the oil tank, to remove oil from the pump discharge air and return it to the crankcase. The air is expelled through a perforated disc strainer to the outside of the engine compartment.

2. REMOVAL.

a. Detach line leading from vacuum pump and plug line.

b. Disconnect air-discharge line.

c. Disconnect oil outlet line leading to crankcase; plug line if necessary, to prevent loss of latent oil.

d. Loosen and remove the two bolts securing air-oil separator mounting bracket to the engine mount interior brace.

e. Remove separator.

3. MAINTENANCE AND REPAIR. — All maintenance and repair will be effected at a designated repair depot.

4. INSTALLATION.—To install, reverse removal instructions outlined above.

(g) CAMERA VALVE.—In earlier AT-6 and SNJ series airplanes, a shut-off valve is installed to provide suction at the camera to hold the film flat against its frame.

c. PITOT-STATIC INSTRUMENTS.

(1) DESCRIPTION.—The pitot-static system operates the air-speed indicator, the altimeter, and the rate of climb indicator. Impact pressure and static air conditions are derived from a pitot head mounted on the pitot mast extending forward of the leading edge of the right wing near the tip. An air line from the pitot head transmits the impact pressure, or pressure due to the forward speed of the airplane through the air, to the air-speed indicator only. The altimeter and rate of climb indicators are actuated by the atmospheric pressure at the level at which the airplane is flying. A static air line transmits this atmospheric pressure from the static head in the pitot tube to the indicating instruments. The static line is also connected to the air-speed indicator to assure equal barometric pressure in the case and on the diaphragm. The pitot head

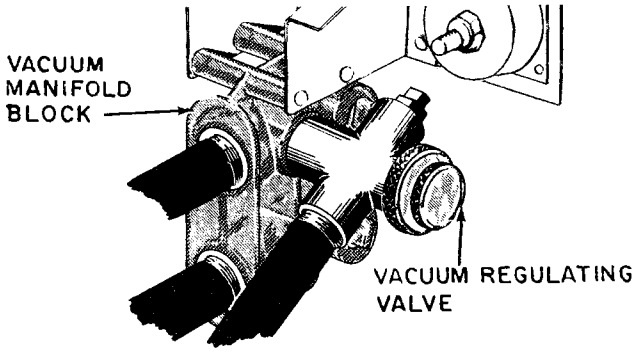


Figure 183A — Vacuum Control Valve

contains integral heating elements to prevent ice from clogging the air-speed orifice and from forming in the static openings of the pitot head. The pitot heating elements are controlled from the front cockpit control panel. Removable moisture traps for the system lines are located just forward of the right wheel well and are accessible through a removable panel in the lower wing surface. A red marker on the glass of the air-speed indicator at 240 mph indicates maximum diving speed.

CAUTION

All activities are cautioned to properly maintain the entire air-speed tube installation. Particular care should be exercised in keeping the air-speed tube clean at all times. When airplanes are not flying, the air-speed tube will be protected from dust, dirt, oil, and other foreign particles by an appropriate cloth, canvas, or leather sack with a streamer to be fabricated locally. The sack should cover all openings in the tube.

(2) TROUBLE SHOOTING.

(a) AIR-SPEED INDICATOR TYPE C-14.

CAUTION

In all trouble shooting it should be remembered that the air-speed indicator is connected through both the static and pressure lines to the pitot tube and that the altimeter and rate of climb indicators are connected through the same static line to the static outlets in the pitot-static tubes. Great care should be exercised not to damage any of these instruments when testing one of them.

Trouble	*Possible Cause*	*Remedy*
POINTER FAILS TO RESPOND.	Impact (pitot) pressure connection (P) not connected properly to impact pressure line from pitot-static tube.	Check tubing for correct connection.
	Defective indicator mechanism.	Replace with serviceable instrument.
POINTER INDICATES INCORRECTLY.	Leak in tubing from pitot-static tube or in connection.	Check lines to pitot-static tube for leaks.
	Leak in indicator case.	Replace with serviceable instrument.
	Defective indicator mechanism.	Replace with serviceable instrument.
	Pitot-static head misaligned.	Align pitot-static head.
	Clogged static line.	Disconnect static line at instrument and blow through line to remove obstructions. Empty moisture trap.
POINTER DOES NOT SET ON ZERO WHEN AIRPLANE IS ON THE GROUND.	Defective indicator mechanism.	Replace with serviceable instrument.
POINTER VIBRATES.	Excessive vibration of instrument board.	Check instrument board and if excessive vibration is apparent, replace worn or deteriorated Lord mounting units.
POINTER OSCILLATES.	Leak in tubing from pitot-static tube or in connections.	Disconnect lines from airspeed indicator. Check lines to pitot-static tube for leaks.
	Leak in indicator case.	Replace with serviceable instrument.
	Leak in rate of climb indicator or altimeter installations.	Check lines for leaks. If an instrument is at fault, replace with a serviceable instrument.
DEFECTIVE LIGHTING AND CASE LEAKS. TYPE C-7 INDICATORS WITH CASE NOT MARKED WITH A (P).	Due to shrinkage and distortion of Lucite light or window rings which soften at temperature of about 50° C (122° F). (P) means instrument has been equipped with Polystyrene light and window rings which will not soften until temperature of 85° C (184° F).	Replace with serviceable instrument.

(b) ALTIMETER TYPE C-13.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE SCALE ERROR.	Improper calibration adjustment.	Replace instrument.
EXCESSIVE POINTER OSCILLATION.	Defective mechanism. Excessive vibration.	Replace instrument. Eliminate vibration.
LOW READING.	Improper venting.	Eliminate leak in pressure line, and check alignment of airspeed tube.
SETTING KNOB TURNS EXCESSIVELY HARD.	Defective mechanism.	Replace instrument.
INNER REFERENCE MARKER FAILS TO MOVE WHEN SETTING KNOB IS ROTATED.	Out of engagement.	Replace instrument.
SETTING KNOB LOCK SCREW LOOSE OR MISSING.	Excessive vibration, careless maintenance.	Tighten screw, if loose. Replace instrument, if screw is missing.
CRACKED OR LOOSE COVER GLASS.	Excessive vibration.	Replace cover glass.
DULL OR DISCOLORED LUMINOUS MARKINGS.	Age.	Replace instrument.
BAROMETRIC SCALE AND REFERENCE MARKERS OUT OF SYNCHRONISM.	Slippage in mating parts.	Replace instrument.
BAROMETRIC SCALE AND REFERENCE MARKERS OUT OF SYNCHRONISM WITH POINTERS.	Drift in the mechanism or careless maintenance.	Replace instrument.

(c) RATE OF CLIMB INDICATOR TYPE C-2.

Trouble	*Possible Cause*	*Remedy*
POINTER OFF "ZERO."	Mechanism shift.	Return pointer to "ZERO" by means of knob. Tap panel next to instrument lightly while making adjustment.
POINTER OFF "ZERO" AND CANNOT BE BROUGHT BACK BY ZERO ADJUSTING KNOB.	Broken pivot.	Return to overhaul depot for overhaul.
POINTER FAILS TO RESPOND.	Obstruction in static line. Defective mechanism.	Disconnect all instruments which may be connected to the static line. Open drain plug and blow line clear. Replace instrument.

Trouble	*Possible Cause*	*Remedy*
INSTRUMENT INDICATES LESS THAN ACTUAL RATE OF CLIMB	Case leak.	Return to overhaul depot for overhaul.
	Broken diffuser.	Return to overhaul depot for overhaul.
	Defective instrument	Replace instrument.
FRICTION.	Dirty pivots and jewels.	Return to overhaul depot for overhaul.
	Broken jewels.	Return to overhaul depot for overhaul.
	Improper clearances.	Return to overhaul depot for overhaul.
POINTER OSCILLATES.	Defective instrument.	Replace instrument.

d. ENGINE INDICATING INSTRUMENTS.

(1) DESCRIPTION.—Engine instruments consist of a manifold pressure indicator, tachometer, engine gage unit, fuel-air mixture indicator, cylinder temperature gage (thermocouple), and carburetor mixture temperature gage. The tachometer, engine gage unit, and manifold pressure gage (AT-6F models only) are duplicated in the rear cockpit. The manifold pressure gage consists of two connected metallic bellows, one evacuated and the other subjected to manifold pressure, that give indication, through linkage, of pressure in the intake manifold. A drain cock on the left side of the front cockpit marked "MANIFOLD PRESSURE GAGE DRAIN" should be opened for a short time when the engine is first started and running at idling speed to exhaust the moisture that has accumulated in the manifold pressure line. On the AT-6F airplanes push-type manifold pressure purge valves are located on the upper right-hand section of both front and rear instrument panels. Pushing the valve button opens the manifold pressure line, purging it of moisture when the engine is started and idling. The tachometer is of the electric-generator type. The assembly consists of an electric generator driven by the engine and connected to a voltmeter-type indicator that is responsive to the generator output voltage. The indicator is calibrated in engine revolutions per minute. The engine gage unit consists of three instruments in one, a vapor pressure type thermometer for oil temperature, and two Bourdon tube gages for indicating oil pressure and fuel pressure. The AT-6F models utilize an electric type thermometer for oil temperature. The fuel-air mixture indicator makes an electrical analysis of the exhaust gases of the engine which, in fact, is an indication of mixture of fuel and air in the carburetor. This analysis is made by using a two-cell analysis chamber, a Wheatstone bridge circuit, and a galvanometer. The thermocouple principle is used for indicating cylinder temperature.

NOTE

Theory of operation of the thermocouple: When two wires of dissimilar metal are joined together and the junction is heated, an electromotive force will appear at the opposite ends of the two wires. The magnitude of this E.M.F. will depend on the difference in temperature at the two ends of the wires and the composition of the metals used.

The induced E.M.F. is transmitted to the indicator having a sensitive D'Arsonval-type mechanism with a coil arranged to move in an annular air gap of a permanent magnet. The coil carries the pointer and the control is one bimetallic spring and two hair springs which also serve to conduct current into the coil. An adjusting screw on the face of the instrument provides a means of setting the pointer to indicate the temperature of the instrument. The instrument temperature may be determined by using a check thermometer.

NOTE

Before pointer adjustments are made, the thermocouple leads must be disconnected.

The carburetor air mixture temperature indicator is for indicating the temperature of the carburetor intake air. A resistance-type bulb screwed into the top of the carburetor is interconnected with the indicating instrument on the front cockpit instrument panel.

(2) TROUBLE SHOOTING.

(a) MANIFOLD PRESSURE INDICATOR TYPE D-9 AND D-10.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE ERROR AT EXISTING BAROMETRIC PRESSURE.	Pointer shifted.	Return to instrument maintenance activity to have pointer reset.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE ERROR WHEN ENGINE IS RUNNING	Line leak.	Tighten line connections.
SLUGGISH OR JERKY POINTER MOVEMENT.	Improper damping adjustment.	Adjust damping screw.
BROKEN OR LOOSE COVER GLASS.	Vibration. Excessive pressure.	Replace glass and reseat case.
DULL OR DISCOLORED LUMINOUS MARKINGS.	Age.	Replace instrument.
INCORRECT READING.	Moisture in line.	Open manifold pressure drain for short period at idling speed.

(b) TACHOMETER TYPE E-12.

Trouble	*Possible Cause*	*Remedy*
POINTER WON'T ZERO.	Maladjustment of adjusting screw.	Make correction with adjusting screw.
EXCESSIVE SCALE ERROR.	Weak magnets in generator.	Replace generator.
NO READING ON INDICATOR EITHER PERMANENT OR INTERMITTENT.	Break or short circuits in leads.	Repair.
	Poor connections at indicator or generator terminals.	Clean and tighten terminals.
	Break inside indicator or generator circuits.	Replace indicator or generator.
LOW READING ON INDICATOR EITHER PERMANENT OR INTERMITTENT.	Poor connections at indicator or generator terminals.	Clean and tighten terminals.
	Zero connector screw off adjustment on indicator.	Disconnect lead and reset pointer to zero.
	Defective indicator pivots.	Replace indicator.
HIGH READING ON INDICATOR EITHER PERMANENT OR INTERMITTENT.	Zero indicator screw off adjustment on indicator.	Disconnect lead and reset pointer to zero.
	Indicator resistance off adjustment.	Replace indicator.

(c) ENGINE GAGE UNIT TYPE B-7, FUEL PRESSURE.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE ERROR AT ZERO.	Pointer loose on shaft.	Reset pointer and calibrate.
	Excessive overpressure.	Reset pointer and calibrate.
EXCESSIVE SCALE ERROR.	Excessive pressure.	Calibrate and adjust.
	Excessive vibration.	Calibrate and adjust.
	Improper calibration adjustments.	Make proper adjustments.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE POINTER OSCILLATION.	Improper damping.	Disconnect line and drain; reconnect making sure there are no leaks. If trouble persists, work on relief valve.

(d) ENGINE GAGE UNIT TYPE B-7, OIL PRESSURE.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE ERROR AT ZERO.	Pointer loose on shaft. Excessive overpressures. Seasoning of Bourdon tube.	Return to instrument maintenance activity for calibration and adjustment.
EXCESSIVE SCALE ERROR.	Improper calibration adjustment.	Adjust and calibrate gage.
EXCESSIVE POINTER OSCILLATION.	Improper damping or rough relief valve.	Disconnect line and drain. Reconnect. Check for leaks. If trouble persists, clean and adjust relief valve.
SLUGGISH OPERATION OF POINTER OR PRESSURE FAILS TO BUILD UP.	Low temperature of fluid in line.	Drain line and refill.

(da) ENGINE GAGE UNIT TYPE AN5773-1, PRESSURE UNITS.

Trouble	*Possible Cause*	*Remedy*
POINTER DOES NOT REGISTER.	Pressure line plugged. Pressure line broken.	Remove foreign matter. Repair or replace.
POINTER FAILS TO RETURN TO "0".	Foreign matter in pressure line.	Remove foreign matter.
POINTER FAILS TO REGISTER FULL PRESSURE	Leak in pressure line. Out of calibration.	Repair line. Replace and return to depot.
UNIT DOES NOT REGISTER PROPERLY.	Faulty mechanical adjustment.	Replace and return to depot.

(e) ENGINE GAGE UNIT TYPE B-7, OIL TEMPERATURE.

Trouble	*Possible Cause*	*Remedy*
INSTRUMENT FAILS TO SHOW ANY READING.	Broken or damaged capillary.	Replace instrument.
EXCESSIVE SCALE ERROR.	Improper calibration adjustment.	Return to instrument maintenance activity for calibration and adjustment.
JERKY POINTER ACTION.	Progressive restrainer out of adjustment.	Return to instrument maintenance activity for calibration and adjustment.
POINTER FAILS TO MOVE AS ENGINE IS WARMED UP.	Broken or damaged capillary.	Replace instrument.
SLUGGISH POINTER MOVEMENT.	Restricted capillary.	Replace instrument.
DULL OR DISCOLORED LUMINOUS MARKINGS.	Age.	Replace instrument.

(ea) ENGINE GAGE UNIT TYPE AN5773-1, OIL TEMPERATURE.

Trouble	*Possible Cause*	*Remedy*
POINTER FAILS TO REGISTER.	Break in power leads. Break in indicator.	Replace. Replace and return to depot.
JERKY POINTER MOVEMENT.	Pointer touching dial or glass. Foreign matter on dial. Foreign matter between core and pole piece.	Straighten pointer. Clean dial. Return to depot.
POINTER FLUTTERS.	Broken lead wire making intermittent contact.	Locate breaks and repair lead.

(f) FUEL AIR MIXTURE INDICATOR TYPE A-7 AND B-5.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE ERROR AT MECHANICAL ZERO.	Pointer out of adjustment.	Make proper adjustment.

Trouble	*Possible Cause*	*Remedy*
INCORRECT READING.	Unbalanced resistance in junction box.	Make proper circuit adjustment.
	Unbalanced resistance in cell.	Make adjustment of electrical zero.
	Burnt out resistance in analysis cell.	Replace instrument.
FAILURE OF POINTER TO MOVE.	Broken electrical circuit.	Check continuity of wiring.
REVERSED READINGS.	Fouled filter or corroded cell.	Clean filter and leave current on with engine inoperative for thirty minutes.
	Reversed electrical connections.	Check electrical connections.

(g) CYLINDER TEMPERATURE INDICATOR TYPE B-9.

Trouble	*Possible Cause*	*Remedy*
FAILURE TO INDICATE CORRECT ENGINE TEMPERATURE.	Break in lead.	Replace.
	Break in thermocouple.	Replace.
	Break in indicator.	Replace and return indicator to depot.
LOW READING, EITHER PERMANENT OR INTERMITTENT.	Poor connection at thermocouple connectors.	Clean and tighten.
	Poor connection in the indicator.	Replace and return indicator to depot.
	Short circuit in leads.	Repair.
	Short circuit at thermocouple leads.	Replace thermacouple and leads.
	Short circuit at indicator binding posts.	Repair.
INSTRUMENT READING REVERSED.	Reverse leads at instrument.	Check connections.

(h) CARBURETOR MIXTURE TEMPERATURE INDICATOR TYPE F-9 AND AN5790-6.

Trouble	*Possible Cause*	*Remedy*
BROKEN OR LOOSE COVER GLASS.	Excessive vibration.	Return to overhaul depot.
DULL OR DISCOLORED LUMINOUS MARKINGS.	Age.	Replace instrument.

(3) MAINTENANCE.

(a) TACHOMETER SHAFT. — Nonmagnetic tachometer shafts, being constructed of nonferrous materials, must not be subjected to extreme loads due to improper lubrication or to faulty installation. Clean the shaft and the case thoroughly with solvent and compressed air, and lubricate LIGHTLY as directed in the Lubrication Chart, in section III of this Handbook. After lubrication, protect from dust and dirt until installed. Broken shafts are not reparable and must be replaced with new parts. Installation of shaft and casing is of primary importance in assuring satisfactory operation and should be accomplished as follows:

1. The assembled shaft and casing during handling must not be bent in a circle of less than *6 inches diameter at any time.*

2. When installing or handling, the shaft and casing should not be subjected to an end pull of *more than 15 pounds.*

3. The shaft should be installed so that all bends are in as large a radius as possible and in no case shall the bend be less than 6-inch diameter circle at any point. The amount of protrusion of the shaft from the casing will vary with the number of bends in one casing combination. As the number of bends is increased, the protrusion is increased.

4. When completely installed, the key end of the shaft should protrude beyond the face of the casing not less than 9/16 inch or more than 1¼ inches. If the protrusion is less than 9/16 inch, the casing has been subjected to excessive end pull. This condition can be corrected by loosening the casing from its points of attachment and recoiling it in approximately 16-inch diameter loops before reinstalling. If the protrusion is more than 1¼ inches, the casing may be lengthened by flexing and pulling along its lengths to eliminate small bends and kinks.

5. If the shaft assembly is removed from the casing for any reason, care must be taken when reassembling to keep the shaft and casing free of dirt. When assembling a shaft, straighten the casing so that the shaft and fitting may pass through freely.

6. After the shaft is in place and secured, and before connecting to the engine and tachometer, it should be tested for free rotation.

(b) FUEL-AIR RATIO ASSEMBLIES.—(Deleted on the AT-6F.)

1. Remove filter cover and filter. Clean filter with gasoline or benzine, Specification No. 4-1016. If benzine is used, follow by washing in water. Inspect inlet and outlet pipes and remove all obstructions to prevent stoppage of gas flow. Examine all joints for gas tightness.

CAUTION

Do *not* clean the filter chamber with compressed air as this may damage the resistance units in the cell block.

Keep cleaning fluid off ballast tube (current regulating tube) and ballast tube cover to prevent failure of the tube.

2. Clean the vent hole in the saturation plug by using .01-inch diameter steel music wire as a cleaner.

3. Clean the sampling lines. Repair or replace all cracked sampling lines.

4. Ascertain that all electrical connections are properly made and locked.

5. Check for proper voltage:

Type A-7 series (12-volt airplanes)—11.5 to 15 volts

Type B-5 series (24-volt airplanes)—23 to 28 volts

6. Check the ballast tubes. If the instrument fails to deflect or the calibration appears to be in error, check mechanical and electrical zero adjustment.

7. A slight disorder, such as water in the cell block, may be remedied by simply drying out the cell.

8. If the pointer is violently deflected to either end of the scale when the current is turned on, a short or open circuit is indicated.

e. MISCELLANEOUS INSTRUMENTS.

(1) DESCRIPTION. — *(See figure 184.)* — A type B-16 internally lighted compass is mounted on the instrument panel in each cockpit. The compass lights are individually controlled from each cockpit. A type B-21 standby compass is mounted on the front cockpit instrument panel of the AT-6F and is illuminated by the instrument lights. An 8-day clock is mounted on the instrument panel in each cockpit. An ammeter is mounted on the control panel in the front cockpit only. The 12-volt airplane also has a voltmeter mounted on this control panel. The hydraulic pressure gage is mounted on the hydraulic shelf at the left side of the front cockpit. On later airplanes a direct reading free air temperature indicator is located either on the forward left side of the cockpit or on one of the windshield panels. Twelve-volt airplanes are equipped with a temperature bulb-type indicator installed on the front cockpit instrument panel. Individually lighted fuel gages are installed at each side of the front cockpit seat on the right and left fuel tanks (figure 185). The fuel gage lights are controlled from either cockpit, and the gages are visible from either cockpit. A radio marker beacon indicating light is installed on the front cockpit instrument panel in the 24-volt airplane only and also on the rear panel of AT-6F models. (The 12-volt airplane does not have marker beacon equipment.) Twelve volt airplanes are equipped with a camera signal indicating light on the front cockpit instrument panel. A fuel switch-over signal indicating light is installed on the front cockpit instrument panel in both the 12- and 24-volt airplanes.

(2) TROUBLE SHOOTING.

(a) COMPASS TYPE B-16 OR B-21.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE CARD ERROR.	Compass not properly compensated.	Compensate instrument.
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
	Air in bowl.	Deairate the compass.
EXCESSIVE CARD OSCILLATION.	Insufficient liquid.	Refill bowl.
	Excessive vibration of instrument mounting panel.	Remove excessive vibration of instrument mounting panel.

Trouble	*Possible Cause*	*Remedy*
CARD ELEMENT NOT LEVEL.	Leaking float chamber.	Replace instrument.
	Card magnets detached from card.	Replace instrument.
CARD SLUGGISH.	Weak card magnets.	Replace instrument.
	Excessive pivot friction or broken jewel.	Replace instrument.
	Instrument heavily compensated.	Remove excessive compensation.
LIQUID LEAKAGE.	Loose bezel screws.	Replace instrument.
	Broken cover glass or case.	Replace instrument.
	Defective sealing gaskets.	Replace instrument.
DISCOLORED LUMINOUS MARKINGS OR DAMPING LIQUID.	Age.	Replace instrument.
DEFECTIVE LIGHT.	Burnt out lamp or broken circuit.	Replace lamp. Check continuity of wiring.

(b) HYDRAULIC PRESSURE GAGE TYPE E-4.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE ERROR AT ZERO.	Pointer loose on shaft.	Return to instrument maintenance activity for calibration and adjustment.
	Excessive overpressure.	Return to instrument maintenance activity for calibration and adjustment.
	Seasoning of Bourdon tube.	Return to instrument maintenance activity for calibration and adjustment.
EXCESSIVE POINTER OSCILLATION.	Improper damping.	Disconnect line to instrument and drain. Reconnect line and make sure there are no leaks.
EXCESSIVE SCALE ERROR.	Improper calibration.	Return to instrument maintenance activity for calibration and adjustment.

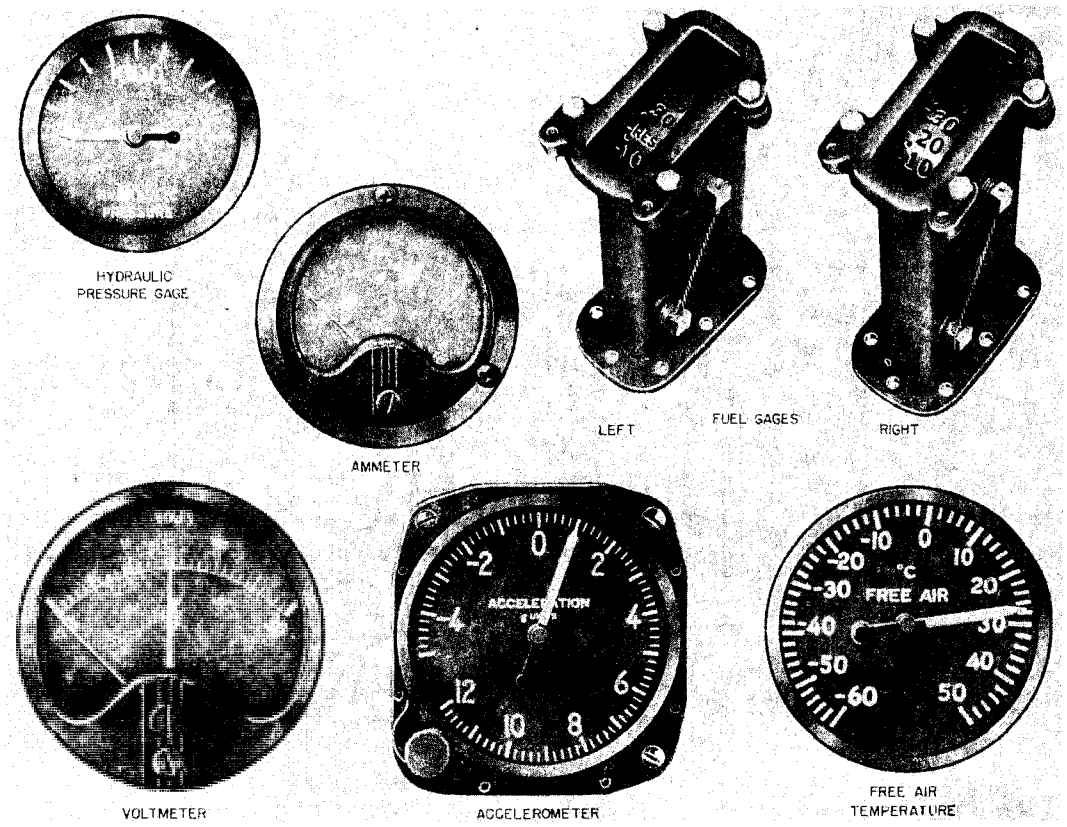


Figure 184 — Miscellaneous Instruments

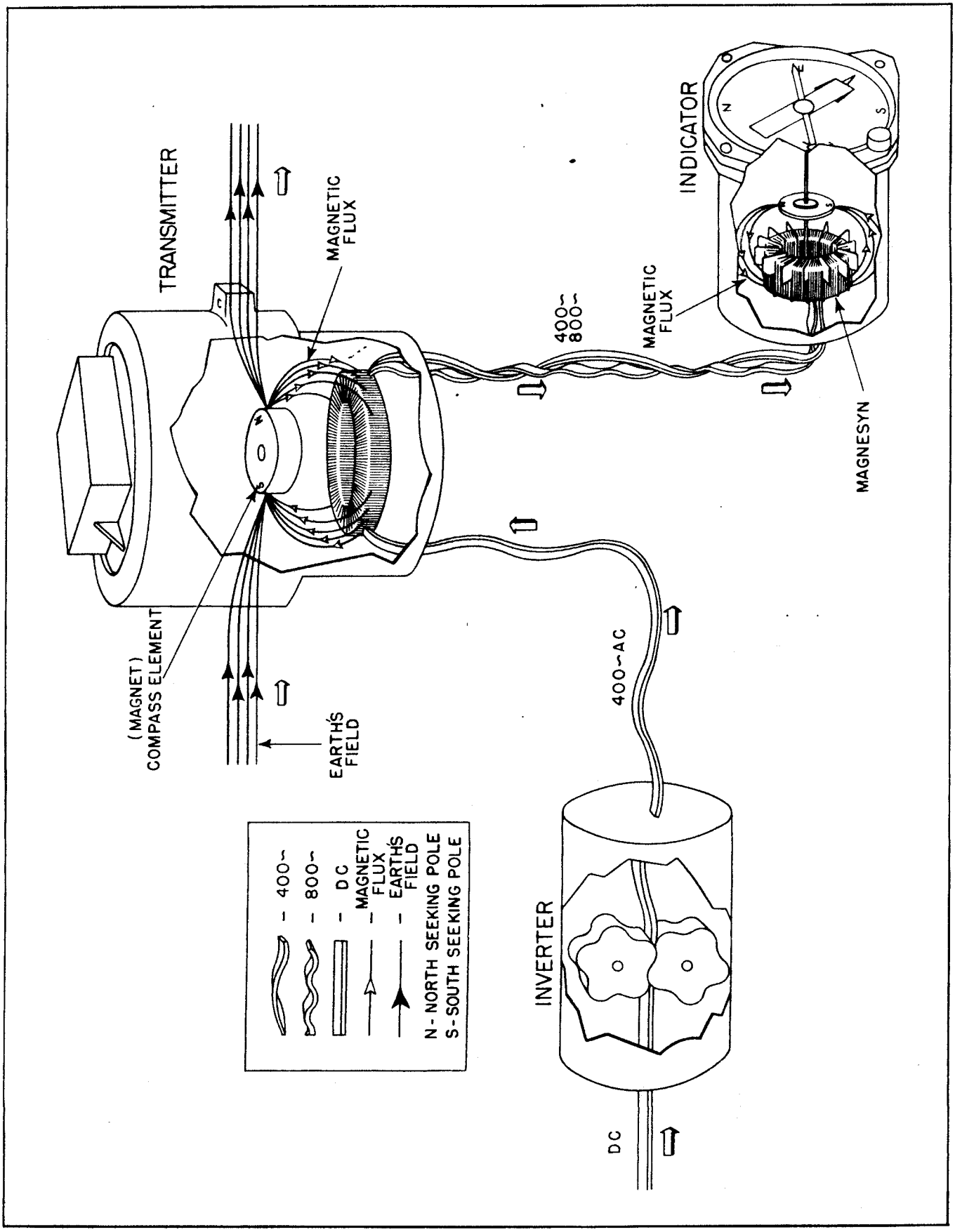


Figure 184A — Magnesyn Compass

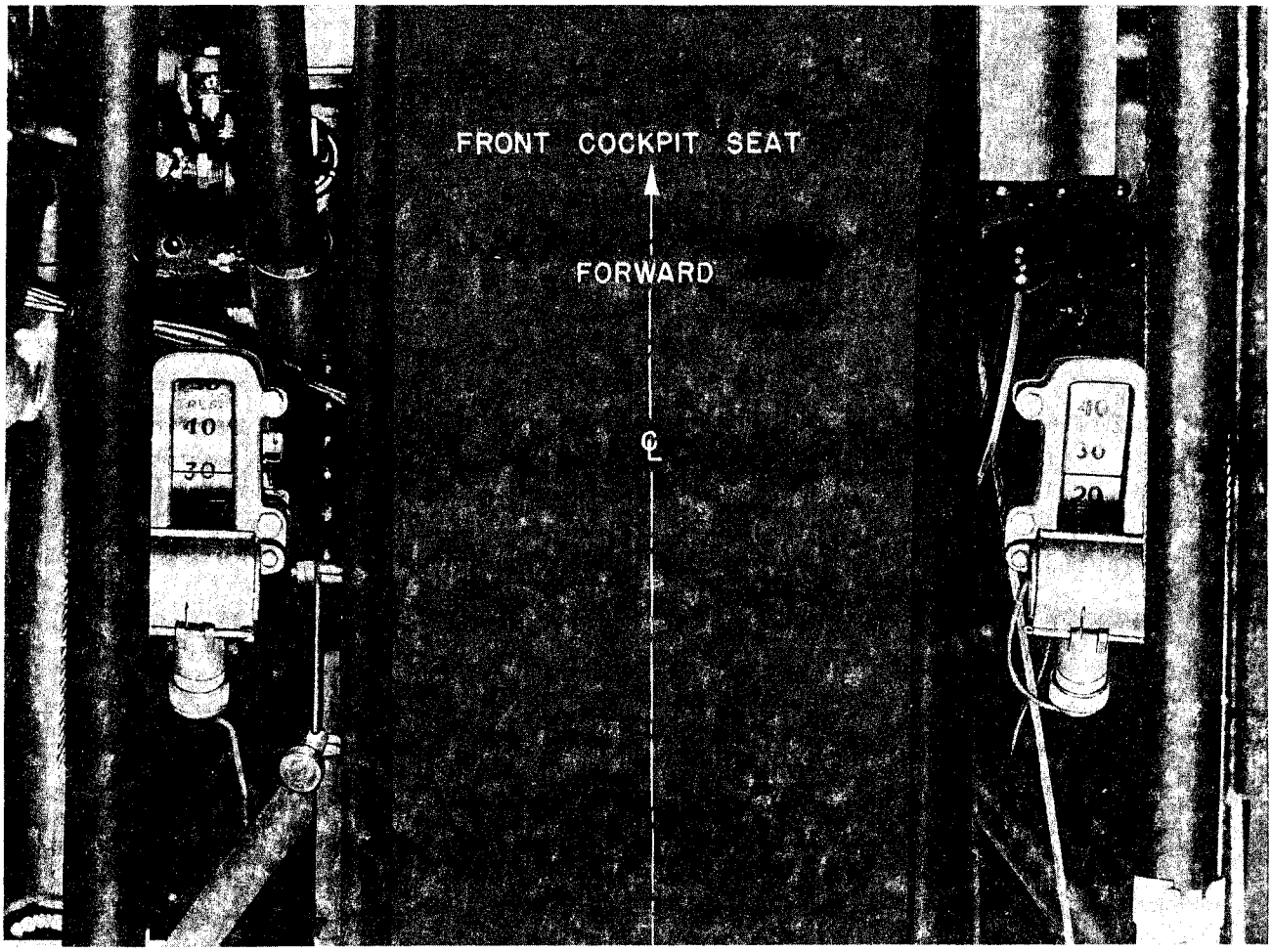


Figure 185 — Fuel Tank Gages

(3) DRIFT METER INSTALLATION. — Before installing the drift meter in the airplane, remove the fuselage opening plug by pulling on the handle located on the face of the plug. Depress with fingers the tension spring in the end of each channel rail, and slide the meter onto the rails provided for it. The detent (guide pin) in the center of each rail will drop into alignment hole when the meter is correctly positioned.

f. MAGNESYN COMPASS SYSTEM.

(1) GENERAL.—*(See figure 184A.)*—The remote reading magnesyn compass system is installed to provide indicator readings least influenced by local magnetic disturbances. The system incorporates a transmitter, two indicators, and an inverter, powered by the main electrical system. The transmitter is located in the rear fuselage aft of station 179.5 and is away from the bulk of magnetic materials of the airplanes. The indicators are located on the front and rear instrument panels and are lighted by the instrument lights. The inverter is located on the bulkhead at station 106.5, and changes the 24-volt dc to 26-volt, 400-cycle ac to transmit the magnetic indications from the transmitter to the indicators and show the magnetic heading of the airplane.

(2) TRANSMITTER (Type AN 5730-3)

(a) DESCRIPTION.

1. The float assembly is immersed in compass fluid and contains the directive magnet which is the compass element.

2. The flux gate assembly or transmitter coil consists of a toroidal winding wound on a circular laminated core and is located directly beneath the float assembly.

3. Compensation is accomplished by means of a "polyplane compensator" located on top of the transmitter housing.

(b) LOCATION.

1. The transmitter is located in the upper part of the rear fuselage aft of station 179.5.

2. The transmitter is mounted so that the plane of the mounting lugs is horizontal in normal level flight. The arrow on the compensator housing must point forward. Fine adjustments in alignment may be made by rotating the unit in its mounting slots.

3. The transmitter is connected to its lead wires by an AN standard plug at the lower front part of the unit.

(c) TROUBLE SHOOTING.

Trouble	*Possible Cause*	*Remedy*
SWIRL OF LIQUID GIVING ERRATIC INDICATION.	Not enough liquid in the bowl.	Replace the transmitter and forward it to the overhaul depot.
LEAKAGE OF COMPASS LIQUID.	Leaky gaskets.	Replace the transmitter and forward it to the overhaul depot.
COMPENSATOR DOES NOT HAVE SUFFICIENT COMPENSATING EFFECT.	Weak compensation magnets.	Replace with another indicator until condition is corrected by trial and error method.

(3) INDICATOR. (Type AN5730-2A)

(a) DESCRIPTION.

1. The cover assembly is a rigid, dust-tight cover for the component parts of the indicator and is attached to the case or housing assembly which is furnished with self-locking nuts in the mounting lugs so that the indicator can readily be mounted on a panel.

2. In the dial and pointer assembly the dial is marked in luminous two-degree graduations. The hand assembly is attached to the end of the rotor shaft. A course setting pointer is operated by an external adjusting knob.

3. The receiving magnesyn consists of a permanent magnet rotor, a stator assembly, and a return path for the magnetic flux of the rotor magnet. A shield around the magnesyn unit is provided to minimize the effect of any stray magnetic fields. On later models, a front shield is provided over the magnesyn case cover.

(b) LOCATION.

1. Magnesyn remote compass indicators are installed on both instrument panels of the AT-6F and a type B-21 standby compass is installed on the front panel only.

2. Indicators are front mounted to the panels and are held in place by three screws.

3. The indicator outside electrical connector is an AN standard type receptacle located on the rear part of the cover assembly.

(c) TROUBLE SHOOTING.

Trouble	*Possible Cause*	*Remedy*
EXCESSIVE OSCILLATION WHEN AT LEAST TWO INDICATORS ARE USED.	Incorrect combination of indicators.	Replace with another indicator until condition is corrected by trial and error method.
ERRATIC INDICATION.	Loose pointer.	Replace the indicator and forward it to overhaul depot.
SLUGGISH INDICATION.	Dirty jewels or pivots.	Replace the indicator and forward it to overhaul depot.

(4) INVERTER (Type AN5730-4.—The inverter, located in the center of the left forward side of the bulkhead at station 106-31/32 is base-mounted with No. 10 screws and has an AN standard electrical receptacle.

11. SURFACE CONTROLS.

a. DESCRIPTION.—A complete set of controls is installed in each cockpit for operating the ailerons, rudder, elevator assembly, and trim tabs.

(1) CONTROL STICKS.—Control sticks (aluminum-alloy tube, or hickory on some later airplanes) are located in the conventional position in each cockpit and are mounted on an aluminum-alloy torque tube horn assembly. Adjustable stops for the ailerons are provided on the torque tube horn assembly to limit the side movement of the sticks. Fore-and-aft movement of the control sticks, controlling the UP and DOWN movement of the elevator, is limited by an adjustable stop on either side of the aileron torque tube. (See figure 186.) Both sticks are connected by a push-pull rod passing through the aileron torque tube. A trigger-type electrical switch for firing machine guns is provided in the front of the handle on the front control stick while a push-type electrical button switch for releasing the bombs is centered in the top of this handle. The rear cockpit control stick may be removed by pulling aft on the lock plunger button at the base of the stick and may be locked in the stowed position at the left side of the cockpit by the same device. (See figure 187.)

CAUTION

Make certain the rear control stick is locked in the STOWED POSITION when not in use.

(2) RUDDER PEDALS.—*(See figure 188.)*—Rudder control is obtained by rudder pedals located in the conventional position in each cockpit. They are connected with the rudder by cables. The steerable tail wheel cables are interconnected with the rudder cables by idler arms in the rear of the fuselage. The front

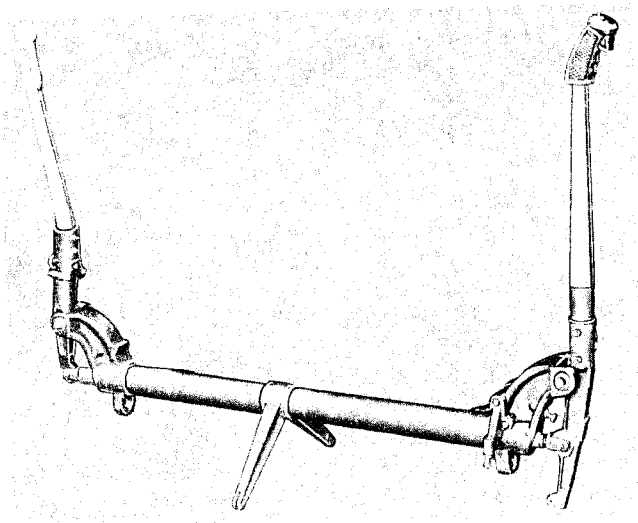


Figure 186 — Control Stick Torque Tube Assembly

and rear rudder pedal assemblies obtain a common balance through a rudder balance cable which, passing around two pulleys, connects both pedals of the rear assembly. Balance of the rear pedals thus achieved is transmitted to the front pedals by connecting tubes. The tubes, attached to the outboard side of the pedals, unite the respective right and left pedals of the front and rear pedal assemblies and provide an adjustment means to compensate for the pilot's leg length. This latter function is accomplished by a series of holes, the attachment points beginning at either end of the connecting tubes and extending a few inches along their length. By moving the point of attachment, the rudder pedals can be adjusted as desired. The pedals should be adjusted for proper leg length and the pedals checked to ascertain that they are adjusted so the pilot can easily maintain full rudder throw, especially when recovering from a spin. Adjustable stops are provided

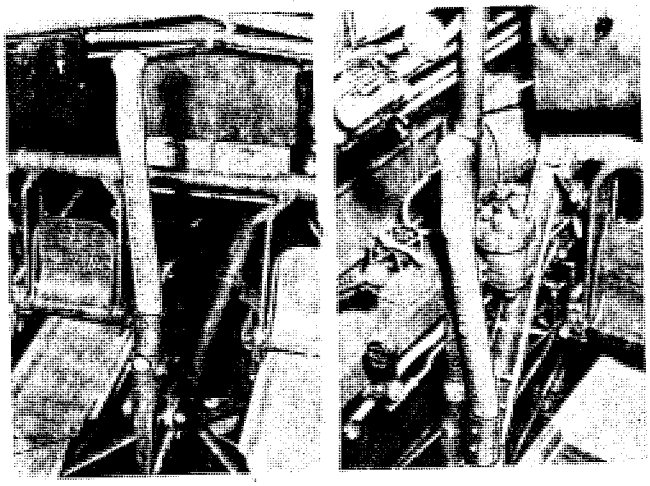


Figure 187 — Rear Cockpit Control Stick — Locked and Stowed Positions

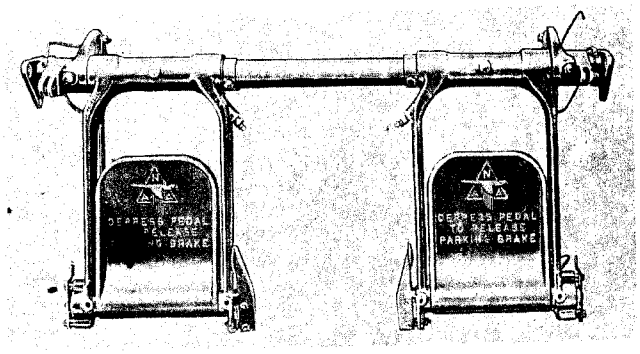


Figure 188 — Rudder Pedal Assembly

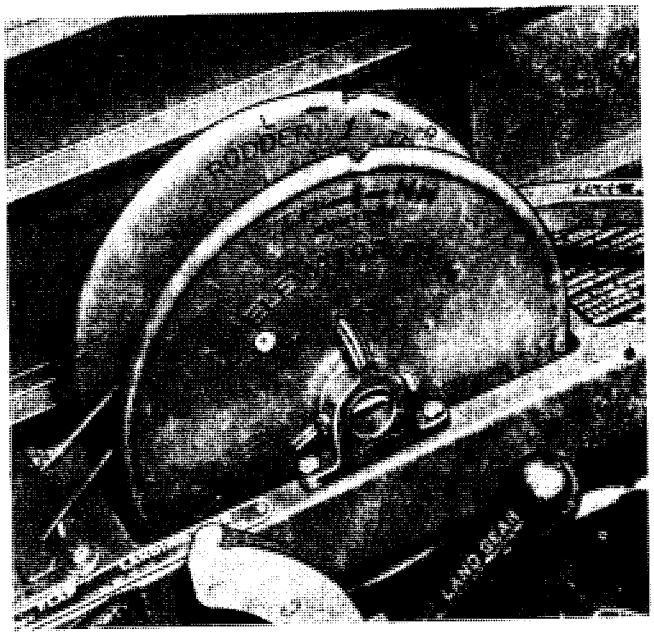


Figure 189 — Trim Tab Controls — Front Cockpit

on either side of the lower rudder hinge support fitting on the vertical stabilizer rear spar to limit rudder movement. Brake control pedals are incorporated in the rudder pedal assemblies.

(3) TRIM TAB CONTROLS.—*(See figure 189.)* —The aileron trim tabs, or the booster tabs installed on earlier airplanes, must be adjusted manually with the airplane on the ground. Elevator and rudder trim tabs are controlled by a system of cables and pulleys actuated by control wheels located at the left side of each cockpit. Trim tab control cables are connected with the trim tabs by means of a drum and tab operating mechanism located in the leading edge of each of the respective control surfaces. The tab mechanism is connected with the tab by a threaded push-pull rod assembly. Stops are provided on the control wheels in both cockpits. Neutral marks on control wheels when lined up vertically, locate the tabs in a NEUTRAL position. The tabs should be adjusted as required to obtain directional and longitudinal trim of the airplane. Clockwise or counterclockwise rotation of

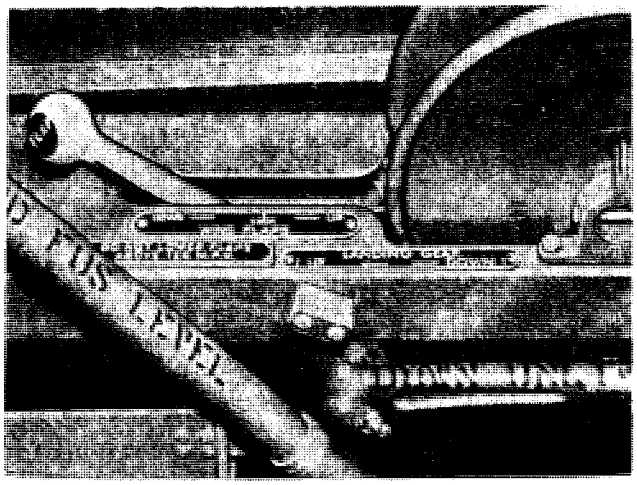


Figure 190 — Flap Control

the outboard wheel controlling the rudder tab compensates for directional instability to the left or right respectively. Clockwise or counterclockwise rotation of the inboard wheel which controls elevator tabs compensates for an existing tail-heavy or nose-heavy condition respectively.

(4) FLAP CONTROLS.—*(See figure 190.)*—The split-type wing flaps are hydraulically operated. A flap control handle is mounted on the control shelf at the left side of each cockpit. The controls are interconnected with a hydraulic selector valve. The UP position of the flap control handle selects the UP position of the flaps and the DOWN position selects the DOWN position. The center LOCK position is used when it is desired to stop the flaps at any intermediate position between UP and DOWN. A flap position indicator is located at the left side of the front cockpit on the control shelf. (See figure 191.) In later airplanes, slight changes have been made in the rudder and aileron control systems to improve the spin characteristics of the airplane. Details of the wing flap hydraulic system are contained in section IV, paragraph 12.

(5) SURFACE CONTROL LOCK.—*(See figure 192.)*—The surface control locking mechanism located left and forward of the control stick in the front cockpit locks the entire surface control system. To do this, place the rudder pedals in NEUTRAL, push the control stick forward, and center it laterally. Pull up and back on the lock handle assembly and engage the control stick in the lock recess; then engage the handle plunger in the locked position. To release, push forward on the control handle; then push the lock mechanism forward into the stowed position. The lock mechanism should be stowed in the locked down position when not engaged with the control stick.

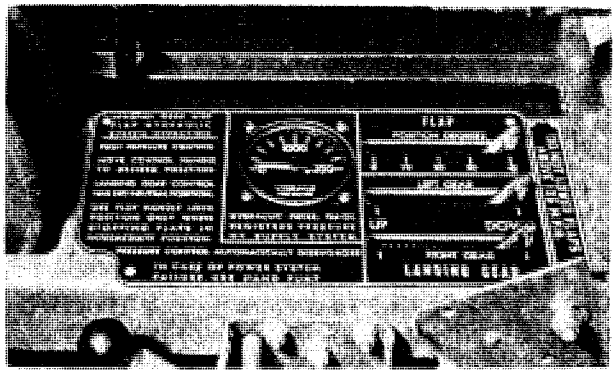


Figure 191 — Flap Position Indicator

CONTROL CABLE CHART

Cable Location	*Reqd. No.*	*NAA Dwg. No.*	*Cable Dia.*	*Length in Inches (C/L of Fitting)*		*End Fittings*
Rudder Control—Rear RH	1	88-52460-3	1/8	63-3/8	AN668-4	NAF310621-S21D-4LH
	1	*77-52460	1/8	63-5/32	NAF310621B-4	NAF310621-S21D-4LH
Rudder Control—Rear LH	1	88-52460-2	1/8	63-11/16	AN668-4	NAF310621-S21D-4LH
	1	*66-52460	1/8	63-27/32	NAF310621B-4	NAF310621-S21D-4LH
Rudder Control—Intermediate RH	1	88-52479	1/8	56-11/16	NAF310621B-4	NAF310621-S21D-4RH
Rudder Control—Intermediate LH	1	88-52477	1/8	83-5/8	NAF310621B-4	NAF310621-S21D-4RH
Rudder Control—Front RH	1	88-52490	1/8	106-7/16	AN668-4	NAF310621-S21D-4LH
	1	*88-52478	1/8	107-7/16	NAF310621B-4	NAF310621-S21D-4LH
Rudder Control—Front LH	1	88-52491	1/8	79-17/32	AN668-4	NAF310621-S21D-4RH
	1	*88-52476	1/8	80-17/32	NAF310621B-4	NAF310621-S21D-4LH
Rudder Balance	1	88-52461	3/32	112-7/16	AN668-3	AN669-53LH 23-52464 (Nut) 23-52453 (Screw)
	1	*66-52461	3/32	111-9/16	NAF310621B-3	NAF310621-S16D-3LH 23-52464 (Nut) 23-52453 (Screw)
Rudder Trim—Rear	1	66-52538-5	1/16	197-7/8	1T2-L	AN168-2
Rudder Trim—Intermediate Upper	*1	88-52562-0	1/16	56-31/32	1T2-R	NAF310621-8D-2RH
Rudder Trim—Intermediate Upper	1	88-52562-4	1/16	57-11/32	1T2-R	NAF310621-8D-2RH
Rudder Trim—Intermediate Lower	*1	88-52563-0	1/16	66-15/16	1T2-R	NAF310621-8D-2LH
Rudder Trim—Intermediate Lower	1	88-52563-4	1/16	67-3/8	1T2-R	NAF310621-8D-2LH
Rudder Trim—Front	1	88-52561	1/16	218-17/32	AN669-8D-2LH	AN669-8D-2RH
Elevator Control—Rear	2	77-52219	1/8	45-19/32	NAF310621B-4	NAF310621-S21D-4LH

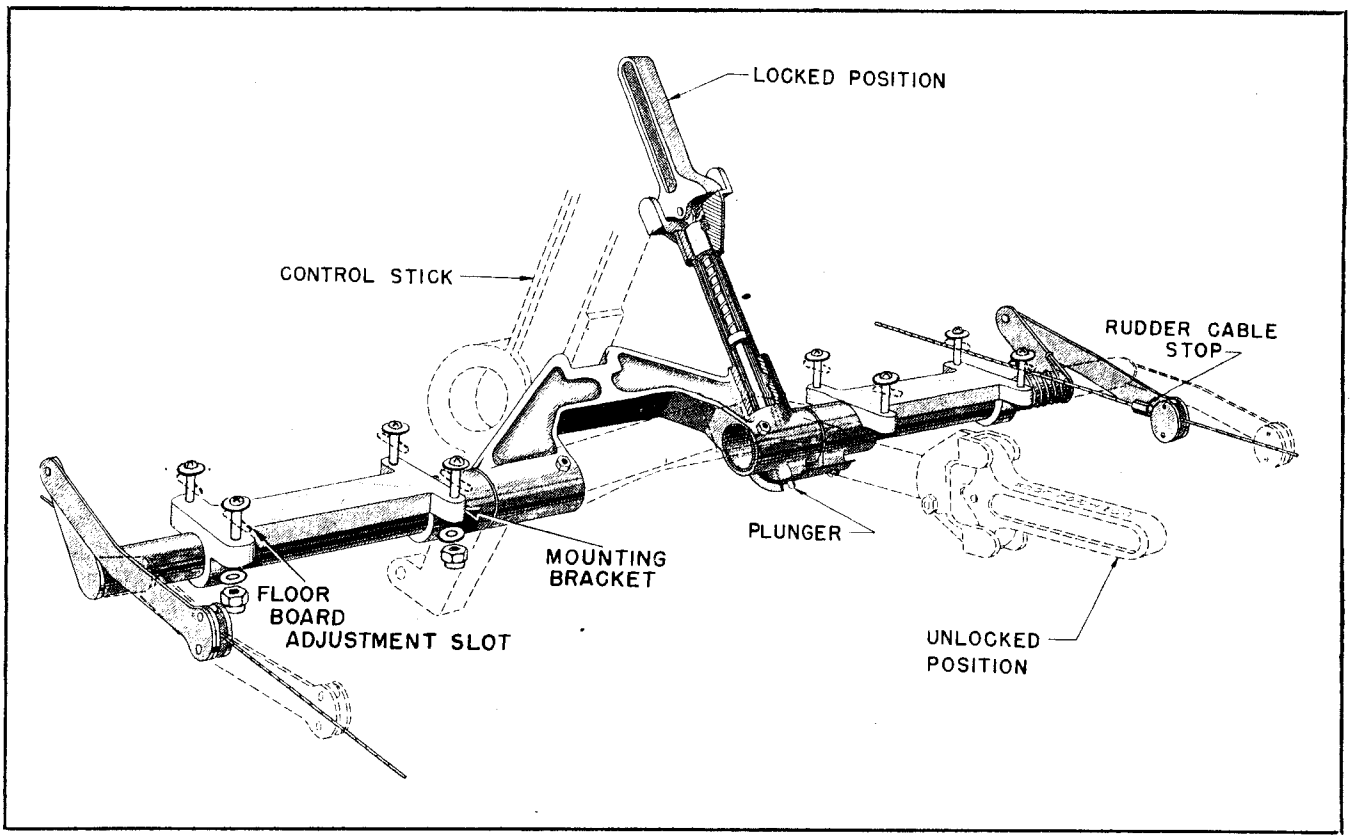


Figure 192 — Surface Control Lock Assembly

CONTROL CABLE CHART

Cable Location	*Reqd. No.*	*NAA Dwg. No.*	*Cable Dia.*	*Length in Inches (C/L of Fitting)*	*End Fittings*	
Elevator Control—Intermediate Upper	1	88-52229	1/8	93-13/32	NAF310621-S21D-4LH	NAF310621-S21D-4RH
Elevator Control—Intermediate Lower	1	88-52226	1/8	102-7/16	NAF310621-S21D-4RH	NAF310621-S21D-4RH
Elevator Control—Front Upper	1	88-52228	1/8	78-25/32	NAF310621B-4	NAF310621-S21D-4RH
Elevator Control—Front Lower	1	88-52227	1/8	111-1/2	NAF310621B-4	NAF310621-S21D-4LH
Elevator Trim—Rear	1	66-52527-5	1/16	233-7/8	1T2-L	AN668-2
Elevator Trim—Intermediate Upper	1	88-52565	1/16	39-5/64	NAF310621C-2	NAF310621-8D-2LH
Elevator Trim—Intermediate Lower	1	88-52566	1/16	33-27/64	AN667-2	AN669-2
Elevator Trim—Front	1	88-52564	1/16	231-1/2	AN669-8D-2LH	AN669-8D-2RH
Aileron Control—Outer Wing Rear	2	88-52313	1/8	76-3/32	AN668-4	NAF310621-S21D-4LH
	2	*66-52313	1/8	69-15/32	AN668-4	NAF310621-S21D-4LH
Aileron Control—Outer Wing Front	2	88-52312	1/8	75-5/32	AN668-4	NAF310621-S21D-4LH
	2	*66-52312	1/8	67-21/32	AN668-B-4	NAF310621-S21D-4LH
Aileron Control Wing Center Section—Rear	2	66-52311	1/8	90-5/32	1T1-4	NAF310621-S21D-4RH
Aileron Control Wing Center Section—Front	2	66-52310-5	1/8	92-13/32	1T1-4	NAF310621-S21D-4RH
	2	66-52310	1/8	92-9/16	1T1-4	NAF310621-S21D-4RH
Flap Position Indicator	1	55-52629	1/16	77-7/16	AC066135	AN665-21R
Tail Wheel Control—RH	1	88-34160-5	5/32	40-1/8	AN667-5	AN669-S5LH
Tail Wheel Control—LH	1	88-34160-4	5/32	39-3/4	AN667-5	AN669-S5LH
	2	*66-34012	5/32	33-5/32	NAF310621B-5	NAF310621-S32D-5LH
Manual Starter Engaging Control	1	88-45041	1/16	24-3/8	77-45039	77-45042
Parking Brake	1	77-33450	1/16	25-15/16	NAF310621B-2	AC 066135
Rear Brake—Rear Rudder to Master Brake Cylinder	2	66-33476-3	5/32	72-11/32	AN668-5	AN669-S5-RH
Front Brake—Front Rudder Pedal Master Brake Cylinder	2	66-33477	5/32	12-5/8	NAF310621B-5	NAF310621B-5
Instrument Flying Hood Release Latch—Front	1	58-73012	1/16	48-3/4	AN665-21R	1T5
Instrument Flying Hood Release Latch—Rear	1	59-73034	1/16	85-3/8	AN665-21R	1T5
Landing Gear Position Indicator—LH	1	36-33562-2	1/16	53	AC 066135	AN665-21R
Landing Gear Position Indicator—RH	1	36-33562-3	1/16	88-3/8	AC 066135	AN665-21R

**Used on earlier airplanes.*

(6) BEARINGS.—Sealed-type ball bearings are incorporated in all pulleys, bell cranks and control surface hinge points with the exception of wooden trim tabs which utilize Ledaloyl self-lubricating hinge bearings.

(7) CABLES.—All primary surface control cables are 1/8 inch diameter, with the exception of the rudder pedal equalizer cable which is 3/32 inch diameter. All trim tab control cables are 1/16 inch diameter.

b. MAINTENANCE REPAIRS.

(1) MINOR DAMAGE.—When broken wires are found in the cables of the trim tab control system or the main control system, where such breakages occur in that length of cable normally passing over a pulley or through a fairlead, they should be cut off short and soldered to the cable.

(2) CABLE REPLACEMENT.

(a) Aircraft control cables, 7 strands of 19 wires each, that are found to be frayed (individual wires broken) will be considered serviceable unless there are more than six wires broken in any 1 inch length of cable. The number of broken wires will be noted, particularly where the cables pass over pulleys or guides. Only those with broken wires in excess of the number specified in any 1 inch length need be replaced. Wherever possible, therefore, duplicate spare cables should be utilized for replacements. No difficulty should be experienced when installing control cables in the field. It is impractical to swage a replacement cable and for this reason they are manufactured with one end swaged while the other end is unfinished except for a drop of solder to keep the strands from fraying. When the cable is to be installed, the unfinished end is threaded through drum holes, pulleys, fair-leads, etc., as the case may be, while the swaged end is secured to its proper connection. The opposite end, before being connected, is fitted with the proper size bearing and the cable end secured around the latter by splicing and soldering. Whenever possible, use the bearing from the replaced cable to finish the raw end of the new one. Secure the bearing by splicing and soldering in the manner the bearing was secured to the old cable.

(b) The ends of rudder and elevator trim tab drum cables should be equidistant from their respective drums before either end is connected to fuselage cables. Drops of solder should be applied to the cables at the inside of the drum holes to keep them from slipping on the drums. Following this operation the trim tab cables are wrapped around the drums and passed into the fuselage for the proper connection.

(c) All cables and splices should be tested for proper strength prior to installation. They should be arranged to simulate installation, including pulleys where required and gradually tested by applying a load to one end of the cable for a period of 3 minutes. A suitable guard should be placed over the cable while it is being tested to prevent personal injury in the event of cable failure. The test load should be applied to cables as follows:

Cable size	Load in Pounds
1/16	300
3/32	550
1/8	1150
5/32	1550

(3) COLOR MARKINGS.—*(See figure 193.)*—To facilitate rigging and adjustment procedure, color markings for cables, cranks, and horns should be used to identify control cables and horns or arms to which they are attached. The width of each color in the marking band should be 1/2 inch. Cables may be banded with cellulose tape in appropriate colors and coated with clear lacquer approximately 1/2 inch behind each wrap. Horns and arms should be banded with lacquer in appropriate colors approximately 1/2 inch below the fork to which cables attach.

NOTE

Band at both sides of all turnbuckles.

(4) RUST PREVENTION.

(a) On airplanes operating from extremely dusty landing fields or through dusty (desert) areas, control cables will be thoroughly cleaned where they pass over pulleys, or through fair-leads, and at other points of contact throughout the airplane, and will not be coated with lubricant or rust-preventive compound.

(b) In coastal or insular areas where conditions are conducive to corrosion, clean cables at points of contact and coat with rust-preventive compound, Specification No. AN-C-52.

c. RIGGING AND ADJUSTMENT.

NOTE

After performing any cable rigging operation, always ascertain that the cables are not crossed. Make a complete check for any other obstacle to proper cable operation.

(1) GENERAL.

(a) It is to be noted that control cable tensions will vary considerably with changes of air temperature. Cable tensions should be checked more frequently where these conditions are encountered and adjusted to compensate for the temperature changes. Cables should be rigged to the proper tension when the air temperature is as close as possible to the temperature at which the airplane is to be flown and is uniform for the whole airplane; that is, when one side of the airplane is not exposed to the hot sun. A tension tolerance of plus or minus 5 pounds is all that is permissible.

NOTE

Accurate cable tension is insured through the use of a cable tension indicator. (See figure 194.) Cable tension indicators are individually calibrated and provided with a conversion chart for converting the dial readings to pounds tension.

Control Cable	*Color Band*
AILERONS	
Cockpit—Left Horn on Torque Tube	
Cockpit—Right Horn on Torque Tube	
*Left Wing Bell Crank—Front Cable	
*Left Wing Bell Crank—Rear Cable	
*Right Wing Bell Crank—Front Cable	
*Right Wing Bell Crank—Rear Cable	
ELEVATORS	
Control Stick Socket (Front)	
Control Stick Socket (Rear)	
Lower Horn (Nose Down)	
Upper Horn (Nose Up)	
ELEVATOR TRIM TABS	
Forward Cable (Referred to Cockpit Drum)	
Rear Cable (Referred to Cockpit Drum)	
RUDDER	
Left Horn (at Rudder)	
Right Horn (at Rudder)	
RUDDER TRIM TABS	
Forward Cable (Referred to Cockpit Drum)	
Rear Cable (Referred to Cockpit Drum)	
TAIL WHEEL	
Left Horn (at Cable)	
Right Horn (at Cable)	

*This cable color band coding is also used on later airplanes equipped with quadrants.

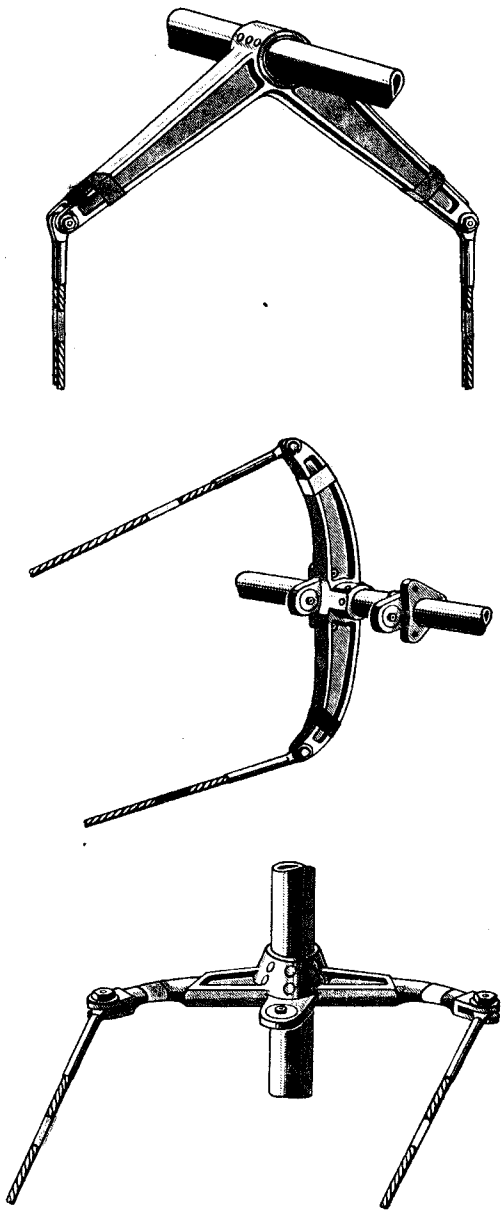


Figure 193 — Control Cable Color Band Chart

(b) Turnbuckle terminals shall have not more than three threads exposed at either end. All turnbuckles should be safetied with four to six turns of .040 inch zinc coated steel wire, or annealed corrosion-resisting (stainless) steel wire. The adjustable rods and fittings are provided with safety holes. The threads of the adjustments must completely cover these holes in order to maintain the thread safety factor of the adjustment.

(c) Cable tensions are as follows:

Cable	*Tension in Pounds*
Elevator	45
Elevator trim tabs	10
Rudder	55
Tail wheel	17 to 20
Rudder trim tab	10
Aileron	45

Note

Cable tensions given are for rigging at an ambient temperature of 70° Fahrenheit.

(2) RUDDER CONTROLS.

(a) GENERAL.— *(See figure 195.)*—The rudder and tail wheel steering control system used on early model airplanes is entirely different from the system used on late model airplanes; consequently a different rigging procedure must be employed in the adjustment of each individual system. The specified rudder throw, cable tension, and position of rudder pedals and cable idler arms vary in the two systems.

CAUTION

Since the adjustment of the rudder control system has a direct bearing on the adjustment of the tail wheel steering mechanism and vice

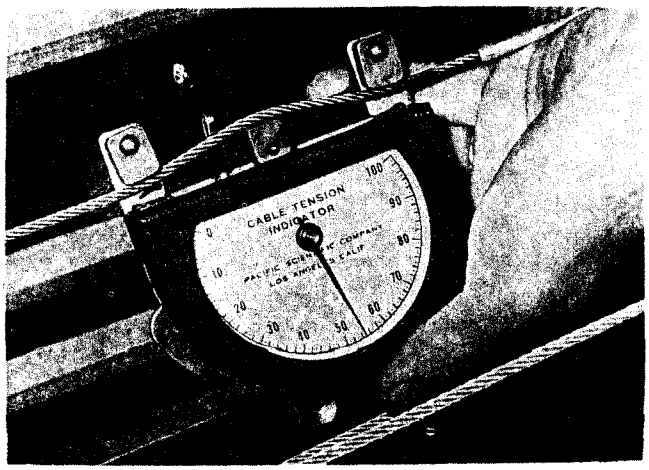


Figure 194—Cable Tension Adjustment With Tensiometer

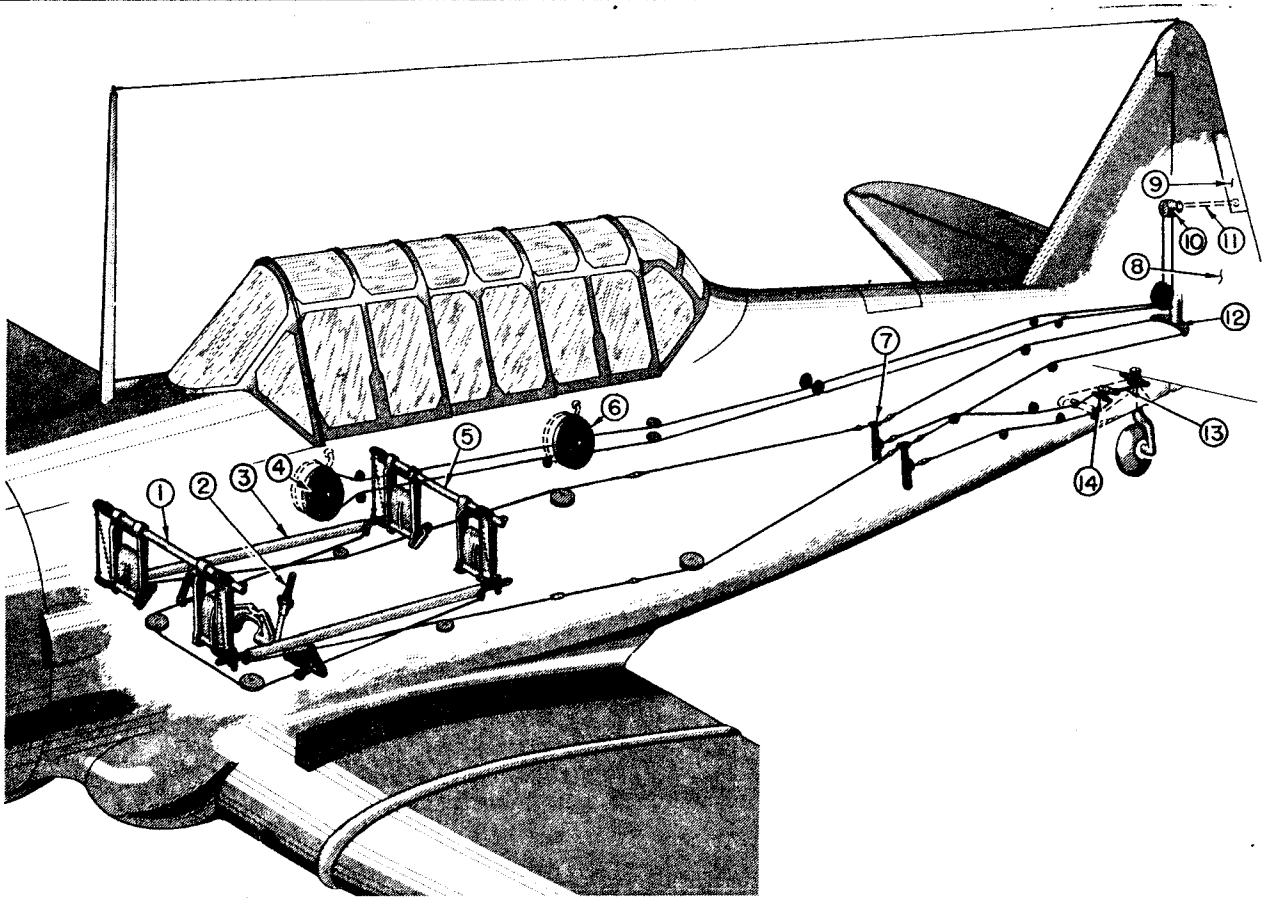
versa, it is essential that the two systems be rigged simultaneously.

(b) RIGGING PROCEDURE FOR EARLY MODEL AIRPLANES (AT-6, AT-6A, B, C (EARLY), SNJ-3, AND 4 (EARLY).)

1. Jack the aft end of the fuselage so that the tail wheel is clear of the ground.

2. Position both front rudder forks in the center hole in the forward end of the rudder connect bar (A, figure 196).

3. Place a suitable bar across the aft side of both front rudder pedal forks so that it is held in position by the rudder pedal adjustment lever. This bar positions both rudder pedal forks so that they are exactly even (B, figure 196).



1. Front Rudder Pedal Assembly
2. Surface Control Lock
3. Rudder Pedal Connecting Tube
4. Front Trim Tab Control Wheel
5. Rear Rudder Pedal Assembly
6. Rear Trim Tab Control Wheel
7. Rudder Cable Idler Arm
8. Rudder
9. Rudder Trim Tab
10. Trim Tab Drum
11. Trim Tab Push-Pull Rod
12. Rudder Horn
13. Bell Crank Linking Rod
14. Bell Crank Assembly
15. Deleted

Figure 195—Rudder Control System

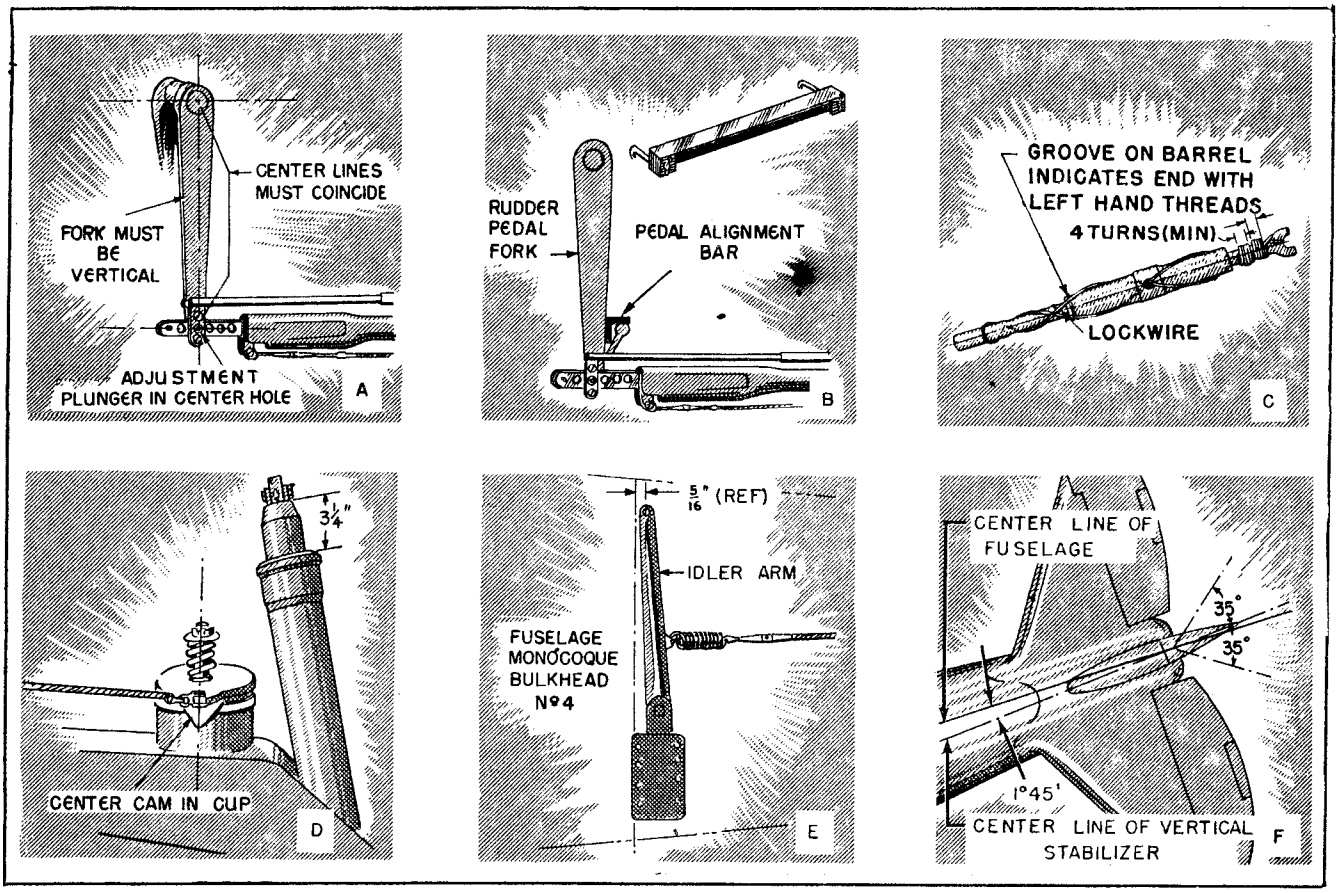


Figure 196—Rudder and Tail Wheel Rigging Procedure for Early Model Airplanes

4. Move the rudder pedal forks forward or backward until they reach the neutral or vertical position, so that the center line of the rudder pedal fork support tube coincides with the center line of the rudder pedal adjustment plunger.

5. Join the ends of the rudder balance cable at turnbuckle and leave from 0 to 3 threads showing after safetying (C, figure 196).

6. With the tail wheel assembly in the "UP" position so that a dimension of 3-¼ inches exists between the top of the tail wheel shock strut piston and the top of the strut cylinder cap (D, figure 196), take up or let out on the rudder cable turnbuckles forward of the idler arms until a tension of 55 pounds is obtained on the rudder cables forward and aft of the idler arms. The tail wheel cables must be slack while the rudder cables are being rigged.

7. With the tail wheel assembly in the "UP" position as described above, and the tail wheel in direct alignment with the fuselage center line and locked, adjust both tail wheel cable turnbuckles so that an even tension of approximately 20 pounds is acting on both cables. A tension tolerance of plus or minus 5 pounds is permissible on the rudder and tail wheel cables after the rigging procedure has been completed.

8. Let out and take up equal amounts on the aft rudder and tail wheel cable turnbuckles in order to position the rudder and tail wheel in direct alignment with the fuselage center line. The tension on the rudder and tail wheel cables should be rechecked to see that the limits specified above have been maintained. Both idler arms should be tilted slightly forward so that the center lines of the rudder cable clevis bolts in the upper ends of the idler arms are approximately 5/16 inch aft of the center line of bulkhead No. 4, when the rudder is in the neutral position (E, figure 196).

IMPORTANT

The tail wheel must still remain locked and aligned with the fuselage center line after above adjustment has been made.

9. Remove alignment bar from the front rudder pedal forks, place a protractor device on the rudder and establish the angular movement of 35 degrees to the right and left of the vertical stabilizer center line (F, figure 196) by means of stops located on the extensions at the bottom of the vertical stabilizer rear spar. A tolerance of plus or minus ½ degree is permissible in the specified rudder throw.

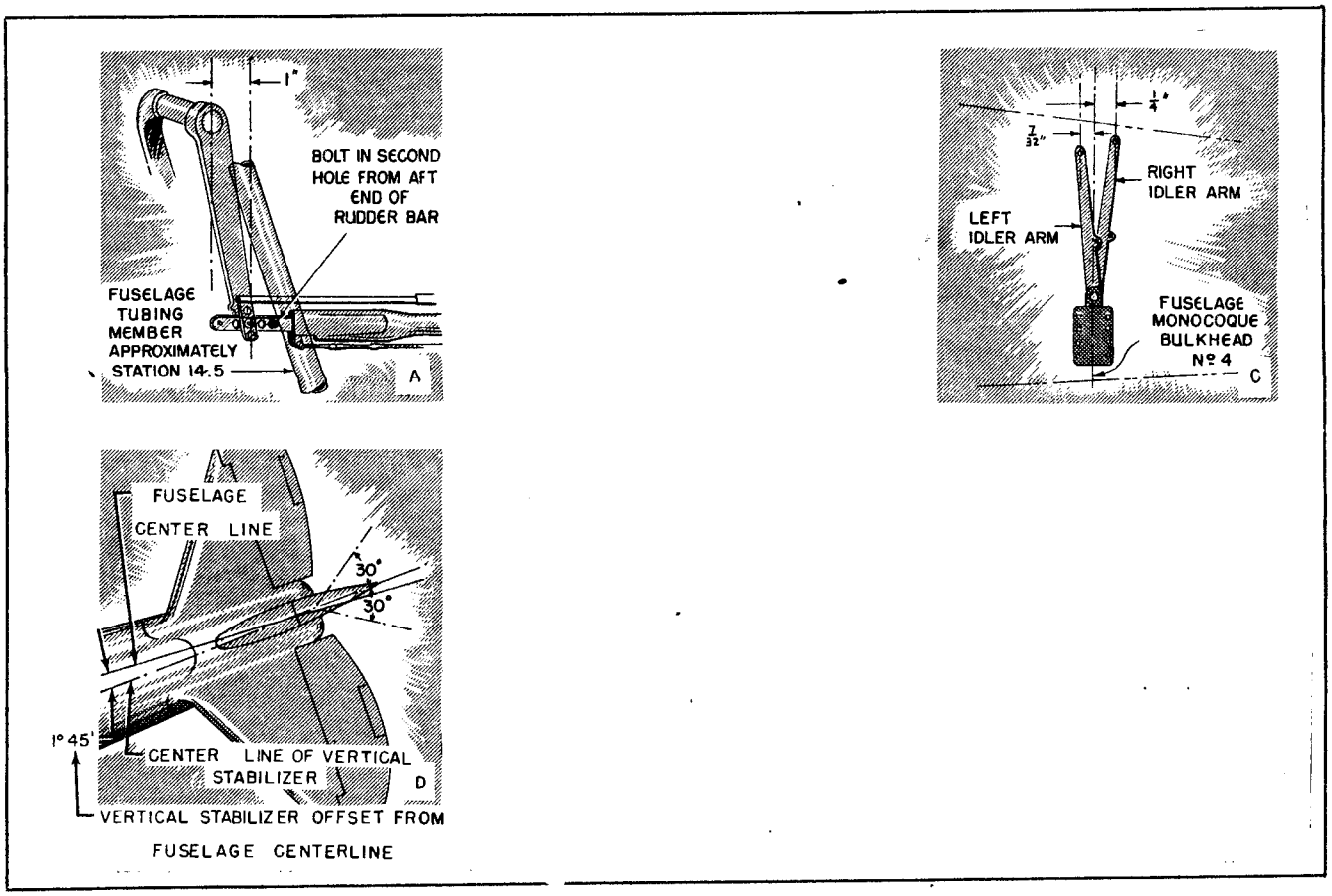


Figure 197 — Rudder and Tail Wheel Rigging Procedure for Later Model Airplanes

(c) RIGGING PROCEDURE FOR LATER MODEL AIRPLANES (AT-6C (LATE), AT-6D, SNJ-4 (LATE), SNJ-5.)

1. Jack the aft end of the fuselage so that the tail wheel assembly is permitted to drop down into flight position.

2. Connect the ends of the rudder balance cable at the turnbuckle so that not more than three threads remain showing after the turnbuckle has been safetied.

3. Place the rudder forks in the center hole in the forward end of the rudder connect bar (A, figure 197) and then position both rudder pedal forks in the neutral position so that the center line of the rudder pedal adjustment plunger is 1 inch aft of the center line of the rudder pedal support tube. This position may be maintained by placing a bolt in the forward end of the rudder connect bar and pushing the pedal assembly forward so that the bolt contacts the aft side of the fuselage tubing member, located at approximately station 14.5, when the slack is taken up in the balance cable. The bolt should be placed in the second hole from the aft end of each rudder connect bar.

4. Adjust the turnbuckles on the rudder cables located forward of the idler arms so that a tension of 55 pounds acts on both pairs of cables located forward and aft of the idler arms. Should the rudder pedals move aft away from the neutral position so that the bolt in the rudder pedal connect bar is over 1/8-inch aft of the aft side of the fuselage tubing member, the rudder balance cable may be tightened a small amount in order to reposition the bolt against the tubing member.

5. With the tail wheel locked and aligned with the fuselage center line, rig the tail wheel cables by adjusting turnbuckles so that all slack is removed. The tension on the tail wheel cables should be approximately 17 to 20 pounds.

6. Let out and take up equal amounts on the rudder and tail wheel cable turnbuckles aft of the idler arms in order to position the rudder and tail wheel in direct alignment with the fuselage center line. The right idler arm should be tilted slightly aft so that the center line of the rudder cable clevis bolt is approximately 1/4 inch aft of the center line of bulkhead No. 4, and the left idler arm should be tilted slightly forward so that the center line of the rudder cable clevis bolt is approximately 7/32 inch forward of the center line of bulkhead No. 4 when the rudder is in the neutral position (C, figure 197). The tension on the rudder and tail wheel cables should be rechecked to see that the

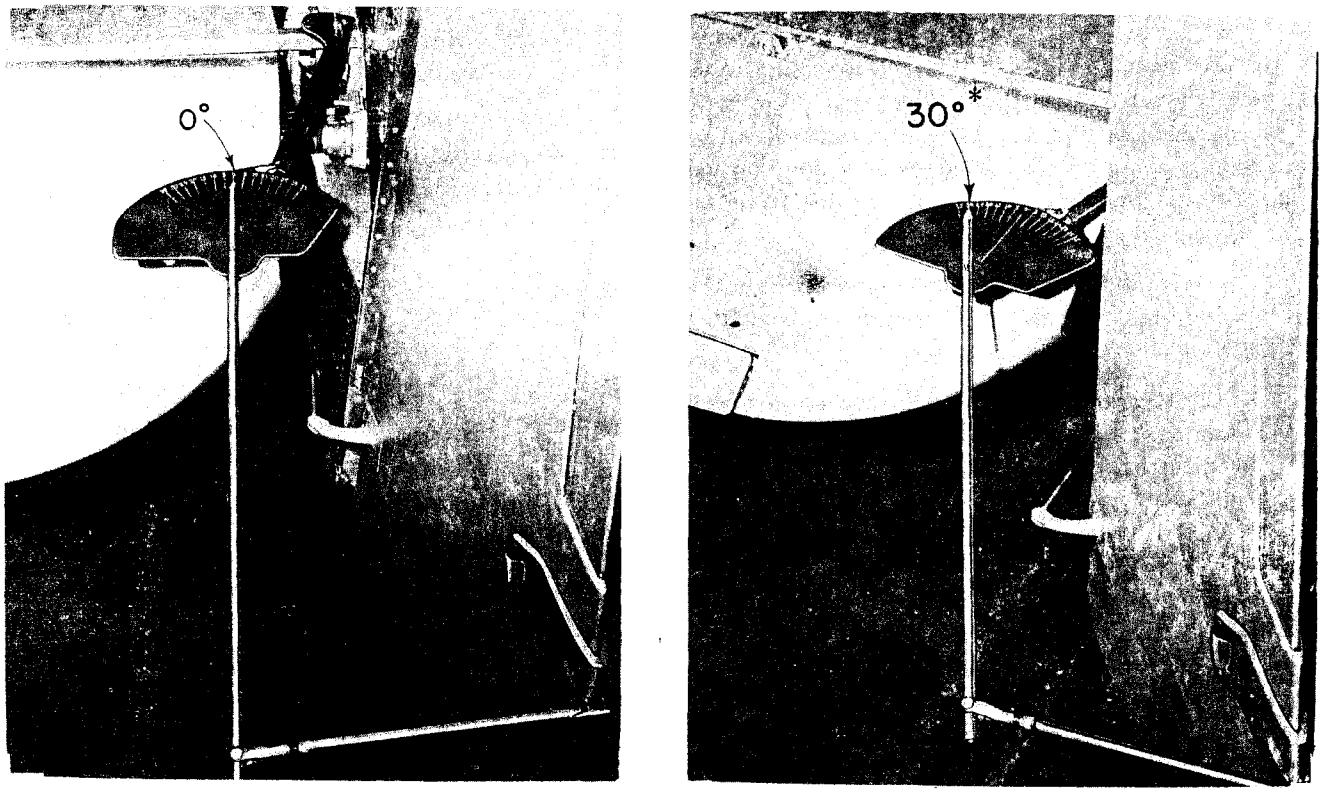


Figure 198—Checking Rudder Angular Travel—Later Airplanes

tension specified above has been maintained. The tension on the rudder cables forward of the idler arms will increase to approximately 60 pounds and the tension on the rudder cables aft of the idler arms will decrease to approximately 50 pounds after the tail wheel cables have been rigged. In general, a tension tolerance of plus or minus 5 pounds is permissible on rudder and tail wheels cables after the rigging procedure has been completed.

IMPORTANT

The tail wheel must remain locked and aligned with the fuselage center line after above adjustment has been made.

7. Remove the bolts from the ends of the rudder connect bars, place a protractor device (figure 198) on the rudder and establish the angular movement of the rudder to 30 degrees to the right and left of the vertical stabilizer center line (D, figure 197) by means of stops located on the extensions at bottom of the vertical stabilizer rear spar. A tolerance of plus or minus ½ degree is permissible in the specified rudder throw.

(3) RUDDER TRIM TAB CONTROLS.—Before proceeding with any adjustments, ascertain that the forward section of the trim tab control cable is positioned around the control wheels, wheel locks and pulleys, and through fair-leads and lightening holes in the fuselage bulkheads.

(a) Extend the cable ends along the left side of the fuselage; hold or tie them so they will be even, taut, and in their approximate normal, neutral position.

(b) Rotate the control wheels with the cables stationary so as to place their respective notched neutral marks at the top vertical position; tighten the control cable locks by means of the screw, nut, and washers on the wheels.

(c) Hold the cable ends taut. Then, permitting them to move, rotate the control wheels against the non-adjustable stops which limit the movement of the rudder trim tab to 4 degrees to the RIGHT and 10 degrees to the LEFT. (See figure 200.)

(d) Before making the necessary connections, be certain the rear section of the trim tab drum cable is properly secured by drops of solder at the drum holes to prevent it from slipping on the drum, that it is correctly wrapped around the drum grooves, and that the drum cover is installed to prevent the cable from unwinding.

(e) Connect the forward and rear sections of the drum cable by means of turnbuckles and by matching corresponding colors.

(f) Ascertain that the cable is properly positioned in the drum grooves by rotating the control wheels. If it is not, position it with a screw driver while rotating the control wheels slowly.

Figure 199—Deleted

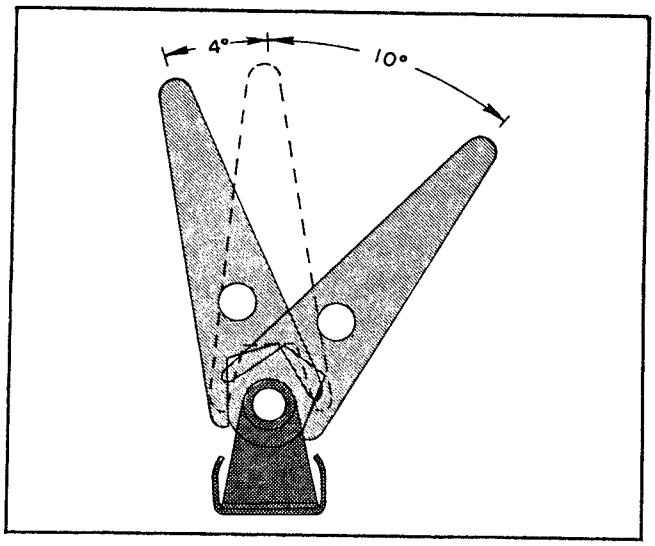


Figure 200—Rudder Tab Throw

(g) Adjust the turnbuckles simultaneously to obtain a cable tension of 10 pounds.

(h) Adjust the tab drum actuating screw to obtain approximately 1-⅛ inches between the center line of the hole in the clevis and the end of the drum sleeve. (See figure 201.) The clevis bolt spacer should be located approximately in the center of its guide slot with the tab in the neutral position. Adjust and tighten the two large nuts on the drum sleeve to allow the washer behind the nuts to turn without any lost fore-and-aft motion of the drum sleeve.

(i) Do not set the lock nuts too tightly, as binding in the tab actuating screw will result.

(j) Set the control wheels to NEUTRAL.

(k) Equally adjust both ends of the tab control rod to position the tab in alignment with the rudder when the rod is connected to the actuating screw and the tab. Approximately two threads should be visible through the inspection hole in each rod end fitting after final adjustments have been made.

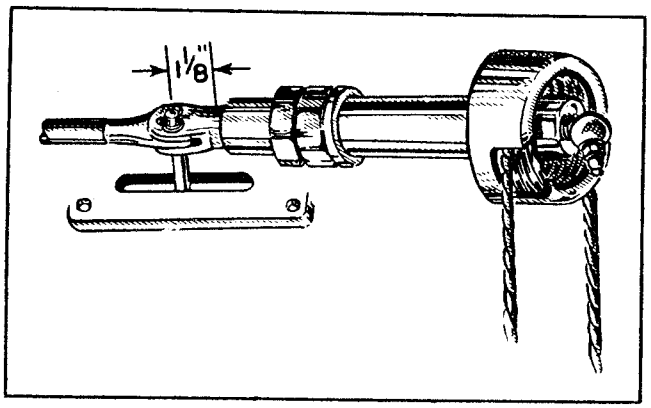


Figure 201—Rudder Tab Drum Screw Adjustment

(l) Connect the forward rod end to the actuating screw; then connect the aft end of the rod to the tab.

(4) ELEVATOR CONTROLS.—*(See figure 202.)*

(a) Ascertain that the elevator cables are properly connected to the ends of the torque tube horn and the end of the front cockpit stick socket, and are strung over the correct pulleys and through the correct fair-leads.

(b) Adjust the forward control stick interconnecting tube clevis end so that a dimension of approximately 45-3/4 inches exists between the clevis bolt holes in the forward and aft interconnecting tube clevis ends.

(c) Position the elevator in the neutral static position by holding it in direct alignment with the horizontal stabilizer.

(d) Place a simple, tapered block between the elevator torque tube and fuselage rear deck to hold the elevator in the neutral position and check the alignment by sighting along the ends of the stabilizer and elevator. The edge of the horizontal stabilizer end caps should be in alignment with the elevator end caps when the elevators are in the neutral position. If this is not the case, loosen the horizontal stabilizer end-cap attachment screws and move the end cap up or down to align it with the elevator cap.

(e) Connect the ends of the elevator cables at the turnbuckles located within the fuselage aft section and adjust the turnbuckles to remove all slack.

(f) Remove the neutral static position block and place a protractor on the elevator as shown in figure 203.

(g) Adjust the elevator throw to 20 degrees DOWN and 30 degrees UP by adjusting the stops on the forward and aft end of the torque tube assembly.

1. Adjust DOWN throw to 20 degrees by turning the forward stop bolt clockwise to increase or counterclockwise to decrease the throw.

2. Adjust UP throw to 30 degrees by turning the aft stop bolt clockwise to increase or counterclockwise to decrease the throw.

3. A tolerance of plus or minus 1/2 degree is permissible on elevator UP or DOWN throw.

4. After making this adjustment, ascertain that the forward control stick socket clears the torque tube and torque tube attachment bolt approximately 1/8 inch. (See figure 204.)

(h) After adjusting the elevator throw as specified above, let out and take up an equal number of threads on the two elevator cable turnbuckles located within the fuselage aft section until a tension of approximately 45 pounds is obtained on the cables. A cable tension tolerance of plus or minus approximately 5 pounds is permissible.

(i) Recheck the rudder throw after making the cable tension adjustment.

(j) Readjust the position of the forward and aft stop bolts, if necessary, to obtain the proper turnbuckle adjustment. A maximum of three threads should be visible on each end of all turnbuckles after final adjustment of elevator throw and cable tension has been made.

(5) ELEVATOR TRIM TAB CONTROLS.—Before proceeding with any adjustments, determine whether the forward trim tab control cable is in proper position around the control wheels, wheel locks, and pulleys, and through the fair-leads and lightening holes in the fuselage bulkheads.

(a) Extend the cable along the left side of the fuselage; hold or tie the ends so they will be even with each other, taut, and in their approximate normal, neutral positions.

(b) Rotate control wheels with the cables stationary so as to place their respective notched neutral marks at the top vertical position. Tighten the control cable locks by means of the screws, nuts, and washers on the control wheels.

(c) Hold the cable ends taut and, permitting them to move, rotate the control wheels against the non-adjustable stops which are located on the forward wheel and which limit the movement of the elevator trim tab to 8 degrees UP and 16 degrees DOWN.

(d) Before making the necessary connections, see that the rear trim tab drum cables are properly secured by drops of solder at the drum holes to prevent them from slipping on the drums, that they are correctly wrapped around the drum grooves, and that the drum covers are installed to prevent the cables from unwinding.

(e) Make sure the drum cables are around their respective pulleys, connect them to the fuselage cables by means of links and turnbuckles. Connect the cables by matching corresponding colors. Ascertain that the cables are properly positioned in the drum grooves by rotating the control wheels. If they are not, position them in the grooves with a screw driver while rotating the control wheels slowly.

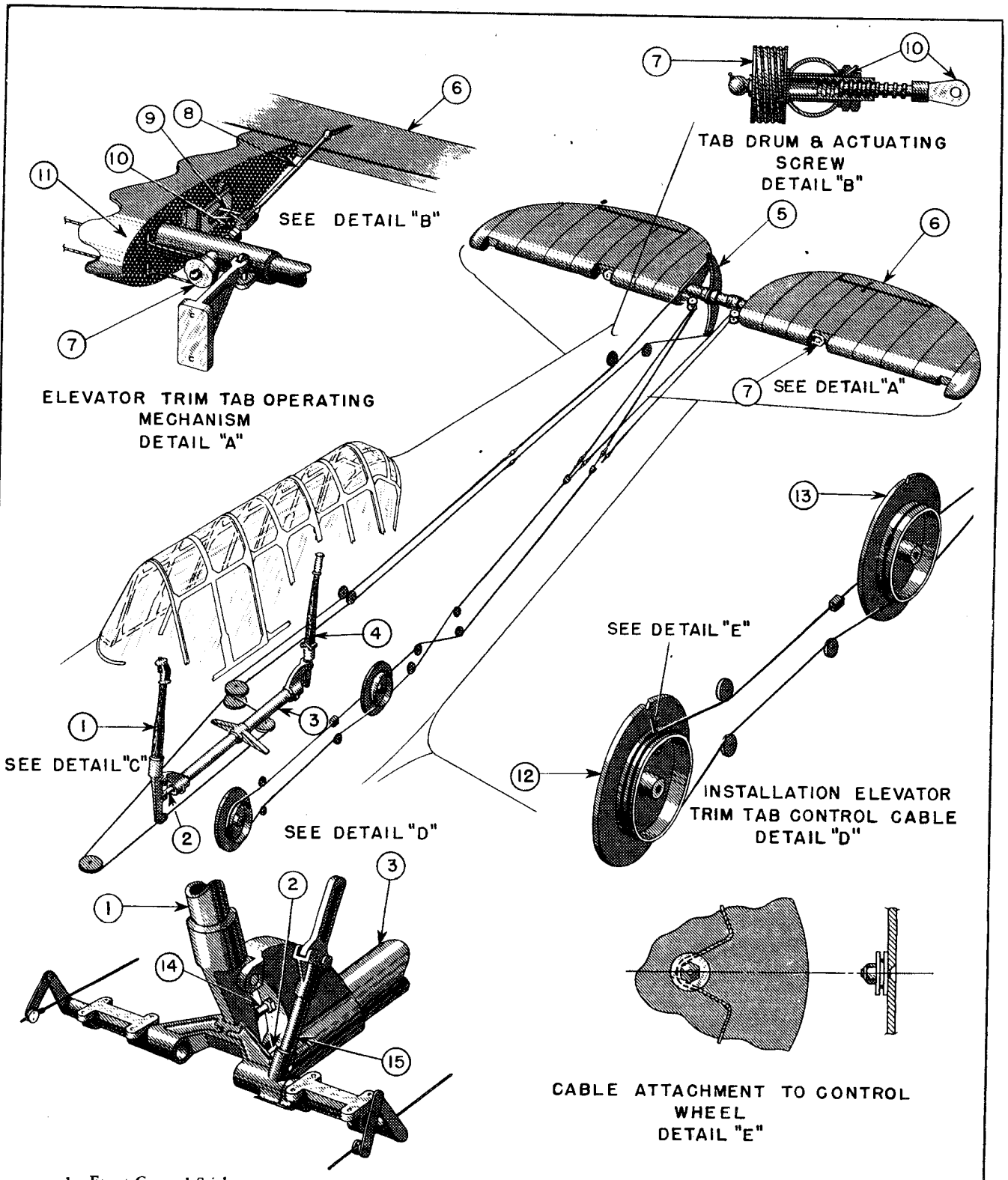
(f) Adjust turnbuckles simultaneously to obtain the cable tension of 10 pounds.

(g) Adjust the tab drum actuating screw to obtain approximately 1-1/8 inches between the center line of the clevis hole and the end of the drum sleeve to allow the washer behind the nuts to turn without any fore-and-aft lost motion of the drum sleeve.

1. The clevis bolt spacer should be located approximately in the center of its guide slot with the tab in the neutral position.

2. Do not set lock nuts too tightly, as binding in the tab actuating screw will result.

3. It should be possible to turn the thrust washer with the fingers.



1. Front Control Stick
2. Control Stick Connecting Tube
3. Control Stick Torque Tube
4. Rear Control Stick
5. Elevator Horn
6. Elevator Trim Tab
7. Trim Tab Drum
8. Trim Tab Push-Pull Rod
9. Trim Tab Guide Spacer
10. Trim Tab Actuating Screw
11. Elevator
12. Front Trim Tab Control Wheel
13. Rear Trim Tab Control Wheel
14. Elevator Stop Adjustment Nut and Bolt
15. Surface Control Lock

Figure 202 — Elevator Control System

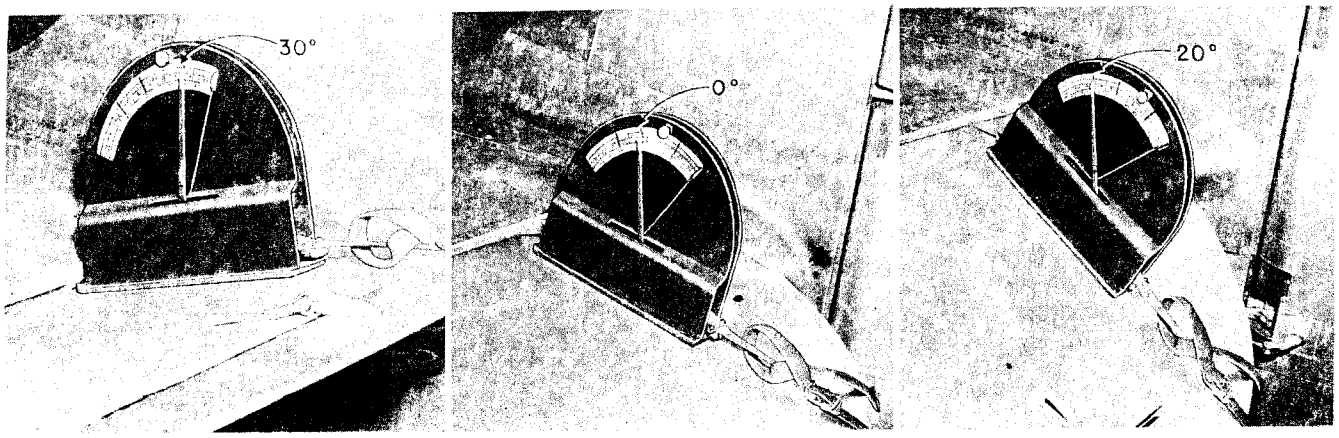


Figure 203 — Checking Elevator Angular Travel

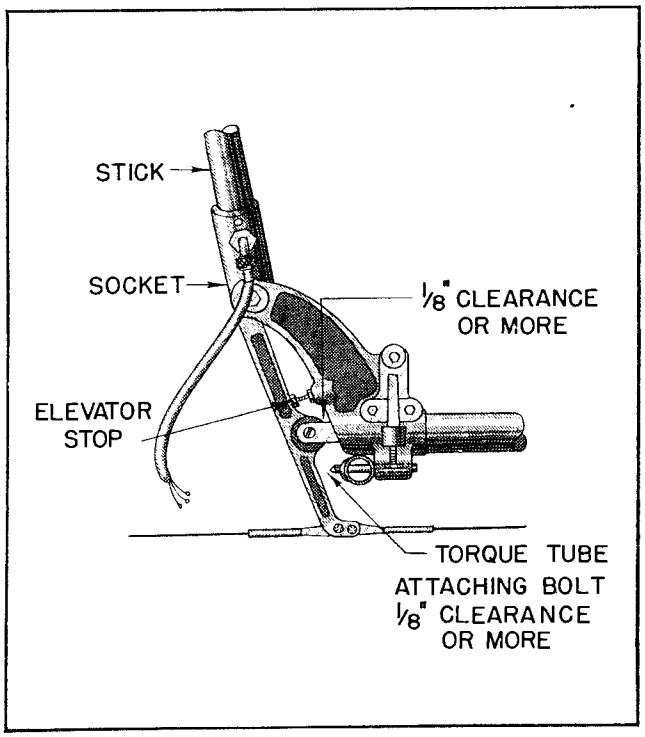


Figure 204 — Front Cockpit Control Stick Socket Clearance

(h) With the tab control wheel set at NEUTRAL, adjust both ends of the tab control rod to position the tab in alignment with the elevator when the rod is connected to the actuating screw, clevis, and the tab.

(i) Connect the rod to the actuating screw; then connect the opposite end of the rod to the tab.

NOTE

Since the surface control lock is used to position the control stick so that the ailerons are in the neutral static position, the surface control lock must be adjusted before the ailerons are rigged.

(6) SURFACE CONTROL LOCK.—Before adjusting the surface control lock mechanism for the fore-and-aft position, adjust the turnbuckle on the rudder pedal balance cable to obtain proper cable tension with the rudder pedal assemblies positioned in the neutral position and with the rudder pedal adjustment plungers in the center adjustment holes.

(a) Loosen the lock contact stops on the rudder pedal balance cable to prevent interference during the stick-lock adjustment.

(b) Place the control stick in full forward position, centering it laterally.

(c) Engage the control lock in the locked position by lifting up on the handle and moving it back until the plunger is engaged.

(d) Move the control lock assembly forward or aft in the pilot's floor assembly as required to align the lock assembly with the control stick so that the stick is held in the extreme forward position against its stop bolt.

(e) Tighten the screws holding the lock assembly to the floor assembly when the desired engagement with the control stick is obtained.

(f) Check the control stick to ascertain that it is being held in the exact vertical position in relation to the airplane's transverse leveling brackets.

(g) If the stick is not vertical, loosen the clamps securing the aft end of the floor assemblies and move them to the side required.

(h) Retighten the clamps when the correct position of the stick is obtained and the control lock has no lost motion to either side and does not bind between the floor assemblies.

(i) Place a bar across the forward rudder pedals and secure them in the neutral position. (See B, figure 196.)

(j) With the control lock in its locked position, move the balance cable stops against the lock mechanism arms and tighten them slightly.

(k) Release the lock mechanism, move each cable stop forward 1/16 inch, and tighten them securely.

(l) Lock the surface controls; check for loose motion at the stops by moving the rudder pedals.

(7) AILERON CONTROLS.—*(See figure 205.)*—Position the control stick in the vertical, neutral position by means of the surface control lock and ascertain that the aileron cables are properly attached to their respective bell cranks in early model airplanes (AT-6, A, B, early AT-6C, SNJ-3 and early model SNJ-4). Quadrants replace bell cranks in late model airplanes. (See figure 206.)

(a) With the aileron cables disconnected at the turnbuckles just outboard of the wing joint bolting angles, adjust the aileron control rods to obtain the initial DOWN throw setting of the ailerons.

1. On early model airplanes equipped with bell cranks, the initial DOWN throw setting is approximately 16 degrees while on late model airplanes equipped with quadrants, the initial DOWN throw is approximately 22 degrees.

2. The threaded end of the clevis on the aft end of the control rod provides a means of shortening or lengthening the rod. Access to the adjustable clevis is gained through inspection holes located in lower surface of the outer wing panels directly forward of each aileron inboard hinge.

3. Approximately two threads should be visible through the inspection hole in the rod end clevis fitting so that it is impossible to insert a wire through the hole after the final adjustment has been made.

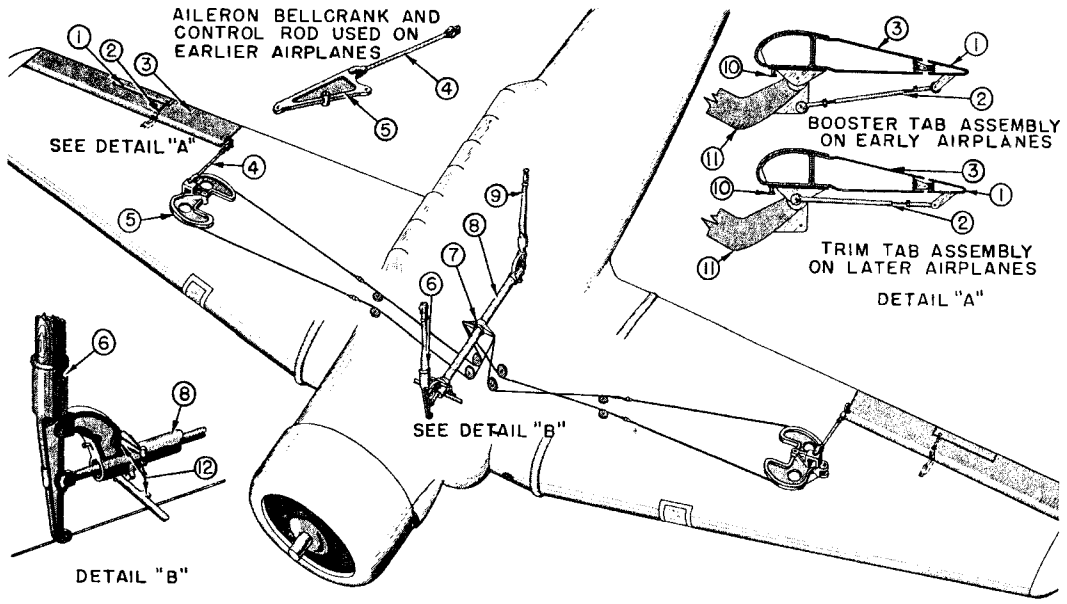
(b) Connect the ends of the aileron cables by means of the turnbuckles located just outboard of the wing joint bolting angle after ascertaining that the correct cables have been properly strung over the correct pulleys in the wing center section.

1. Connect the cables by matching the corresponding identification colors on the ends of the cables.

2. Access to the turnbuckles is gained through inspection holes located in the lower surface of the outer wing panel just outboard of the bolting angle.

(c) Position the control stick in the neutral position by locking it with the surface control lock.

(d) Adjust the cable turnbuckles so that a tension of approximately 45 pounds is obtained on the cables. A tolerance of plus or minus 5 pounds is permissible.



1. Aileron Trim-Booster Tab
2. Trim-Booster Tab Connecting-Push-Pull Rod
3. Aileron
4. Aileron Quadrant-Bell Crank Control Rod
5. Aileron Quadrant-Bell Crank
6. Front Control Stick
7. Aileron Torque Arm
8. Aileron Torque Tube
9. Rear Control Stick
10. Aileron Hinge Stop
11. Aileron Hinge Bracket
12. Aileron Torque Tube Stop Assembly and Stop Lug

Figure 205 — Aileron Control System

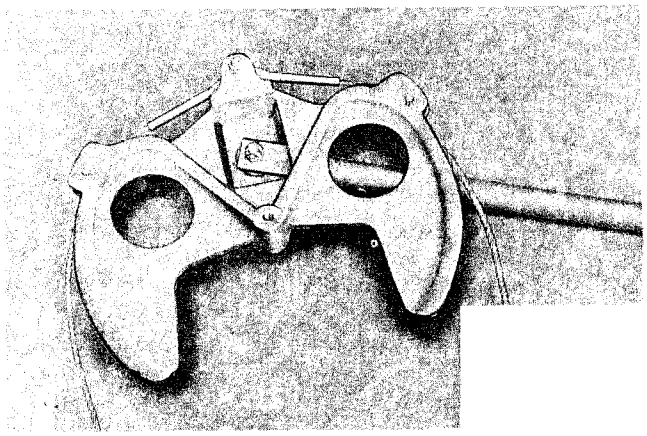


Figure 206 — Aileron Control Quadrant — Later Airplanes

(e) After adjusting the cable tension, take up and let out an equal number of threads on the turnbuckle until a droop of 1 degree (1/4-inch) is obtained on each aileron. The 1 degree droop position is considered the NEUTRAL static position of the aileron. A tolerance of plus 1/2 degree (1/8-inch) or minus 1 degree (1/4-inch) is permissible on the 1 degree droop adjustment. (See figure 207.)

(f) Screw in the center hinge stop on each aileron sufficiently to prevent its interference with proper aileron movement and unlock the surface control lock.

(g) Adjust the stops on the control stick torque tube to obtain the proper throw on each aileron.

1. The aileron throw on AT-6A, B, SNJ-3, and early model AT-6C and SNJ-4 airplanes is 30 degrees UP and 15 degrees DOWN, measured from the NEUTRAL static, or droop position, and is obtained by adjusting the aileron throw stops on the torque tube so that an UP throw of 29 degrees and DOWN throw of 16 degrees exists when measured from the center line of the wing trailing edge.

2. The aileron throw on late model AT-6C, SNJ-4, and on AT-6D and SNJ-5 airplanes is 15 degrees UP and 15 degrees DOWN. The UP and DOWN throw of 15 degrees measured from the NEUTRAL, static or droop position is obtained by adjusting the torque tube throw stops so that an UP throw of 14 degrees and DOWN throw of 16 degrees exists when measured from the center of the wing trailing edge. (See figure 208.) A tolerance of plus or minus 1/2 degree is permissible.

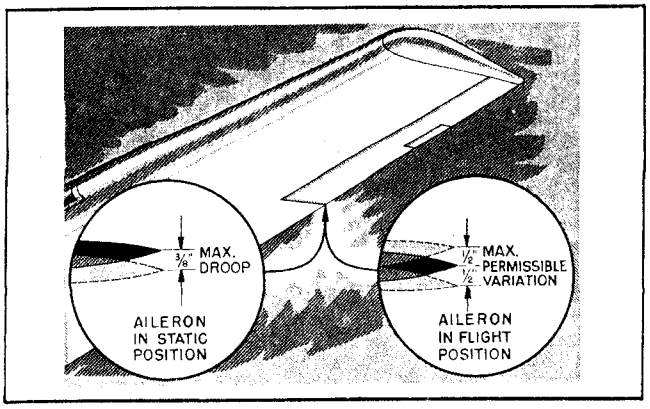


Figure 207 — Aileron Neutral Static Position

3. The aileron throw stop adjustment bolts are located on the forward end of the torque tube assembly below the torque tube guard in the front cockpit. Turn the bolts clockwise to increase the aileron throw and counterclockwise to decrease the throw.

(h) When airplane is in level flight, trailing edge of ailerons may deviate as much as 1/2 inch above or below the wing trailing edge. (See figure 207.)

(i) After completing the aileron throw adjustment, hold each aileron in the UP position by means of the control stick and adjust the aileron center hinge stop to obtain a clearance of approximately 1/32 inch between the stop and the aileron hinge bracket. (See figure 209.)

(8) AILERON TABS.

(a) On early airplanes having booster tabs, adjust the tab actuating rod at each aileron when the

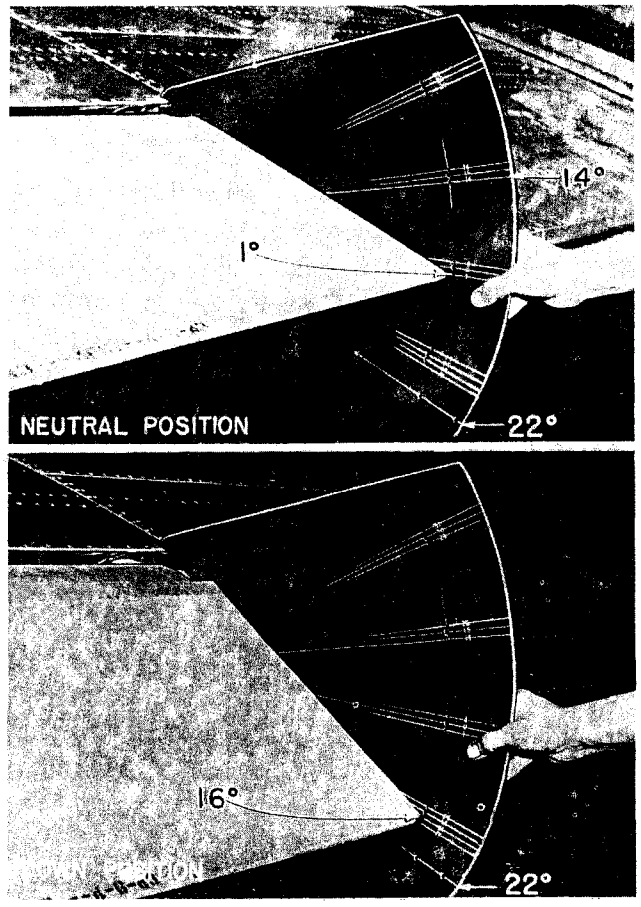


Figure 208 — Checking Aileron Angular Travel — Later Airplanes

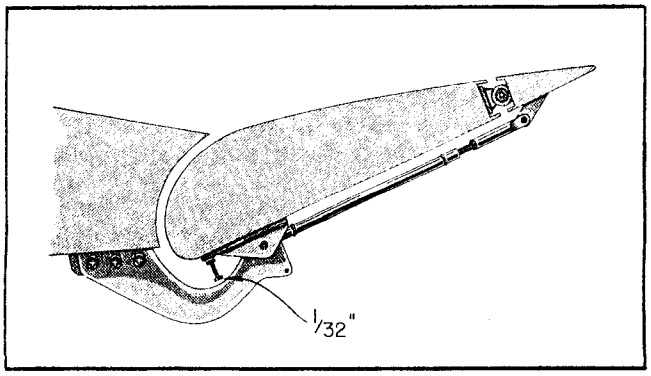


Figure 209 — Aileron Hinge Stop Clearance

aileron is positioned in direct alignment with the trailing edge of the outer panel. It is important that the adjustment not be accomplished with the aileron in the NEUTRAL static position. However, the booster tabs may be used to compensate for wing heaviness by lengthening or shortening the actuating rods.

(b) On later airplanes, adjust tthe trim tab adjustment rod on each aileron to align the trailing edge of the trim tab with the trailing edge of the aileron.

(c) On both early and late model airplanes, final adjustment of the tabs should be accomplished after flight testing the airplane to determine whether or not one wing is flying heavy. If one wing is flying heavy, adjust the tabs to compensate the unbalanced condition. Approximately two threads should be visible through the inspection hole in the aft rod end clevis after the final trim tab rod adjustment has been made.

(9) FLAPS.—To adjust the wing flaps proceed as follows:

(a) Loosen the lock nut on the left end of the left push-pull rod equalizer control rod and screw the

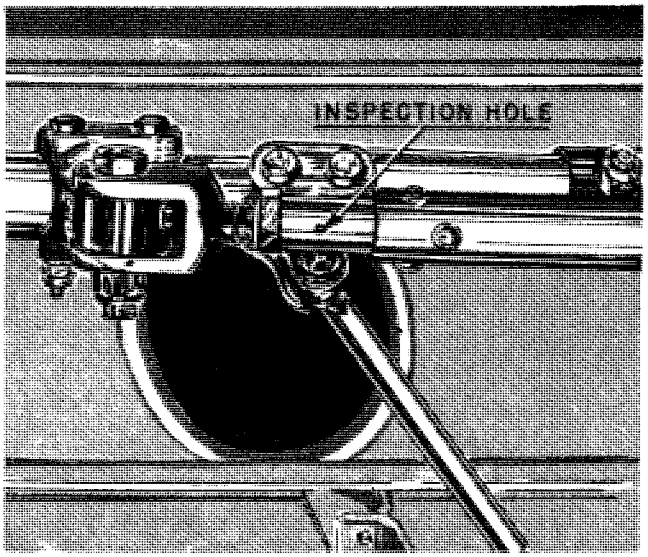
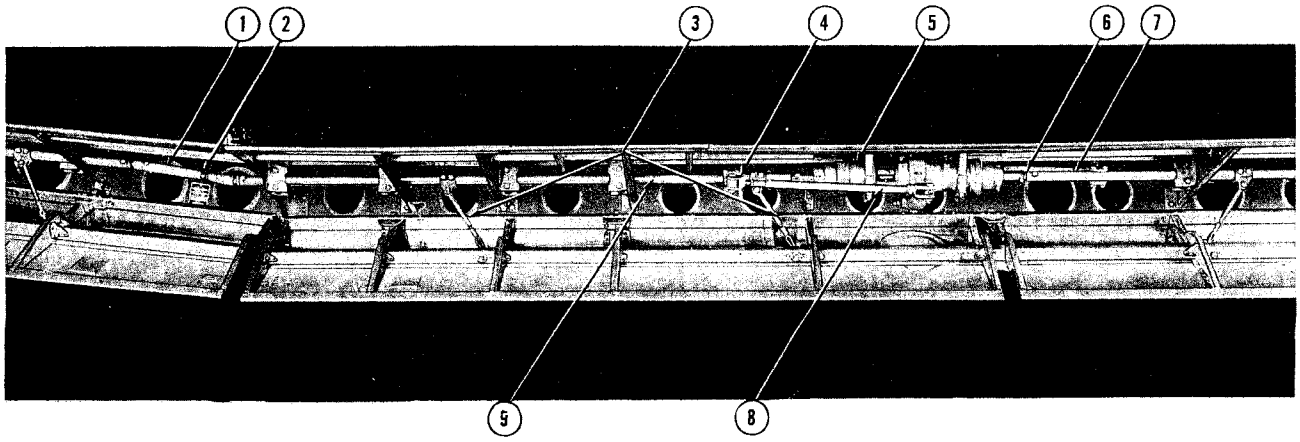


Figure 210 — Clevis End Adjustment

clevis end (figure 210) out until only one complete thread is visible through the inspection hole in the rod. Tighten the clevis lock nut and attach the left end of the rod to the bracket on the inboard end of the left push-pull rod.

(b) Disconnect the right end of the right push-pull equalizer rod from the main right push-pull rod (figure 211). Ascertain that both the left and right hydraulic flap operating cylinder pistons are in the fully retracted or flap down position so that the stops on the outboard ends of the piston rods bear against the ends of flap operating cylinder. Disconnect the inboard end of the right push-pull rod from the outboard end of the adjustment screw (figure 212) and screw the adjustment screw in or out until the bolt hole in the right end of the right equalizer rod lines up with the



1. Push-Pull Rod Universal Joint Assembly
2. Universal Adjustment Screw
3. Flap Turnbuckle Rods
4. Clevis End Adjustment
5. Flap Operating Cylinder
6. Push-Pull Rod Adjustment Screw
7. Right Equalizer Control Rod
8. Left Equalizer Control Rod
9. Main Push-Pull Rod

Figure 211 — Flap Installation

bolt hole in the bracket located on the forward side of the main right center section flap push-pull rod. In order to determine whether or not the above mentioned bolt holes line up, it is necessary that the inboard end of the main push-pull rod be reconnected to the outboard end of the adjustment screw. After adjusting the main push-pull adjustment screw properly, connect the right end of the right equalizer rod to the bracket on the main push-pull rod.

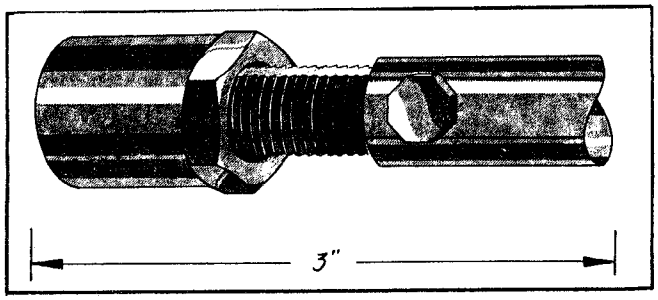


Figure 212 — Main Push-Pull Rod Adjustment Screw

(c) Wing flaps shall be set at 45 degrees, plus 1/2, minus 2 degrees. The center section flap and each outer panel must be rigged to match by adjusting the turnbuckle rods. A special protractor with suction cup foot should be used to check the travel. If this is not available, measurement shall be checked at the outer points of each panel to a dimension of 11-1/16 inches.

(d) Adjust the inboard turnbuckle rod on the outer wing flap so that the trailing edges of the center section flap and outer wing flap are in alignment when the flaps are in the extended position. A maximum misalignment tolerance of 1/4 inch between the trailing edges of the center section and outer wing flaps is permissible when the flaps are in the extended position. Adjust the extreme outboard turnbuckle rod on the outer wing flap so that the outboard and inboard ends of the outer wing flap are flush with the trailing edge of the wing when the flap is raised to the retracted position. The hydraulic hand pump may be used to raise and lower the flaps during the adjustment procedure. After raising the flaps to the retracted position, determine whether the center turnbuckle rod on the outer wing flap should be lengthened or shortened to cause the center portion of flap trailing edge to retract flush with the trailing edge of the wing.

(e) If the outer wing flap fails to extend or retract simultaneously with the center section flap, both the push-pull and turnbuckle rods must be adjusted to obtain synchronized movement of the flaps. If the outer wing flap retracts before the center section flap, the push-pull rod must be shortened at the adjustment rod on the inboard end of the universal assembly (figure 214) by disconnecting the universal at the outboard end of the center section flap push-pull rod and turning the adjustment rod clockwise. After the push-pull rod has been shortened one or more threads, all three turnbuckle rods on the outer wing flap push-pull rod must be shortened two or more threads. One turn on the push-pull rod adjustment rod is equivalent to approximately two turns on the turnbuckle rods. If the outer panel flap retracts after the center section flap, the push-

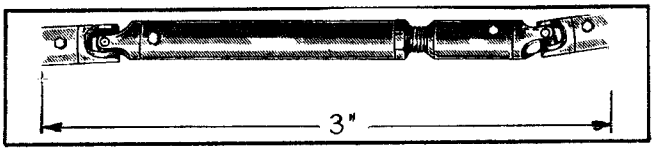


Figure 214 — Push-Pull Rod Universal Assembly

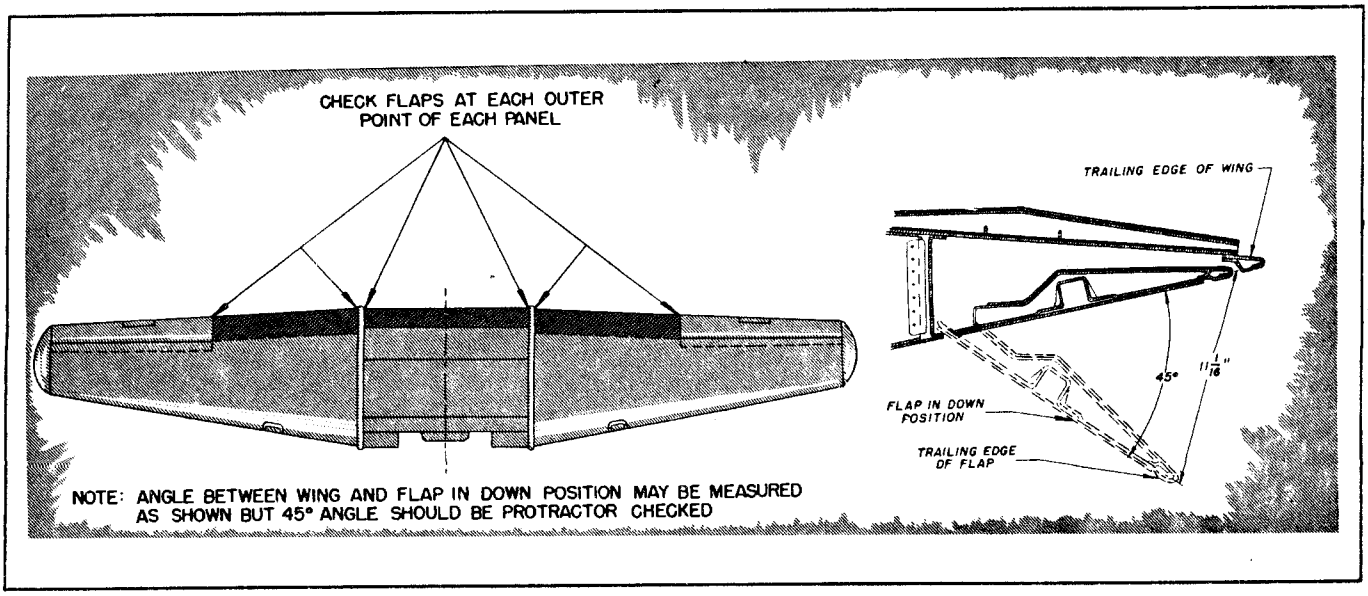


Figure 213 — Checking Points for Checking Flap Travel

pull rod must be lengthened one or more turns by turning the adjustment rod counterclockwise and the three turnbuckle rods must be lengthened two or more turns by disconnecting the rods from the flap and turning the clevis ends counterclockwise. Frequently the adjustment rod on the push-pull rod universal assembly must be adjusted to approximately its maximum length so that not more than one or two complete threads are visible through the inspection hole. The number of threads the push-pull and turnbuckle rods are lengthened or shortened will depend on the degree of misalignment between the trailing edges of the flaps as they are retracted and the trailing edge of the wing and the flaps in the retracted position. Both outer wing flaps are adjusted so that they extend and retract simultaneously with the center section flap as outlined above.

(f) Ascertain that the rib clips which attach the flap ribs to the center flap channel do not bear against the lower edge of the wing trailing edge ribs when the flaps are in the retracted position. See that the turnbuckle rod eyebolts are properly adjusted in their bushings on the flap channel. The eyebolts may be adjusted by tightening the eyebolt nut until a slight drag is felt on the eyebolt as it is turned in its bushing and then backing the nut off one castellation. The turnbuckles on the ends of the turnbuckle rods should turn freely on the threaded ends of the rods.

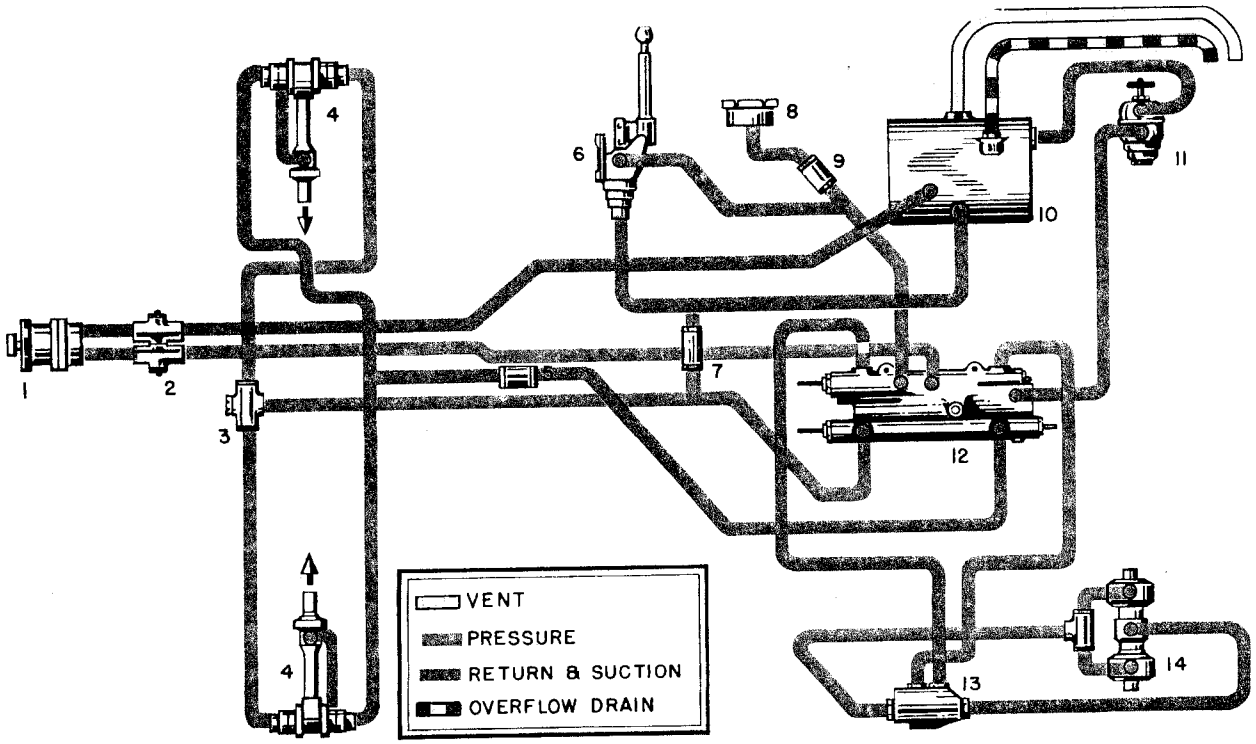
12. HYDRAULIC SYSTEMS

NOTE

The hydraulic systems of all airplanes in the AT-6 series are essentially similar except for the selector valve unit and the flap ratchet valve. Earliest models of the series used selector valve unit 55-58011 and flap ratchet valve 55-58014. Intermediate models of the series were equipped with selector valve unit 66-58011 and flap ratchet valve 66-58070 and 78-58070. Later models are equipped with selector valve unit 88-58011 and flap ratchet valve 88-58070. When replacements are made, the 88-series of each unit should be used.

a. GENERAL.—Two individual hydraulic systems are incorporated in the airplane; namely, the main and the brake hydraulic systems. Each is treated separately in the text. However, the following general maintenance instructions are applicable to both systems.

(1) GENERAL MAINTENANCE DATA.—Access to all of the hydraulic units, with the exception of the engine-driven pump, landing gear and flap operating cylinder, and most brake system units, is gained by removing the left-side panel from the forward section of the fuselage. Particular care should be exercised in seeing that the packing cups and rings are not damaged as they are withdrawn from the assembly. A visual inspection of some of the units in the hydraulic systems will readily determine the procedure to be followed in removal and disassembly; therefore, detailed instruc-



1. Engine-Driven Pump
2. Test Connections
3. Drain Plug
4. Landing Gear Operating Cylinders
5. Restrictor Valve
6. Emergency Hand Pump
7. One-way Check Valve
8. Pressure Gage
9. Snubber Valve
10. Reservoir
11. Filter
12. Selector Valve
13. Ratchet Valve
14. Flap Operating Cylinder

Figure 215—Main Hydraulic System Flow Diagram

tions for the disassembly of these units are omitted. Reference to each exploded view of the assembly should clarify the disassembly and assembly procedure. After disconnecting hydraulic lines involved, plug the ends to prevent the entrance of foreign matter. As each of the hydraulic units is removed and disassembled, the component parts should be thoroughly cleaned. Bushings, springs, rubber washers, packing cups, rings, gaskets, etc., should be thoroughly inspected for deterioration, wear and damage. Replacement of parts is not necessary unless they are in poor condition. Prior to reassembly of a unit, thoroughly flush all lines. It is also important that the component parts of all hydraulic units be thoroughly cleaned and coated with hydraulic fluid prior to reassembly. All units in the hydraulic systems should be cleaned with kerosene or naphtha. For replacement of packing and gaskets, refer to the applicable Illustrated Parts Catalog. Most replacements will consist of gaskets and packings only. The majority of the units are replaced as an assembly should extensive damage and wear occur.

(2) REPLACEMENT OF SEALING MEDIUMS.—Replacement of parts or complete assemblies is necessary when adjustment will not correct leakage. Replacement of chevron rings and external seals of the landing gear operating strut piston rod, the wing flap piston rod, the hand-pump piston rod, and the selector valve plungers is not necessary unless the leak cannot be eliminated by adjustment of the respective packing nuts. Caution should be exercised, however, in tightening these nuts. They should be only slightly tighter than finger-tight. The seal of the pressure control plunger in the selector valve unit cannot be improved by tightening the nut. Leakage of internal parts is indicated by slow action of the operating units or complete malfunctioning. Parts to be replaced may be determined by the location of the leakage. A visual inspection of the location where leakage is occurring and of attaching and surrounding parts will determine to what extent disassembly is necessary in order to accomplish replacement. If replacement is accomplished without removal of the unit, care should be taken to see that the mechanism is kept clean and free of foreign substances. Prior to installation, parts (except butadiene packing cups) should be thoroughly cleaned with kerosene or naphtha and coated with hydraulic oil as used in the hydraulic system. Replace gaskets that are in poor condition. During assembly, make certain that all sealing mediums, retainers, guides, pins, washers, etc., are properly installed and safetied as required. After the assembly of any unit, or part of a unit, it should be pressure-tested. Refer to the ensuing paragraphs for sealing medium requirements and pressure-testing.

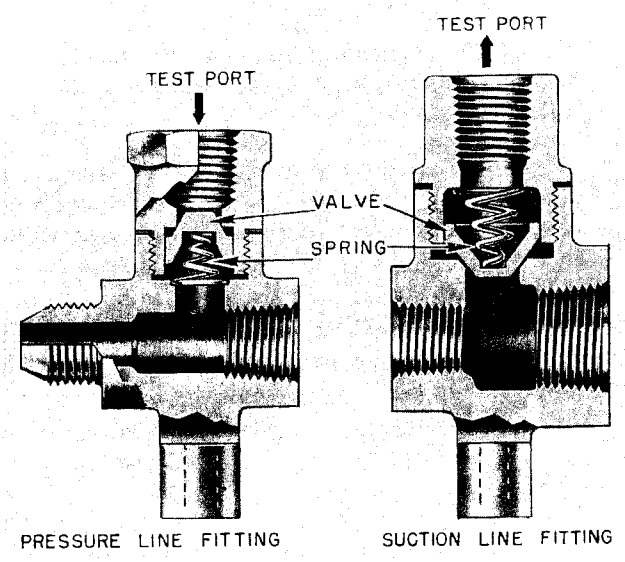


Figure 216—Test Connections

(3) CLEANING.—Prior to reassembly of a unit, or installation of parts, thoroughly flush all lines and clean and coat the parts with hydraulic fluid. Clean hydraulic system with kerosene or naphtha only after all packing cups have been removed.

WARNING

Do not use kerosene, naphtha, or other cleaning solvents unless all packing cups have been removed, as these solvents may cause deterioration of the packing material. Packing cups may be cleaned with a clean lint-free cloth. During assembly make certain that all parts are correctly installed and locked as required. There must not be any leaks. All tube fittings for the hydraulic system are of the triple-compression type, which uses a sleeve under the tubing nut.

NOTE

When flaring new tubing, the proper flaring tool should be used and care exercised so that no burrs are left on the end of the tubing and that flared ends are not cracked. See section VIII for tube-bending data. Hydraulic lines are identified by a band of light blue on each side of a yellow band.

CAUTION

In all work involving the replacement of hydraulic tubing, use as few bends and restricting fittings as possible in order to minimize line pressure losses. Make the bend radius as large as possible. Check the installation carefully to see that all connections are tight and that all tubing is properly supported.

(4) TESTING.—For testing the hydraulic system, a suction line disconnect block and a pressure line disconnect block are incorporated in the suction and pressure lines of the hydraulic system, and are attached to the lower left tube of the engine structure. (See figure 218.) The suction line test connections used on early model airplanes are equipped with ball check

valves while the suction line test connections used on late model airplanes are equipped with cone check valves. (See figures 216 and 217.) Remove the plugs from the disconnect blocks; connect the test equipment. Whenever a hydraulic unit is disassembled, repaired, parts or cups replaced, or merely inspected, it should be pressure tested after assembly. The tests require a high pressure hand pump, pressure gage (3000 pounds), fluid reservoir, and the necessary lines and fittings.

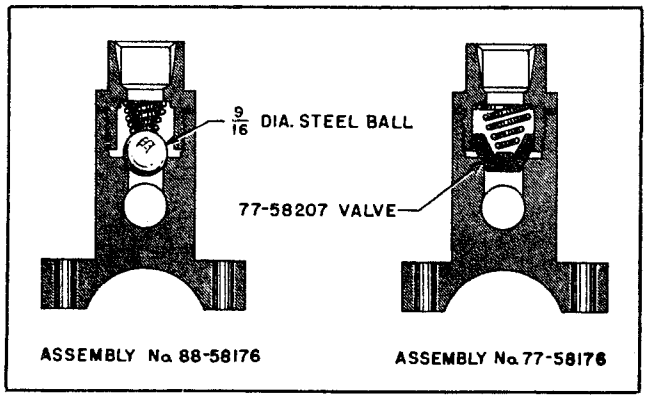


Figure 217 — Suction Line Test Connection Valves

(5) HYDRAULIC FLUID.

NOTE

Refer to section III, paragraph 3, for instructions on servicing the main and brake hydraulic systems.

—Main Hydraulic System—Use only mineral base fluid Specification No. AN-VV-O-366 Red Color.

—Brake Hydraulic System—Use only vegetable base fluid AAF Specification No. 3586 Blue Color.

(a) HANDLING.—Every precaution must be observed in handling hydraulic fluid to prevent its contamination. The storage containers should be kept sealed. All handling equipment must be kept clean and should be used for handling hydraulic fluid only. Do not expose hydraulic fluid to the air longer than absolutely necessary. The fluid will absorb dust and grit from the air, and in certain localities this constitutes a serious menace.

(b) FILTERING.—Fluid that has been exposed to dust or other contamination should be filtered before using. Fluid that has been used should also be filtered before reuse. Filtering will remove the sludge from used fluid, as well as all metal flakes and grit. The simplest equipment for filtering hydraulic fluid consists of a ribbed glass or metal funnel of approximately 1-gallon capacity, a sheet of standard commercial filter paper, and a container to support the funnel and contain the

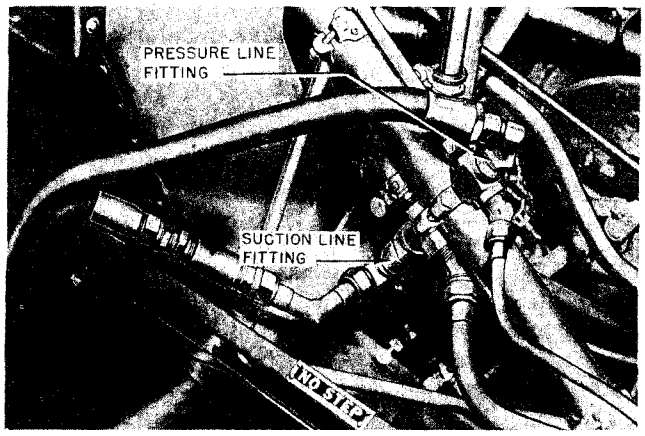


Figure 218 — Test Connections Installed

filtered fluid. The filter paper is folded into a funnel shape and placed in the funnel. The oil passes through the filter slowly and should be protected from contamination by dust particles in the air. A cloth dampened in hydraulic fluid placed over the open end of the container will protect the filtered fluid during the operation. The filtered fluid should be placed in a clean container, properly marked to identify the contents, and kept sealed until required for use.

(6) FILLING MAIN HYDRAULIC SYSTEM WITH TEST STAND.—To fill the hydraulic system when ground test stand equipment is available, proceed as follows:

NOTE

It is not necessary to fill the hydraulic fluid reservoir before proceeding with the following instructions.

(a) Place the airplane on jacks and visually inspect all hydraulic pipe connections.

CAUTION

DO NOT use a wrench on any of the nuts unless they show leaks after the system has been filled with fluid.

(b) Remove the two plugs from the ground test connections on the lower left-hand engine mount tube. Connect the pressure line of the test equipment to the upper disconnect block and the suction line to the lower block.

(c) Place a clean container under the hydraulic fluid reservoir vent pipe located on the fuselage at the left wing trailing edge.

(d) Circulate fluid through the system until approximately one-half gallon has overflowed into the container.

(e) During the foregoing operation, operate the hydraulic hand pump to free this portion of the system from air.

NOTE

In case the hand pump does not take hold of fluid immediately, prime the pump by blowing air from a high-pressure air hose into the reservoir vent pipe, being particularly careful to hold the end of the hose at a distance of not less than 3 inches from the end of the vent tube, as excessive air pressure will damage the reservoir.

(f) With the ground test stand stopped, proceed to operate the landing gear and flaps several times by use of the hand pump to free these parts of the system from air locks. During these operations, pipes and equipment should be inspected for leaks and the proper fluid level maintained in the reservoir.

(g) Shut off test stand reservoir flow to the test pump so as to circulate only such fluid as is now in the system of the airplane. Start the test pump and operate the landing gear and flaps several times. During these operations, note the hydraulic gage pressure reading. This reading should be 1000 pounds per square inch after the landing gear or flap movement has been completed and before the pressure control starts to disengage. To correct variations of the above pressure, it will be necessary to adjust the system pressure relief valve.

(h) Stop the test pump, disconnect the ground test equipment, and replace and safety the plugs.

(i) Check the fluid level in the reservoir; replenish if necessary. Also, turn the strainer control handle at least one full turn before the airplane is placed in service.

(j) Ascertain that the landing gear control handle is placed in the "DOWN" position and that both landing gear legs are locked in the extended position. Take the airplane off the jacks and start the engine.

(k) Test the engine pump by operating the flaps only. In case no pressure is obtained from the engine pump with the engine running, loosen the pressure pipe at the pump to determine if the pump is operating. If the pump is not operating remove and inspect for damage to the drive mechanism.

(7) FILLING MAIN HYDRAULIC SYSTEM WITH AIRPLANE HAND PUMP.—To fill the hydraulic system when there is no ground test pump equipment available, use the hand pump. Proceed as follows:

(a) Place the airplane on jacks and visually inspect all hydraulic pipe connections.

(b) Fill the fluid reservoir to overflowing.

(c) Operate the flaps and the landing gear separately several times by setting the control handles to either the "UP" or "DOWN" position and using the hand pump.

NOTE

If at the beginning of the above operation it is noticed that the hand pump does not take hold of fluid immediately, prime the pump by blowing air from a high-pressure air hose into the reservoir vent pipe, being particularly careful to hold the end of the hose at a distance of not less than 3 inches from the end of the vent tube, as excessive air pressure will damage the reservoir.

(d) Refill the fluid reservoir to overflowing.

(e) Ascertain that the landing gear control handle is placed in the "DOWN" position and that both landing gear legs are locked in the extended position. Take the airplane off the jacks and start the engine.

(f) Test the engine pump by operating the flaps only. In case no pressure is obtained from the engine pump with the engine running, loosen the pressure pipe at the pump to determine if the pump is operating. If the pump is not operating, remove and inspect for damage to the drive mechanism.

(g) As a final step, recheck the fluid reservoir; replenish, if necessary. Also turn the strainer control handle one full turn before the airplane is placed in service.

(8) DRAINING MAIN HYDRAULIC SYSTEM.—Complete drainage of the hydraulic system cannot be accomplished from any one point. However, to remove a considerable portion of the fluid (mainly that contained in the fluid reservoir), place the tail of the airplane slightly above the level flight position, and disconnect the aft line of the lower test pump connection block mounted on the left side of the engine mount. Approximately one-half gallon of fluid will be obtained from this point. With the landing gear control handle in the "DOWN" position, further drainage may be accomplished by placing a receptacle under the drain tee fitting on the landing gear hydraulic line, located in the left landing gear retracting well, and removing the cap. Using the hand pump, remove the remainder of the fluid. The total capacity of the hydraulic system is approximately 11 pints, including the reservoir, lines, and the various units. The fluid that remains in the system may be drained from the various units as they are removed from the airplane.

WARNING

DO NOT operate the hand pump when any part of the hydraulic system is disconnected, except as noted above.

(9) ASSEMBLY OF HYDRAULIC UNITS.—Reference to the exploded view of the assembly will help to clarify the procedure and sequence to be followed in assembling the component parts. Exercise particular care to make certain that none of the syn-

thetic rubber packing cups and rings are cut or damaged in any way when assembling the cups or rings themselves or an assembly on which they are attached. It is advisable to use shim stock to protect the rings from sharp corners when installing them in the assembly. All male fittings should be tinned before assembly. The application of white petroleum jelly (vaseline) is imperative before the tinned fittings are screwed into their female ports or "B" nuts. When flaring tubing, employ the proper flaring tool and see that no burrs are left on the ends of the tubing. All parts of the assembly should be thoroughly cleaned with naphthalene or kerosene before assembly. Before assembling internal parts, coat them with hydraulic fluid to prevent scoring during assembly. Safety all drilled nuts and studs with lock wire; install the unit on the airplane, using the anti-seize compound mentioned above on all male fittings. Excessive torque must not be applied to "B" nuts and fittings during assembly.

(10) TROUBLE SHOOTING.

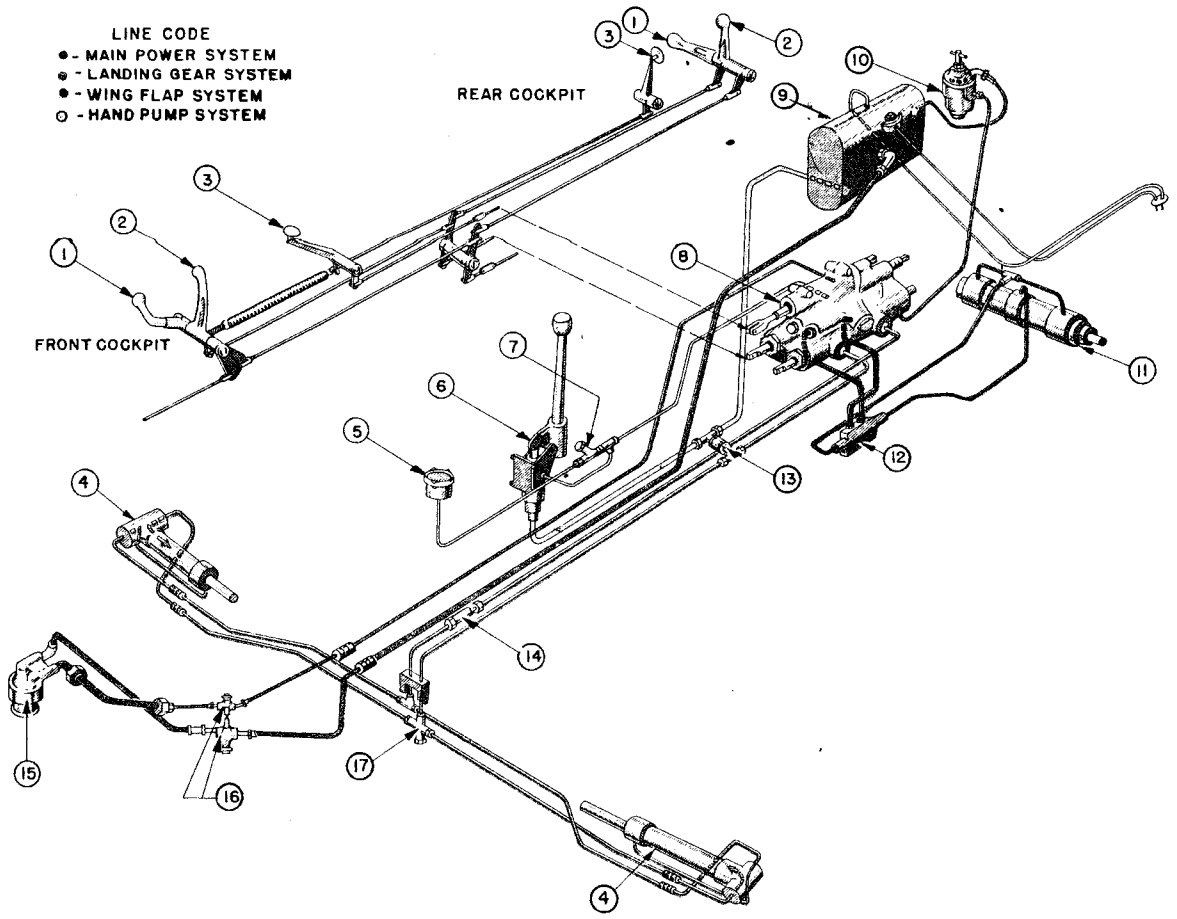
Trouble	*Possible Cause*	*Remedy*
ENGINE DRIVEN PUMP NOT DELIVERING FLUID.	Wrong direction of shaft rotation.	Check to see that direction of rotation of pump corresponds with direction of rotation of engine drive.
	Fluid level in reservoir low.	Fill fluid reservoir.
	Air leak in suction line.	Tighten fittings and replace faulty line if necessary. Test line and reservoir with air pressure and soapy water.
	Pump shear-coupling sheared.	Examine pump for faulty prime check valve or foreign matter jammed between gear teeth. Replace pump.
	Pump not primed.	Prime pump by filling half full of 3580 hydraulic fluid.
PUMP NOT DELIVERING PRESSURE.	Pump not delivering fluid for any of the above reasons.	Check fluid circulation by watching fluid in reservoir, or loosening pressure line near pump.
LOSS OF SYSTEM PRESSURE.	Leakage in system lines due to loose fitting.	Tighten fittings. Replace lines with faulty flared ends.
	Leakage in hydraulic units.	Replace hydraulic unit in which leak occurs.
	Selector valve plunger control valve leaks, permitting fluid from pressure port to seep through into return port.	Replace selector valve.
	Selector valve relief valve leaks.	Repair or replace selector valve.
	Internal leakage in operating cylinder.	Repair or replace operating cylinder.
GEAR FAILS TO EXTEND OR RETRACT PROPERLY.	Defective operating cylinder.	Check alignment of cylinder. Check for internal leakage.
	One way check valve in selector valve leaks when hand pump is used.	Reseat valve.
	Excessive leakage around plunger control valve in selector valve.	Refit plunger valve or replace selector valve.
	Relief valve setting too low.	Block piston rod travel and test with pressure gage. Set relief valve to relieve at 1000 pounds per square inch.
	Leak in selector valves or operating cylinder.	Replace valves.
AIR IN HYDRAULIC SYSTEM.	Small air leaks in pump intake line.	Tighten fittings or replace.
	Air leak at pump shaft oil seal.	Replace pump.
	Reservoir air vent plugged.	Clear vent line.

Trouble	*Possible Cause*	*Remedy*
EXTERNAL LEAKAGE AROUND PUMP.	Pump shaft oil seal worn.	Replace seal.
	Loose plug in body.	Tighten plug.
	Pump cover seal loose, or faulty gasket.	Tighten cover bolts and/or replace gasket.
FAILURE OF LANDING GEAR TO RETRACT AFTER PRESSURE HAS BUILT UP TO 1200 POUNDS.	Internal leakage in landing gear operating cylinder.	Replace packing.
	Hydraulic power cutting in too soon.	Adjust control rod clevis to position center line of selector valve plunger rod clevis bolt 13/16 inch from forward face of selector valve body with landing gear control handle in UP position.
FLAPS DO NOT RETRACT AFTER PRESSURE HAS BUILT UP TO 1000 POUNDS PER SQUARE INCH WHEN CONTROL LEVER IS PLACED IN "UP" POSITION.	Internal leakage in landing gear operating cylinder.	Replace packing.
	Flap selector valve plunger control valve improperly adjusted.	Adjust control rod clevis to position center line of selector valve plunger rod clevis bolt 2-5/16 inch from forward face of selector valve body with the flap control handle in the UP position.
FLAPS DO NOT EXTEND AFTER PRESSURE HAS BUILT UP TO 1000 POUNDS PER SQUARE INCH WHEN FLAP CONTROL LEVER IS PLACED IN "DOWN" POSITION.	Flap selector valve plunger control valve improperly adjusted.	Adjust as outlined above.
LANDING GEAR FAILS TO EXTEND AND LOCK AFTER LANDING GEAR CONTROL LEVER HAS BEEN MOVED TO THE "DOWN" POSITION.	Relief valve setting too low.	Adjust relief valve to relieve pressure at 1000 pounds per square inch.
	Leak in one way check valve in DOWN line.	Remove reservoir filler cap and check for bubbling of fluid in reservoir. Replace check valve.

b. MAIN HYDRAULIC SYSTEM.—*(See figures 215 and 219.)*—This hydraulic system is provided to operate the up and down movement of the wing flaps and landing gear.

(1) ENGINE-DRIVEN HYDRAULIC PUMP.

(a) DESCRIPTION. — *(See figures 220 and 221.)*—A Pesco pump, model IP-263-E, is used in the system. This gear-type hydraulic pressure pump is mounted on the left side of the engine accessory case and is the normal source of energy for the hydraulic system. The pump is designed for one direction of rotation (clockwise) and is capable of operating under pressure of 500 to 1000 pounds per square inch for brief intervals. Hydraulic fluid is drawn from the reservoir into the engine-driven pump and is directed to the discharge port by means of a set of two closely meshed gears. The drive gear is coupled with the power take-off of the engine and furnishes energy to rotate the driven gear which is closely meshed in with the drive gear. Clearance between the two gears does not permit the fluid to flow directly between them, but diverts the flow around the gears in the direction in which they rotate. Thus the flow to the pressure line is actuated. The gear supporting bushings allow fluid to flow to either end of the gears and back into a section of the intake port channels in the bushings. Back pressure at the ends of the gears is also relieved through these channels. A ball-type check valve (spring loaded) encased in the drive gear keeps the pump primed with hydraulic fluid to prevent air from being drawn through when pump is first started. In the event the pressure check valve becomes inoperative, fluid would rush back into the pump causing possible damage to the mechanism; however, this possibility is eliminated by means of a shear coupling on the rotor assembly, which acts as a shear pin that renders the pump inoperative when excessive load is put on the pump.



1. Landing Gear Controls
2. Flap Controls
3. Power Controls
4. Landing Gear Operating Cylinders
5. Pressure Gage
6. Emergency Hand Pump
7. Snubber Valve
8. Selector Valve
9. Reservoir
10. Filter
11. Flap Operating Cylinder
12. Flap Ratchet Valve
13. One-way Check Valve
14. Restrictor Valve
15. Engine-Driven Pump
16. Test Connections
17. Drain Plug

Figure 219 — Main Hydraulic System

(aa) PRESSURE-LOADED PUMP. *(See figure 220A.)*—Pumps of this type are installed on most of the AT-6F airplanes. Interchangeable with the 263-E, the newer pump is the Pesco IP-320-MA pressure-loaded type which operates successfully at temperatures down to —54°C. The pumping action is obtained by a pair of concisely meshed steel gears rotating in a closely fitted aluminum housing. As the teeth separate on one side, the resultant tooth space is filled with fluid from the inlet port and is carried around to the opposite side where the meshing teeth displace the fluid in the outlet port. Fluid is conducted from the discharge port to the underside of the flange on the gear supporting bearings, forcing the bearings, which are loosely fitted in the cover, against the gear faces. A channel incorporating a ball-type check valve scavenges to the pump inlet the fluid which is passed through the bearing lubricating grooves. The drive gear has a safety shear section which protects the pump in event of pump failure due to excessive load or jamming of parts. The meshing gears are lubricated within the pump.

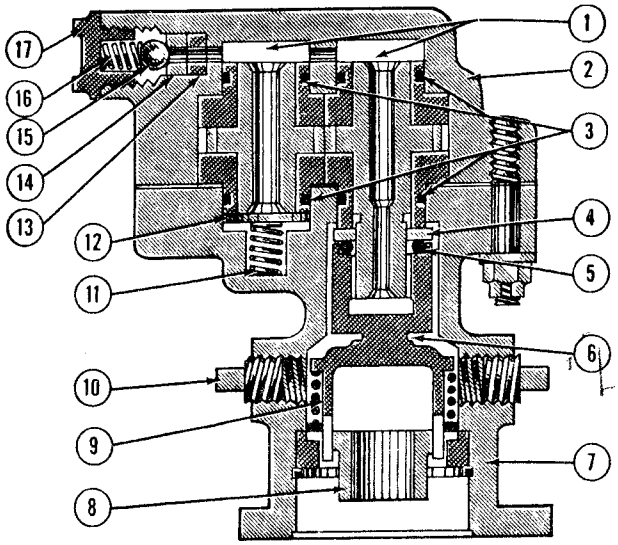
(b) REMOVAL.—The engine-driven hydraulic pump is mounted on the left side of the engine accessory section. To remove, first disconnect the two hydraulic lines attached to the inlet and outlet ports of the pump, then remove the four lockwired nuts which hold the pump body flange to the engine accessory section studs.

(c) TEST BEFORE INSTALLATION.—In the event that slow action in operating the hydraulic system cannot be traced to malfunction of other units of the system, the engine-driven pump is probably at fault, because of excessive wear. The pump should be removed and tested at 2200 rpm for an output of from ¾ to 1 gallon-per-minute and a pressure of 500 pounds per square inch.

(d) INSTALLATION.—Pumps in storage are filled with engine oil, so it is necessary to drain and flush with hydraulic fluid Specification No. AN-VV-O-336 before installing. Fill the pump about half full with the above fluid, and proceed as follows:

1. First remove the cover plate and gasket from the engine drive, and wipe the pad clean. Remove the shipping plugs from the pump ports; turn the shaft with the fingers to test for freedom of operation. Then, note carefully the direction of rotation of the engine drive, making sure it corresponds with the rotation as indicated by the markings on the pump. The markings are on the pump flange or pump body.

2. Before installing, coat drive splines with compound, anti-seize, Spec. No. AN-C-53. Also, apply a thin coat of the same lubricant to the male pipe threads. Take care to see that the first (leading) thread gets no lubricant. Place the gasket over the mounting studs, and mount the pump in the position most desirable for connecting the hydraulic lines. Pumps which have only



1. Oil Relief Passage
2. Cover
3. Seal Rings
4. Seal Disc
5. Seal Ring
6. Safety Shear Section
7. Body
8. Coupling
9. Coupling
10. Plug
11. Thrust Spring
12. Spacer
13. Seal
14. Seat
15. Ball Check Valve
16. Spring
17. Retainer

Fig. 220A — Section View of IP-320-MA Pump

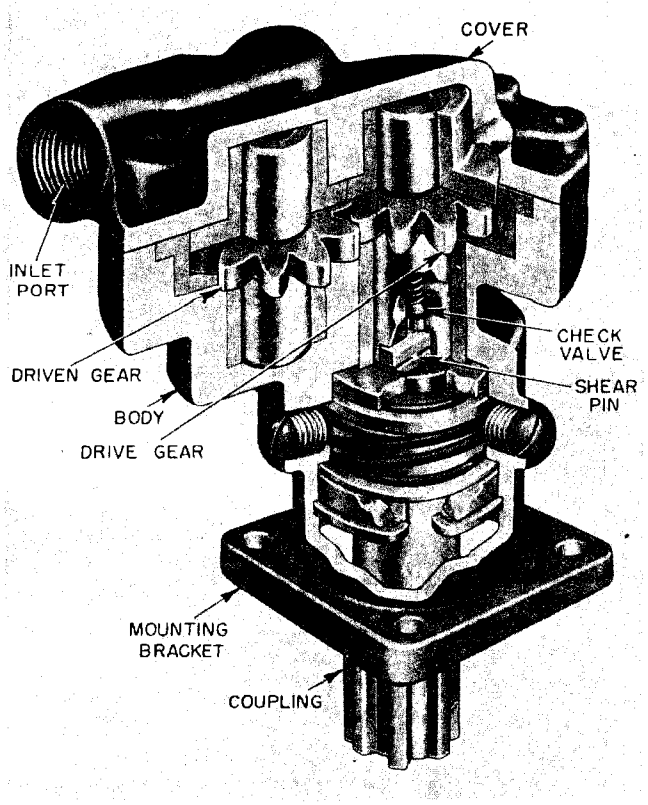


Figure 220 — Engine-Driven Hydraulic Pump

one or two drain holes have removable adapters which may be located to provide a drain hole in the lowest position. The adapter can be relocated by removing the four adapter screws and replacing the adapter in the desired position. Tighten the adapter screws and secure with safety wire. Mount the pump on the engine; tighten the mounting nuts evenly and tightly, and safety.

(2) SELECTOR VALVE UNIT.—*(See figure 222.)*

(a) DESCRIPTION.—The selector valve unit is mounted by means of brackets below the control shelf at the forward left side of the rear cockpit. It is the main control unit of the hydraulic system which diverts the flow of hydraulic fluid under pressure for operation of the landing gear and flaps and provides a relief valve for the power system. The selector valve unit incorporates the following valves: Power control valve, pressure relief valve, landing gear and flap selector valves, landing gear and flap one-way check valves, hand pump one-way check valve. The location and functions of these valves are contained in the paragraphs to follow.

1. POWER CONTROL VALVE.—This valve is incorporated in the upper part of the selector valve body and is connected to the power controls in the front and rear cockpits. When this valve is engaged, it diverts the flow of fluid from its course through the selector valve to the reservoir and directs it to the landing gear and flap selector valves. It operates on the time-lag principle and automatically disengages after a set length of time, approximately twice the time necessary to operate the flaps and landing gear. After disengaging, the valve diverts the fluid back to the reservoir. When using the engine-driven hydraulic pump, the power control valve must be engaged in order to operate the landing gear and flaps. The time-lag may be adjusted as described under paragraph *(d)*, ADJUSTMENTS.

2. PRESSURE RELIEF VALVE.—This valve is incorporated in the selector valve unit body below the power control valve and is set to relieve at approximately 1000 pounds per square inch, thus preventing excess pressure from building up and damaging the system. The relief valve is an easily adjustable, spring-loaded, piston-type valve which permits excess fluid to by-pass into the reservoir return port. The pressure relief valve will function only when the power control valve is engaged.

3. LANDING GEAR AND FLAP SELECTOR VALVES.—The lower portion of the selector valve unit body is composed of the landing gear and flap selector valves proper. They are of identical design. The outboard valve is the landing gear selector valve and the inboard valve is the flap selector valve. The two horizontal bores in the body of the unit are interconnected with drilled flow channels which permit the fluid to flow to and from the various component valves in the selector valve unit. Each of the above-mentioned horizontal bores contain a plunger with two large flap-fitted lobes designed to divert the pressure flow to the desired operating cylinder pressure line port.

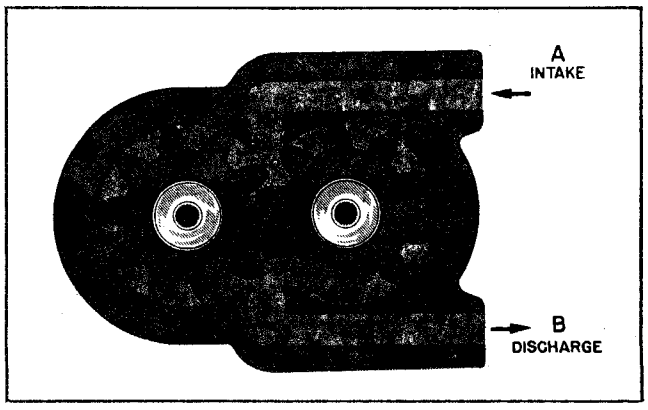
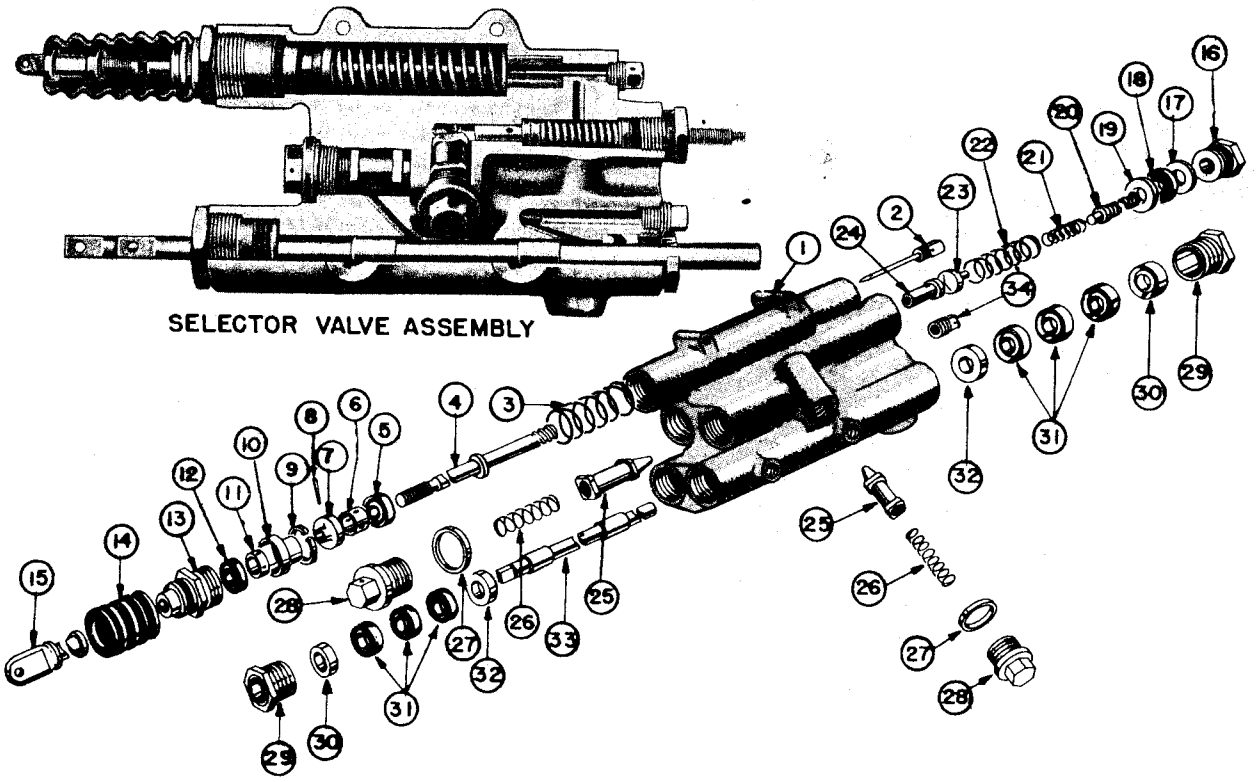


Figure 221 — Engine-Driven Pump Function Diagram

4. LANDING GEAR AND FLAP ONE-WAY CHECK VALVES.—These two valves are of identical construction and function in identical manner. Each valve is simply a plunger with a conical-faced end which seats in the unit body and is held in place by a



1. Control Unit Body
2. Power Control Needle Valve Needle
3. Return Spring
4. Power Control Needle Valve
5. Cup
6. Center Cup Retainer
7. Valve Stop
8. Pin
9. Seal Gasket
10. End Seal Retainer
11. Relief Valve Cap Small Retainer
12. Cup
13. Control Unit Power Control End
14. Dust Boot
15. Rod Clevis
16. Relief Valve Nut
17. Relief Valve Washer
18. Relief Valve Gasket
19. Relief Valve Seal Base Washer
20. Relief Valve Adjustment Screw
21. Relief Valve Innerspring
22. Relief Valve Outer Spring
23. Relief Valve Seat
24. Relief Valve
25. One-way Valve
26. One-way Valve Spring
27. One-way Valve Chamber Plug Gasket
28. One-way Valve Chamber Plug
29. Selector Valve Assembly End
30. Packing Base Ring
31. Packing Ring
32. Packing Base Retainer
33. Selector Control Valve Plunger
34. Plug

Figure 222 — Selector Valve Unit — 88-58011

spring. The landing gear one-way check valve is located directly above the landing gear selector valve and the flap one-way check valve is located directly above the flap selector valve. Each valve is placed between the power control valve pressure port and main center selector valve pressure port. The function of these two valves is to prevent pressure equalization in the event both the flap and landing gear selector valves are operated simultaneously. Fluid flowing from the power control valve pressure port unseats the valve and passes on to the selector valve main center pressure port. The instant the fluid ceases to flow because of a sudden pressure drop, the pressure on the back side of the valve causes the valve to seat, thus preventing a return flow of fluid. Consequently, the initial pressure is confined in the corresponding selector valve and operating cylinder until the power control is again engaged, thus completing the operation.

5. HAND PUMP ONE-WAY CHECK VALVE.—The hand pump one-way check valve is located in the center of the outboard side of the selector valve unit body between the lower power control valve pressure port and the landing gear one-way check valve. The hand pump pressure port has an inlet to the check valve chamber just behind the conical valve head. The hand pump one-way check valve prevents hand pump fluid pressure from by-passing through the power control pressure port and into the reservoir return line port. Thus pressure is confined to the landing gear and flap selector valves and operating cylinders as required. The hand pump check valve also prevents pressure generated by the hand pump from being dissipated through the system relief valve. No relief valve is necessary for hand-pump pressure output since the pump is designed to prevent generation of excessive pressure which would be detrimental to any part of the system.

6. EXPLANATION OF SELECTOR VALVE FUNCTION DIAGRAM.—*(See figure 223.)*

CONDITION I: AIRPLANE ON GROUND WITH ENGINE RUNNING — FLAPS AND LANDING GEAR INOPERATIVE.

Power Control—DISENGAGED
Flap Control—UP
Landing Gear Control—DOWN
Hand Pump—INOPERATIVE

Fluid under slight pressure from engine-driven pump flows unrestricted through the pressure control chamber "H," through channel "N" and out through return line channel "D'." Fluid in other channels "O," "R," "P," "A'," "V," "S," and "T" is static because the flap is in full "UP" position, the landing gear has already reached its full "DOWN" position and the piston seal cup and check valve in the hand pump prevents fluid from returning to reservoir; therefore, the fluid will take the path of least resistance through "H." The same applies if the landing gear selector valve "Y" is in the "UP" position and also if the flap selector valve "U" is in the "DOWN" or locked position. The check valves "K," "J," and "M" and the relief valve "L" are not used in this condition.

CONDITION II: AIRPLANE IN FLIGHT.

Landing Gear Control—DOWN
Flap Control—LOCKED
Power Control—ENGAGED
Hand Pump—INOPERATIVE

Power control valve stem "E" closes chamber "H," thus fluid under pressure from engine-driven pump flows through check valves "M" and "K" through line "R" to landing gear selector valve "Y" and out through port "B'" to actuate the landing gear. Return fluid enters port "C," flows through channel "A'" and returns to reservoir through line "D'." A somewhat similar condition will exist when the landing gear or flap controls are moved for different selected positions. Check valves "K" and "J" will retain fluid under pressure in lines "R" and "P" if the original source of pressure is suddenly cut off. They will retain pressure for a certain length of time, such as to permit the power control to be pressed again immediately. During the time that the power control is engaged any pressure from port "F" in excess of 1000 pounds per square inch, which may result when landing gear has reached its full down position, will be relieved through relief valve "L." During the operation of the landing gear or flaps, the power control is gradually returning to the disengaged position by means of fluid slowly flowing through hole "A," displacing the fluid in chamber "D." When the power control valve is moved forward by the power control, fluid is forced past piston seal cup "B" into chamber "D." Packing cup "B" will not permit fluid to return. Therefore, pressure from spring "C" will force valve stem "E" to the left thus forcing fluid through hole "A" which will be metered out stem "E" by needle valve "G," permitting power control valve to slowly return to its disengaged position. When the power control valve has been disengaged, fluid from engine-driven pump will be diverted to reservoir. The

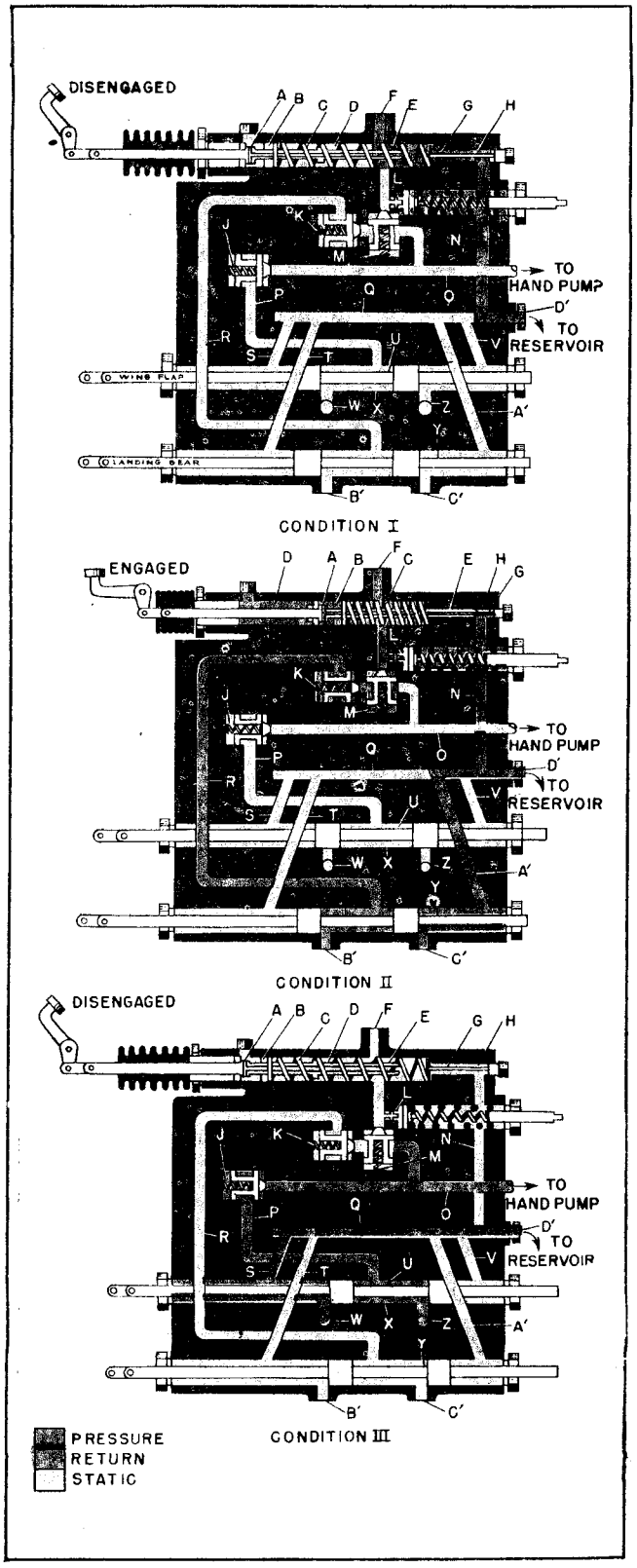


Figure 223 — Selector Valve Function Diagram

flaps are maintained in a fixed intermediate position when the flap selector valve is in the LOCKED position, thus closing off both pressure-lines, selector valve ports "W" and "Z."

CONDITION III: HAND-PUMP OPERATION.
Power Control—DISENGAGED
Flap Control—DOWN
Landing Gear Control—UP
Hand Pump—IN OPERATION

The emergency hand pump is being operated to produce fluid pressure which flows through hand-pump pressure line "O" to hand-pump check valve "M." The hand-pump check valve prevents the fluid from flowing through the power control valve chamber and into the return line channel "N." Fluid under pressure flows past check valve "J" and into channel "P" and flap selector valve chamber "X." The fluid then flows out of the flap selector valve "DOWN" port "Z" to the flap operating cylinder to actuate the flaps. Fluid displaced by the flap operating cylinder piston returns through the flap "UP" lines, through port "W" and then to return channels "S" and "Q" and line "D'." Since the landing gear remains unchanged in the retracted position, fluid pressure and flow is of no importance in the landing gear selector valve. A somewhat similar condition will exist when the flaps or landing gear controls are moved for different selected positions. When the engine-driven pump is in operation, the power control valve must be disengaged before the hand pump can be operated.

(b) REMOVAL.—The landing gear and flap selector valve unit is mounted by means of brackets to the underside of the control shelf at the left forward side of the rear cockpit. Disconnect the seven hydraulic lines at outlets located on the valve body; also disconnect control rods attached to valve piston rods, remove the two bolts attaching the valve unit to the support bracket.

(c) TEST BEFORE INSTALLATION.—*(See figure 224.)*—To test the selector valve unit, proceed as follows:

1. Apply 1000 pounds per square inch pressure at port "B" with ports "D," "E," "F" and "G" plugged. There should be no leakage at port "A" and a maximum leakage of 4 ounces per minute at port "C," with the selector valve rods in any of the three positions.

2. Apply 750 pounds per square inch pressure at ports "D" and "E," with the selector valve rods in the forward extended position and ports "F" and "G" plugged. There should be no leakage at port "B."

3. Apply 1000 pounds per square inch pressure at one gallon per minute at port "A;" fit the power control valve needle in the valve stem as outlined under adjustment.

4. Apply 1100 to 1200 pounds per square inch pressure at port "A;" adjust the relief valve to release at a pressure of 1000 pounds per square inch.

5. Apply 750 pounds per square inch pressure at port "A." Over-all leakage of the unit should not exceed 10 ounces per minute.

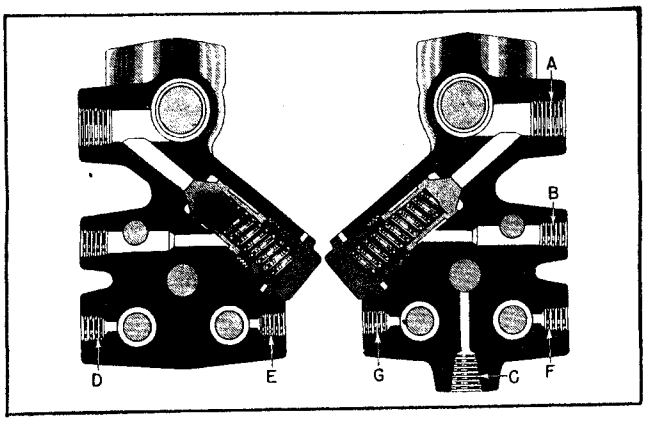


Figure 224—Selector Valve Test Diagram

6. Apply 2000-2500 pounds per square inch pressure at port "A" with other ports plugged. Check for external leaks.

(d) ADJUSTMENTS.

1. POWER CONTROL VALVE.

a. GENERAL.—To check and adjust power control valve, proceed as follows:

(1) Although the time-lag of the power control valve may vary widely with extreme high or low temperatures, the valve should be adjusted so that the power control disengages at the end of approximately 1 to 2 minutes. The check for the time-lag should be made when the fluid in the system is warm but not hot, approximately 43°C (110°F). (See figure 225.)

(2) It is to be noted here that when the system is cold, that is, when the engine is started after the airplane has not been flown for some time (especially in zero weather), the time-lag may be as much as 10 minutes. Therefore, time should not be checked until system is warm. When the system is very cold, engaging the power control several times will accelerate warming the fluid.

(3) To check the time-lag, push firmly on power control lever with engine running, and record the time elapsed between the removal of the hand from lever until the pressure on the gage begins to drop. There will be no rapid complete drop of pressure, merely a reduction when the power control disengages. Make several tests; if the average is above or below the above limits, adjustments are necessary.

b. POWER CONTROL ADJUSTMENT (LATE MODEL.)—Selector valve unit No. 88-58011 uses a non-adjustable time-lag needle and stem assembly. No means of external adjustment is provided for the power control time-lag on the selector valve unit itself, since the select fit of the power control valve needle and stem essentially control the time-lag interval. The stem and needle are a select fit on asssembly, and the predetermined setting is such that the time-lag interval is of approximately 1 to 2 minutes duration when the fluid is warm (approximately 110°F (43°C)). The

6. EXPLANATION OF SELECTOR VALVE FUNCTION DIAGRAM.—*(See figure 223.)*

CONDITION I: AIRPLANE ON GROUND WITH ENGINE RUNNING — FLAPS AND LANDING GEAR INOPERATIVE.

Power Control—DISENGAGED
Flap Control—UP
Landing Gear Control—DOWN
Hand Pump—INOPERATIVE

Fluid under slight pressure from engine-driven pump flows unrestricted through the pressure control chamber "H," through channel "N" and out through return line channel "D'." Fluid in other channels "O," "R," "P," "A'," "V," "S," and "T" is static because the flap is in full "UP" position, the landing gear has already reached its full "DOWN" position and the piston seal cup and check valve in the hand pump prevents fluid from returning to reservoir; therefore, the fluid will take the path of least resistance through "H." The same applies if the landing gear selector valve "Y" is in the "UP" position and also if the flap selector valve "U" is in the "DOWN" or locked position. The check valves "K," "J," and "M" and the relief valve "L" are not used in this condition.

CONDITION II: AIRPLANE IN FLIGHT.

Landing Gear Control—DOWN
Flap Control—LOCKED
Power Control—ENGAGED
Hand Pump—INOPERATIVE

Power control valve stem "E" closes chamber "H," thus fluid under pressure from engine-driven pump flows through check valves "M" and "K" through line "R" to landing gear selector valve "Y" and out through port "B'" to actuate the landing gear. Return fluid enters port "C," flows through channel "A'" and returns to reservoir through line "D'." A somewhat similar condition will exist when the landing gear or flap controls are moved for different selected positions. Check valves "K" and "J" will retain fluid under pressure in lines "R" and "P" if the original source of pressure is suddenly cut off. They will retain pressure for a certain length of time, such as to permit the power control to be pressed again immediately. During the time that the power control is engaged any pressure from port "F" in excess of 1000 pounds per square inch, which may result when landing gear has reached its full down position, will be relieved through relief valve "L." During the operation of the landing gear or flaps, the power control is gradually returning to the disengaged position by means of fluid slowly flowing through hole "A," displacing the fluid in chamber "D." When the power control valve is moved forward by the power control, fluid is forced past piston seal cup "B" into chamber "D." Packing cup "B" will not permit fluid to return. Therefore, pressure from spring "C" will force valve stem "E" to the left thus forcing fluid through hole "A" which will be metered out stem "E" by needle valve "G," permitting power control valve to slowly return to its disengaged position. When the power control valve has been disengaged, fluid from engine-driven pump will be diverted to reservoir. The

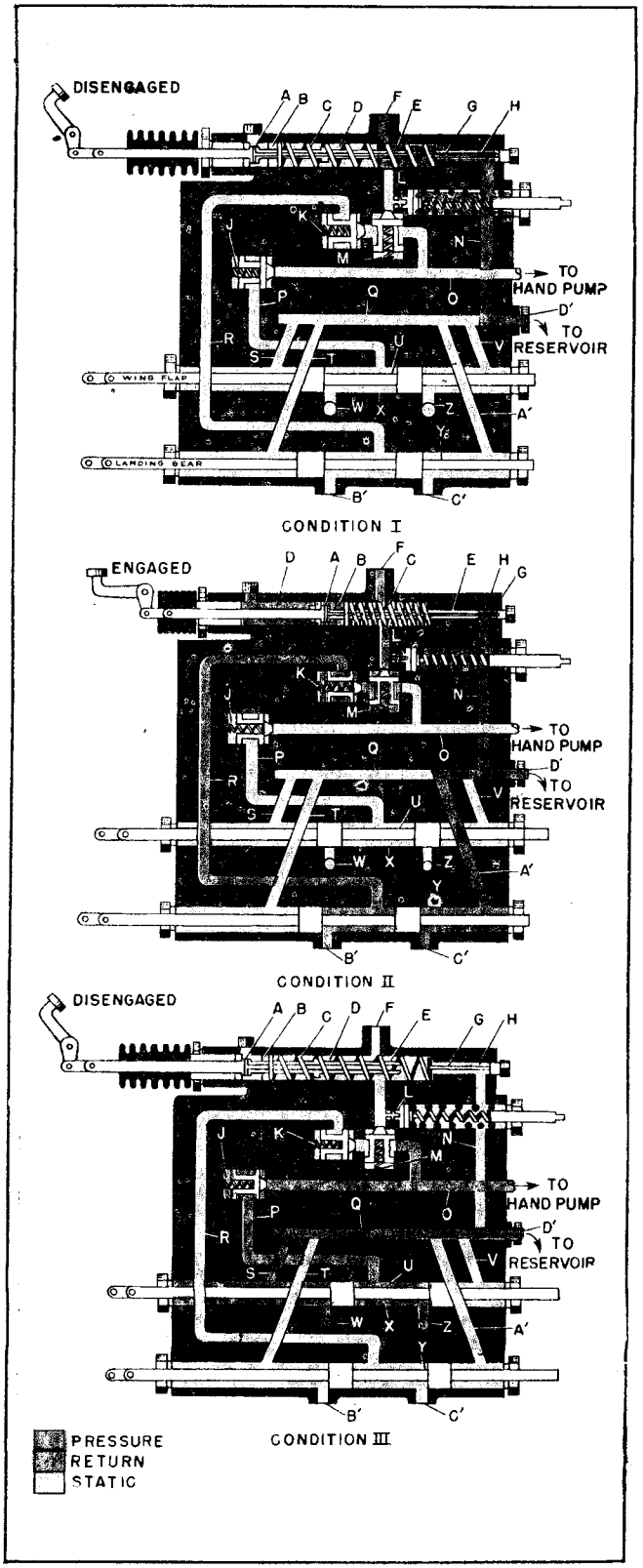


Figure 223 — Selector Valve Function Diagram

flaps are maintained in a fixed intermediate position when the flap selector valve is in the LOCKED position, thus closing off both pressure-lines, selector valve ports "W" and "Z."

CONDITION III: HAND-PUMP OPERATION.
Power Control—DISENGAGED
Flap Control—DOWN
Landing Gear Control—UP
Hand Pump—IN OPERATION

The emergency hand pump is being operated to produce fluid pressure which flows through hand-pump pressure line "O" to hand-pump check valve "M." The hand-pump check valve prevents the fluid from flowing through the power control valve chamber and into the return line channel "N." Fluid under pressure flows past check valve "J" and into channel "P" and flap selector valve chamber "X." The fluid then flows out of the flap selector valve "DOWN" port "Z" to the flap operating cylinder to actuate the flaps. Fluid displaced by the flap operating cylinder piston returns through the flap "UP" lines, through port "W" and then to return channels "S" and "Q" and line "D'." Since the landing gear remains unchanged in the retracted position, fluid pressure and flow is of no importance in the landing gear selector valve. A somewhat similar condition will exist when the flaps or landing gear controls are moved for different selected positions. When the engine-driven pump is in operation, the power control valve must be disengaged before the hand pump can be operated.

(b) REMOVAL.—The landing gear and flap selector valve unit is mounted by means of brackets to the underside of the control shelf at the left forward side of the rear cockpit. Disconnect the seven hydraulic lines at outlets located on the valve body; also disconnect control rods attached to valve piston rods, remove the two bolts attaching the valve unit to the support bracket.

(c) TEST BEFORE INSTALLATION. — *(See figure 224.)*—To test the selector valve unit, proceed as follows:

1. Apply 1000 pounds per square inch pressure at port "B" with ports "D," "E," "F" and "G" plugged. There should be no leakage at port "A" and a maximum leakage of 4 ounces per minute at port "C," with the selector valve rods in any of the three positions.

2. Apply 750 pounds per square inch pressure at ports "D" and "E," with the selector valve rods in the forward extended position and ports "F" and "G" plugged. There should be no leakage at port "B."

3. Apply 1000 pounds per square inch pressure at one gallon per minute at port "A;" fit the power control valve needle in the valve stem as outlined under adjustment.

4. Apply 1100 to 1200 pounds per square inch pressure at port "A;" adjust the relief valve to release at a pressure of 1000 pounds per square inch.

5. Apply 750 pounds per square inch pressure at port "A." Over-all leakage of the unit should not exceed 10 ounces per minute.

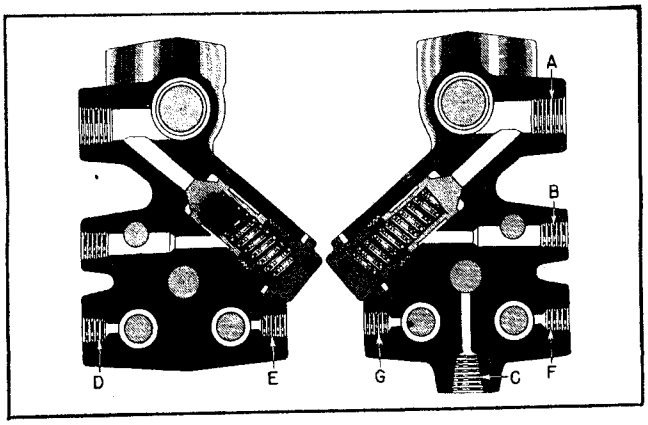


Figure 224 — Selector Valve Test Diagram

6. Apply 2000-2500 pounds per square inch pressure at port "A" with other ports plugged. Check for external leaks.

(d) ADJUSTMENTS.

1. POWER CONTROL VALVE.

a. GENERAL.—To check and adjust power control valve, proceed as follows:

(1) Although the time-lag of the power control valve may vary widely with extreme high or low temperatures, the valve should be adjusted so that the power control disengages at the end of approximately 1 to 2 minutes. The check for the time-lag should be made when the fluid in the system is warm but not hot, approximately 43°C (110°F). (See figure 225.)

(2) It is to be noted here that when the system is cold, that is, when the engine is started after the airplane has not been flown for some time (especially in zero weather), the time-lag may be as much as 10 minutes. Therefore, time should not be checked until system is warm. When the system is very cold, engaging the power control several times will accelerate warming the fluid.

(3) To check the time-lag, push firmly on power control lever with engine running, and record the time elapsed between the removal of the hand from lever until the pressure on the gage begins to drop. There will be no rapid complete drop of pressure, merely a reduction when the power control disengages. Make several tests; if the average is above or below the above limits, adjustments are necessary.

b. POWER CONTROL ADJUSTMENT (LATE MODEL.)—Selector valve unit No. 88-58011 uses a non-adjustable time-lag needle and stem assembly. No means of external adjustment is provided for the power control time-lag on the selector valve unit itself, since the select fit of the power control valve needle and stem essentially control the time-lag interval. The stem and needle are a select fit on asssembly, and the predetermined setting is such that the time-lag interval is of approximately 1 to 2 minutes duration when the fluid is warm (approximately 110°F (43°C)). The

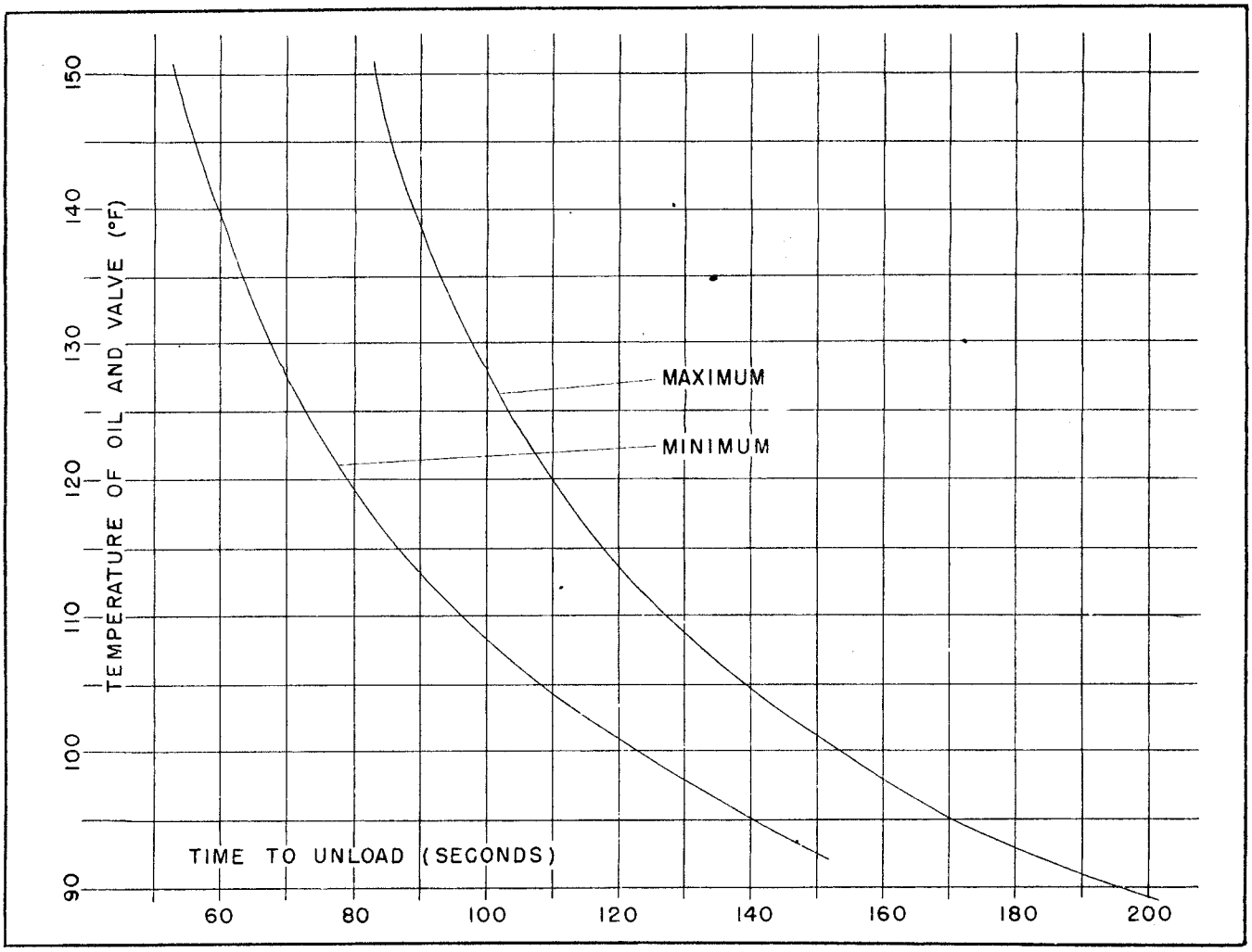


Figure 225 — Time Lag Chart for Power Control Valve

predetermined setting of approximately 120 seconds should be made when the selector valve is mounted on a test stand or on the airplane, provided the power control linkage is disconnected from the control valve. The control valve must be engaged its full stroke in either case. The diameter of the needle is increased to increase the time-lag and decreased to decrease time-lag. Normally a large needle is hand-honed to size to obtain the proper time-lag setting. The fact that the time-lag interval is also affected by the distance the power control valve needle enters the valve stem provides a means for final external adjustment of the power control time-lag after the selector valve is installed on the airplane. If the distance that the power control valve enters the valve stem is increased, the time-lag is increased. Decreasing the distance that the needle enters the stem decreases the time-lag. An adjustable setscrew, which is located on the front cockpit power control lever outboard shaft support, controls the movement of the power control lever, which in turn controls the inward movement of the power control valve stem. Turning the setscrew clockwise decreases the time-lag while turning the setcsrew counterclockwise increases the time-lag. (See figure 226.) If the average time-lag is longer than 2 minutes, turn the setscrew clockwise to decrease the time-lag and test. If after depressing the power control lever six or more times the average time-lag is less than 1 minute, turn the setscrew counterclockwise to increase the time-lag.

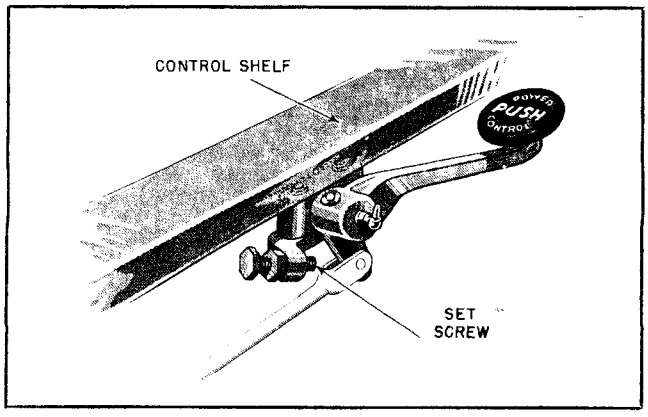


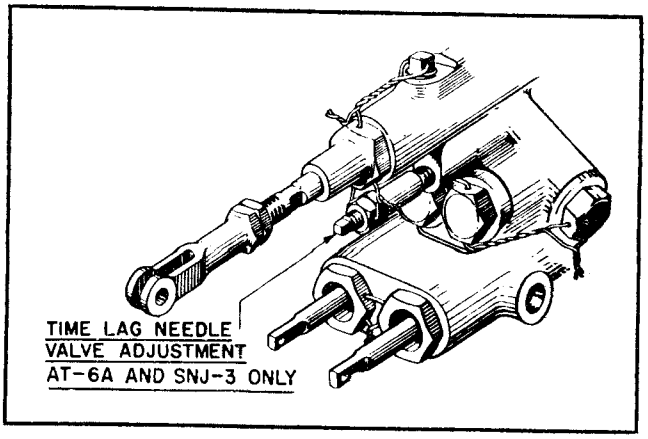
Figure 226 — Power Control Lever Adjustment Screw

c. POWER CONTROL ADJUSTMENT (EARLY MODEL.)—*(See figure 227.)*—Check time-lag as instructed in paragraph *1.* a. *(1)* through *(3)* above. Readjust as follows, if necessary.

(1) Selector valve unit No. 55-58011 uses the nonadjustable metering pin No. 50-58054. Screw valve stem farther into the clevis for less time-lag, and farther out for more time-lag. This allows a total 1/2 inch adjustment. Adjustment should not be made in such a way that a wire can be passed through the inspection hole in the clevis, or in such a way that the stem screws into the clevis slot. After adjustment, recheck time-lag and readjust as indicated. If, after adjustment, the time-lag still exceeds 2 minutes, remove the pipe plug immediately under the pressure control valve stem, and remove the metering pin 50-58054. Metering pin 55-58202 is not interchangeable with pin 50-58054. For unit employing pin 55-58202, see following additional power control adjustment instructions. After removing pin 50-58054, clean the chamber and lightly polish pin. Reassemble, recheck time, and readjust as required. If after adjustment, the time-lag is still less than 1 minute, the metering pin should be replaced. If new pins are not available, the diameter of the old pin may be built up slightly by tinning the pin. It must be hand-finished to suit, that is, it must be polished down until the proper time-lag is obtained, with the valve stem adjusted to a position intermediate between extremes. The power control will not engage unless the engine pump is running.

(2) Selector valve unit No. 66-58011 uses the adjustable time-lag needle valve No. 55-58202. Adjust the valve assembly with pin 55-58202 for the same time-lag as previously specified. Check to see that full stroke of 1-1/4 inches is obtained on movement of power control plunger; adjust if necessary. Back-off on hexagonal lock nut on time-lag adjusting valve located immediately below the power control plunger, and back-off on stud three to four turns. With engine pump or test pump running, operate power control six or more times. The control will disengage rapidly under these circumstances. After this has been done, adjust the time-lag valve stud in, until it is snugly tight; then back-off one-quarter turn. Check power control for time of engagement, and adjust valve stud *in* for more time-lag, or *out* for less.

2. RELIEF VALVE.—To adjust this valve, back off on the large hexagonal nut (figure 228) located on upper aft end of the valve approximately 1-1/2 turns. Then, with engine running at 1200 rpm, engage power control; adjust threaded stem until pressure of 1000 pounds per square inch is indicated on the pressure gage in the cockpit. Turn the stem clockwise to increase pressure, and counterclockwise to decrease it. When proper pressure is obtained, hold the stem to prevent it from turning, tighten the hexagon lock nut, and safety with lockwire.



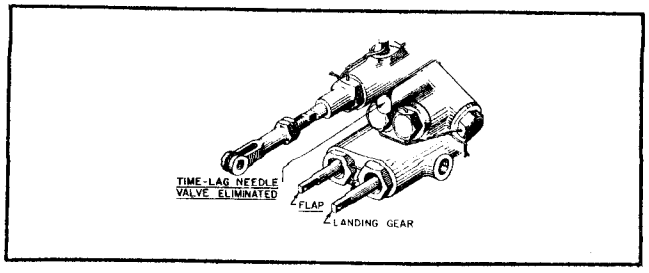


Figure 227 — Selector Valve Time Lag Adjustment — Earlier Airplanes

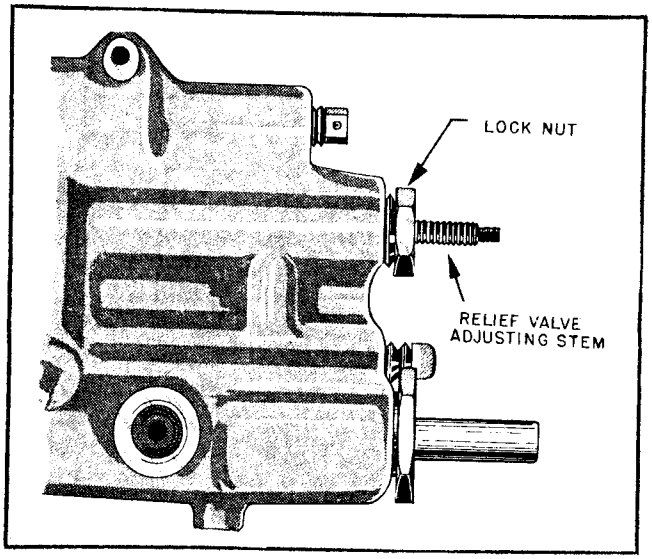


Figure 228 — Selector Valve Relief Valve Adjustment

3. SELECTOR PLUNGER VALVE.—*(See figure 229.)*—With the landing gear control lever in the "DOWN" position, the landing gear selector valve plunger rod should extend beyond the forward end of the valve body so that a dimension of 2-7/16 inches exists between the center of the clevis bolt which attaches the selector valve plunger rod to the control rod and the lower forward face of the selector valve unit body. This

adjustment is necessary in order to clear "DOWN" pressure port and return port. The control rod on the flap selector valve plunger should be adjusted so that a dimension of 2-5/16 inches exists between the center of the clevis bolt and forward face of the valve body when the flap selector valve control handle is in the "UP" position.

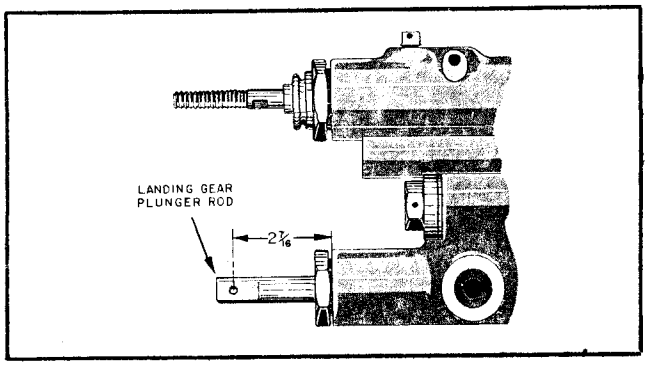
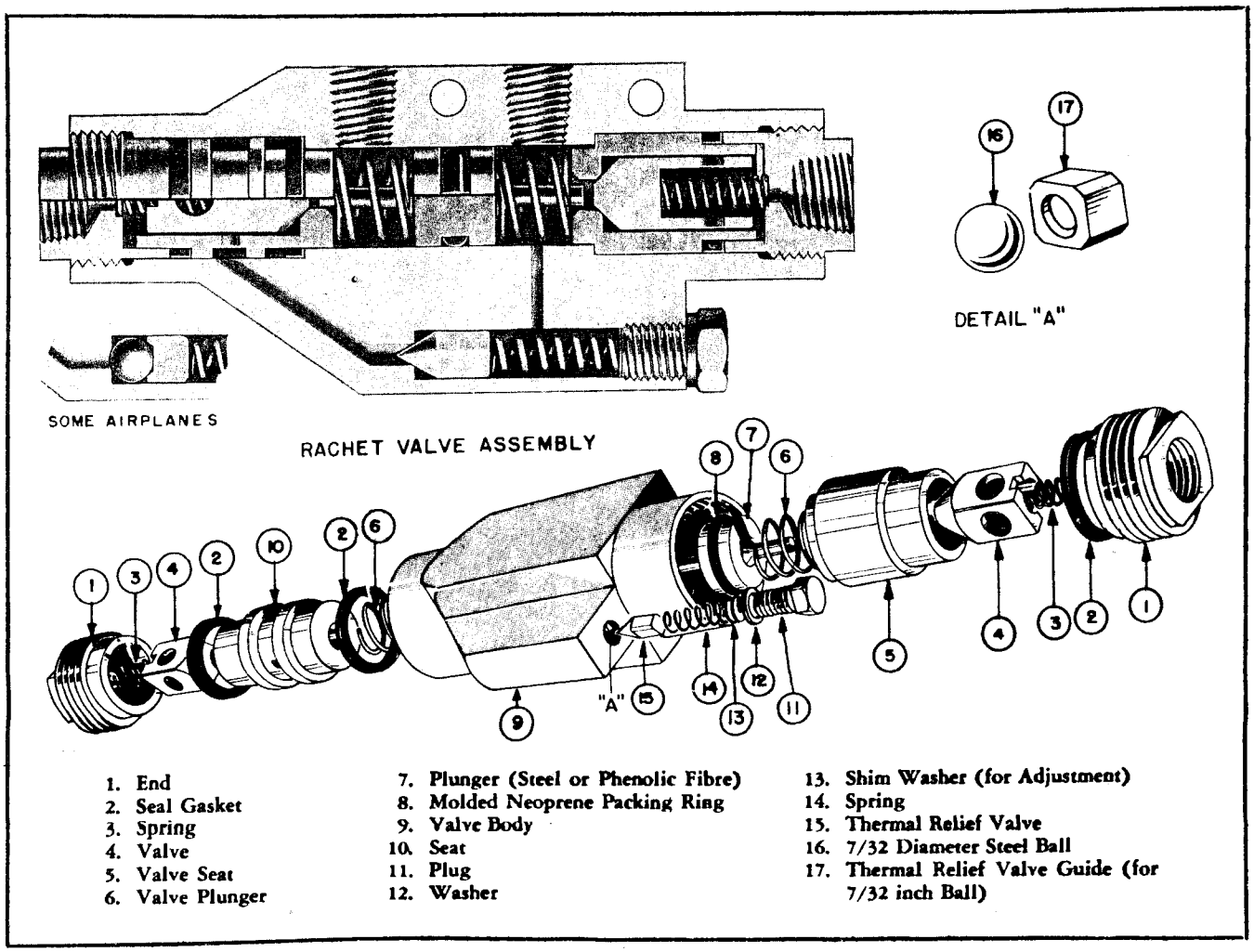


Figure 229 — Selector Valve Landing Gear Plunger Rod Adjustment

(e) INSTALLATION. — Attach inboard and outboard selector valve supports to flanges mounted on the control shelf forward of the rear cockpit, using two AN4-5A bolts at each flange. Insert bell crank shaft through the opening at the forward end of supports, at the same time installing bell cranks and washer on the shaft. Secure the shaft in place with an AN392-45 pin and cotter. Mount the selector valve unit between the supports and bolt in place with an AN3-44A bolt and an AN3-51A bolt. Connect bell cranks to actuating rods and selector valve plunger links.

(3) FLAP RATCHET VALVE — 88-58070 — LATER MODELS.—*(See figure 230.)*

(a) DESCRIPTION.—The flap ratchet valve is located between the wing flap selector valve and the wing flap operating cylinder in the hydraulic system and is attached to the lower left fuselage longeron below the selector valve unit body. The valve consists of an aluminum-alloy body with a spring-centered plunger located between two spring-loaded, one-way check valves facing in opposite directions. The spring-centered plunger on earlier airplanes is made of steel, while some later air



1. End
2. Seal Gasket
3. Spring
4. Valve
5. Valve Seat
6. Valve Plunger
7. Plunger (Steel or Phenolic Fibre)
8. Molded Neoprene Packing Ring
9. Valve Body
10. Seat
11. Plug
12. Washer
13. Shim Washer (for Adjustment)
14. Spring
15. Thermal Relief Valve
16. 7/32 Diameter Steel Ball
17. Thermal Relief Valve Guide (for 7/32 inch Ball)

Figure 230 — Flap Ratchet Valve — 88-58070

planes have plungers made of phenolic fiber. The top front port provides an outlet to the flap selector valve "DOWN" port, while the top rear port provides an outlet to the flap selector valve "UP" port. The left end (or forward port) is the flap "DOWN" port to the flap operating cylinder, and the right end (or aft port) is the flap "UP" port to the flap operating cylinder. The function of the ratchet valve is to retain sufficient pressure in the flap operating cylinder to hold the flaps in the desired position since the selector valve is not designed to be leak-proof. A pressure of 700 pounds per square inch is usually retained in that portion of the system between the ratchet valve and the flap operating cylinder. The ratchet valve automatically locks the flaps in either the "UP," "DOWN," or "INTERMEDIATE" positions by means of the one-way check valve. An adjustable spring-loaded thermal relief valve located in the bottom of the ratchet valve body permits excess fluid to return to the selector valve unit via the flap "DOWN" pressure line should thermal expansion cause the fluid pressure to exceed 1400 pounds per square inch. Early airplanes have a spring-loaded, conical-shaped relief valve and seat, while some later airplanes have a guide and ball check valve.

NOTE

FLAP RATCHET VALVE—EARLY MODELS.

Earlier models of this series were equipped with units having the same function as the flap ratchet valve described above, but differing in details of construction. (See figures 231 and 232.) These valves do not include any neoprene or other parts subject to deterioration so do not require disassembly for replacements. The most likely cause of malfunctioning is foreign matter becoming lodged in the valve.

EXPLANATION OF RATCHET VALVE FUNCTION DIAGRAM.—*(See figure 233.)*

CONDITION I: FLAPS UP OR DOWN—STATIC FLUID.—When the flap control cylinder has completed its operation of extending or retracting the flaps, the ratchet valve resumes this condition. With the flaps "DOWN," hydraulic fluid pressure from the operating cylinder entering port "G" forces valve "H" to its seated position. With the flaps "UP" hydraulic fluid pressure from the flap cylinder entering port "E" forces valve "C" to seat. Thus hydraulic pressure is locked

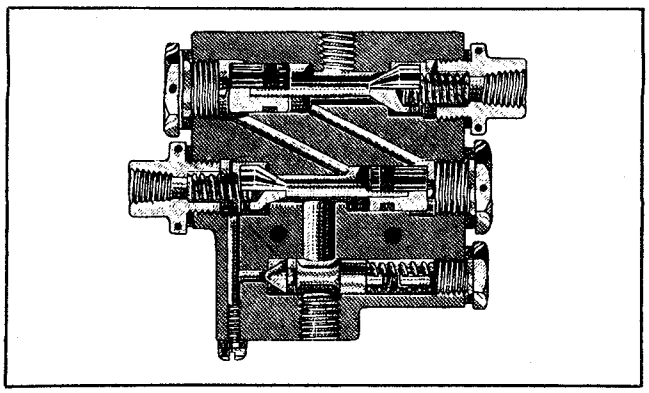


Figure 231 — Flap Ratchet Valve — 66-58070

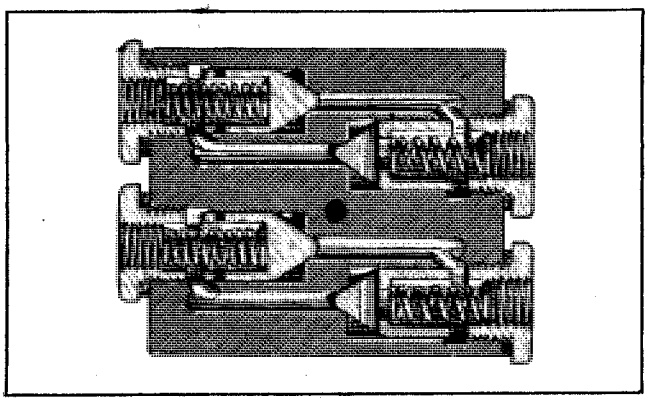


Figure 232 — Flap Ratchet Valve — 55-58014

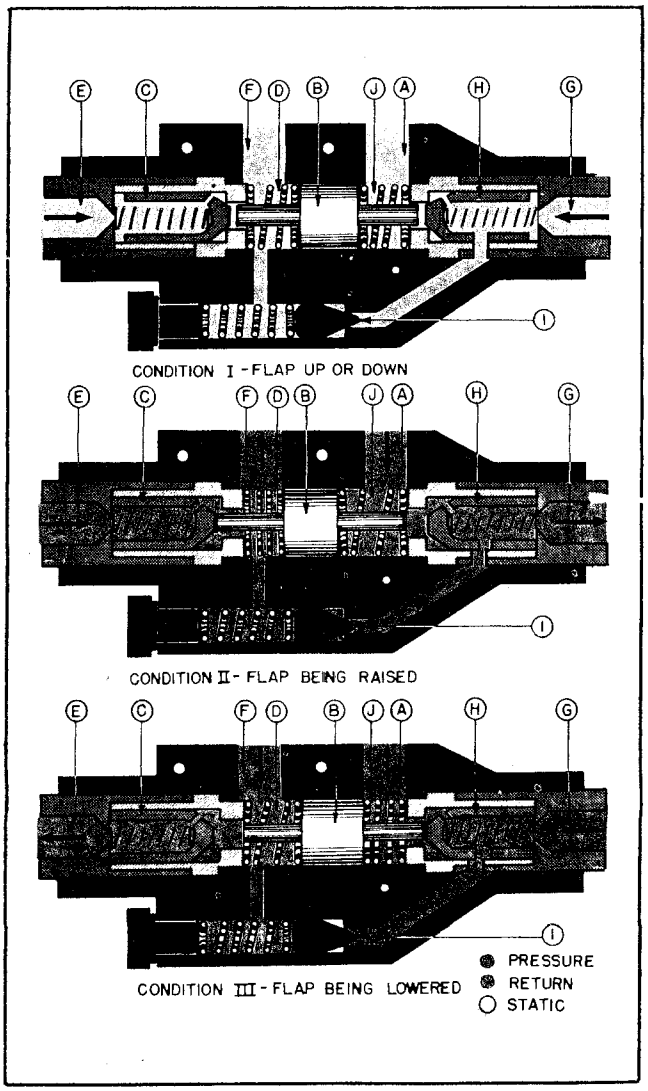


Figure 233 — Flap Ratchet Valve Function Diagram — 88-58070

in the flap operating cylinder. Should the pressure of the flap operating cylinder exceed 1400 pounds per square inch due to thermal expansion, the spring-loaded one-way relief valve "I" will move off its seat, allowing excess fluid to drain into the main body of the valve and return to the selector valve through port "F."

CONDITION II: FLAPS BEING RAISED. — Hydraulic fluid under pressure from the flap selector valve "UP" port enters port "A" and passes through check valve "H" and port "G" to the flap operating cylinder. The pressure necessary to move the operating cylinder piston builds up in chamber "J," thus moving plunger "B" which unseats check valve "C," allowing displaced fluid from the operating cylinder to enter port "E" and flow out port "F" to the selector valve return port. This condition, therefore, will permit the flap to actuate until necessary displacement has been completed, and the pressure drops in the line entering port "A." When pressure drops in port "A," check valves "H" and "C" will seat, retaining fluid pressure in the operating cylinder, which in turn will hold the flaps in the desired position as illustrated in Condition I. A thermal expansion relief valve "I" is located in the bottom of the ratchet valve. This valve relieves pressure in the operating cylinder should it exceed 1400 pounds per square inch and allows the excess fluid to by-pass from chamber "J" through relief valve "I" into chamber "D."

CONDITION III: FLAPS BEING LOWERED.—Hydraulic fluid under pressure from the flap selector valve "DOWN" port enters port "F" and passes through check valve "C" and port "E" to the flap operating cylinder. The pressure necessary to move the operating cylinder piston builds up in chamber "D," thus moving plunger "B" which unseats check valve "H," allowing displaced fluid from the operating cylinder to enter port "G" and flow out port "A" to the selector valve return port. This condition, therefore, will permit the flap operating cylinder to actuate until necessary displacement has been completed and the pressure drops in the line entering port "F." When pressure drops in port "F," check valves "C" and "H" will seat, retaining fluid in the operating cylinder, which in turn will hold the flaps in the desired position as illustrated in Condition I.

(b) REMOVAL.—The wing flap ratchet valve, located at the lower left forward corner of the rear cockpit, may be readily removed by disconnecting the four flap hydraulic lines and removing the two nuts and bolts attaching the valve body to its mounting clips on the lower left fuselage longeron.

(c) TEST BEFORE INSTALLATION.—Assemble test stand system, as shown in figure 234, and proceed as follows:

1. With ports "A," and "B" and "D" plugged, apply 2500 pounds per square inch at port "C." Check for external leaks.

2. With valve "E" open, "F" closed, port "A" plugged and port "B" open, apply hand-pump pressure at port "C." Adjust thermal relief valve to release at 1500 plus or minus 100 pounds per square inch.

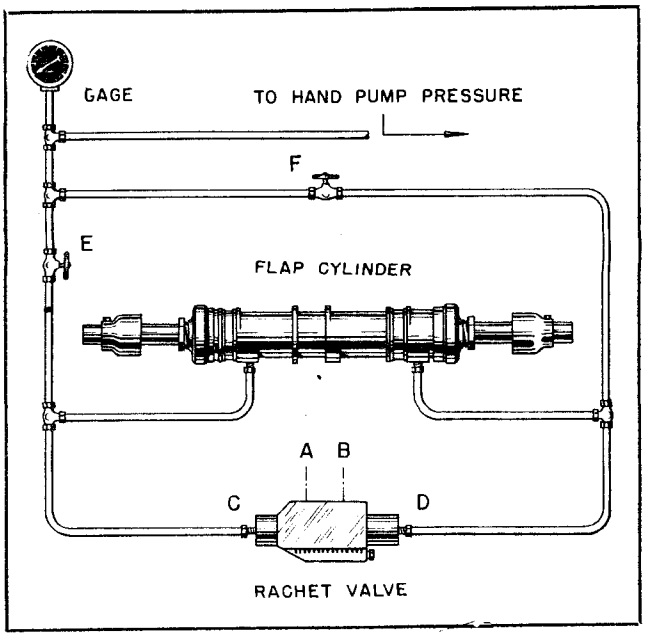


Figure 234 — Flap Ratchet Valve Test Diagram

3. Open valve "F," close valve "E," and with port "A" open, apply 1000 pounds per square inch pressure at port "B." The flap cylinder piston should travel its full stroke. Release the pressure at port "B," noting the drop in the pressure gage reading. The gage reading should not drop below 700 pounds per square inch and should remain at this pressure.

4. Open valve "E," close valve "F," and apply 1000 pounds per square inch pressure at port "A." The flap cylinder piston should travel through its full stroke in the opposite direction to the above-mentioned movement. Release the pressure at port "A," noting the drop in the pressure gage reading. The reading should not drop below 700 pounds per square inch and should remain at this pressure, denoting that the check valves are functioning properly.

(d) ADJUSTMENT.—After the ratchet valve is tested as outlined above, the ratchet valve should require no further adjustment. However, should leakage around either of the two check valves occur, lapping them in with fine emery paste should render them leakproof. The thermal expansion relief valve should relieve at 1500 plus or minus 100 pounds per square inch. If the relief valve requires adjusting, remove the cap nut holding the compression spring-loaded plunger on the underside of the ratchet valve body, and insert or remove the small shims between the spring and the cap nut, thus increasing or decreasing the pressure relief setting. (See figure 235.) Assemble relief valve and test.

(4) FLAP OPERATING CYLINDER.

(a) DESCRIPTION.—*(See figure 236.)*—The flap operating cylinder is a single cylinder, dual piston, double acting hydraulic jack. The operating cylinder unit is attached to the bottom of the upper trailing edge of

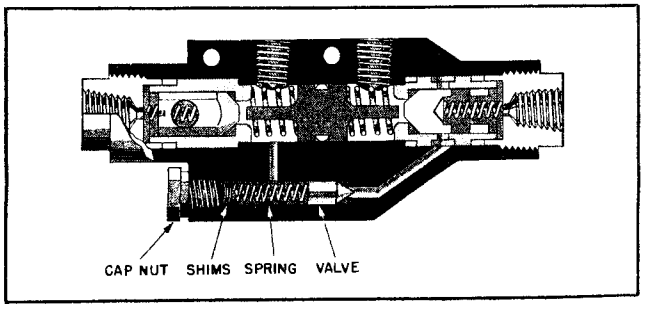


Figure 235 — Flap Ratchet Relief Valve Adjustment — 88-58070

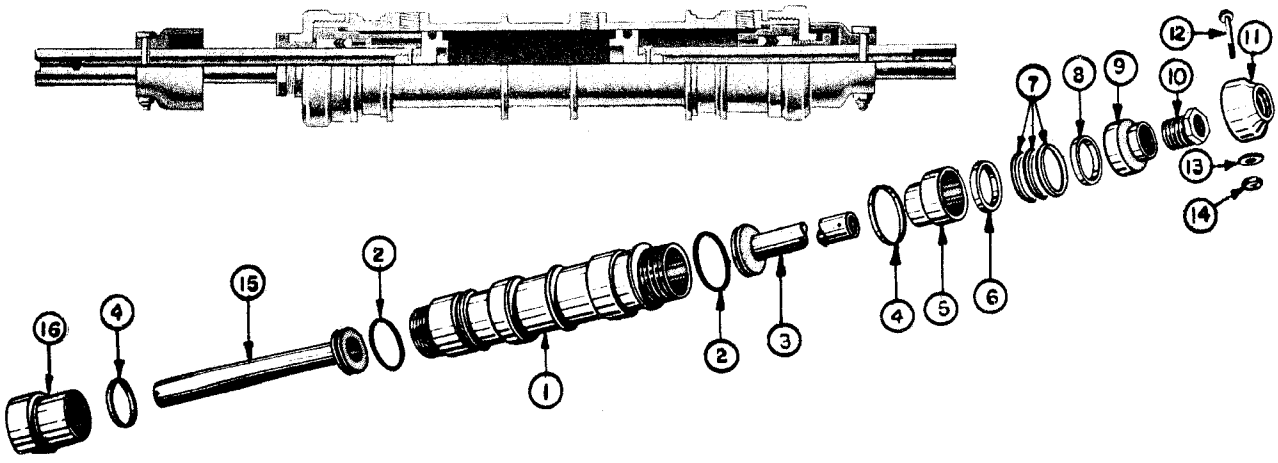
the wing center section, aft of the rear spar. A piston rod at each end of the cylinder is attached to the flap push-pull rod. A rotating sleeve bearing is located in the center and around the outside of the cylinder. A pivoted cross arm is attached to the rotating sleeve and to each end of the cross arm there is attached a connecting rod which in turn is attached to the flap push-pull rods beyond the ends of the piston rods. This rotating sleeve, cross arm and rod assembly functions as an equalizing mechanism which serves to equalize the movement and load on both the operating strut pistons and the push-pull rods. Since the mechanism equalizes the piston and flap push-pull rod movement, the movement of the flaps is synchronized. As fluid pressure is applied to the port at each end of the flap operating cylinder, the actuating pistons and flap rods are simultaneously moved toward the center of the operating cylinder, thus extending the flaps. The displaced fluid returns through the flap ratchet valve to the flap selector valve. As pressure is applied to the port in the center of the cylinder, the actuating pistons and flap push-pull rods are forced outward, thus retracting the flaps. The displaced fluid escapes through the ports in the ends of the cylinder and returns to the flap selector valve after passing through the flap ratchet valve. The time required to lower the flaps ranges from 5 to 15 seconds, while the time required to raise the flaps ranges from 5 to 10 seconds.

EXPLANATION OF FLAP OPERATING CYLINDER FUNCTION DIAGRAM. *(See figure 237.)*

CONDITION I: FLAPS BEING LOWERED. — Hydraulic fluid pressure is applied to both ports "A" and "C," simultaneously. The two pistons "E" and "D" retract, causing flap push-pull rods "G" and "F" to move inward, thus lowering the flaps by means of short rods attached to the flaps proper. The rocker arm assembly, which pivots at a point of the flap cylinder, tends to guide and equalize the travel of the piston rods. The fluid displaced by the inward movement of the pistons escapes through port "B."

CONDITION II: FLAPS BEING RAISED. — Fluid pressure is applied at port "B," which forces pistons "E" and "D" outward, causing flap push-pull rods "G" and "F" to extend outward, thus raising the flaps by means of short rods attached to the flaps proper. The fluid displaced by the pistons "E" and "D" escapes through ports "A" and "C" simultaneously.

(b) REMOVAL. — FLAP OPERATING CLYINDER.—This unit is supported by means of four bolts inserted through holes in upper surface of the center section trailing edge at the left side. To remove the



1. Cylinder Body
2. Ring
3. Piston
4. Seal Gasket
5. Seal Retainer
6. Packing Base Ring
7. Garlock Chevron Packing
8. Packing Cap Ring
9. Piston Rod Outer Bearing
10. Packing Gland Nut
11. Piston Rod Stop
12. Bolt
13. Washer
14. Nut
15. Piston
16. Seal Retainer

Note: Items 7 through 15 contained in both ends of strut.

Figure 236 — Flap Operating Cylinder

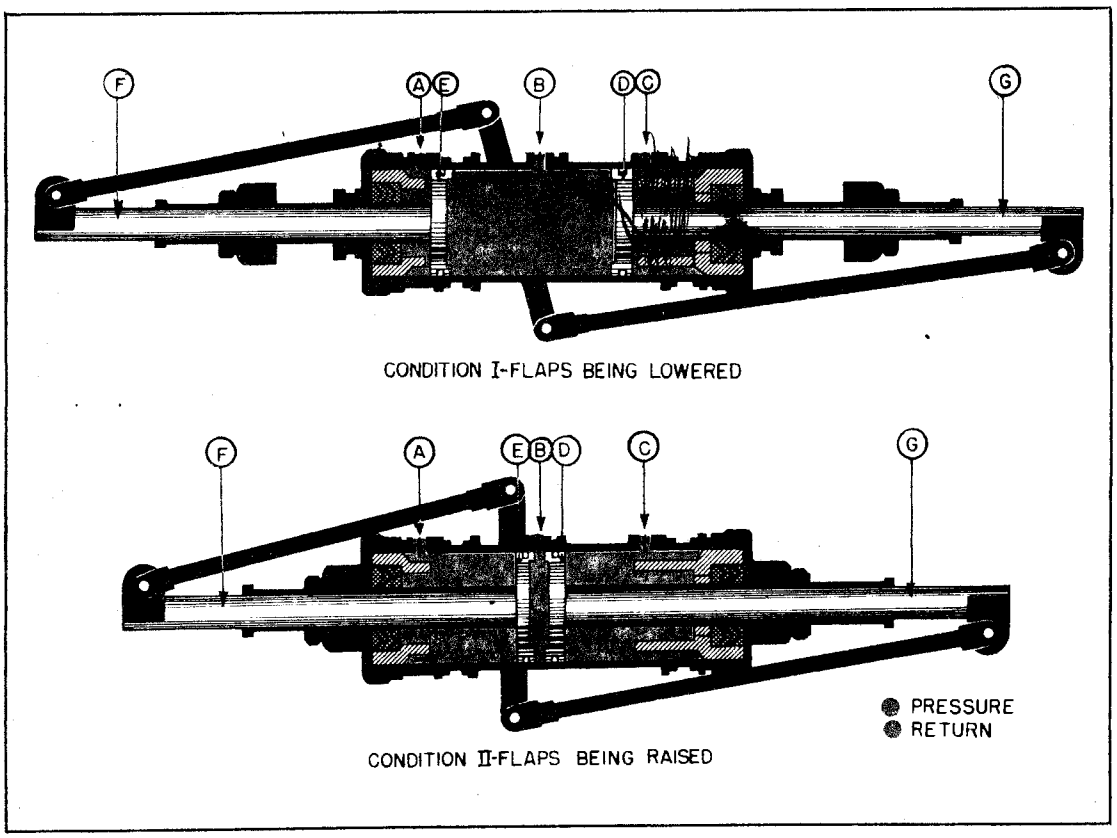


Figure 237 — Flap Operating Cylinder Function Diagram

operating cylinder, lower the flaps to the full "DOWN" position and disconnect the three hydraulic lines from the flap operating cylinder at the fittings extending through the upper surface of the wing center section. Disconnect the outboard ends of the two flap equalizer control rods from the flap push-pull rod brackets and then disconnect the inboard ends of the push-pull rods from the operating cylinder piston rod. Remove the four bolts and fittings supporting the strut, and remove the assembly from the center section.

(c) TEST BEFORE INSTALLATION. — Pressure-test the flap operating cylinder by applying 2000 pounds per square inch alternately to each of the three ports, with the remaining ports open. Piston rod stop collars must be in place.

(d) ADJUSTMENT. — On reassembly of the flap operating cylinder, each piston should have a stroke of 2-3/8 inches. See adjustment procedure, paragraph 11, *e*, (8).

(e) INSTALLATION. — Insert four AN4-35A bolts through holes in upper surface of center section at left side of trailing edge. Install upper half of cylinder supports over these bolts. With the threaded piston rod end facing toward the right, place flap cylinder in position with upper supports resting in grooves on the cylinder. Install lower half of cylinder supports over cylinder; secure with stop nuts.

(5) LANDING GEAR OPERATING CYLINDER.

(a) DESCRIPTION.—*(See figure 238.)*—There are two hydraulic cylinders employed in the landing gear hydraulic system for the purpose of operating the "UP" and "DOWN" movement of the right and left landing gear. These cylinders are interchangeable from right to left. The cylinders are located inboard and in front of the front of the right and left outer wing front spars in the wing nose-section. The head of the cylinder is securely mounted to a "hat-section" type support, which includes a part of the castings and bearing assembly that form the pivot point of the operating cylinder. Thus, the cylinder is free to follow the movements of the mechanism necessary in the operation of the "UP" and "DOWN" movement of the landing gear. These hydraulic cylinders are accessible after removing cover plates in the lower skin of the leading edge of the wings. These covers are located directly under each corresponding hydraulic cylinder. The forward end of the piston rod is coupled to the landing gear strut mechanism by means of a yoke fitting and a bearing. This attachment provides a linkage for transmitting force dispatched by the operating cylinder piston to actuate the "UP" and "DOWN" movement of the landing gear. The encased piston rods are extended and retracted in a horizontal direction by means of hydraulic fluid pressure transmitted to the head or base of the

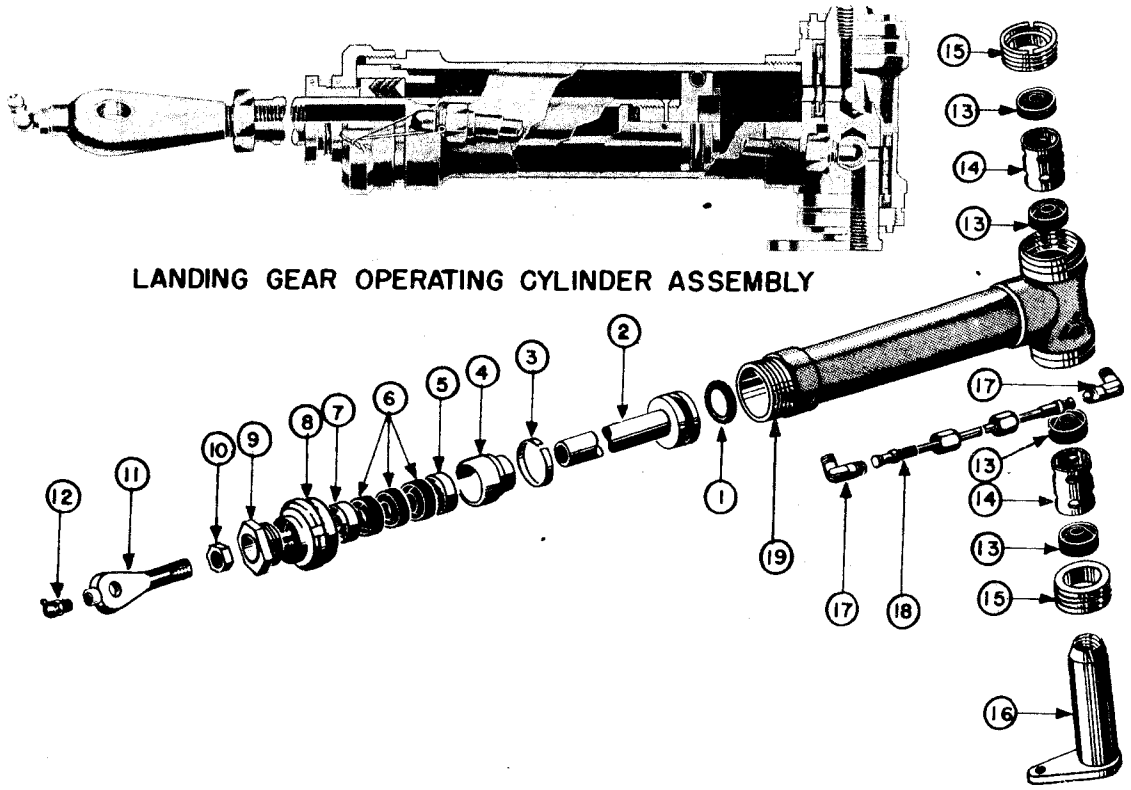


Figure 238 — Landing Gear Operating Cylinder

piston through inlet and displacement ports of the cylinder, which are connected to the main hydraulic system. With the landing gear in the "DOWN" position, the piston rod is extended, and in the "UP" position, the rod is retracted.

EXPLANATION OF LANDING GEAR OPERATING CYLINDER FUNCTION DIAGRAM. *(See figure 239.)*

CONDITION I: LANDING GEAR DOWN.—Fluid under pressure is applied at port "A" where it flows through swivel joint "B" into the actuating cylinder "C," forcing piston "D" to the left against the stop in the extreme left end of the cylinder as shown, thus moving the landing gear strut to the extended position. The displaced fluid is forced out port "E" to return line "F" and back through swivel joint "G" and finally out return port "H."

CONDITION II: LANDING GEAR UP.—Fluid under pressure enters port "H" and flows through swivel joint "G" and line "F" through port "E" into the cylinder chamber "C," forcing piston "D" to the right end of the cylinder, thus retracting the landing gear strut by means of the yoke attached to the end of the piston rod. Displaced fluid escapes from the cylinder through swivel joint "B" and finally flows out return port "A," as shown.

(b) REMOVAL.—A landing gear operating cylinder is located inboard on the front face of the front spar of both outer wing panels. Disconnect the piston rod from the landing gear strut attachment fitting; loosen the lock nut adjacent to the piston rod end fitting; turn the piston rod counterclockwise until the rod is free of the fitting. The cylinder may be easily removed from the wing by first disconnecting the two hydraulic lines attached to the cylinder assembly, then removing the two bolts which attach the aft cylinder support bracket to the front spar, and then slipping the cylinder assembly back out of the front support bracket bearing. The aft bracket may then be removed from the cylinder assembly after removing the bolt attaching the cylinder pivot shaft flange to the support bracket. The aft hydraulic line elbow fitting must be

removed before the bracket will slip free of the cylinder assembly.

(c) TEST BEFORE INSTALLATION.—Pressure is applied through the T-head and is alternated two or three times to clear the cylinder of air. Pressure is then applied at 2000 pounds per square inch and is held for 3 to 5 minutes. During this time, check for leaks. If no signs of leaks occur, drop the pressure to 500 pounds per square inch and again hold for a period of 3 to 5 minutes and check for leaks.

(d) INSTALLATION.—Place the landing gear operating cylinder in position with the cylinder hydraulic line on the bottom and set cylinder end in bearing. Tighten bearing with bolts provided for this purpose.

(e) ADJUSTMENT.—*(See figure 240.)*—To adjust the landing gear operating cylinder piston rod stroke, proceed as follows:

1. Ascertain that the operating cylinder bearing blocks are properly installed and that the operating cylinder moves freely beyond the bearing blocks.

2. Install the operating cylinder piston rod end fitting on the stud which is mounted on the landing gear shock strut fitting. Screw the piston rod onto the rod-end fitting several turns. Since the outboard end of the operating cylinder is confined between the bearing blocks, it cannot move to either side along its swivel head pin to compensate for slight, unavoidable misalign-

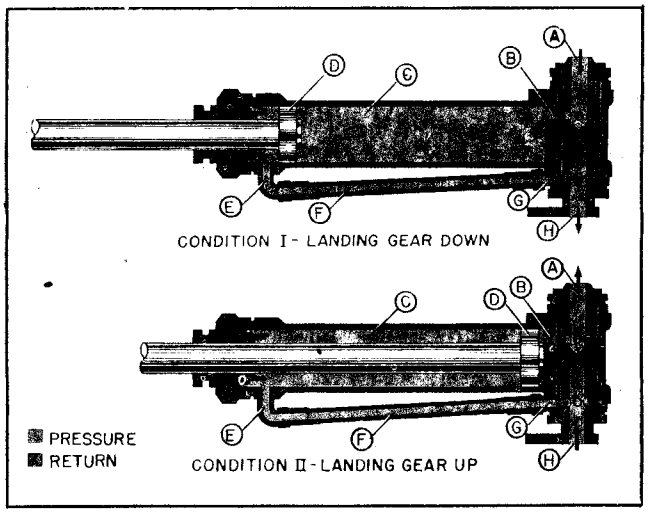


Figure 239 — Landing Gear Operating Cylinder Function Diagram

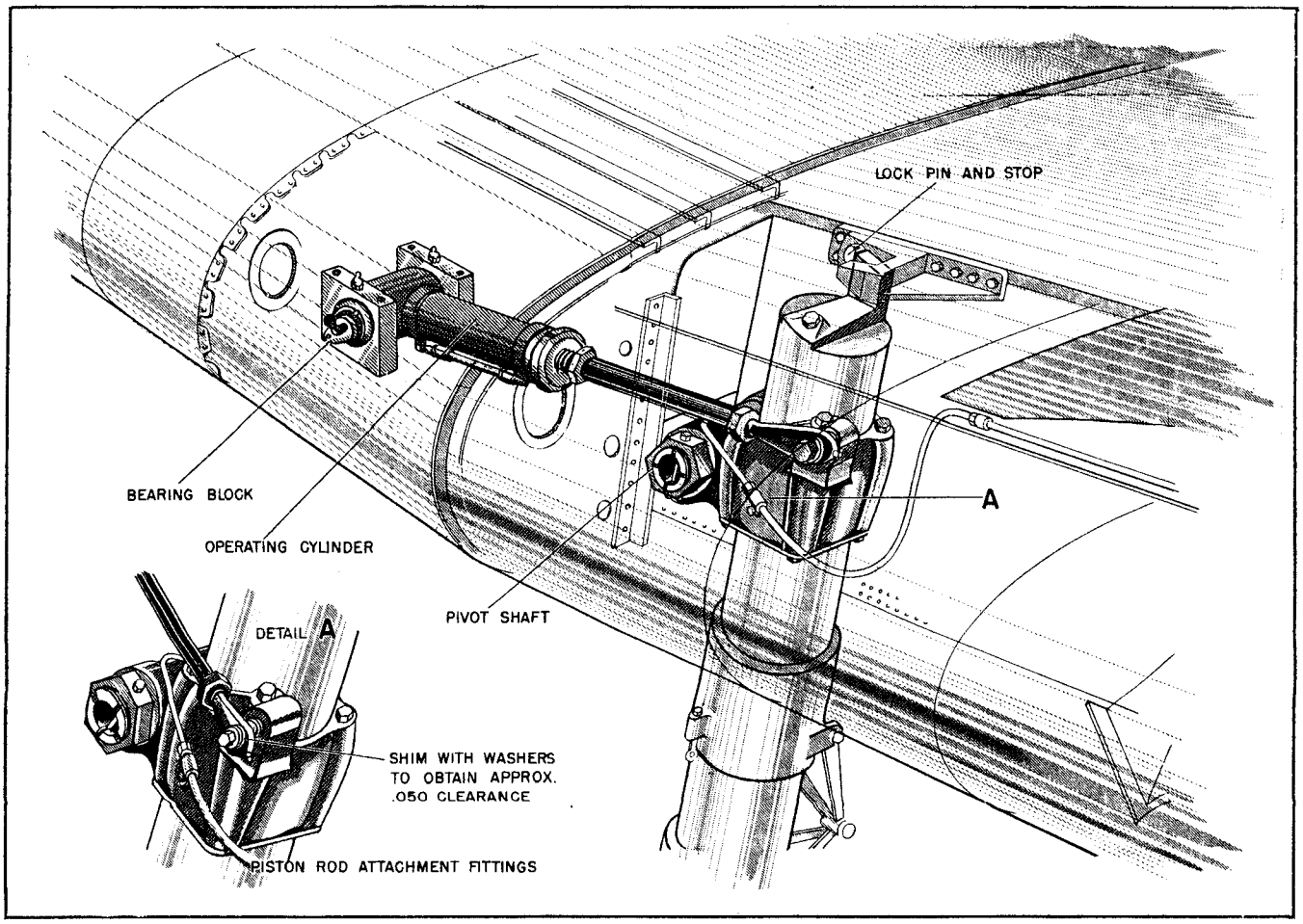


Figure 240 — Landing Gear Operating Cylinder Installation

ment in the landing gear strut and retracting mechanism due to manufacturing and assembly tolerances; consequently the piston rod end fitting must be aligned so that it has sufficient free movement or side play along its attaching stud to permit free operation of the landing gear without causing misalignment of either end of the operating cylinder.

3. To align the piston rod end fitting, place the specified washers on either side of the rod end fitting as required so that a free movement or side play of approximately .050-inch between the washers and the fitting is obtained. The small outermost washer on the attaching stud should be held firmly against the shoulder on the stud by the castellated nut.

4. To check the stroke of the piston rod, unscrew the piston rod from the rod end fitting and pull the piston rod out of the cylinder so that a dimension of 10-3/8 inches exists between the inboard face of the operating-cylinder piston rod bearing cap and the end of the piston rod. Then pull the piston rod out farther and check to see that it has an overstroke of 9/32 plus or minus 1/32 inch beyond the normal 10-3/8 inch stroke. This 9/32 inch overstroke is necessary to prevent the piston from bottoming against the stop in the end of the operating cylinder.

5. To make a final adjustment of the piston rod stroke, place the landing gear strut in the DOWN, LOCKED position, pull the piston rod out of the cylinder and screw it onto the end of the piston rod end fitting until a dimension of 10-3/8 inches exists between the inboard face of the operating cylinder bearing cap and the end of the piston rod. (See figure 241.) Make certain that the 10-3/8 inch dimension is measured between the inboard face of the cylinder bearing cap and the end of the piston rod and not from the face of the boss of the bearing cap to the end of the piston rod. Then while holding the piston rod to prevent it from turning, run the end fitting locknut up against the end of the piston rod. Assuming that the operating cylinder has been properly assembled, the approximate 9/32 inch overstroke in either direction will be obtained without further adjustment.

6. Recheck the free movement or side play of the end fitting on the attaching stud. Raise and lower the landing gear several times and check to see that the operating cylinder assembly does not bind at the bearing blocks or piston rod end fitting stud.

(6) EMERGENCY HAND PUMP.—*(See figure 242.)*

(a) DESCRIPTION. — The emergency hand pump is located below the left front corner of the pilot's seat in the front cockpit. The pump is used in the event that the engine-driven pump becomes inoperative and for testing the hydraulic system when the airplane is at rest on the ground. The pump is a double-acting differential-type pump which produces pressure with each stroke of the piston. Fluid enters the pump cylinder through a bottom port and flows through a suction one-way check valve when the pump piston is moved upward. The volume of fluid which enters the pump on the suction stroke is equal to the area of the cylinder times the stroke. For a full stroke, this is about 1 cubic inch. When the piston is moved down, the one-way suction check valve closes and prevents fluid from escaping through the suction line. Since the synthetic seal cup on the piston is designed to allow pressure to by-pass on the down stroke, the fluid flows past the seal cup on the piston and into the space above the piston. There is insufficient space for half the volume of fluid which flows into the upper area because the piston rod has a cross sectional area of about half that of the cylinder, consequently half of the fluid is forced out through the pressure port. When the piston is again moved upward, the piston seal cup expands, preventing the fluid remaining above the piston from by-passing, thus the fluid is displaced and forced out the pressure port. Simultaneously, the suction port check valve opens, allowing another charge of fluid to be drawn into the cylinder below the piston. A special type synthetic material seal cup with flexible lip is used, which seals sufficiently on the up stroke, but offers very little resistance to the fluid flowing by it on the down stroke. The pump rod is sealed with chevron-type packing. The pump handle is a spring-loaded telescoping type. The pump can be operated with the handle in the shortened position, but should be operated in the extended position in order to develop full efficiency.

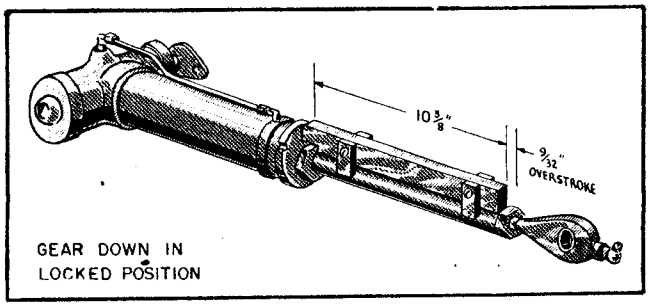
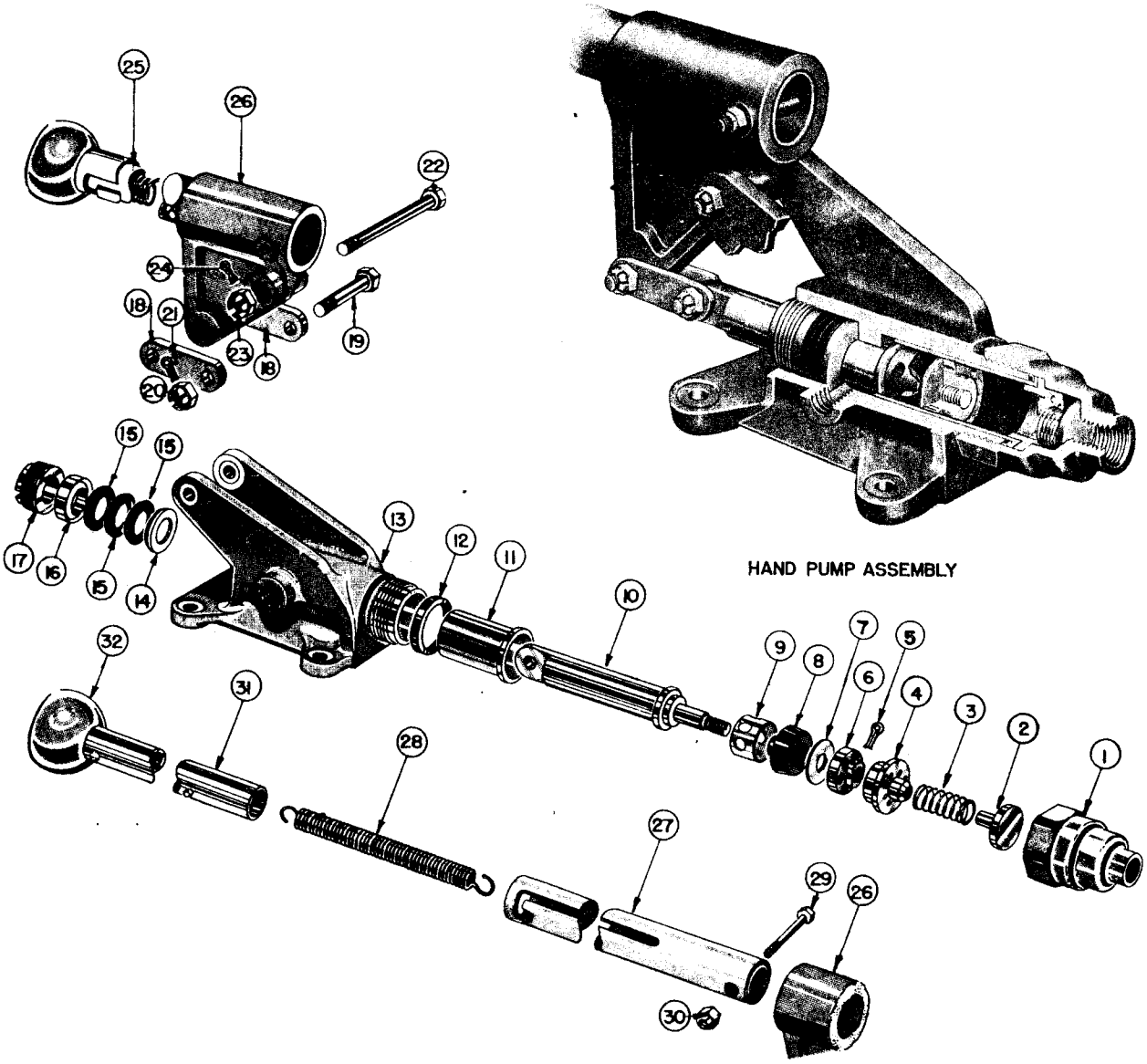


Figure 241 — Operating Cylinder Adjustment

EXPLANATION OF HAND-PUMP FUNCTION DIAGRAM.—*(See figure 243.)*

CONDITION I: INTAKE AND DISPLACEMENT OF FLUID UNDER PRESSURE ON UP STROKE OF PISTON.—As piston "D" is moved upward (to left on illustration), fluid is drawn in through port "H" as check valve "G" is moved off of its seat by the partial vacuum created in chamber "F." Fluid in chamber "C" is forced out port "A" to the selector valve unit since seal cup "I" prevents fluid from passing piston "D" and returning to chamber "F."

CONDITION II: DISPLACEMENT OF FLUID UNDER PRESSURE ON DOWNWARD STROKE OF PISTON.—As piston "D" is moved downward (to right on illustration), check valve "G" is forced against its seat, preventing the escape of fluid through port "H." Fluid in chamber "F" passes through hole "E" in piston "D," between the seal cup and the cylinder wall and into chamber "C." Simultaneously, fluid in chamber "C" is displaced by the large diameter piston rod "B" and forced out port "A" under pressure to the selector valve unit.



1. Head
2. One-way Valve
3. One-way Valve Spring
4. One-way Retainer
5. Pin
6. Piston Head
7. Washer
8. Cup
9. Head Cup Retainer
10. Piston
11. Cylinder Liner
12. Gasket
13. Body
14. Packing Base Ring
15. Packing
16. Packing Cap Ring
17. Piston Rod Bearing
18. Piston Link
19. Bolt
20. Nut
21. Pin
22. Bolt
23. Nut
24. Pin
25. Handle (Consists of 27 through 34)
26. Support Bracket
27. Support Tube
28. Retracting Spring
29. Bolt
30. Nut
31. Tube
32. Knob

Figure 242 — Hand Pump

(b) REMOVAL.—The hydraulic hand pump assembly located at the forward left corner of the front cockpit seat may be readily removed by disconnecting the two lines at the fittings on the assembly and removing the five bolts securing the assembly to the support bracket and brace. Remove the head, valve spring, and retainer from the lower end of the hand pump body assembly. The piston assembly may then be removed from the bottom of the body assembly and parts of the assembly replaced if necessary.

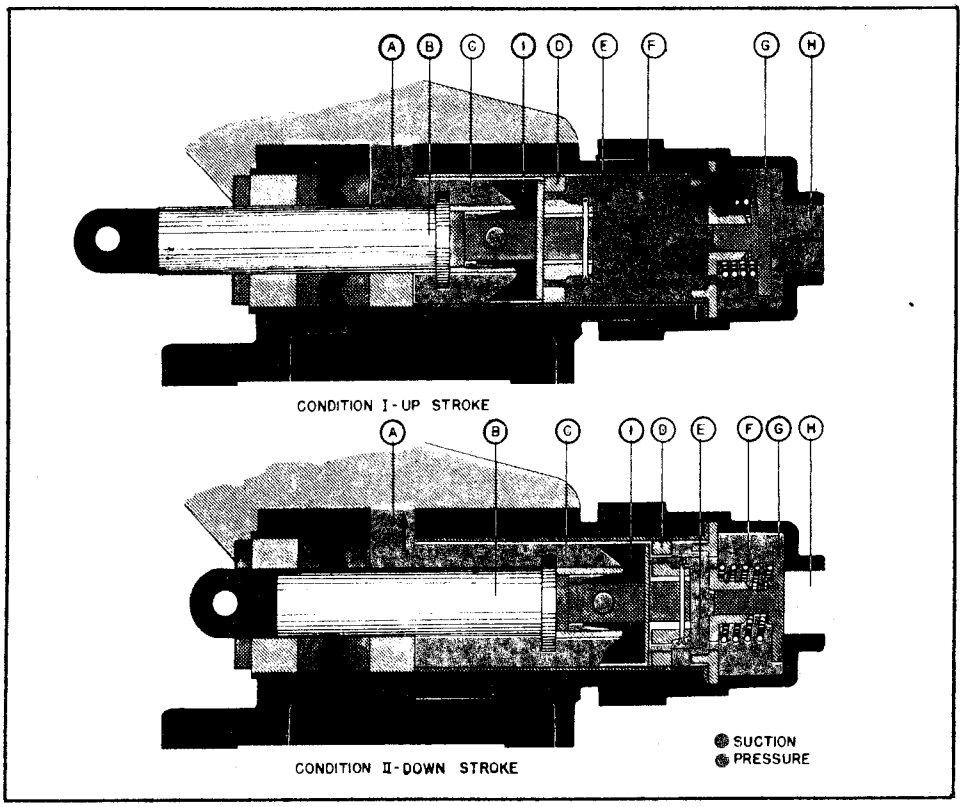


Figure 243 — Hand Pump Function Diagram

(c) TEST BEFORE INSTALLATION.—Connect a ½-inch line from end port of pump to a reservoir containing hydraulic fluid approximately 2-½ feet below the pump. With side port open, operate pump handle. The maximum number of full strokes required for pump to prime itself is 150. Care should be taken to see that test lines and fittings are tight. When a full flow of fluid is obtained and lines are cleared of all air, check output of pump, which should be 100 cubic inches for 100 strokes (200 half-strokes) at the rate of approximately 100 per minute. The nonadjustable piston stroke is 1-⅛ inches. Test pump for leakage with ½-inch line still attached, lifting pump handle so that pump piston is extended and applying test pressure to side port. Test pressure is 2500 pounds per square inch.

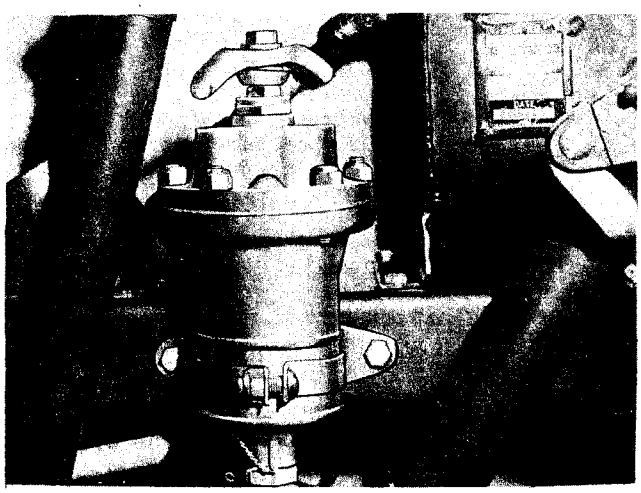


Figure 244 — Filter and Reservoir Installation

(d) INSTALLATION.—Installation is essentially the reverse of the removal procedure.

(7) FILTER.

(a) DESCRIPTION.—The filter is located on the rear cockpit control shelf. It consists essentially of a container body and a cylindrical filter element. The Cuno hydraulic filter which is used on early model airplanes is equipped with a multiple disc type filter unit consisting of a series of closely spaced discs mounted on a vertical shaft. Foreign matter is filtered from the fluid as it flows between the discs. Rotating the handle on top of the filter unit rotates one set of discs and clears out foreign matter which settles to the bottom of the filter. The Purolator filter (figure 245) used on late model airplanes is equipped with a cylinderical filter element which is simply a coil wound from deformed wire. Closely fitted to the outside of the element is a scraper blade which scrapes off foreign matter collected on the outside of the element cylinder and deposits it in the bottom of the filter body as the filter element is revolved by means of the T-handle on top of the unit. The filtered oil passes out of the filter element through a port in the top of the filter case. Two spring-loaded one-way ball-check valves are incorporated in

the top of the unit which functions as relief valves in the event the filter element becomes stopped up with foreign material, thus preventing the return of fluid to the reservoir. The relief valves permit the fluid to bypass without flowing through the filter element. The filter element T-handle should be turned one complete rovolution after every 10 hours of operation. A drain plug in the bottom of the filter should be removed once every 50 hours to remove any sludge collected in the bottom of the filter.

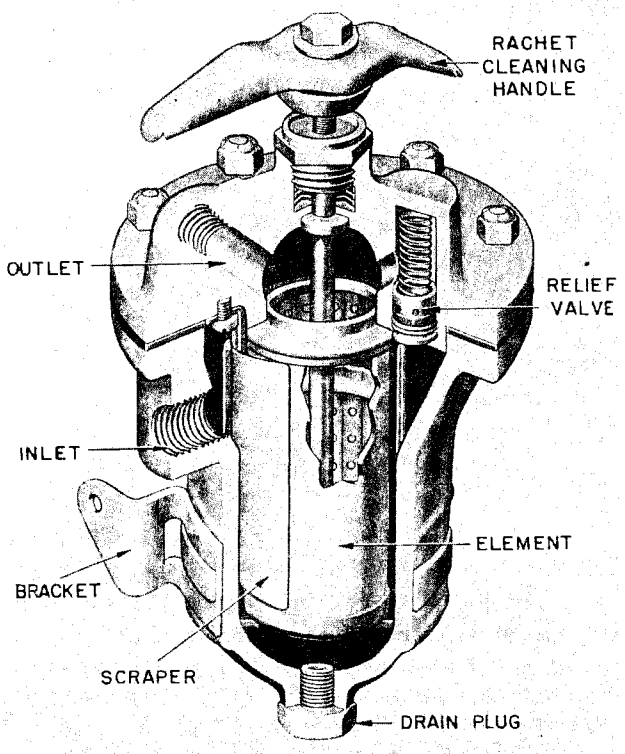


Figure 245 — Purolator Filter

(b) REMOVAL.—The fluid filter may be removed by disconnecting the two hydraulic lines and removing the two bolts securing it to the control shelf in the rear cockpit.

(c) TEST BEFORE INSTALLATION.—Apply a pressure of 250 pounds per square inch to the inlet port after plugging the outlet port. Check for leaks around gasket and packing.

(d) INSTALLATION. — Installation is essentially the reverse of the removal procedure. Ascertain that the return line from the reservoir is connected to the top of the filter and that the line from the selector valve enters the lower part of the filter.

(8) FLUID RESERVOIR.—*(See figure 246.)*

(a) DESCRIPTION.—A fluid reservoir is provided in the hydraulic system to supply the main system and emergency-hand pump unit with fluid. It is located approximately half-way between the front and rear cockpits on the control shelf. The reservoir is made of aluminum-alloy sheet metal welded together. Outlets are provided for the main suction line, the hand-pump suction line, the return line, and the vent line. The hand-pump suction line draws fluid from an emergency supply made possible by tapping the fluid reservoir at a point below that of the main suction line. A filler neck with an overflow scupper and drain line provides a means of accurately filling the reservoir by overflowing when airplane is in the three-point position. Inside the filler neck is a screen which should not be removed when filling the reservoir since it serves to filter the fluid as it is poured into the reservoir. Since the reservoir is never completely full, an expansion area is provided in the upper part of the reservoir. Fluid entering the reservoir through the return port is deflected upward by a V-shaped baffle welded to the end plate of the reservoir, thus preventing foaming of the fluid. The total capacity of the reservoir is approximately 1 U. S. gallon. The fluid capacity is .77 U. S. gallons (.53 Imp. gallons) with the airplane in the three-point position. The hand pump reserve is .39 U. S. gallons (.27 Imp. gallons).

(b) REMOVAL.—The fluid reservoir is mounted on the control shelf at the left forward side of the rear cockpit. To remove tank, disconnect the five lines at the fittings on reservoir and remove the four bolts attaching the reservoir to the shelf. Remove the plug from the filler neck on the side of the tank; remove the strainer located within the filler neck.

(c) TEST BEFORE INSTALLATION.—Apply 5 to 7 pounds per square inch air pressure to any one of the ports, with the remaining ports plugged. Immerge in water; check to make sure no leaks appear.

(d) INSTALLATION. — Installation is essentially the reverse of the removal procedure.

(9) PRESSURE GAGE.—The pressure gage is located near the forward end of the pilot's control shelf and is visible from the front cockpit only. The gage is not repairable except by the manufacturer.

(10) SNUBBER VALVES.—*(See figure 247.)*

(a) DESCRIPTION.—This valve is designed to protect the gage from sudden pressure surges and pulsations caused by sudden pressure fluctuations which would cause the gage needle to oscillate and otherwise impose undue strain on the gage mechanism. Early airplanes are equipped with a valve which has dual metering pins, while later airplanes have valves with a single metering pin. The early type valve is composed of a body and two metering pins which slide back and forth in two parallel drilled ports, with a common port at both ends. The fluid flow through the two drilled ports is metered by the pins, thus dampening surges and pulsation caused by sudden pressure changes. The new type valve operates on the same principle except that a single metering pin is employed. This valve is located between the hand-pump pressure line and the pressure gage line

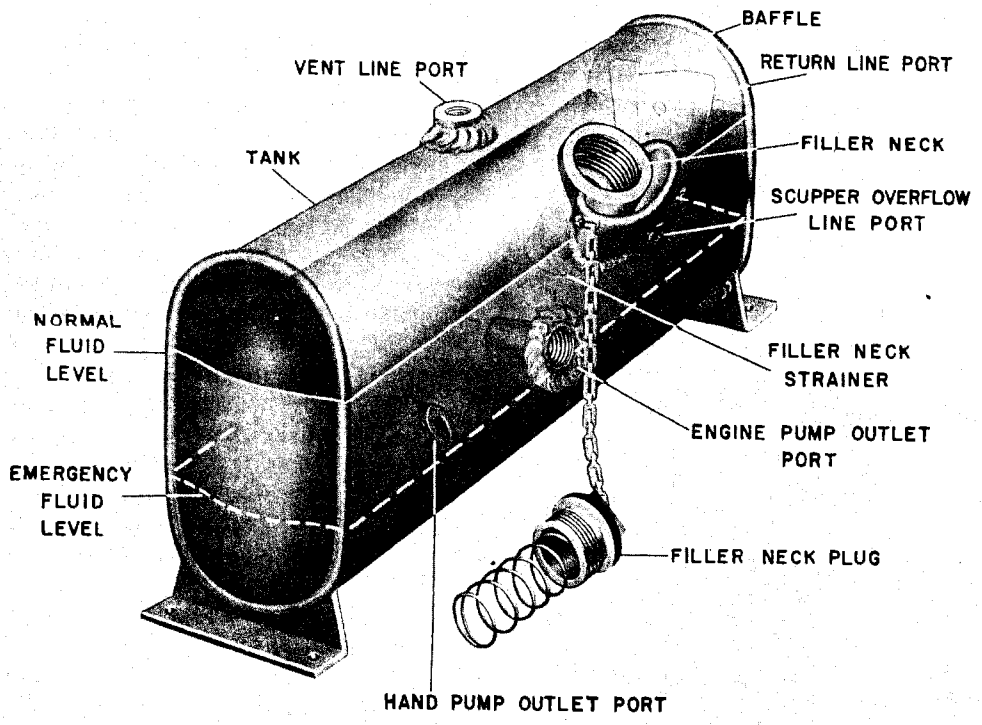


Figure 246 — Reservoir

at the left side of the front cockpit below the control shelf.

(b) REMOVAL.—Either type snubber valve may be removed from the line after the two attaching "B" nuts have been removed.

(c) TEST BEFORE INSTALLATION.—To test the snubber valve, attach pressure gage to "OUT" port and apply pressure. Pressure gage pointer should not oscillate.

(d) INSTALLATION. — Reverse the removal procedure. On early models, install the valve in the line so that the capped end of the knob on the top of the valve points forward. On late models, install the valve in the line so that the male threaded end of the valve points forward.

(11) ONE-WAY CHECK VALVE.—*(See figure 249.)*

(a) DESCRIPTION.—This valve is located below and forward of the selector valve unit and between the landing gear DOWN pressure line and the hand-pump fluid supply line. The valve permits free fluid flow from the hand-pump supply line to the landing gear DOWN pressure line, but prevents fluid from flowing into the hand-pump supply line from the landing gear DOWN line. This valve is necessary to prevent a partial vacuum forming in the leading gear operating cylinder and landing gear DOWN pressure line when the landing gear is lowered without hydraulic pressure. The one-way check valve allows a sufficient amount of fluid to enter the landing gear DOWN line and operating cylinder to eliminate the partial vacuum formed.

(b) REMOVAL.—This valve connects the hand-pump suction line and the landing gear DOWN pressure line. It is attached to two T-fittings, which may be removed by backing off on the four B-nuts holding the assembly in the lines. The valve is located at the left side of the front cockpit below the control shelf.

(c) TEST BEFORE INSTALLATION.—ONE-WAY VALVE. — Denoting large end of one-way valve as port "A," and small end as port "B," check free flow operation of valve by applying pressure at port "B." Then with port "B" plugged, apply 2500 pounds per square inch pressure at port "A" to check for leakage at the gasket between the two sections of the valve body. With port "B" open, apply 1000 pounds per square inch pressure at port "A." Leakage from port "B" should not exceed 5 cubic inches per minute.

(d) INSTALLATION. — Installation is essentially the reverse of the removal procedure. Install the valve in the line so that the large end of the valve is attached to the fitting in the "DOWN" line.

(12) RESTRICTOR VALVE.

(a) DESCRIPTION.—*(See figure 250.)* — The landing gear restrictor valve is located in the landing gear UP line in the forward left corner of the front cockpit. The restrictor valve prevents the landing gear from being extended or retracted too rapidly. Fluid flow is more restricted when the landing gear is being ex-

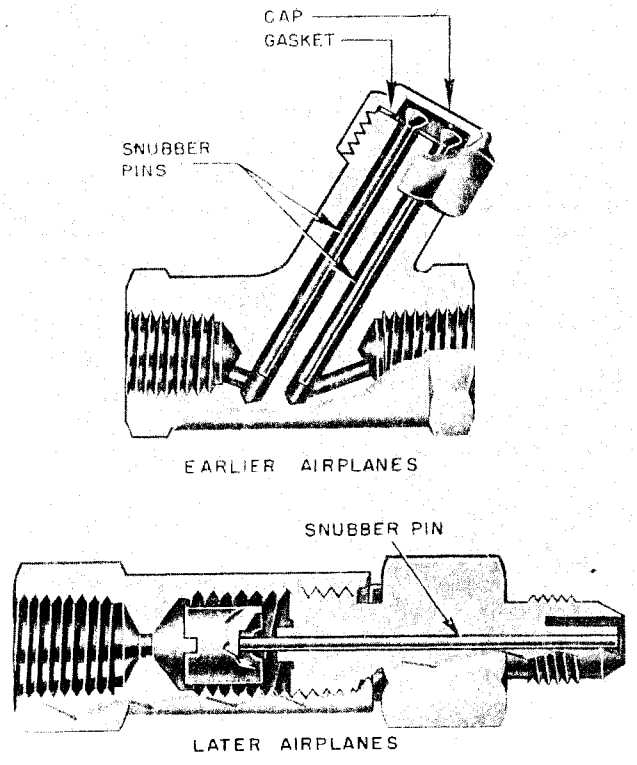


Figure 247 — Snubber Valves

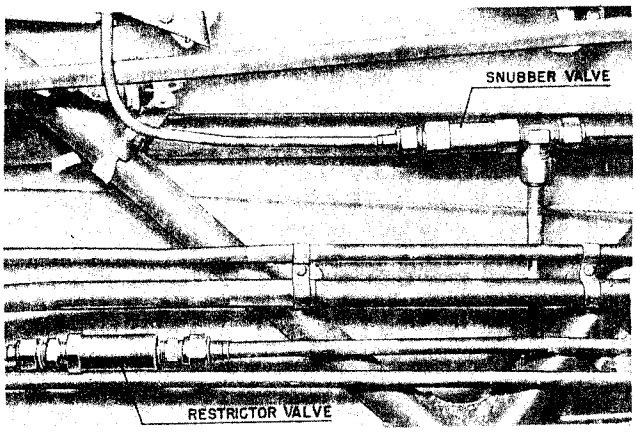


Figure 248 — Snubber Valves and Restrictor Valve Installation

tended or retracted too rapidly. Fluid flow is more restricted when the landing gear is being extended than when it is being retracted. The valve restricts the return flow of displaced fluid through the landing gear UP line when pressure is being applied in the DOWN line, thus slowing down the movement of the landing gear operating cylinder piston. The flow is restricted as the fluid is permitted to pass through a small orifice in the head of the floating valve pin. The flow of fluid under pressure in the UP line to the operating cylinder is less restricted because the fluid is allowed to flow through the small orifice in the head of the valve pin, in addition to two other ports in the side of the valve pin. A certain amount of fluid is permitted to pass between the outer surface of the valve pin and the valve guide in either case.

EXPLANATION OF RESTRICTOR VALVE FUNCTION DIAGRAM.—*(See figure 251.)*

CONDITION I: PRESSURE APPLIED TO LANDING GEAR DOWN LINE.—The flow of displaced fluid returning from the landing gear operating cylinder entering port "A" is restricted as valve "C" seats, permitting fluid to pass through the small hole "E" in the head of the valve pin and between the outer surface of the valve pin and the valve body guide, since the valve pin is a loose fit in the guide.

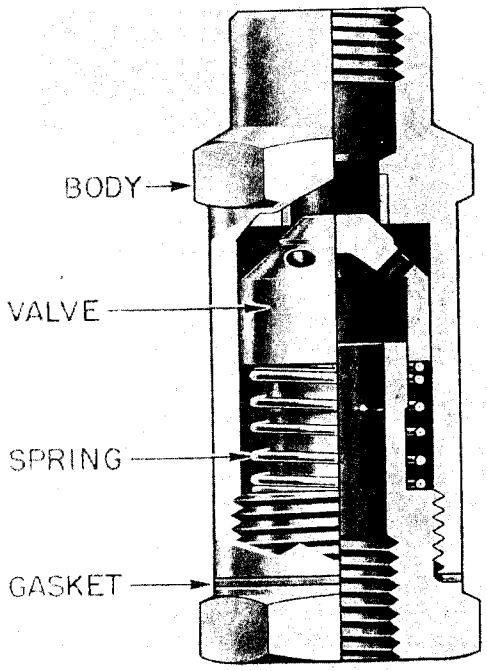


Figure 249 — One-Way Check Valve

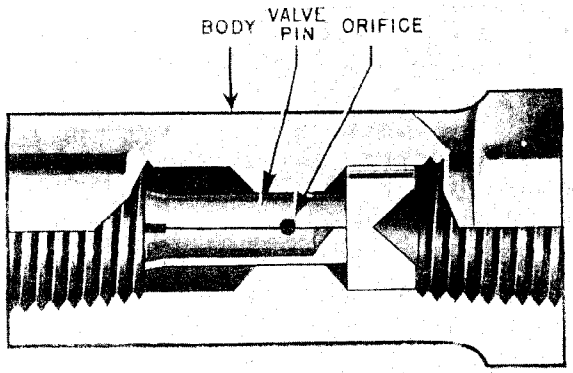


Figure 250 — Restrictor Valve

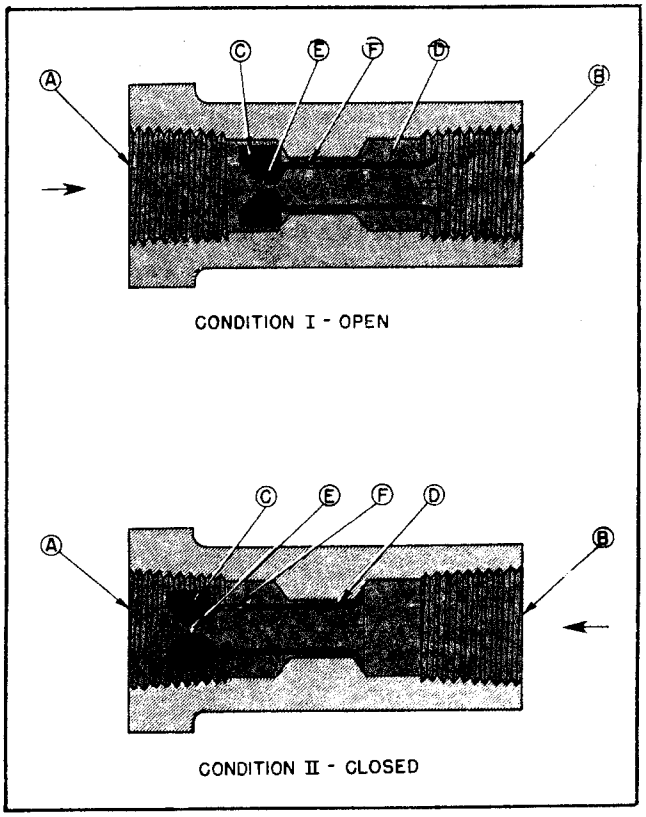


Figure 251 — Restrictor Valve Function Diagram

CONDITION II: PRESSURE APPLIED TO LANDING GEAR UP LINE.—Fluid under pressure flowing through the landing gear UP line enters port "B" forcing valve "C" to the left, as shown, thus allowing fluid to flow through valve pin "D" and out holes "E" and "F". Fluid also flows between the valve pin and the valve body guide.

(b) REMOVAL.—This unit is located in the landing gear UP line and may be removed by backing off on the two B-nuts holding it in the line which is below the control shelf at the lower side of the front cockpit.

(c) TEST BEFORE INSTALLATION.—With 500 pounds per square inch pressure applied at port "A", the output should be from 2 to 2-1/4 gallons per minute at port "B". When 500 pounds per square inch pressure is applied at port "B", the output at port "A" should be from 7 to 8 gallons per minute.

(d) INSTALLATION. — Installation is essentially the reverse of the removal procedure. Install the valve in the landing gear UP line so that the large end of the valve points forward.

c. BRAKE HYDRAULIC SYSTEM.

(1) GENERAL.—*(See figure 252.)*—The brake hydraulic system is separate from the main hydraulic system. The system consists essentially of a master brake cylinder unit which contains two independent master cylinders and a fluid reservoir common to both cylinders. A brake shoe operating cylinder is located on each landing gear wheel brake assembly support plate. Each master cylinder furnishes fluid pressure to its corresponding brake shoe operating cylinder when the tips of the rudder pedals are depressed. The pedals actuate the master brake cylinders by means of a cable, rod, and pulley linkage. Each brake operates independently of the other and either or both may be applied or released singly or together. A separate front cockpit parking brake control handle is interconnected with the master brake cylinder parking brake valve mechanism by means of a cable and pulley linkage. Fluid pressure produced in the master brake cylinder flows through the master brake cylinder ports and out through the connecting lines to the brake shoe operating cylinders where it is confined, thus actuating the individual brake shoe cylinder pistons. The direction of flow of the hydraulic fluid is back and forth from master brake cylinder to brake shoe cylinders. See paragraph 4. *a* (11) "LANDING GEAR BRAKES," in this section.

(2) MASTER BRAKE CYLINDER UNIT.—*(See figure 253.)*

(a) DESCRIPTION.—The brake system with the exception of the pressure lines and the brake shoe operating cylinders is wholly contained within one unit known as the master brake cylinder unit. Except for the brake system reservoir, which serves both sides, this unit is identical at both ends and each end constitutes an individual master brake cylinder, one unit being connected to each of the two main landing gear brake operating cylinders, located outboard on the brake assembly support plates. The top center portion of the master brake cylinder unit is the reservoir which provides for the storage of fluid. This space is vented to the atmosphere by means of a breather tube mounted on the forward side of the unit. The filler port is located so that there will always be an air space at the top of the reservoir, and the breather tube extends a considerable distance above it. This air space is provided to accommodate fluid expansion and surges during operation, thus preventing excess fluid from overflowing. This unit, like the main system reservoir, should be filled when the airplane is in the three-point position. At the bottom of the unit are two piston assemblies. Pressure applied to the brake pedals pulls the piston assemblies outward, forcing trapped fluid ahead of the piston heads and out through the brake line pressure ports to the brake shoe operating cylinders. When pressure is removed from the pedals, the pistons return to their original positions, thus releasing the pressure in the brake system. Pulling outward on the parking brake handle after the brake pedals have been depressed traps fluid under pressure in the upper chambers of the master brake cylinder by means of the parking brake valves, which are then held closed by pressure on top of the valves. To release the brakes, it is only necessary to depress the brake pedals sufficiently to cause the pressure on the underside of the brake valve to equal the pressure on top of the valve thus lifting the parking brake valves.

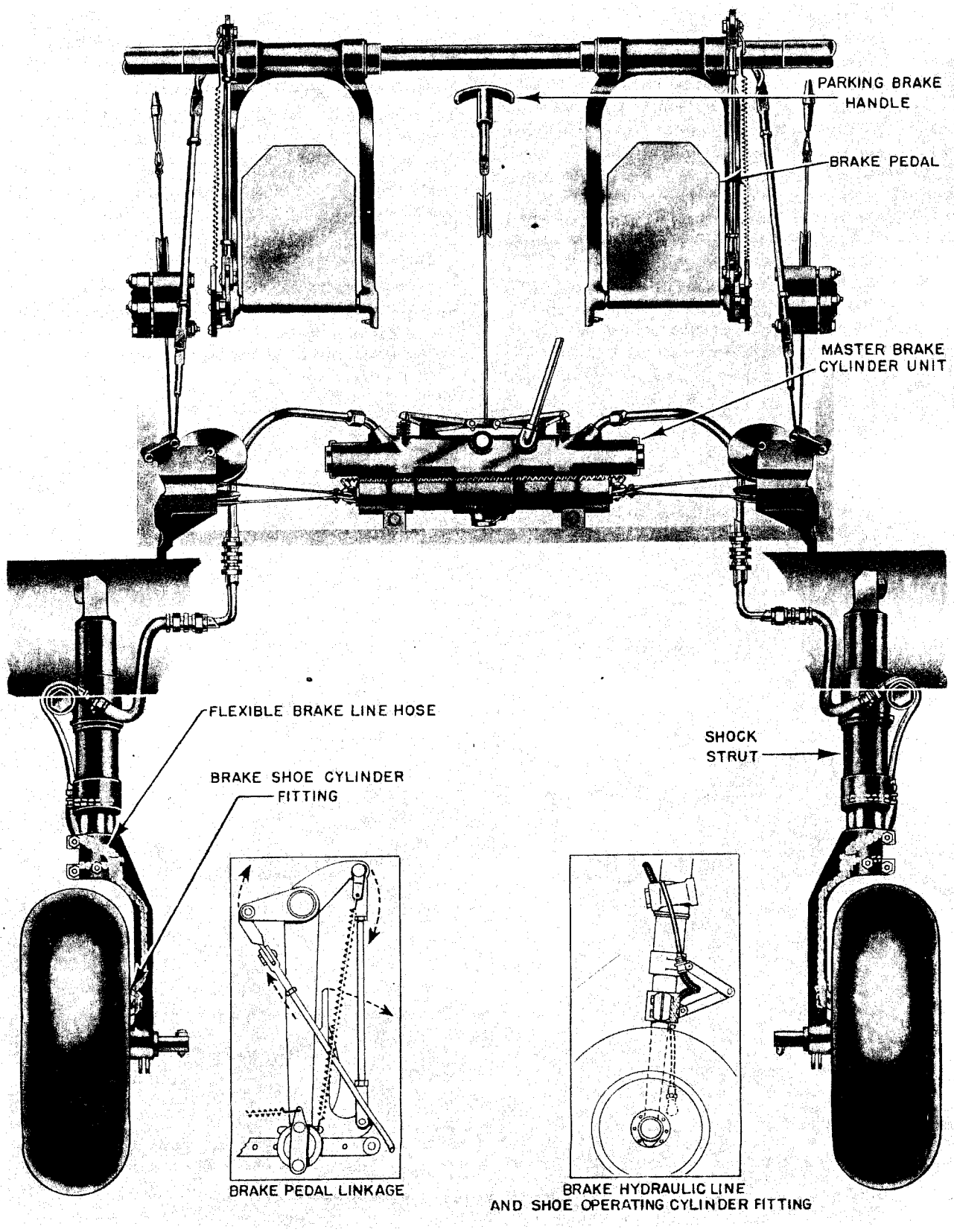


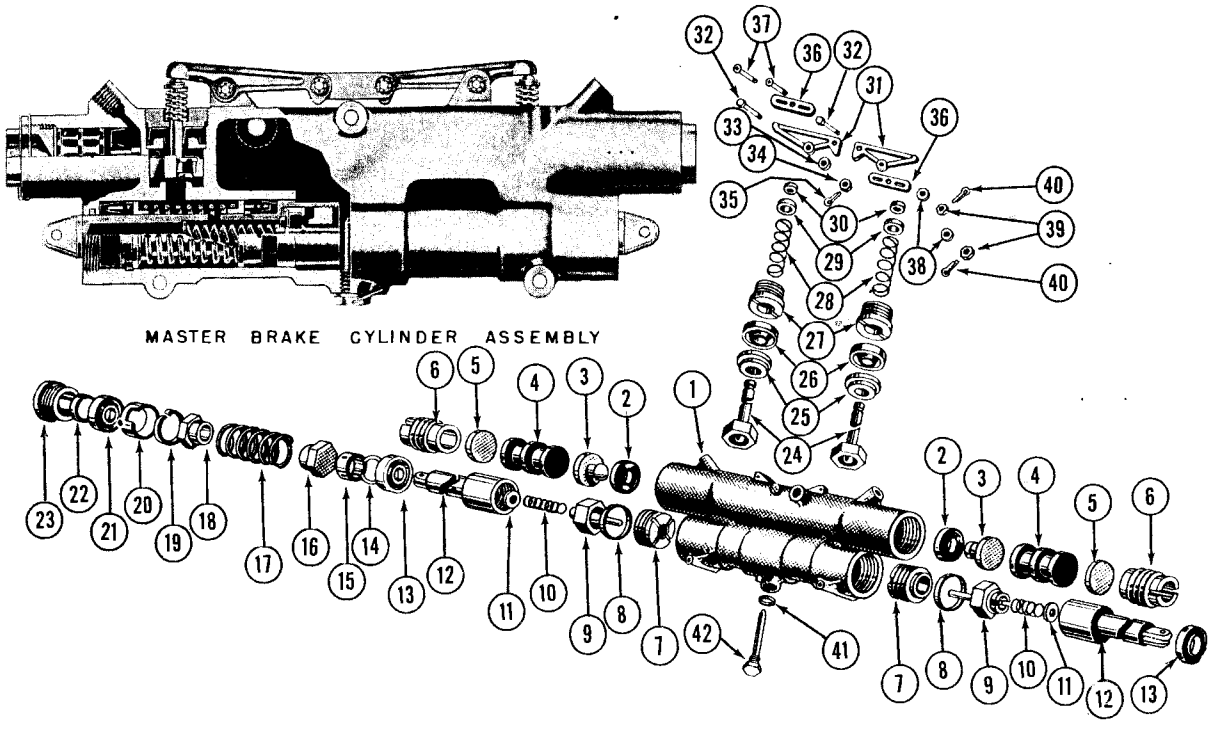
Figure 252 — Brake Hydraulic System

Releasing the pressure on the rudder pedals then releases the pressure in the system. A fluid expansion chamber is provided in each upper end of the master brake cylinder unit. A synthetic spool which contains sufficient resilience to act as a cushion when a stem and cup are forced against it by the pressure in the chamber is located outboard of the stem and cup in the expansion chamber. When the brakes are applied, the spool is compressed, thus causing it to act as a cushion which resists the pressure built up in the system, and providing a reserve supply of pressure to keep the brakes locked in case a slight leak should occur in the system. The capacity of the spool to store reserve pressure, however, is so small that only the very slightest leakage can be compensated. This compensator unit also functions as a thermal expansion relief unit because after full brake pressure has been applied, there is still sufficient resilience in the synthetic spool to accommodate the increased volume due to thermal expansion.

EXPLANATION OF HYDRAULIC BRAKE MASTER CYLINDER FUNCTION DIAGRAM.—*(See figure 254.)*

CONDITION I: FLUID STATIC.—The rudder pedal and parking brake control handle are in the released position and all valves are open, thus there is no pressure in the brake hydraulic system.

CONDITION II: BRAKES APPLIED.—As pressure is applied to the top of the rudder pedal, mechanical linkage attached to piston rod "A" causes piston "I" to be pulled outward against spring "H," allowing valve "D" to be moved inward against its seat by spring "E." Fluid



1. Body Cylinder
2. Cup
3. Compensator Retainer
4. Compensator Spool
5. Retaining Washer
6. Adjusting Screw
7. Feed Valve Seat
8. Seal Gasket
9. Feed Valve Stem
10. Valve Spring
11. Washer
12. Piston
13. Cup
14. Piston Snap Ring
15. Piston Cup Seal Inner Retainer
16. Cup Retaining Washer
17. Spring
18. Cup Retaining Washer
19. Snap Ring
20. Piston Cup Seal Outer Retainer
21. Cup
22. Piston Wiper Washer
23. End
24. Brake Valve Stem
25. Valve Cup Retainer
26. Cup
27. End
28. Spring
29. Washer
30. Spring Retainer Ring
31. Parking Brake Control Arm
32. Bolt
33. Washer
34. Nut
35. Pin
36. Parking Brake Control Plate
37. Bolt
38. Washer
39. Nut
40. Pin
41. Gasket
42. Piston Stop

Note: Items 14 through 23 are contained in both ends.

Figure 253 — Master Brake Cylinder Unit

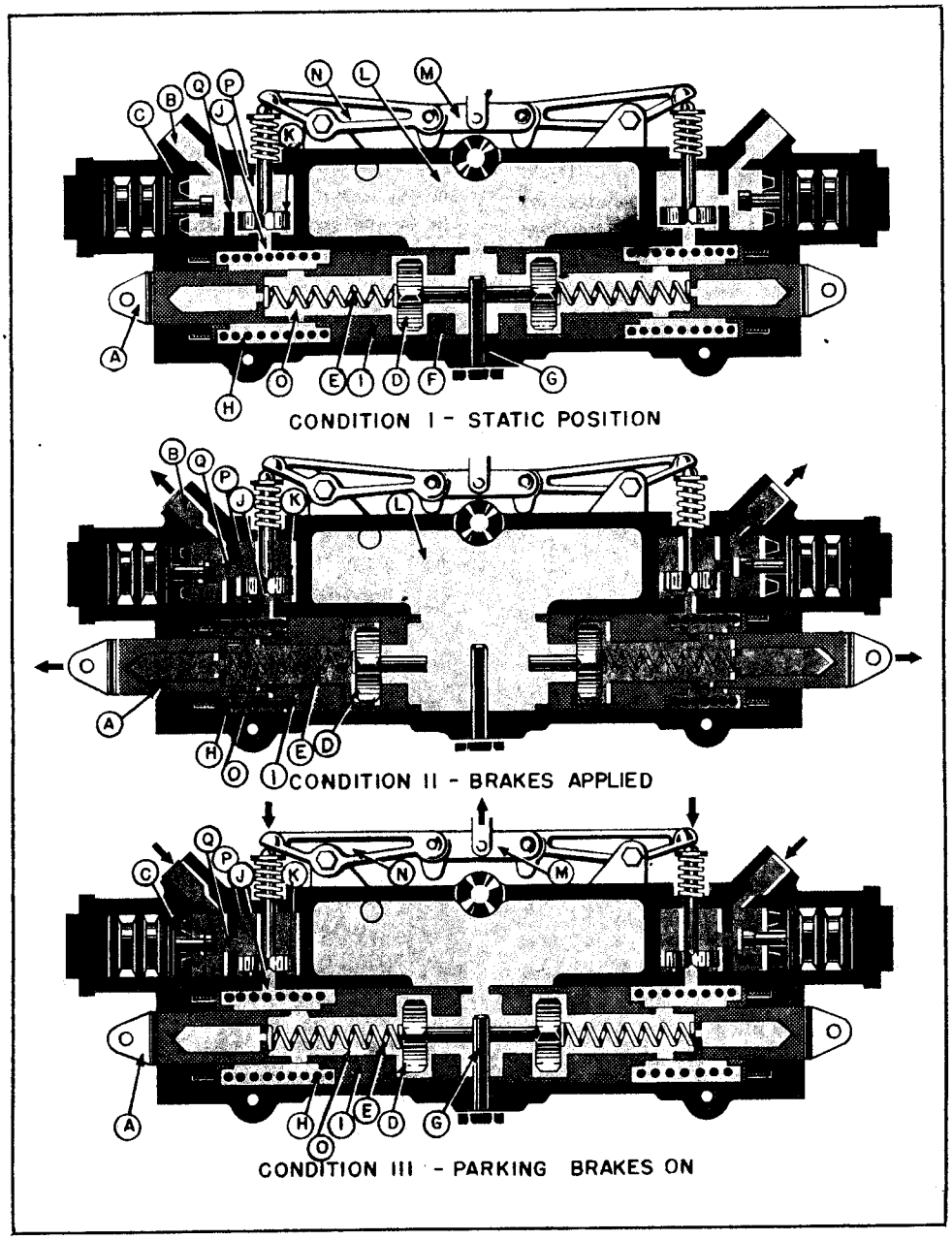


Figure 254 — Master Brake Cylinder Function Diagram

is confined in chambers "O" and "P" and is prevented from returning to the reservoir "L." As the piston is moved outward, the fluid is compressed and forced upward through opening "J" into chamber "P," through opening "Q" and out brake-line port "B" to the corresponding brake shoe cylinder.

CONDITION III: PARKING BRAKES ON.—While pressure is being applied to the tips of the rudder pedals causing the condition outlined above to exist, the parking brake handle is pulled outward causing connecting bar "M" to move upward and rocker arm lever "N" to move downward, forcing valve "K" down over opening "J," thus confining the fluid under pressure in chamber "P" and in the brake line and brake shoe operating cylinder. Releasing the pressure on the pedal allows piston "I" to be moved inward against stop "G" by compression spring "H," thus forcing valve "D" off of its seat and releasing the fluid confined in chamber "O." Therefore, the higher pressure maintained in chamber "P" will hold valve "K" seated. A thermal expansion valve "C" is provided at the end of the brake cylinder, which expands to provide additional fluid area as the volume of the fluid increases, due to thermal expansion, thus preventing excessive pressure from building up in the system. The parking brake is released by depressing the tip of the rudder pedal, which has caused pistor. "I" to move outward, building up sufficient pressure to force valve "K" off its seat, thus releasing the pressure in

chamber "P," and piston "I" moves inward against stop "G" after the release of the brake pedal. Thus all valves are open and the fluid is in a static condition as shown in condition I.

(b) REMOVAL.—The master brake cylinder unit is located just aft of the fire wall on the lower, front fuselage spar. It is attached to the spar by two bolts and nuts. To remove the master brake cylinder unit, remove the two bolts and nuts which attach the brake pedal cables to the piston rods, remove the nut and bolt attaching the master brake control cable to the actuating levers, and loosen the two B-nuts which connect the brake lines to the cylinder elbow port fittings. Then remove the two nuts and bolts attaching the master brake cylinder unit to the brackets on the fuselage spar.

(c) TEST BEFORE INSTALLATION.—Testing the master brake cylinder unit requires special equipment listed below:

Special hand wheel fitting.
2000-pound per square inch hydraulic pressure gage.
Small ball-check one-way valve.
Auxiliary reservoir (desirable but not necessary).
Suitable receptacle.

1. Each side of the master brake cylinder unit should be tested separately as follows:

a. Attach a one-way check valve to the left outlet port to prevent air from getting in the unit, and install an auxiliary reservoir line at the filler plug port if possible. Fill the reservoir with fluid and move the piston in and out by hand to free the system of air and to see that the cylinder unit forces fluid through the one-way check valve when the piston is pulled outward. The piston displacement at 0 pounds per square inch pressure should be approximately 1.2 cubic inches. The effective displacement at 600-800 pounds per square inch should be approximately .974 cubic inch. Next remove the one-way check valve, and install a pressure gage in its place. Also, install a sleeve on the handwheel shaft as shown in figure 255. The B-nut at the gage should be left loose until the piston is pulled out at least once to permit any air in the unit to leak out around the loose fitting. Turn the handwheel counterclockwise to allow the piston to fully retract, then turn clockwise to move the piston outward until a pressure reading of 1200 pounds per square inch is noted on the pressure gage. Allow to stand 5 minutes; if any small loss of pressure is indicated, simply turn handwheel clockwise until 1200 pounds per square inch is again indicated and allow to stand for one-half hour. No loss of pressure should be evident at the end of this time. The possible slight loss of pressure after the first 5 minutes is normal, due to parts settling into place.

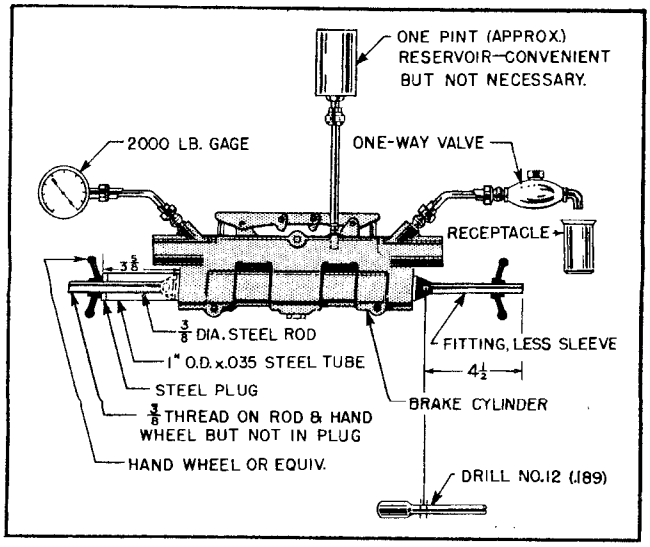


Figure 255—Master Brake Cylinder Test Diagram

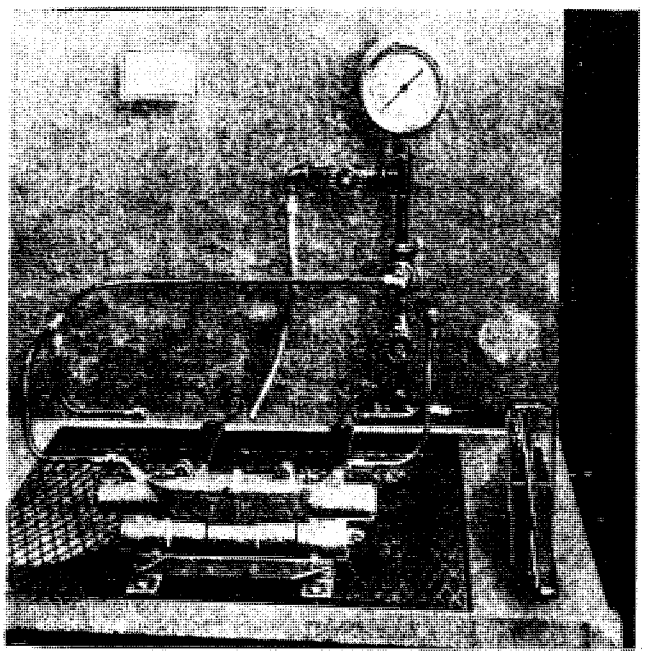


Figure 256—Testing Master Brake Cylinder

b. To check the proper release of the piston valve, turn the wheel counterclockwise to allow the piston to retract. The pressure should decrease as the wheel is backed off; when the piston nearly reaches its fully retracted position, the pressure should fall off rapidly and completely.

c. Repeat the foregoing test procedure on each side of the master brake cylinder unit.

2. The above check tests all valves and seats except the parking brake valve. Proceed as follows to check the parking brake valve:

a. Turn wheel counterclockwise to allow the piston to retract fully. Push down on the parking brake

valve. Turn handwheel clockwise until 1200 pounds per square inch is indicated. While still holding down parking brake valve, turn handwheel counterclockwise until it is free; remove the pressure on the parking brake valve. The gage should continue to read 1200 pounds per square inch. Allow to stand for one-half hour, at the end of which time no reduction of pressure should be evident.

b. Next, check for release of parking brake. With the parking brake valve closed and pressure applied as outlined in the preceding paragraph, turn handwheel clockwise. Two or three turns of the wheel after it begins to tighten should snap out the parking brake valve, and the pressure should drop as the wheel is turned counterclockwise.

c. Repeat procedure in preceding paragraphs, on opposite side of the master brake cylinder unit.

(d) INSTALLATION. — Place master brake cylinder in position on aft side of fire wall at mounting brackets provided on lower fuselage cross tube. Front and rear brackets are provided on left side and a front bracket only on the right. Install the attaching bolts and nuts. Connect the two hydraulic fluid lines to fittings at cylinder ends and bulkhead fittings on top of wing center section. From forward side of fire wall, install elbow through hole in fire wall into brake cylinder. Assemble plug assembly in elbow. Attach brake cables to piston ends, utilizing two links. Assemble spring between extension arms on links at aft side of cylinder. Attach brake pull cables and parking brake cables.

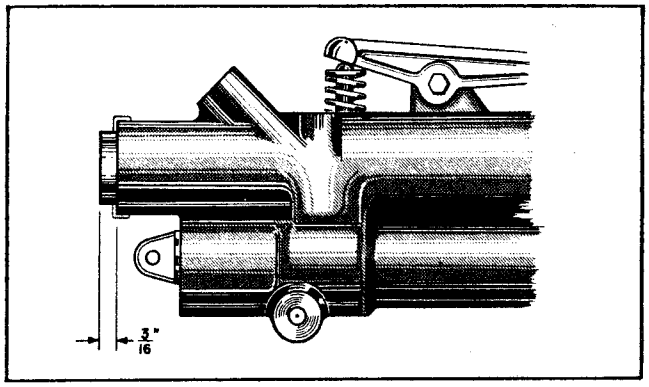


Figure 257 — Master Brake Cylinder Expansion Chamber Adjustment

(e) ADJUSTMENT.—The only adjustment on the master brake cylinder is on the thermal expansion plug or setscrew in the upper end of each cylinder. This plug should be screwed in so that the distance between the end of the plug and the end of the cylinder body is 3/16-inch (figure 257).

For adjustment of brake pedals, refer to section IV, paragraph 4, *a,* (11) *(e).*

(3) BRAKE SHOE OPERATING CYLINDERS.

(a) DESCRIPTION.—*(See figure 258.)*—The brake shoe operating cylinder is located between the ends of the brake shoe on the brake shoe support plate which is bolted to a flange attached to the inboard end of each landing gear strut wheel axle. Fluid under pressure flows from the master brake cylinder port, through the brake line, to the brake shoe operating cylinder where it forces two actuating pistons outward against the ends of the brake shoes, thus expanding the shoes against the brake drum. When the pressure is released, the spring-loaded ends of the brake shoe retract, forcing the pistons back into the cylinder. As the piston moves inward toward the center of the cylinder, fluid is displaced which returns through the port in the center of the cylinder to the master brake cylinder unit reservoir.

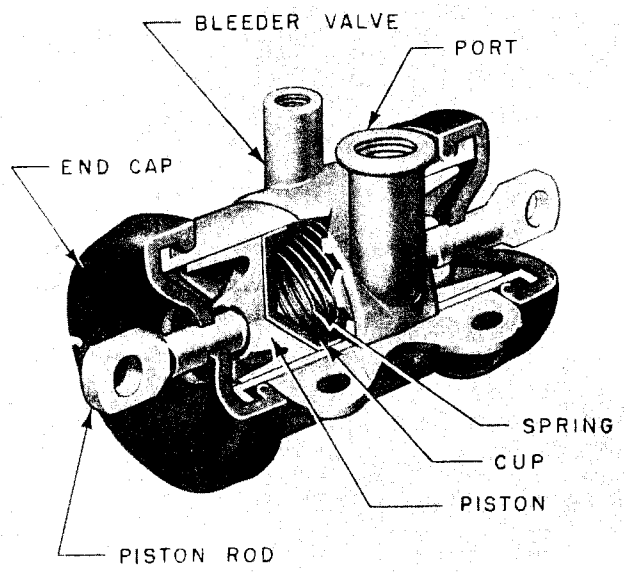


Figure 258 — Brake Shoe Operating Cylinder

EXPLANATION OF BRAKE SHOE CYLINDER FUNCTION DIAGRAM.—*(See figure 259.)*

CONDITION I: BRAKES APPLIED.—Fluid under pressure has entered port "A" and cylinder "G" and has forced pistons "B" and "C" outward away from the center of the cylinder. Rods "H" and "I" have moved outward expanding the ends of the brake shoe. Spring "D" holds cups "E" and "F" against pistons "C" and "B."

CONDITION II: BRAKES RELEASED.—The pressure in the master brake cylinder unit has been released, allowing fluid to return through port "A." The brake shoe retracting springs have caused the brake shoe to retract, thus causing rods "H" and "I" and pistons "B" and "C" to move inward toward the center of the cylinder.

(b) REMOVAL.—Remove the bolt attaching the brake line fitting to the operating cylinder. Remove

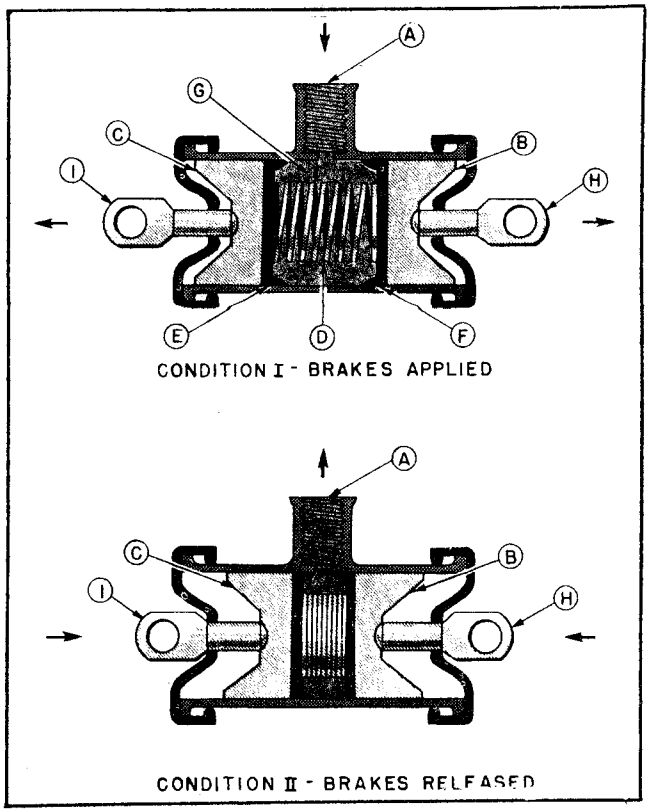


Figure 259 — Brake Shoe Operating Cylinder Function Diagram

the two lock-wired bolts and the two screws attaching the cylinder body to the brake shoe support flange and then remove the two clevis pins attaching the piston rod to the brake shoes. Now remove the operating cylinders from the brake support plate.

(c) TEST BEFORE INSTALLATION.—Test the brake shoe operating cylinder by applying 1200 pounds per square inch pressure at port "A", check for leaks around cylinder and packing cup while pressure is applied. The operating cylinder pistons should be restrained from moving out of the cylinder while pressure is being applied.

(4) BLEEDING BRAKE SYSTEM.—*(See figure 261.)*—Whenever the hydraulic line connecting the master cylinder to the brake cylinder is disconnected, air will be admitted to the system and the line must be bled to remove the air when line is reconnected. This same condition may develop if the master cylinder reservoir becomes empty. Air in the line may be determined by the action of the brake pedals. If a brake pedal has a spongy action when applying the brake, the cause may be due to air compressing in the system. It will be noted that there are two fittings on each brake actuating cylinder, the inlet fitting and the bleeder. To bleed the system, proceed as follows:

(a) Remove the master cylinder filler plug and attach a line to the filler port. The opposite end of the line should be connected to a reservoir containing

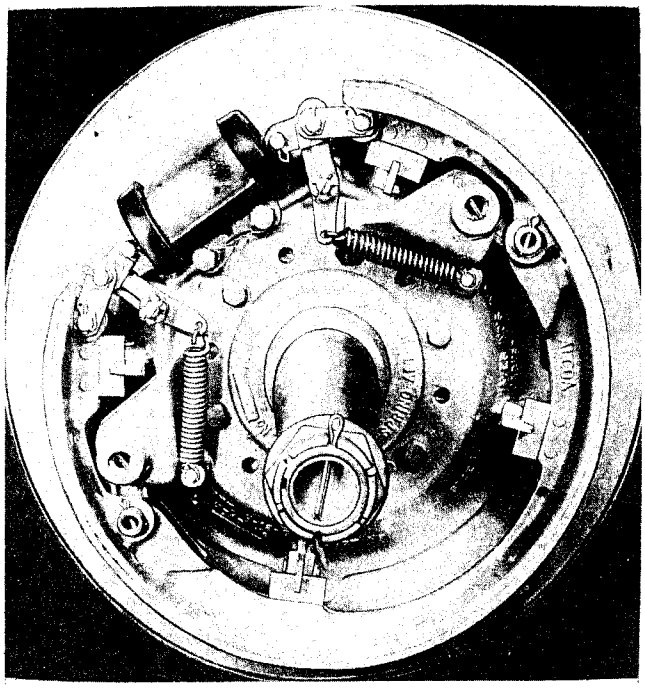


Figure 260 — Brake Shoe Operating Cylinder Installation

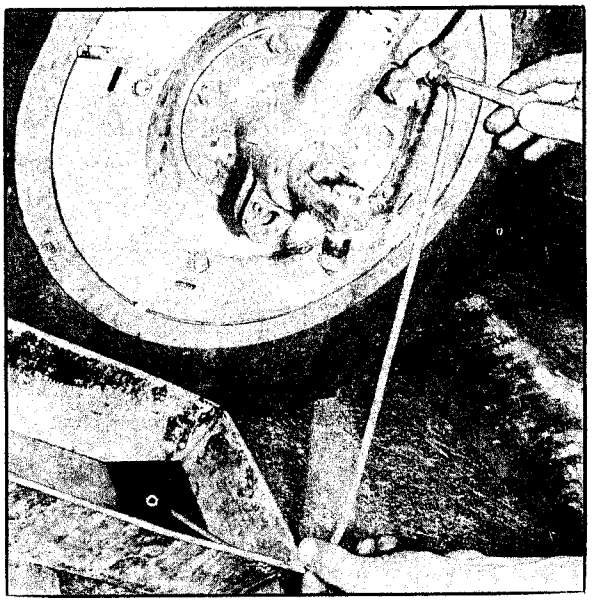


Figure 261 — Bleeding Brake System

at least one pint of hydraulic fluid. Position the reservoir above the master cylinder unit so that fluid in the reservoir is free to flow into the master cylinder filler port.

(b) Remove the bleeder plug from the inboard side of the brake torque plate and attach a bleeder hose to the bleeder port. Submerge the opposite end of the line in hydraulic fluid contained in a suitable container placed at approximately ground level.

(c) Pump the brake pedals several times and note whether air bubbles are present in the bleeder tube con-

tainer. When air bubbles cease to appear in the fluid, remove the bleeder hose and install the bleeder plug. Disconnect the upper reservoir line from the master cylinder filler port and install the filler plug.

(d) If a spongy brake pedal is still evident, check all hydraulic line joints for leaks and repeat above bleeding procedure.

13. ELECTRICAL SYSTEMS

NOTE

AT-6C, SNJ-4, and earlier airplanes are equipped with a 12-volt electrical system. AT-6D and SNJ-5 airplanes have a 24-volt electrical system. This section is, therefore, divided into two parts: *a.* 12-Volt System and *b.* 24-Volt System.

a. 12-VOLT SYSTEM. (AT-6, 6A, B, C, SNJ-3, and 4.)

(1) GENERAL.

(a) DESCRIPTION. — *(See figures 262 and 263.)*—The electrical system of the airplane has two main sources of energy: a storage battery and an engine-driven generator, both connected to a common distribution system. The common system is energized by 12-volt direct current, but some equipment (fluorescent lights and compass lights) requiring alternating current are supplied by a dc to ac inverter. The distribution system is of the single hot-wire type with the metallic structure of the airplane serving as the return, except in some instances where it is necessary to use a two-wire circuit to prevent compass interference or to obtain a more efficient ground. The main power panel on the forward face of the fire wall contains the battery and starter solenoids, and the booster coil. The generator control panel at the forward left side of the front cockpit contains a voltage regulator and a relay cut-out. All circuits (except the bomb release and gun circuits) are fused in the main fuse box at the forward left side of the front cockpit. All electrical equipment is controlled from the control panel in the front cockpit. The bomb release and gun firing circuits are fused in the main control panel in the front cockpit and are controlled by switches on the face of this control panel. Two cockpit lights are provided in each cockpit and the instruments in each are lighted with a fluorescent light.

(b) TROUBLE SHOOTING PROCEDURE.—In trouble shooting the airplane electrical system, the proper procedure is to check from the fuse box (figure 264) to the equipment involved. If after following this procedure the service man is convinced that the trouble exists inside the individual piece of equipment, it should be removed and an identical or interchangeable unit that has been tested for normal operation installed in its place. See "Trouble Shooting" chart.

(c) MAINTENANCE REPAIRS. — Suitable shop and testing equipment should be available before attempting maintenance of any individual item of electrical equipment on the airplane. When it is necessary to test the various circuits and items of electrical equipment, the proper procedure is to first remove all electrical power from the equipment, make necessary circuit changes or meter connections, and then apply the power to the equipment involved.

(2) STORAGE BATTERY.—*(See figure 265.)*—A 12-volt, 68-ampere hour, type D-6 storage battery is installed in a covered metal case secured to a support on the right forward side of the fire wall. The battery is readily accessible for inspection and removal by removing the right engine cowling. The cover to the battery case is fitted with a rubber or neoprene gasket which forms a sealed air chamber inside the case to prevent the escape of corrosive gas. Provision is made to neutralize and vent these battery gases outside, as they would damage the metallic structure of the airplane. This is accomplished by a rubber or neoprene tube leading from an air intake in the bottom of the engine cowling to one side of the battery case, and a tube from the opposite side of the battery case leading to a glass jar containing a cellulose sponge disc 1 inch thick and saturated with a solution of tri-sodium phosphate (NA_3PO_4). (If necessary a solution of sodium bicarbonate [baking soda] may be substituted for this purpose and the sponge may be of felt.) This solution in the jar will neutralize any acid in the battery gases, and a tube from the top of the jar to a vent in the bottom of the cowling will carry the neutralized gas outside the airplane. The jar is accessible through an opening in the lower right side of the engine cowling.

WARNING

When the specific gravity of the battery electrolyte falls below 1.240 (temperature corrected) the battery should be replaced with a fully charged battery. A battery remaining in service after its specific gravity has dropped below 1.240 causes the generator to charge at an extremely high amperage, often as high as between 50 and 75 amperes. This will often result in overheating and consequent damage to the battery.

(3) GENERATOR SYSTEM.—*(See figures 266 and 267.)* — A type E-5A engine-driven generator, mounted on the rear of the engine assembly, serves to keep the battery charged and to furnish power for operating the airplane electrical equipment. A generator control panel, mounted on the forward left side of the front cockpit, serves to regulate the voltage output of the generator. This control panel is a complete unit, including a voltage regulator element, and a reverse current cut-out element. A type F-1 ammeter and a type B-1 voltmeter are installed on the front cockpit control panel. The stationary pointer of the voltmeter is set at 14.25-volts to give a quick visual check for normal generator output.

NOTE

Because of the frequent revisions made from time to time in the electrical system this electrical wiring diagram should be used ONLY as general reference with the accompanying text. For servicing and repairing of the electrical wiring system in the airplane, refer to the latest revision of North American Dwg. No. 88-54002 which accompanies each airplane.

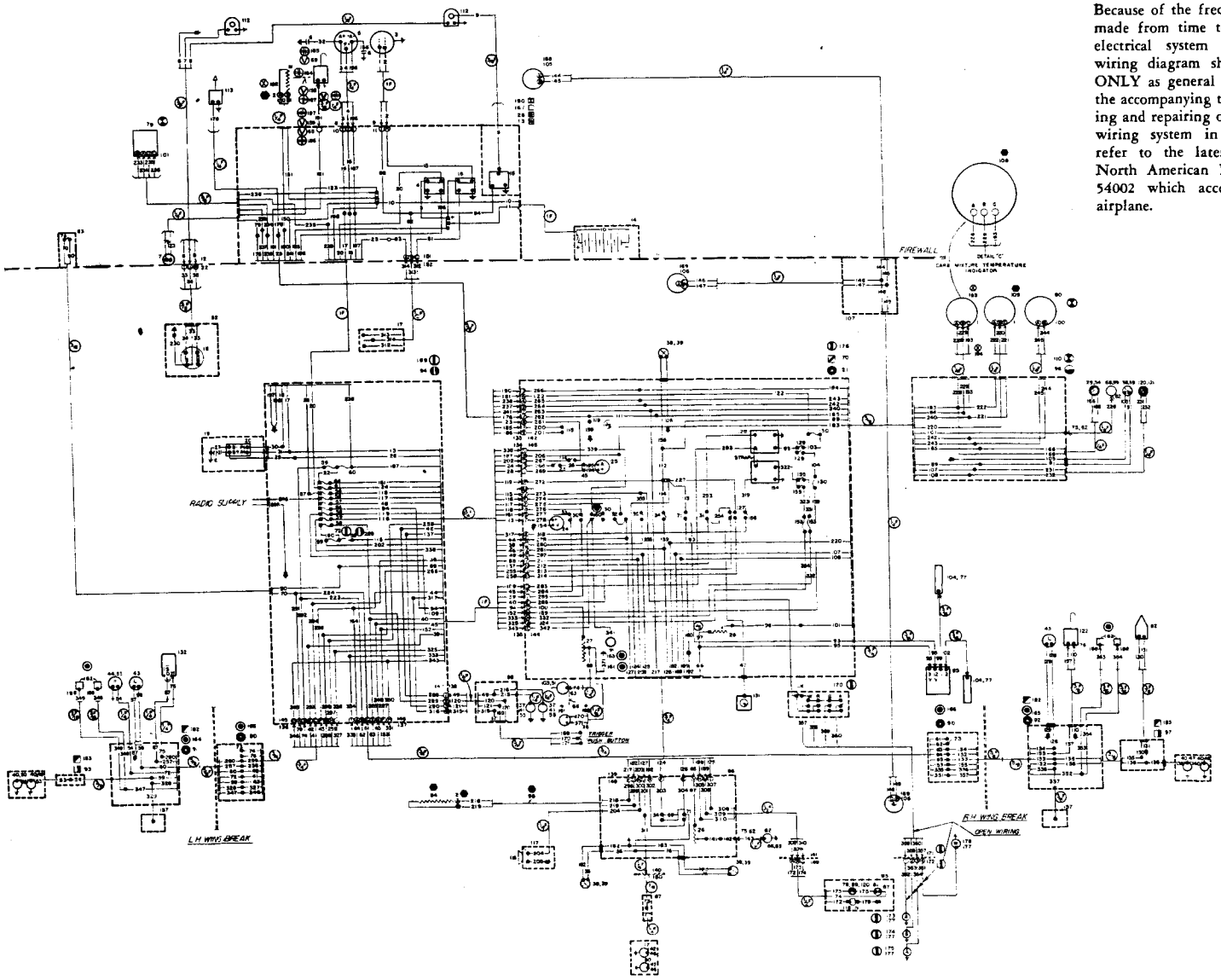


Figure 262 – Electrical Wiring Diagram – 12-Volt

LEGEND - 12 VOLT WIRING DIAGRAM, AT-6C AND SNJ-4 AIRPLANES

CODING SYMBOLS

SERIAL NO.	THROUGH	SERIAL NO.	CHANGES MADE
ARMY		**ARMY**	
41-32073		41-32093	
41-32073		41-32108	
41-32073		41-32152	
41-32073		41-32502	
41-32073		41-35072	
42-32094		41-33072	
41-32109		41-32152	
41-32109		41-32502	
41-32109		41-32400	
41-32109		41-35072	
41-32152		41-35072	
41-32153		41-33072	
41-32153		41-32362	
41-32153		41-32400	
41-32305		41-33072	
41-32401		41-32405	
41-32406		41-33072	
42-3884		42-4243	
42-45847		42-43911	
42-45847		42-45917	
42-45847		42-44409	
42-43912		42-43921	
42-43918		42-43921	
42-43922		42-44021	
42-44022		42-44409	
42-48772		42-49069	
Navy		**Navy**	
09527		05622	
09527		05656	
09527		05674	
09623		05674	
09817		09829	
09817		09973	
09817		10023	
09817		10143	
09817		10516	
09830		10174	
09974		10174	
09984		10516	
10024		10143	
10024		10316	
10144		10516	
10175		10516	
26427		26443	
26427		27778	
26427		27846	
26427		27851	
27847		27851	
51350		51676	
British		**British**	
EX-108		EX-133	
EX-100		EX-234	
EX-100		EX-364	
EX-100		EX-748	
EX-100		EX-846	
EX-134		EX-234	
EX-134		EX-846	
EX-235		EX-364	
EX-235		EX-396	
EX-235		EX-846	
EX-364		EX-846	
EX-397		EX-432	
EX-749		EX-846	

NO.	DESCRIPTION	TYPE	SPEC. OR PART NO.
1	Socket Assembly Carburetor Temperature Free Air	AN9534	AN3106-14s-1s
2	Socket Assembly Carburetor Temperature Free Air	AN9534	AN3106-12s-3s
3	*Starter—Electrical Inertia	H-5	32301
4	*Switch—Solenoid, Battery	B-1	32141-A
5	*Generator—15 volt, 50-amp.	E-5A	95-32018
6	Capacitor—0.5 MFD. 100 W.V.	.....	50131
7	*Switch—Fuel Switch over Sig.	C-3	32215
8	Plug Assembly Generator	.....	36A5956
9	Plug Assembly Starter	.....	36A1874
10	Socket Assembly Generator	.....	35B5168
11	Socket Assembly Starter	.....	36A1881
12	Plug Assembly Ignition	.....	35A2533
13	Box Assembly Main Power Pan.	NAA	88-54072-4
14	*Battery—12 volt, 68 A.H.	D-6	70-40
15	*Coil Assembly Booster	A-1	94-32083-4
16	*Switch—Solenoid, Starter	A-5A	94-32079
17	Switch—Foot Starter	B-11	AN3019
18	Switch—Ignition	A-7	32090
19	Shield—General Control Panel	NAA	55-54031
20	*Panel—Generator Control	A-1	32016
21	Box Assem.—Front Cockpit Switch	NAA	88-54003
22	Socket Assembly—Ignition	Breeze	E-1156-3-10
23	Switch—Generator Main Line	B-13	32103
24	*Voltmeter	E-1	32172
25	*Ammeter	F-1	94-032284
26	Rheostat—Compass Light	C-1 (25 ohm)	32009-C
27	Rheostat—Gun Sight	F-1 (8 ohm)	32032-C
28	Box Assem. Main Power Panel	NAA	88-54072
29	*Lamp 14 volt S.C. Clear Fuel Sig. 1 spare	T-3¼	
30	Switch—Landing Lights	B-5A	AN3015
31	Switch—Gun Safety	B-5A	AN3015
32	Switch—Running Lights	B-7A	AN3017
33	Switch—Pitot Heat	B-5A	AN3015
34	Switch—Fuel Gege Lights	B-5A	AN3015
35	Switch—Passing Light	B-5A	AN3015
36	*Switch—Gun Control Stick	B-4	39B1691
37	Socket—Lamp S.C. Fuel Ga. Lights	.....	31A4527
38	Lamp—12-16-volt, 3 C.P. S. C., Cockpit	T-3¼	.....
39	Lamp Assem. Cockpit—12-volt	C-4	94-32294
40	*Lamp—12-16-volt 6 C.P. S.C., Wing Tip	G-6	.....
41	*Lamp—12-16-volt 2 C.P. S.C. Fuel Gage	F-4¼	.....
42	*Lamp—18-24-volt 3 C.P. S.C. Tail Light	G-6	.....
43	*Lamp—12-volt, 450 W. Sealed Beam	Landing Lamp	H41G9803
44	*Lamp—12-16-volt 50 C.P. S.C. Passing	RP-11	.....
45	*Shunt—Ammeter	F-1	94-32284
46	*Lamp Assembly—Tail, Clear	A-8	37B4962-5
47	*Lamp Assembly Right Wing Upper (gr)	A-8	37B4962-2
48	*Lamp Assembly Right Wing Lower (gr)	A-8	37B4962-4
49	*Lamp Assem. Left Wing Upper (red)	B-8	37B4962-1
50	*Lamp Assem. Left Wing Lower (red)	A-8	37B4962-3
51	*Lamp 12-16-volt 21-21 C.P. Gun Sight	RP-11	.....
52	Box Assembly—Ignition Switch	NAA	55-54054
53	*Lamp Assembly—Passing	B-3	37D4865
54	Lamp Assem.—Fuel Switch-over Sig.	Red	39A2822-2
55	Lamp Assem.—Fuel Level Gage	NAA	25-54052
56	Fuse Landing Lights (2 spare)	70-amp.	32084-C
57	Fuse—Camera and Start-switch (2 spare)	35-amp.	32084-C
58	Fuse—Cockpit Lights, Gun Sel. (3 spare)	20-amp.	32084-C
59	Fuse, Navigation Lights, Landing Gear (4 spare)	15-amp.	32084-C
60	Fuse—Fuel Signal Switch (1 spare)	1-amp.	32084-C
61	Fuse—Generator (1 spare)	100-amp.	32084-C
62	Plug—Inst. Lamp Connector	.....	37A5157
63	Receptacle—Gun Sight	.....	39A2390
64	Fuse—Pitot Heat, Gun Sight (2 spare)	30-amp.	32084-C
65	Socket—Gun Solenoid	.....	AN3102-10s-2s
66	Retainer—Gun Sight	.....	H39D2584
67	Sleeve—Lamp Socket	.....	32A5376
68	*Lamp—3-volt Indiv. Inst. (2 spare)	.....	36A3344
69	Solenoid—Cowl Gun	E-6	24743
70	Box Assem.—Front Cockpit Switch	NAA	88-54105
71	Switch—Fluorescent Lights	B-5A	AN3015
72	Fuse—Pitot Heat, Gun Sight (2 spare)	30-amp.	52084-C
73	Switch—Landing Gear Pos. Indic.	B-10	34A3846
74	Switch—Landing Gear, Warning Reset	B-12	34A6066
75	Socket—Inst. Lamp Conn.	.....	38A1549
76	Plug Assem.—Wing Gun Sol.	.....	37A2323
77	Cartridge—Fluorescent Lamp	.....	H-35
78	Cap Assem.—Lamp Camera Sig.	Green	31-1455-2
79	*Cell—Fuel Mixt. Indicator	A-7	27992Engelhard
80	*Indicator—Fuel Mixture	A-7	27992Engelhard
81	Socket—Camera DC	.....	32A1981
82	*Pitot Head—Elect. Heated	C-7	27884
83	Shield Assem. L.G. Throttle Switch	NAA	55-54139
84	*Bulb—Free Air Temperature	C-12	27990
85	*Inverter—12 Volt	A-4	32280
86	Box Assem.—Rear Cockpit Switch	NAA	88-54004
87	Box Assem.—Tail Light Jct.	NAA	55-54019
88	Box Assem.—Stick Switch Jct.	NAA	88-54195-4
89	Socket—Camera Signal Light	P. R. Mallory Co., Inc.	49-54173
90	Box Assem.—Landing Gear Pos. Ind. Switch	NAA	84-54025-6 L.H. 84-54025-7 R.H.
91	Box Assem.—L.H. Landing Light Junction	NAA	88-54211
92	Box Assem.—R.H. Landing Light Junction	NAA	88-54212
93	Box Assem.—L.H. Wing Tip Light Junction	NAA	55-54209
94	Box Assem.—Main Fuse Panel	NAA	88-54068
95	Box Assem.—Camera Power	NAA	55-54008
96	Box Assem.—Light Distr.	NAA	88-54077
97	Box Assem.—R.H. Wing Tip and Pitot Junction	NAA	55-54208
98	Wire Assembly—Free Air Therm.	NAA	77-54106
99	*Light Assembly—Compass	B-16	94-29807
100	Socket Assem.—Fuel—Air Indic.	AN9534	AN3106-12s-3s
101	Socket Assem.—Fuel Air Cell	AN9534	AN3106-14s-2s
102	Fuse—Nav. Lights, Landing Gear (3 spares)	15-amp.	52084-C
103	*Light Assem.—Fixed Gun Sight	N-3A	.....
104	Lamp Assem.—Cockpit (Fluorescent)	.....	X221
105	*Tachometer—Elect. Trans.	E-12	27511
106	*Tachometer—Elect. Indic.	F-12	27311
107	Box Assem.—Elect. Tachometer Junction	NAA	78-54011
108	*Indic. Carb. Mixture Therm.	F-9	27991
109	*Indicator—Free Air Therm.	C-12	27990
110	Box Assem.—Light Distr.	NAA	88-54077-4
111	*Bulb—Carb. Mixture Therm.	F-9	27991
112	*Magneto—Furn. with Engine	Scint. SB9-R	13758
113	Solenoid—Oil Dilution	.....	37D6210
114	Switch—Oil Dilution	B-6B	AN3016
115	Switch—Battery Main Line	B-5A	AN3015
116	Horn—Signal Assem. Landing Gear	B-3	32153
117	Box Assem.—Horn	NAA	55-54142
118	Receptacle—Camera Power	Harvey Hubbell	7210
119	Switch—Fuel Signal Test	B-6B	AN3016
120	*Lamp—6.3 volt, S.C. Clear, Camera Signals	T-5¼	.....
121	Lamp Assem.—Camera Signal	Green	39A2822-3
122	*Solenoid—Wing Gun	C-4C	41B5099
123	*Indic. Fuel Mixture	A-7	27992 Cambridge
124	*Cell—Fuel Mixture Indicator	A-7	27992 Cambridge
125	Socket Assem.—Fuel Mixt. Indic. (Cell)	AN9534	AN3106-18-4s
126	Socket Assem.—Fuel Mixt. Ind. (Indic.)	AN9534	AN3106-16s-1s
127	Switch—Camera Safety	Cutler Hammer	0701
128	Solenoid—Gun Control	Leach	5030
129	Switch—Gun Selector	B-5A	AN3015
130	Fuse—Cowl and Wing Gun (1 spare)	30-amp.	32084-C
131	*Indicator—Consumption (Flow)	.....	W-7
132	*Cinegun Camera	.....	W-7
133	Plug Assem.—Pilot's Switch Box	Breeze	36A4275
134	Plug Assem.—Pilot's Switch Box	Breeze	E1002-12-10
135	Plug Assem.—Pilot's Switch Box	Breeze	36A3955
136	Plug Assem.—Right Wing	Breeze	36A3955
137	Plug Assem.—Left Wing	Breeze	36A3955
138	Plug Assem.—Stick Switch Jct.	Breeze	E1002-3-100
139	Plug Assem.—Rear Switch Box	Breeze	36A4276
140	Plug Assem.—Tail Light	Breeze	E1002-18-10
141	Plug Assem.—Camera Power	Breeze	E1002-4-120
142	Socket Assem.—Pilot's Switch Box	Breeze	35A5235
143	Socket Assem.—Pilot's Switch Box	Breeze	E1003-12-10
144	Socket Assem.—Pilot's Switch Box	Breeze	35B5160
145	Socket Assem.—Main Fuse Pan	Breeze	35B5160
146	Socket Assem.—Main Fuse Pan	Breeze	35B5160
147	Socket Assem.—Main Fuse Pan	Breeze	35A4269
148	Socket Assem.—Rear Switch Box	Breeze	36A3567
149	Socket Assem.—Camera Power	Breeze	E1156-4-30
150	Socket Assem.—Tail Light	Breeze	E1196-18-10
151	Socket Assem.—Starter Switch	Breeze	E1003-4-30
152	Plug Assem.—Starter Switch	Breeze	E1002-4-120
153	Fuse—Bomb Rack R.H. and L.H.	50-amp.	32084-C
154	Solenoid—Bomb Control	Leach	5050
155	Switch—Bomb Selector	B-5A	AN3015
156	Switch—Bomb Safety	B-5A	AN3015
157	Bomb Rack (See Note No. 17)	NAA	84-53005
158	Socket Assem.—Gun Sol Flex.	AN9534	AN3106-10s-2s
159	Socket Assem.—Gun Sol Flex.	AN9534	AN3106-10s-2p
160	Switch—Arming Control	B-5A	AN3015
161	Lamp—Arm. Control Indic.	.....	42B3593-2
162	*Control—Bomb Arming	B-1	24770
163	*Lamp—3 C.P. 33-amp. 13-volt S.C. Clear	T-5¼	.....
164	Box Assem.—L.H. Landing Light Junction	NAA	88-54223
165	Box Assem.—R.H. Landing Light Junction	NAA	88-54224
166	Box Assem.—Landing Gear Pos. Ind. Switch	NAA	88-54025 L.H. 88-54025-1 R.H.
167	Box Assem.—Main Power Panel	NAA	88-54072-7
168	Plug Assem.—Tach. Transmitter	AN9534	AN3106-12s-3s
169	Plug Assem.—Tach. Indicator	AN9534	AN3106-14s-1s
170	*Box Assem.—Recog. Light Cont'l	42D5051	88-54328
171	Plug Assem.—Recog. Light Dist.	Breeze	35A4273
172	Socket Assem.—Recog. Lights	Breeze	35A4269
173	*Lower Recog. Light (red)	E-2	32574
174	*Lower Recog. Light (green)	E-2	32574
175	*Lower Recog. Light (amber)	E-2	32574
176	*Upper Recog. Light (white)	E-1	32566
177	*Lamp—18-volt, C. and S. C. Bay 6-6-a. [illegible]	RP-11	Furn. with E-1 and E-2 Lights
178	Box Assem.—Front Cockpit Switch	NAA	88-54105-4
179	Switch—Resin Light	B-9A	AN-3018
180	Resistor—Ohmite (Acker)	25 ohm	25 watt
181	Resistor—Ohmite (Acker)	5 ohm	25 watt
182	Panel Assem.—Land Light Connector	NAA	88-54409
183	Panel Assem.—Wing Tip Conn.	NAA	88-54408
184	Retainer—Gun Solenoid Flex.	.....	H39D2548
185	*Solenoid—Cowl Gun	E-4	24610B
186	Socket—Gun Solenoid	.....	AC39A2388
187	Receptacle—Gun Solenoid	.....	AC39A2390
188	*Plug Assem. Bomb Arming Cont.	AN9534	AN3106-10s-2s
189	Box Assem.—Main Fuse Panel	NAA	88-54068-4
190	Box Assem.—Main Power Panel	NAA	88-54072-9
191	Sight Assem.—Gun (Ref.)	N-5B	41G6456
192	Socket Assem.—Gun Sight	.....	AN3106-12s-3s
193	*Ind. Carb. Mixture Therm.	AN5790-6	AN-GG-1-522a
194	Socket Assem.—Ind. Carb. Mix. Temp.	AN9534	AN3106-14s-2s
195	Socket Assem.—Bulb Carb. Mix. Temp.	AN9534	AN3106-12s-3s

*GFE (Government Furnished Equipment)

(a) GENERATOR FIELD FLASHING PROCEDURE. If the generator fails to build up voltage, because of reversed polarity, loss of residual magnetism, or excessively filmed commutator, the generator field may be flashed as follows:

1. Turn generator switch to "OFF" position, and battery switch to "ON" position.

2. Locate position of the nearest convenient terminal or bus, in the aircraft, for a source of battery electrical power. This may be located with a voltmeter.

3. Remove the voltage regulator from the generator circuit which will be flashed.

4. Connect one end of a suitable length of 18-gage or larger cable to the generator "A" lead terminal at the voltage regulator base.

5. With the engine operating at normal cruising rpm, approximately 1800, touch the other end of the cable to the power supply for approximately one second and note if a voltage is shown by the aircraft generator system voltmeter or other voltmeter properly connected.

6. If a voltage is not obtained, the generator is faulty and should be replaced. If voltage is obtained, reinstall voltage regulator, turn "ON" generator switch and see if voltage is maintained. If voltage is not maintained, replace voltage regulator. If generator repeatedly fails to put out voltage on run-up, check generator to see if the commutator is dirty or excessively coated with insulating film oil, etc. Clean the commutator sufficiently to obtain continued operation. The commutator need not be cleaned to a bright surface. A slight lubrication film, identifiable as a bronze discoloration, is desirable for high generator load and high altitude operation. Removal and replacement of the generator may finally be necessary to obtain satisfactory service.

WARNING

Do not flash generator field by closing reverse current relay contacts. Serious damage to the relay, the electrical system, and to the individual closing the contacts may result from the heavy current drawn from the batteries.

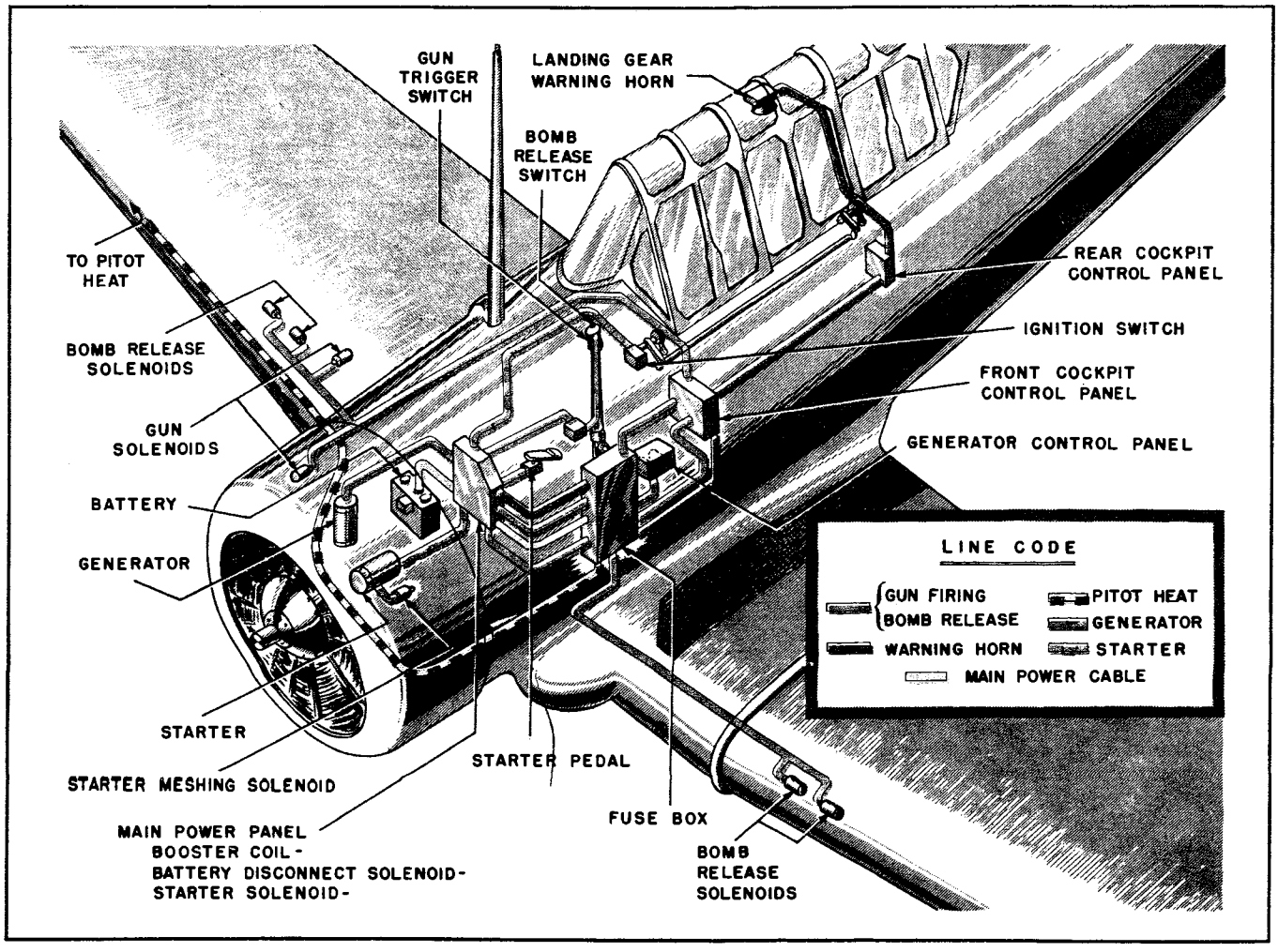


Figure 263—Electrical Power System—12-Volt

(b) DC POWER SYSTEM ADJUSTMENT. Warm-up the engine. The generator and voltage regulator should be at operating temperature before making adjustments. However, due to inadequate engine cooling, the warm-up on the ground will be governed by the limitations of the engine.

1. Turn the generator switch to the "OFF" position.

2. Using a portable precision voltmeter, connect the positive lead to "B" terminal of the voltage regulator and the other lead to a good ground (aircraft structure). Voltmeter, stock No. 7800-961000, is satisfactory for voltage adjustment.

3. Increase the engine speed to normal cruising rpm.

4. The voltmeter should indicate exactly 28.0 volts. If 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 (clockwise) will increase the voltage, and turning it to the left (counterclockwise) will decrease the voltage. In aircraft which are operating in areas where the average ambient temperatures are high, voltage may be set as low as 27.25 volts, in lieu of 28.0 volts. Such areas will be identified by the average battery condition in the area. If considerable boiling of the battery electrolyte is encountered and if frequent adding of battery water is required, the generator voltage will be adjusted lower to prevent boiling of battery electrolyte, but never lower than 27.25 volts.

(c) SHIELDING.—To suppress any interference in the communication circuit, two .5 mfd. 100-working volt capacitors are connected in the generator circuit and one .5 mfd. 100-working volt capacitor is connected in the generator control panel circuit.

(4) GENERATOR MAIN LINE SWITCH.—A generator main line switch on the front cockpit switch panel provides a means of opening the generator circuit in case the automatic relay cut-out in the generator control panel fails to operate. The switch should be left in the "OFF" position when the engine is not running. It is also best to put this switch to the "OFF" position before engaging in acrobatic or inverted flight; otherwise gas from charging may accumulate in the bat-

tery cells because of the anti-spill battery caps and exert enough pressure to damage the battery.

(5) IGNITION SWITCH.—*(See figure 268.)*—A master ignition switch box unit, wired directly to the rear of the magnetos, is located at the left side of the fuselage, forward of the front instrument panel. This master switch is operated from the left side of the instrument panel in both cockpits by a lever or pointer handle mechanically interconnected with the switch.

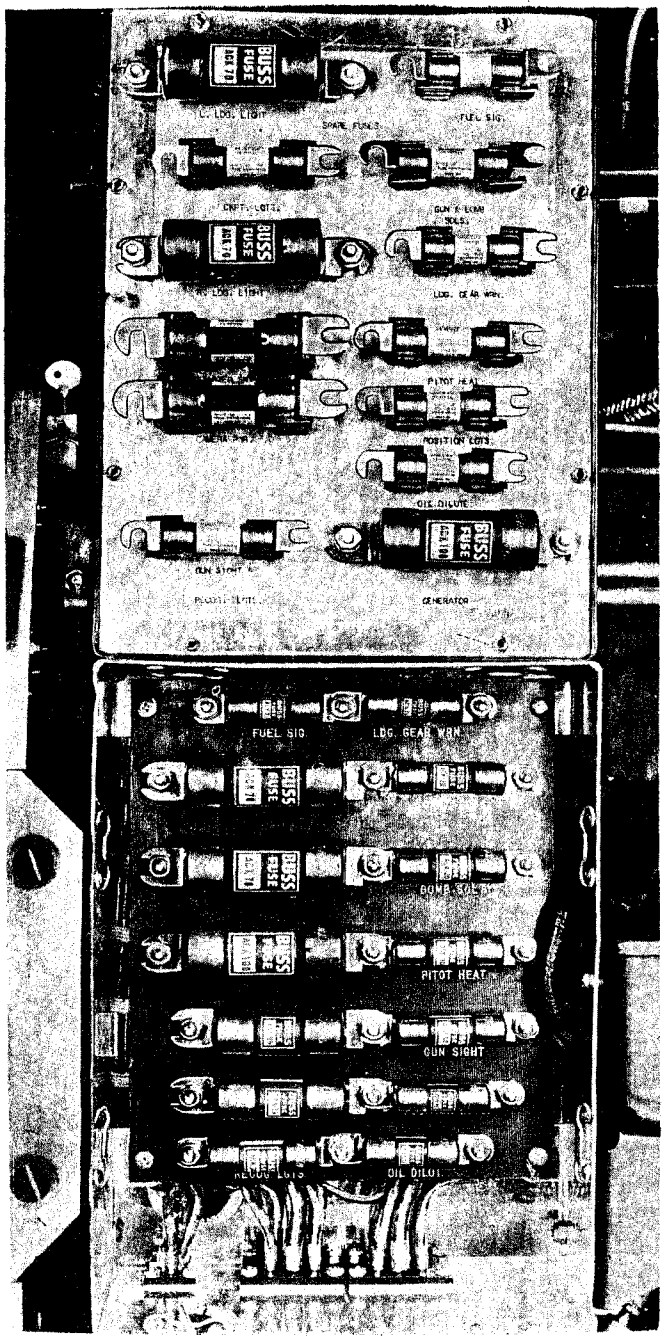


Figure 264 — Fuse Box — 12-Volt

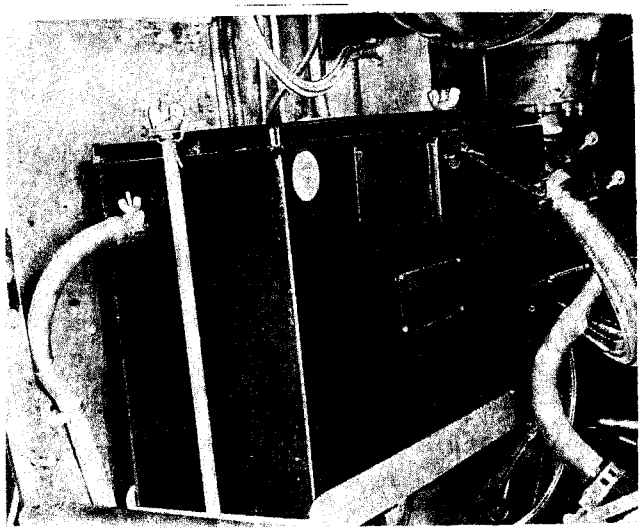


Figure 265 — Storage Battery — 12-Volt

(6) ENGINE STARTING SYSTEM.

(a) A type H-5 starter is mounted on the rear of the engine assembly. This starter was originally installed to operate as a combination electric or hand cranking inertia starter; however, to prevent engine or starter jaw breakage caused by sudden high starter torque resulting from the inertia feature, the installation has been rewired for direct cranking only. This rewiring consisted of removing wire No. 82 from terminal post in the main power panel and connecting a jumper between terminal post where wire No. 82 was removed and where wire No. 81 connects to starter relay. The starter is then operated by pressing on the toe of the foot pedal. The foot pedal shown in figure 269 is mounted between the rudder pedals. When the engine starts, release the foot pedal.

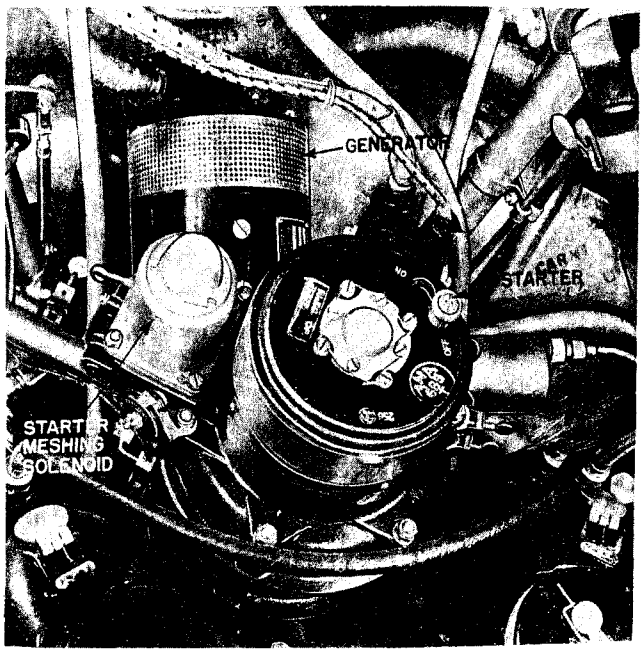


Figure 266 — Generator and Starter

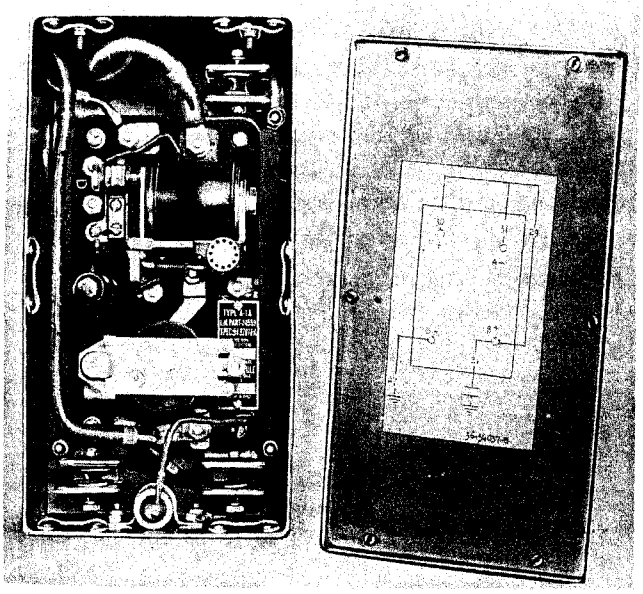


Figure 267 — Generator Control Panel — 12-Volt

(b) For emergency operation when the source of electrical energy is not sufficient to provide proper electrical operation, the starter may be operated as a hand inertia starter. To operate the starter as such, move the brush spring release to the "OFF" position. (When facing the starter, move the brush spring release handle clockwise to the "OFF" position and counterclockwise to the "ON" position.) This is accomplished by reaching through a small inspection door on

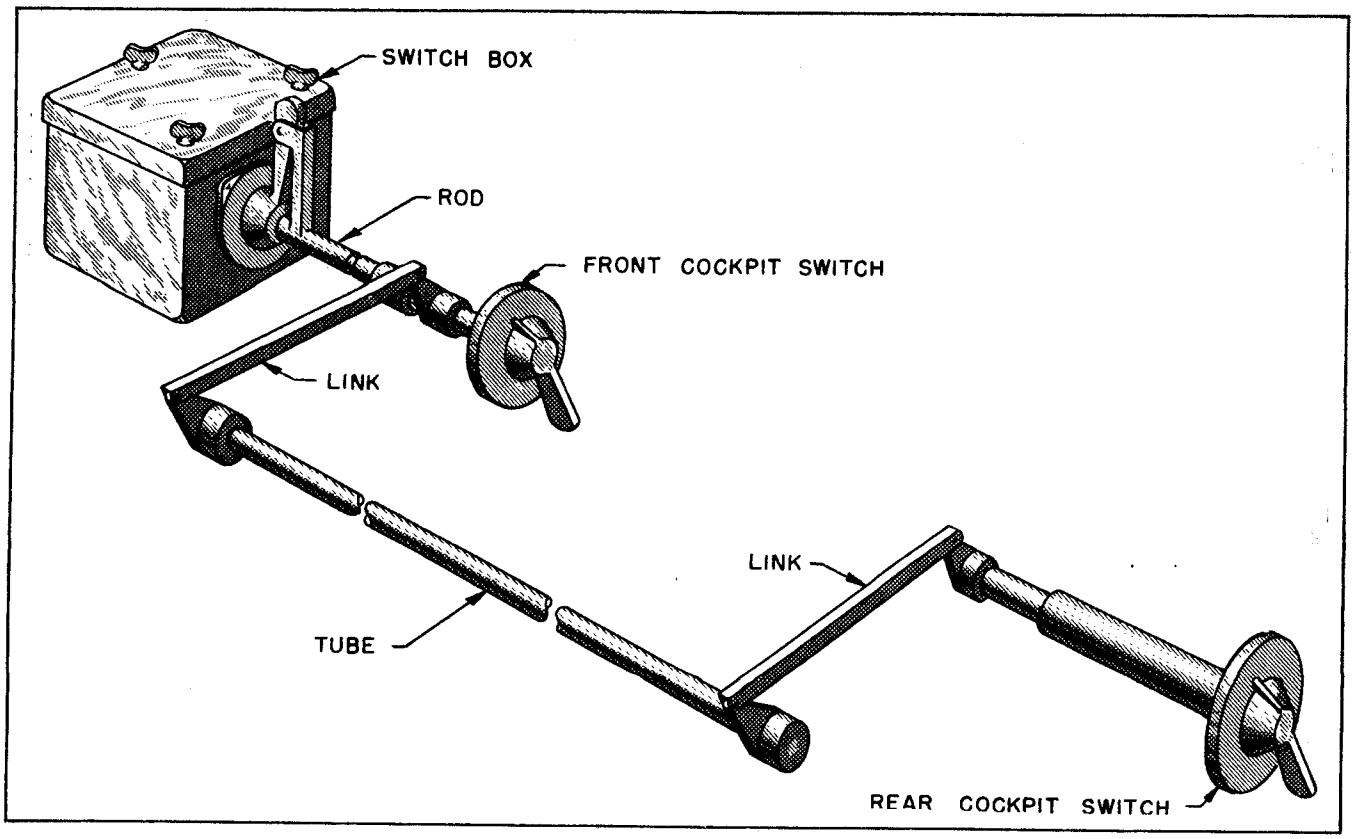


Figure 268 — Ignition Switch and Controls

the upper left side of engine compartment cowling. Insert hand crank (hand crank is stowed in the baggage compartment) and turn the hand crank at approximately 80 rpm or until the flywheel has attained its normal operating speed. When this speed has been attained, remove the hand crank and pull the manual engaging control cable to engage the engine and starter jaws. When the engine starts, release the cable.

CAUTION

After engine is started, the brush spring release handle should always be returned to the "ON" position and safetied.

When the starter flywheel has been accelerated to a speed of approximately 12,000 rpm, it will provide enough torque for engine starting. The starter is engaged by pulling outward on a ring on the left side of the cowling. This ring is on the end of a cable which operates a meshing solenoid on the starter. The starter is operated electrically by means of a foot pedal mounted between the rudder pedals. This foot pedal at one position operates a toggle switch, which in turn operates the type B-1 starter solenoid in the main power panel to energize the starting motor. At the other position, the switch will operate the meshing solenoid to engage the starter to the engine crankshaft and also energize the booster coil. Pressing on the heel of the pedal energizes, and pressing on the toe engages the starter.

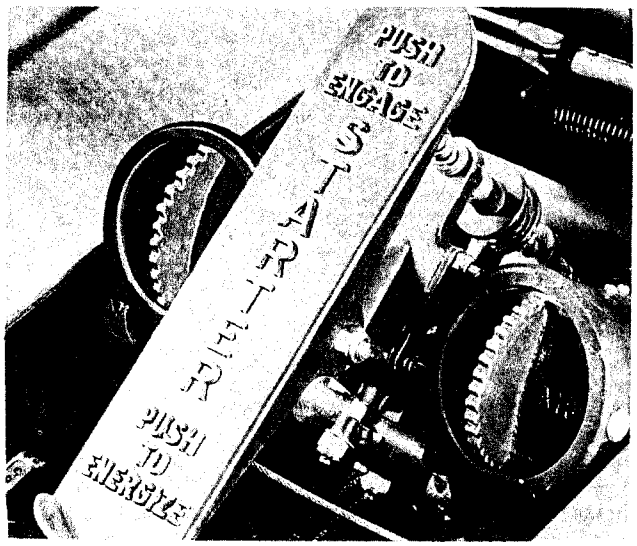


Figure 269 — Starter Pedal — 12-Volt

(7) MAIN POWER PANEL.—*(See figure 271.)*— The main power panel is mounted on the forward face of the fire wall. Circuits to all electrical equipment on the engine (except the ignition circuits) are routed through this panel. The battery solenoid, the starter solenoid, and the booster coil are mounted inside this panel.

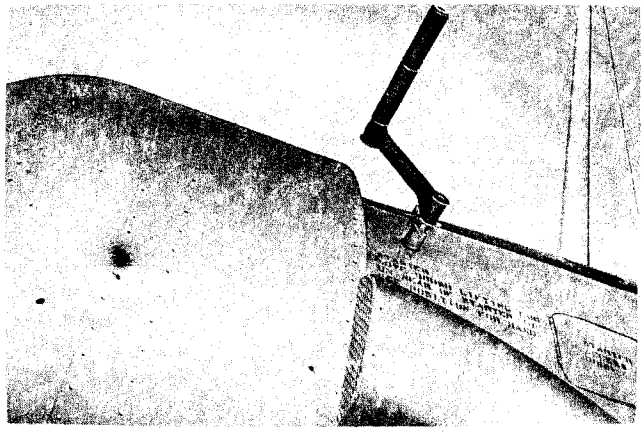


Figure 270 — Hand Crank

(8) BOOSTER COIL.

(a) DESCRIPTION.—A type A-1 booster coil is mounted in shielded housing in the main power panel on the front of the fire wall. The booster coil is energized when the toe of the foot pedal is pressed to engage the starter. The booster coil acts as a high voltage step-up transformer for delivering a high-tension spark through the magnetos to the engine for starting only.

(b) ADJUSTMENT.—The following procedure is recommended for adjusting the booster coil for the proper gap setting.

1. Disconnect the booster coil. Connect the primary terminals of the coil in series with an ammeter and control switch, and hook them to a 10- to 12-volt battery supply.

2. Connect the high-tension terminal of the coil to a spark plug having a .015-inch gap.

3. Install a return lead from the spark plug case to the booster coil housing.

4. With the adjusting screw in the extreme out position, gradually turn the screw in a clockwise direction until a good hot spark is obtained across the .015-inch gap in the spark plug. The current drain with the booster coil firing the .015-inch gap should be 2.0 to 2.5 amperes.

NOTE

If no ammeter is available, the approximate setting may be obtained by adjusting the screw contact on the coil until the spark will jump a $\frac{3}{8}$-inch gap.

(9) BATTERY DISCONNECT SWITCH.—The battery disconnect switch on the control panel in the front cockpit is for operating a solenoid switch in the positive power lead of the battery circuit. The solenoid is mounted in the main power panel on the forward side of the fire wall. The switch is used to disconnect the battery from the electrical system to prevent overcharging.

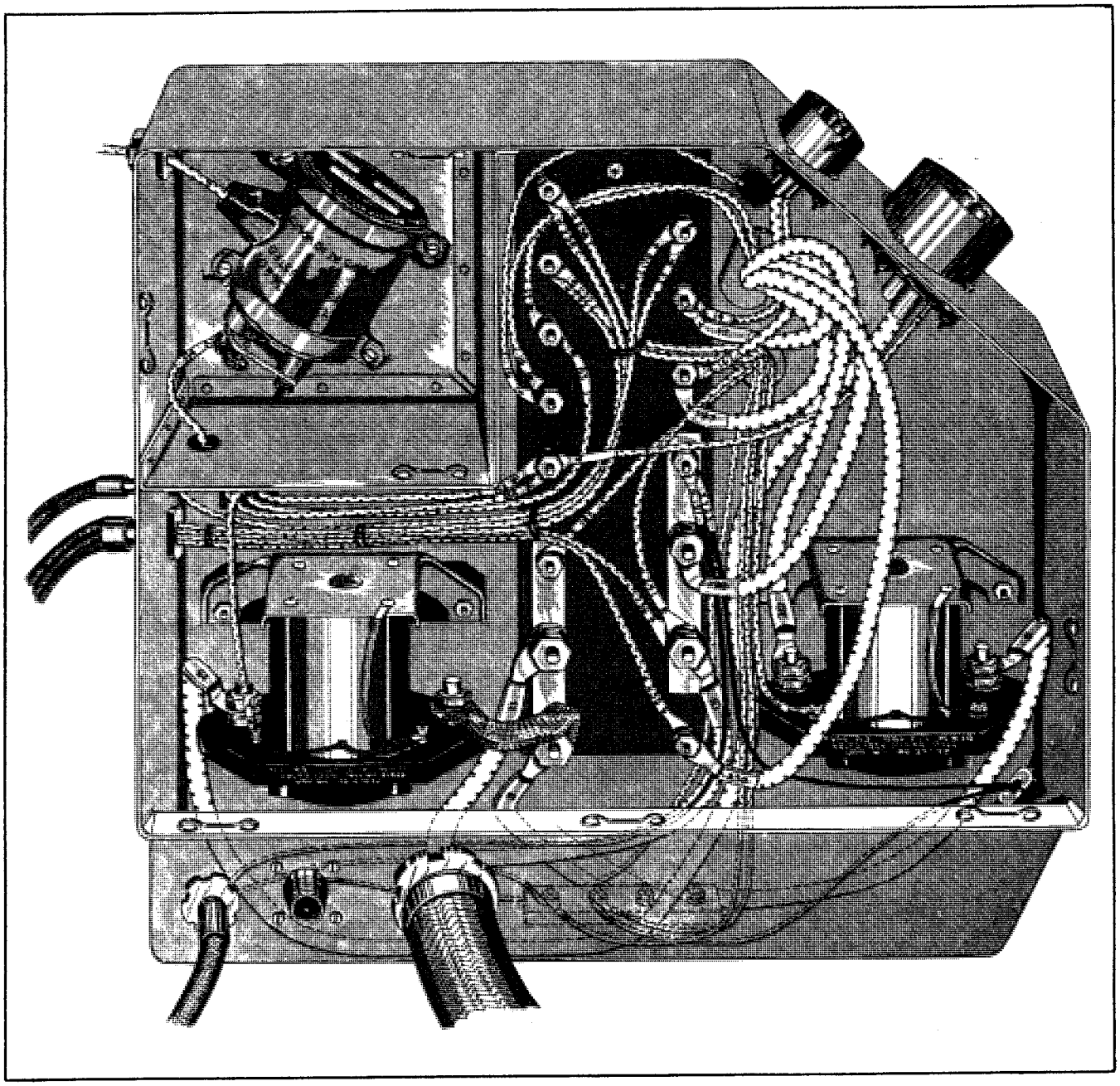


Figure 271 — Main Power Panel — 12-Volt

WARNING

The battery disconnect switch must always be thrown to the "OFF" position before leaving the airplane.

(10) LIGHTING.

(a) DESCRIPTION.—*(See figure 272.)*

1. COCKPIT LIGHTS. — Type C-4 cockpit lights are mounted on each side of both the front and rear cockpits. The lamp mounting has a swiveling range of 360 degrees. The lens housing of the lamp may be moved back or forward to give a beam adjustment from a concentrated spot to a floodlight. The cockpit lights are controlled with the red knob of a rheostat on the bottom of the lamp housings. The rheostats provide a means of varying the intensity of the lights. By lifting a lockspring the filter attachment may be removed to obtain a white light. The lamp assemblies are also equipped with a red push-button switch at the back, on top of the lamp housing, which provides a means of using the lights for signaling. The lamp may be removed from its holding bracket and held in any desired position.

2. INSTRUMENT LIGHTING.—*(See figure 273.)*—Fluorescent lighting is provided for all instruments except the compasses. Both the fluorescent and

compass lights operate on alternating current, which is supplied by a type A-4, dc to ac inverter mounted just below the front instrument panel. A fluorescent light is mounted on a flexible cable at the right side of each cockpit. On earlier airplanes, type X220 fluorescent lights were installed. The housings of this type light have an ultra-violet transmitting filter and a visible aperture. The outer housing of the type X220 lamp can be rotated to give visible or ultra-violet light, and a variable shutter may be moved to give full light, approximately two-thirds output or approximately one-third output for either ultra-violet or visible light. Later airplanes are equipped with type X221 fluorescent light assemblies, which will give only ultra-violet light. The movable shutter on this type light may be rotated to vary the amount of light output. The inverter which supplies alternating current for the fluorescent lights and the compass lights is controlled by the switch marked "FLUORESCENT LIGHTS" on the control panel in both front and rear cockpits. When either switch is thrown to the "ON" position, the fluorescent lights in both cockpits will come on. The 3-volt compass lights are integral with the compasses and are individually controlled by rheostat switches on the instrument panel in each cockpit. The compass lights, however, will not operate unless the fluorescent light switch is "ON." There is a light mounted on the fuel gage on each side of the front cockpit seat. The control panel in each cockpit has a switch for controlling these lights. Either switch will turn the lights on or off at any time. The fuel gages are visible from both cockpits.

3. NAVIGATION OR POSITION LIGHTS. —Type A-8 navigation lights are installed on both the upper and lower wing surfaces at each wing tip and on both sides of the vertical stabilizer. The lights on the left wing are *red,* on the right wing *green,* and on the vertical stabilizer they are *white.* The navigation lights are controlled by individual switches on the front cockpit control panel marked "WING" and "TAIL," with BRIGHT, DIM, and OFF positions.

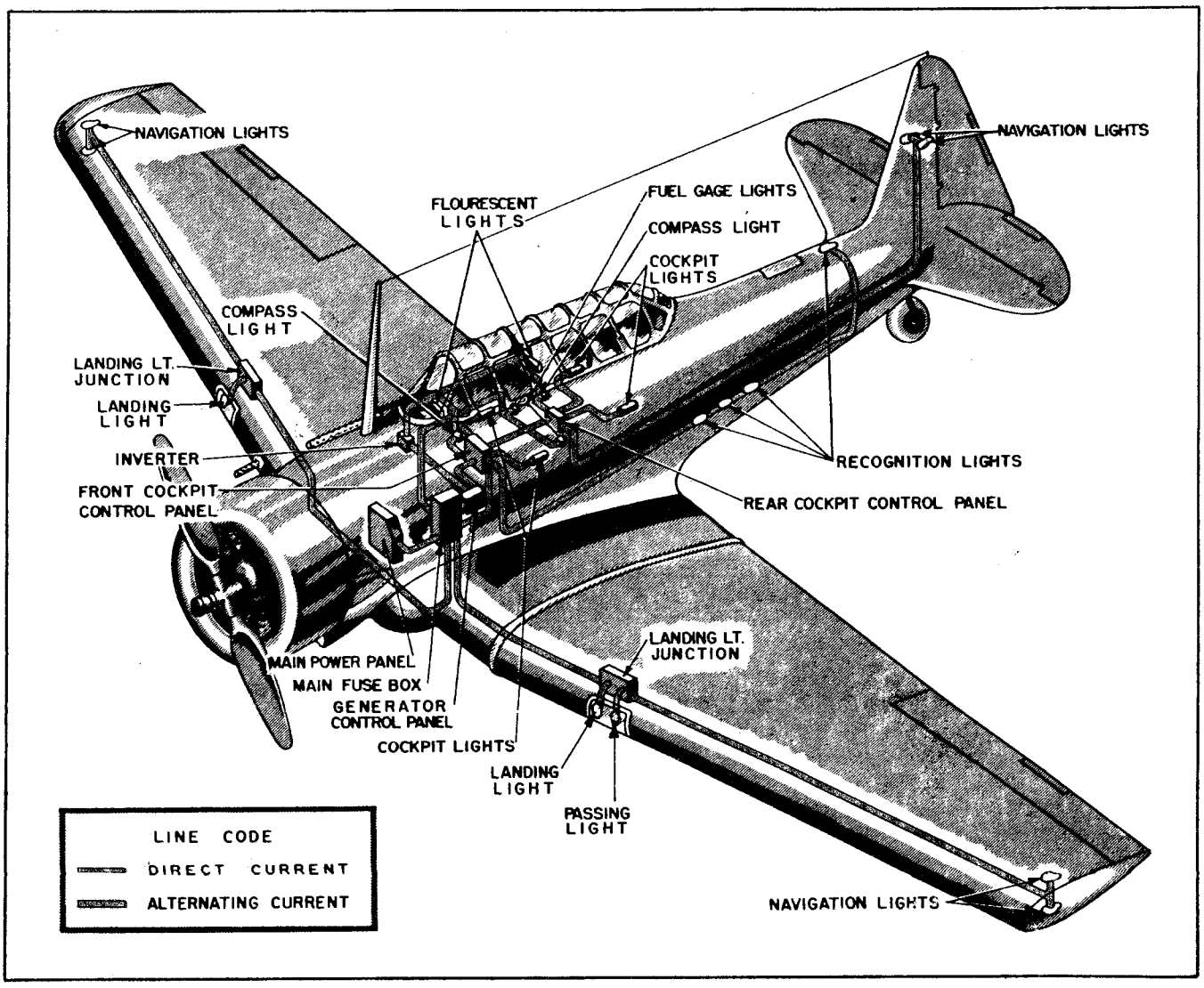


Figure 272 — Lighting System — 12-Volt

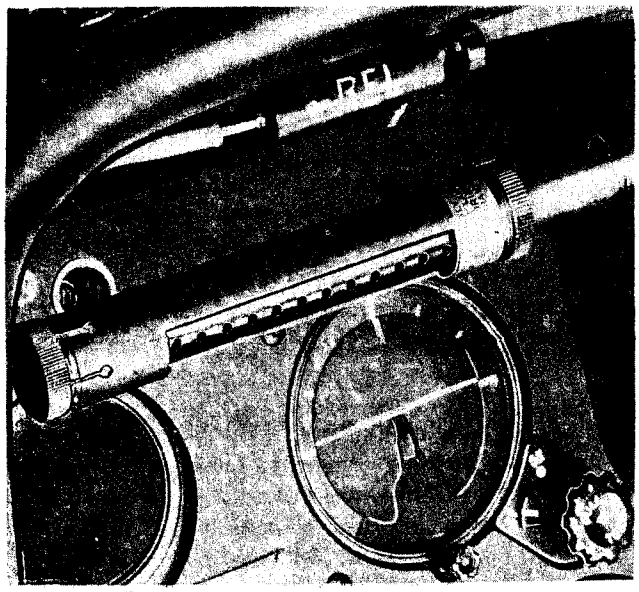


Figure 273 — Instrument Fluorescent Light — 12-Volt

4. RECOGNITION LIGHTS.—Later airplanes are equipped with three type E-2 recognition lights *(red, green,* and *amber)* installed on the lower surface of the fuselage aft of the rear cockpit. These lights are controlled by individual switches mounted in a switch box on the right side of the main control panel. The switches are wired in series with a push-button switch which acts as a telegraph key to provide a means of using lights for signaling. The individual switches must be thrown to the up or "KEY" position for using the telegraph key. The down position is "STEADY," and the center position is "OFF." With proper switching these lights may be used for signaling in various combinations and sequences.

NOTE

The "WHITE" switch has no function in this installation.

WARNING

Do not operate the recognition lights for more than ten seconds when the airplane is on the ground as there must be air circulation to dissipate the heat from the lights.

5. LANDING LIGHTS.—*(See figure 274.)*—A landing light assembly is installed in the leading edge of each outer wing panel. The landing lights are of the fixed-focus type with the light beams parallel to the ground line when the airplane is in the three-point position. The lights are focused 10 degrees outboard from the center line of the airplane and are controlled by individual switches from the front cockpit. The coverglass of each lamp conforms to the contour of the leading edge of the wing.

6. PASSING LIGHT.—*(See figure 274.)*—A type B-3 passing light, controlled from the front cockpit, is installed in the same bay with the landing light in the left outer wing panel. The cover glass of the passing light is red and the light beam is parallel to the line of flight.

WARNING

Do not operate the landing lights for more than 10 seconds when the airplane is on the ground and engine is not running.

(b) LAMP REPLACEMENT. — The following list will give information on lamps used on the 12-volt airplane:

Lamp Assem.	*Quan.*	*Type*	*Volts*	*Candle Power*	*Bulb Type*	*Spare Bulbs*
Landing Lights	2	A-8	14	240	A-19	—
Navigation Wing *(2 red, 2 green)*	4	A-8	12-16	6	G-6	—
Navigation Tail *(2 white)*	2	A-8	12-16	3	G-6	—
Passing *(red)*	1	B-3	12-16	50	RP-11	—
Recognition *(red, green, amber)*	3	E-2	13	6.6A	RP-11	—
Cockpit	4	C-3	12-16	3	G-6	—
Compass	2	B-16	3	—	Spec. 36A3344-2	—
Fuel Gages	2	NAA	12-16	2	T-4-½	—
Fuel Switch-over Signal *(red)*	1	Spec. 39A2822-2	14	—	T-3-¼	1
Fixed Gun Sight	1	N-3A	12-16	21-21	RP-11	—
Camera Signal *(green)*	2	Spec. 39A2822-2		—	T-3-¼	—
Fluorescent	2	C-1	—	4-W	T-6X5½	2
or	2	X221	—	4-W	—	—
Arm Control Ind.	1	Spec. 42B3593-2	13	.33A	T-3-¼	—

(11) FUSES.—*(See figure 264.)*

(a) Active fuses located in the main fuse box mounted on the left side just aft of the fire wall are plainly marked as to amperage and circuit. This box is accessible from the ground only, through a Dzus-fastened door in the removable side fairing. This box contains the following active fuses:

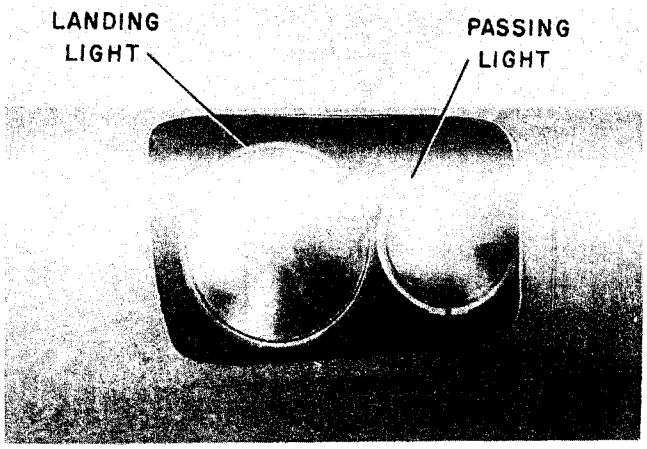


Figure 274 — Landing Light and Passing Light

Quan.	*Capacity*	*Circuit*
1	1 amp	Fuel Signal Lights
2	70 amp	Landing Lights (right and left)
1	100 amp	Generator
1	35 amp	Starter Switch
1	35 amp	Camera Power
1	30 amp	Recognition Lights
1	15 amp	Landing Gear Warning Circuit
1	20 amp	Cockpit Lights
1	20 amp	Gun and Bomb Solenoids
1	30 amp	Pitot Heat
1	30 amp	Gun Sight
1	15 amp	Position Lights
1	15 amp	Oil Dilution

NOTE

A spare for each fuse in the main fuse panel is affixed to the inner side of the cover of this box, and is plainly marked as to the circuit for which it is intended.

(b) There are also four fuses in the main switch panel in the front cockpit. The two 50-ampere fuses in this panel are for the right and left bomb release circuits, and the two 30-ampere fuses are for the wing gun circuit and the cowl gun circuit. There is one spare 50-ampere fuse and one spare 30-ampere fuse affixed to the inside of the cover of this box.

(12) CONTROL PANELS.—Switches and rheostats for controlling electrical equipment of the airplane are located on the main control panel at the left side of the front cockpit. Some equipment may also be controlled from a switch panel at the left side of the rear cockpit. Each switch and rheostat is plainly marked to indicate its operation.

(a) FRONT COCKPIT.—*(See figure 275.)*—The main controls for all electrical equipment are mounted on the control panel in the front cockpit. The control panel is forward of the pilot's left side. The controls for related equipment are grouped together as much as possible. The following switches are mounted on the control panel:

1. Battery Disconnect
2. Generator Main Line
3. Camera Safety
4. Compass Light (Rheostat)
5. Gun Sight (Rheostat)
6. Gun Safety
7. Gun Selectors (Cowl and Wing)
8. Bomb Safety
9. Bomb Selectors (Right and Left Bomb Rack)
10. Bomb Arming
11. Landing Lights (Left and Right)
12. Fluorescent Lights
13. Passing Lights
14. Fuel Gages
15. Pitot Heat
16. Fuel Switch-over Light Test
17. Running Lights (Wing and Tail)
18. Oil Dilution (Spring-loaded)

All switches on this control panel are equipped with luminous tips and markings. A voltmeter, an ammeter, and a bombs-armed indicator light are also mounted on the control panel.

(b) REAR COCKPIT.—*(See figure 276.)*—The control panel at the left side of the rear cockpit contains switches for the fluorescent lights, compass lights, and fuel gage lights. The switches on this control panel are also provided with luminous tips and markings.

(13) PITOT HEAT.—The pitot mast with its internal heating element is mounted on the leading edge of the right outer wing panel. This element is controlled by a switch on the front control panel and serves to prevent ice from clogging the air-speed orifice of the pitot mast.

WARNING

The pitot heat should never be turned on when the airplane is at rest on the ground except for momentary test, as without air circulation the heating element will be damaged from overheating.

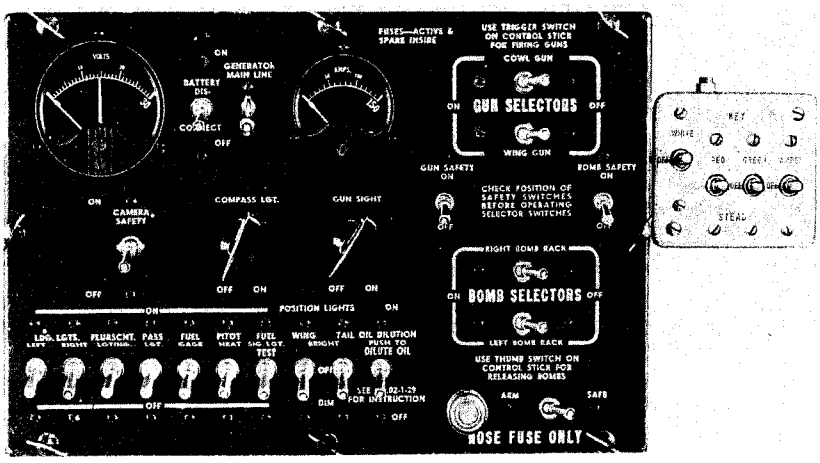


Figure 275 — Front Cockpit Electrical Control Panel — 12-Volt

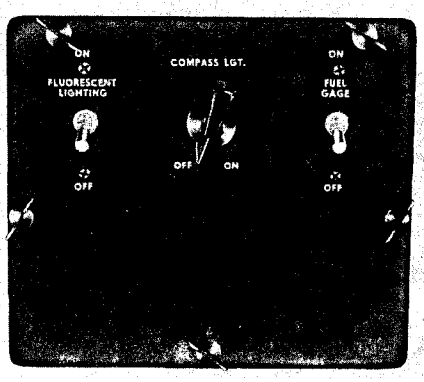


Figure 276 — Rear Cockpit Electrical Control Panel — 12-Volt

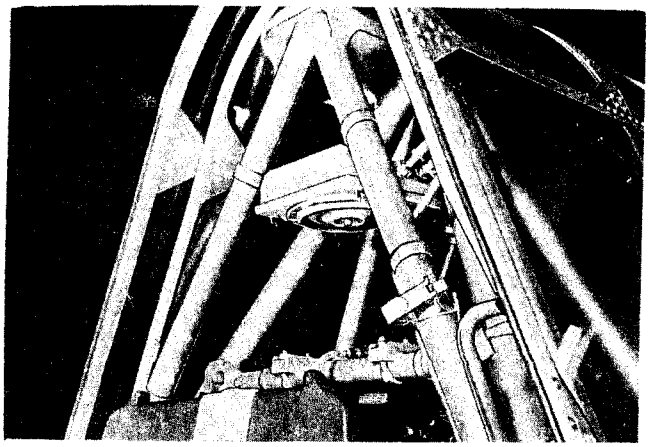


Figure 277 — Landing Gear Warning Horn

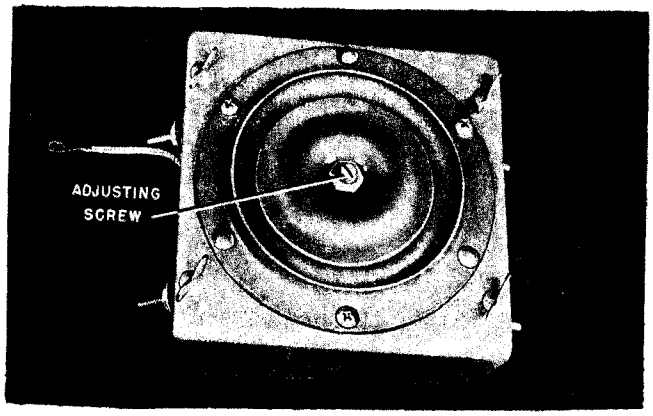


Figure 278 — Warning Horn Adjustment

(14) LANDING GEAR WARNING SYSTEM.

(a) DESCRIPTION.—*(See figure 277.)*—The landing gear warning horn located on the nose-over structure between the two cockpits is a warning device to indicate unsafe landing conditions. When the throttle control is pulled to a position approximately 1000 rpm and the landing gear is not fully extended and locked, the landing gear warning horn will sound to indicate an unsafe landing. This horn is interconnected with the landing gear "DOWN" position lockpins so that it will sound when the throttle is retarded if these lockpins are not in place. A warning horn release is provided on earlier airplanes to stop the horn in case the throttle is retarded during flight maneuvers with the landing gear retracted. On later airplanes this release is eliminated; in order to stop the horn from sounding, the throttle must be opened again or the landing gear must be put in the "DOWN" position with lockpins in place.

(b) ADJUSTMENTS. — *(See figures 278 and 279.)*

1. LANDING GEAR POSITION INDICATOR SWITCH.—The landing gear position indicator switches, actuated by movement of the landing gear strut and lockpin mechanism, operate the horn. To coordinate the horn with the landing gear struts, a switch is provided on the center section at the inboard side of each landing gear strut. A rod and disc actuating each switch is interconnected with the "DOWN" position locking mechanism of each strut. Before adjusting the rod and disc, follow this procedure:

a. Jack the airplane so the landing gear can be operated.

NOTE

Make sure that each landing gear strut is in the full "DOWN" position and locked in place.

b. Remove switch box covers.

c. See that wiring in box is in orderly condition, and that screws holding switches and terminal ends are tight.

d. With struts partially retracted, make sure that the spring-loaded bolt at the outboard end of each switch box moves through its guides without binding. A distorted box will cause excessive binding of these bolts. Apply a small amount of graphite grease at the guide located within the box.

e. Place throttle switch in closed position. (It is located on the fire wall.)

f. Loosen lock nut at end of each switch, and back off the knurled actuating discs towards the ends of the rods.

NOTE

If it is desired to eliminate the noise of the horn while making adjustments, disconnect horn from wiring and connect a light in the circuit.

g. Place the battery disconnect switch in the ON position.

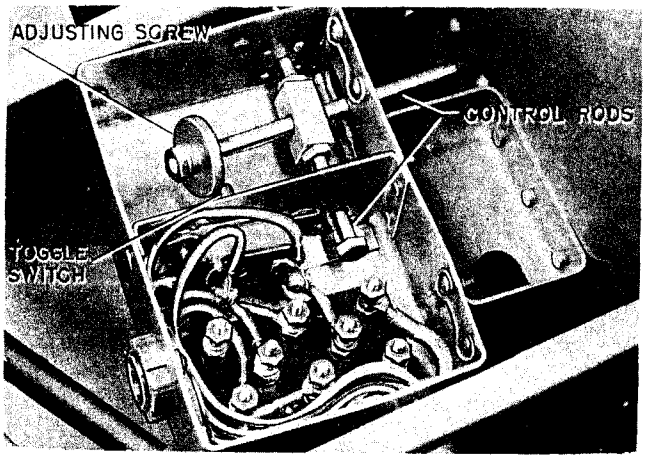


Figure 279 — Landing Gear Position Switch Adjustment

2. ACTUATING ROD AND DISC. — Until the following adjustment is made, the warning horn will continue to function:

a. Adjust the spring-loaded bolt, actuated by the hydraulic strut, so that the spring-back travel of the bolt is one-half inch from the fully extended position to the fully compressed position, actuated by the strut. The adjustment is made by loosening the lock nut on the bolt inside the switch box and rotating the bolt as desired.

b. Place the oleo strut in the LOCKED DOWN position.

c. Rotate the knurled disc on the switch actuating rod until the switch toggle has reached the maximum of its travel. Then back off the knurled disc enough to permit insertion of a .030-inch feeler gage between the disc and toggle.

NOTE

If the toggle switch cannot be BOTTOMED by means of the disc, lengthen the disc actuating rod accordingly.

d. Repeat step c. Make sure that the disc-locking nut is securely tightened after adjustment.

e. Raise and lower the landing gear several times to see that the actuating rod and disc are properly adjusted so as to cut out the warning horn when the landing gear is in the LOCKED DOWN position.

CAUTION

If the travel of the down position lockpins or the landing gear struts is changed, the warning horn adjustment must be changed accordingly.

3. LANDING GEAR THROTTLE SWITCH. —The throttle switch located on the forward left side of the fire wall must be adjusted after the landing gear warning horn switches have been correctly adjusted. Prior to the actual adjustment of the switch actuating rod, adhere to the following:

a. Jack up the airplane so that the landing gear struts may be operated.

b. Set the throttle control to the position used when coming in for a landing.

NOTE

This predetermined position is approximately 1000 rpm, or about 7/16 inch forward of the closed throttle position measured from the stop at the rear end of the throttle guide to the back of the throttle handle.

c. Pull the landing gear lockpins by means of the lever in the front cockpit. With the pins in the OUT position, the warning horn circuits are complete so that the throttle switch adjustment can be accomplished.

d. Disconnect the warning horn. Use a lamp if desirous of eliminating the horn noise while making adjustments.

4. WARNING HORN SWITCH.—After the above has been accomplished, follow this procedure but note that the operation of the switch actuating rod is such that when the throttle lever is pulled back to approximately 1000 rpm or less, a rod interconnected with the throttle lever moves DOWNWARD. At the lower end of the rod a small roller, traveling on a guide, makes contact with the lever of a momentary-type switch, thus making contact and closing the circuit of the warning horn.

a. With the throttle lever set at 7 16 inch forward of closed position, loosen lock nut at each end of rod. Then adjust the length of the rod so that the switch just makes contact. The horn will indicate this.

b. Work throttle back and forth to see that horn starts sounding at the proper point each time.

5. WARNING HORN.—Preparatory to adjustment of the horn, remove it from its mounting and disconnect the wiring. Connect horn to direct current and connect an ammeter in the circuit. Adjust the horn as follows:

a. Adjust the tone of the horn by varying the position of the adjusting screw at the back of the horn. As the adjustment is very sensitive, turn the screw a small amount at a time, and lock its position each time before sounding the horn. The horn should not pull more than 2 amperes when sounding. If the proper tone is not obtained with less than 2 amperes, it is necessary to adjust the air gap.

b. Adjust the air gap as follows:

(1) Disconnect horn from circuits.

(2) Loosen lock nut on stud at front of the horn; turn the stud to the RIGHT until it just touches the core.

(3) Back the stud away from the core ¼ turn to the LEFT, lock in position, and then connect the horn to the current. If the tone is harsh and high pitched, turn the adjusting stud to the LEFT; if the pitch is too low, turn the stud to the RIGHT.

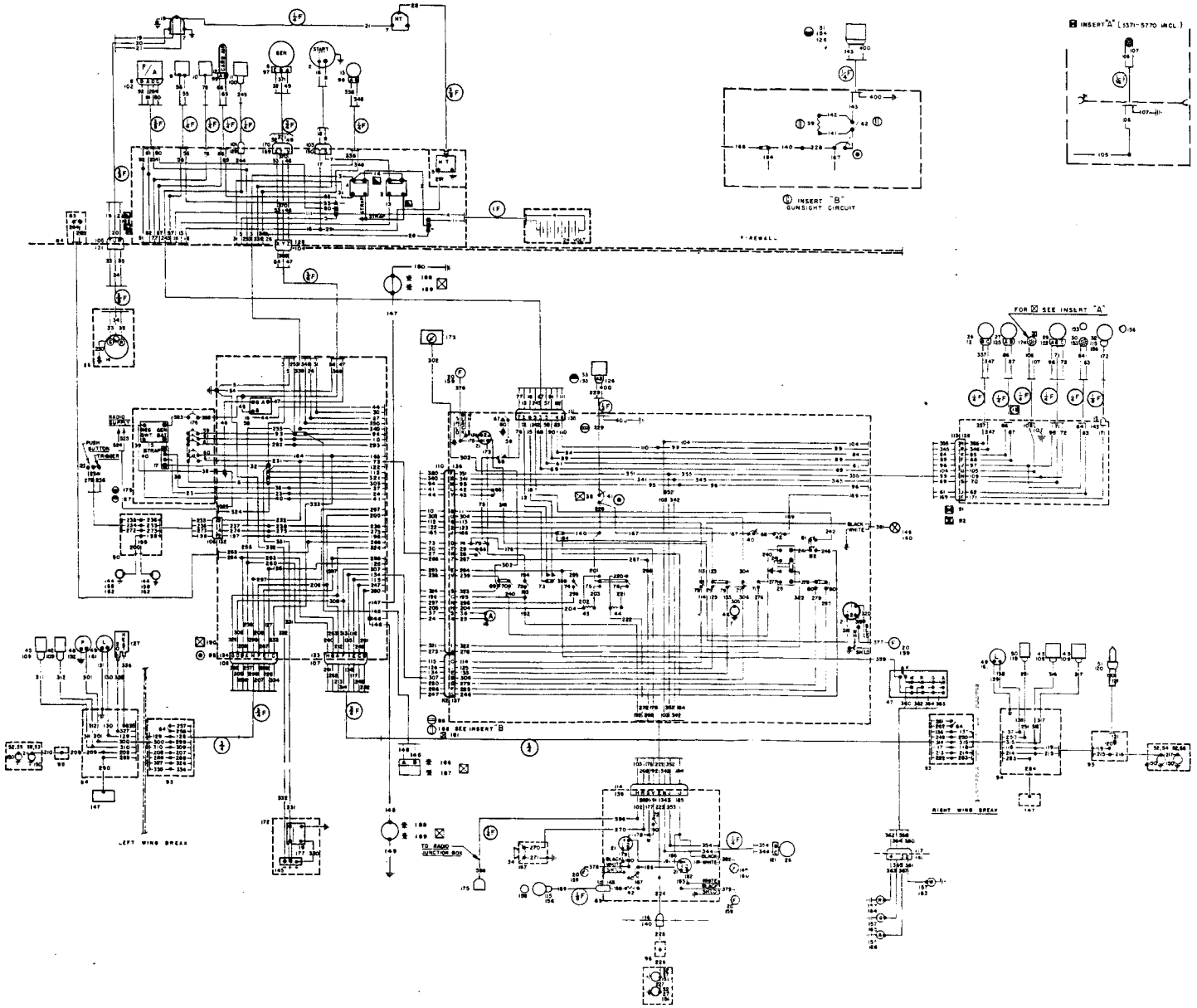
NOTE

When the adjustment is near the correct setting, turn the stud slightly and lock in position *each time* before trying the horn.

b. 24-VOLT SYSTEM.—(AT-6D, AT-6F, and SNJ-5)

(1) GENERAL.

(a) DESCRIPTION.—*(See figures 280 and 281.)* —The electrical system of the airplane has two main sources of energy: a 24-volt storage battery and a 24-volt, 50-ampere engine-driven generator, both connected to a common distribution system. The distribution



NOTE

Because of the frequent revisions made in the electrical system, this electrical wiring diagram should be used ONLY as general reference with the accompanying text. For servicing and repairing the electrical wiring system in the airplane, refer to North American Dwg. No. 88-54052, 121-54002, or 121-541002 installed in the airplane. AT-6F models are furnished with a circuit diagram book, Report NA54005.

Figure 280 — Electrical Wiring Diagram — 24-Volt

LEGEND - 24 VOLT WIRING DIAGRAM, AT-6D AND SNJ-5 AIRPLANES

CODING SYMBOLS

SERIAL NO.	THROUGH	SERIAL NO.	CHANGES MADE
ARMY		ARMY	
41-34127		41-34666	
42-44412		42-44588	
42-44412		42-44605	
42-44412		42-44668	
42-44412		42-44728	
42-84202		42-84582	
Navy		Navy	
43658		44011	
43658		43840	
43859		44011	
51715		51808	
51715		51871	
51715		51874	
51715		52021	
51822		52021	
51872		52021	
51897		52021	
52047		52049	
British		British	
EX-846		EX-908	
EX-847		EX-937	
EX-847		EX-944	
EX-847		EX-989	
EX-925		EX-989	
EX-938		EX-989	
EX-983		EX-999	
EZ-118		EZ-278	
EZ-118		EZ-558	
EZ-295		EZ-358	

NO.	DESCRIPTION	TYPE	NO. REQD.	SPEC. OR PART NO.
1	*Battery—24 Volt 34 A.H.	G-1	1	32234
2	*Starter Electric, Inertia and Dir. Crank	G-5	1	95-32303
3	*Switch—Solenoid Starter	B-8	1	32424
4	*Switch—Solenoid Battery	B-4	1	32524
5	*Coil Assembly Booster	C-1	1	94-32182
6	*Generator—24 Volt, 24 Amp.	M-3	1	95-32361
7	*Magneto (Furn. with Engine)	Scint. SB9-R	2	15738
8	*Indicator Fuel Mixture—Cell	B-5	1	94-27932-A
9	*Signal Assembly Fuel Pressure	C-2	1	96-32175
10	*Solenoid—Oil Dilution 24 Volt	.....	1	37D6210
11	*Solenoid—Cowl Gun Sync.	G-18	1	24839
12	*Thermometer Carb. Mixture Bulb	AN 5525-1	1	AN-GG-E-796
13	*Tachometer—Electric Generator	E-12	1	27511
14	*Switch—Ignition	A-7	1	32090
15	*Relay—Gen. Current Control	.....	1	94-32278
16	*Regulator Voltage	.....	1	94-32276
17	*Shunt—Ammeter	F-1	1	96-32284
18	*Ammeter	F-1	1	96-32284
19	*Switch—Solenoid Relay Cir. Control	B-4	1	96-32324-A
20	Lamp Assembly Fluorescent	C-5	4	94-32356
21	Control Unit Fluorescent—Light	C-5	4	94-32356
22	*Switch—Gun and Bomb Control	B-5	1	95-24708
24	Relay—Gun Control 24 Volt	B-5	1	94-32351
25	Relay—Bomb Control 24 Volt	B-5	1	94-32351
26	*Tachometer—Electric Indicator	E-12	2	27511
27	*Indicator Fuel Mixture Indicator	B-5	1	94-27932-A
29	*Thermometer Carb. Mixture	AN 5790-6	1	AN-GG-1-522a
30	Lamp Assembly—Fuel Pressure Indic.	Red	1	39A28222
31	*Fixed Gunsight (Modified Type)	N3B	1	42G20092
32	*Light Assembly—Compass	B-16	2	94-29807
33	*Light Assem.—Fixed Gun Sight	N-3A	1	.....
34	Signal—Landing Gear Warning	E-1	1	32184
38	Rheostat—Gunsight	200 Ohm, 50W OIC	1	94-3229-D
39	Resistor—Gunsight	60 Ohm, 25W Ohmite	1	Acker Type
40	Rheostat—Compass Light	C-1 (25 Ohm)	2	37009-C
41	Rheostat—Gun Sight Light	C-1B (90 Ohm)	1	94-32229
42	Resistor—Compass Light	120 Ohm .5 W	2	37A32229
43	Resistor—Wing and Tip Pos. 10 Ohm, .25 Watt	Ohmite	1	Acker Type
44	Resistor—Tail Pos. 60 Ohm, .25 W.	Ohmite	1	Acker Type
45	*Arming Control—Bomb	A-2	4	43B9887
46	*Lamp Assem.—Arm Control Indic.	.....	1	43B3595-2
47	*Control Assem. Recog. Lights	42D5051	1	88-54586
48	*Lamp Assem.—Position (Passing)	B-3	1	37D4865
49	*Adapter - 7-in. Sealed Beam Lamp	Adams & Westlake CM-1356	2	
50	*Solenoid—Gun Firing, Wing Gun	B-9	1	95-24706
51	*Pitot Head—Electric Heated	D-1	1	94-27876
52	*Lamp Assem.—Position (37B4962)	A-8	6	94-32116
53	*Lens—Position Lamp Upper L.H. Red	.....	1	32B1984-1
54	*Lens—Position Lamp Upper R.H. Green	.....	1	32B1984-2
55	*Lens—Position Lamp Lower L.H. Red	.....	1	32B1984-3
56	*Lens—Position Lamp Lower R.H. Green	.....	1	32B1984-4
57	*Lens—Pos. Lamp Tail Cl. & Opaque	.....	2	32B1984-5
58	Base Assem.—Voltage Regulator	.....	1	40D8443
59	Circuit Protector 5 Amp.	Klixon	1	P5M
60	Circuit Protector 10 Amp.	Klixon	1	P5M
61	Circuit Protector 15 Amp.	Klixon	3	P5M
62	Switch—Gunsight	B-5A	1	AN3015
63	Switch—Landing Gear Warning Throttle	B-12	1	34A6066
64	Switch—Landing Gear Position Indicator	B-10	2	34A3846
65	Switch—Generator Main Line	B-5A	1	AN3015
66	Switch—Battery Disconnect	B-5A	1	AN3015
67	Switch—Fuel Signal Light Test	B-6B	1	AN3016
68	Switch—Oil Dilution	B-6B	1	AN3016
69	Switch—Camera Safety	B-5A	1	AN3015
70	Switch—Gun Safety	B-5A	1	AN3015
71	Switch—Bomb Safety	B-5A	1	AN3015
72	Switch—Fuel Gage Lights	B-5A	2	AN3015
73	Switch—Starter	B-6B	2	AN3016
74	Switch—Passing Light	B-5A	1	AN3015
75	Switch—Position Lights (Wing)	B-8A	1	AN3018
76	Switch—Position Lights (Tail)	B-8A	1	AN3018
77	Circuit Breaker—Arm Control 5A	Sq. D. Elec. Co.	1	Class 9500-5B
78	Circuit Breaker—Pitot Heat 10A	Sq. D. Elec. Co.	1	Class 9500-10B
79	Circuit Breaker—Land. Lights 35A	Sq. D. Elec. Co.	2	Class 9500-35B
80	Circuit Breaker—Bomb Racks 15A	Sq. D. Elec. Co.	2	Class 9500-15B
81	Circuit Breaker—Cowl Gun 15A	Sq. D. Elec. Co.	1	Class 9500-15B
82	Circuit Breaker—Wing Gun 10A	Sq. D. Elec. Co.	1	Class 9500-10B
83	Box Assembly—Main Power Panel	NAA	1	88-54372
84	Box Assembly Throttle Switch	NAA	1	55-54139-4
85	Box Assem. Generator Control	NAA	1	88-54360
86	Box Assem. Ignition Switch	NAA	1	55-54094
87	Box Assem. Generator Relay	NAA	1	88-54358
88	Box Assem. Front Pilot's Swt.	NAA	1	88-54344
89	Box Assem. Rear Pilot's Swt.	NAA	1	88-54094
90	Box Assem. Stick & Pedal Gage Jct.	NAA	1	88-54395
91	Box Assem. Instrument Distr.	NAA	1	88-54377
92	Box Assembly—Instrument Distributor	NAA	1	88-54377-4
93	Box Assem. Ldg. Pos. Ind. Swt.	NAA	1 RH 1	88-54025-8 L.H. 88-54025-7 R.H.
94	Connector Panel Assem. Landing Light	NAA	2	88-54409
95	Connector Panel Assem. Wing Tip	NAA	2	88-54408
96	Connector Panel Assembly Tail Lamp	NAA	1	55-54094
97	Connector Assembly Generator	AN9536	1	AN3106-22-12s
98	Connector Assembly Tach. Generator	AN9534	1	AN3106-12s-5s
99	Connector Assembly Carburetor Air Temperature Bulb	AN9534	1	AN3106-12s-5s
100	Connector Assem. Cowl Gun Sol.	AN9534	1	AN3106-10s-2s
101	Connector Assem. Cowl Gun Disc.	AN9536	1	AN3106-10s-2p
102	Connector Assem. Mixt. Indic. Cell	AN9534	1	AN3106-14s-2s
103	Connector Assem. Starter	.....	1	56A1874
104	Connector Assem. Gen. Control	.....	1	E1002-3-30
105	Connector Assem. Ignition Disc.	.....	1	35A2933
106	Connector Assem. Stick Swt. Jct.	.....	1	E1002-5-160
107	Connector Assem. R. Wing Disc.	.....	1	56A9955
108	Connector Assem. L. Wing Disc.	.....	1	56A9955
109	*Connector Assem.—Bomb Arm. Cont.	AN9534	4	AN3106-10s-2s
110	Connector Assem.—Pilot's Swt. Box	.....	1	E1002-12-10
111	Connector Assem.—Pilot's Swt. Box	.....	1	56A4275
112	Connector Assem. Pilot's Swt. Box	.....	1	56A9955
113	Connector Assem.—Inst. Dist. Box	.....	1	56A4276
114	Connector Assem.—Rear Swt. Box	.....	1	56A4276
115	Connector Assem.—Compass Light	.....	4	37A5157
116	Connector Assem.—Tail Light	.....	1	E1002-18-10
117	Connector Assem.—Recog. Lights	.....	1	E1002-3-160
119	Connector Assem. Wing Gun Sol.	AN9534	1	AN3106-10s-2s
120	*Connector Assem.—Pitot Heater	.....	1	39A3657
121	Connector Assem.—Tach Indic.	AN9534	2	AN3106-14s-1s
122	Connector Assem.—Carb. Mixture	AN9534	1	AN3106-14s-2s
125	Connector Assem.—Mixture Indi.	AN9534	1	AN3106-12s-3s
126	Connector Assem.—Gunsight	.....	1	AN3106-12s-3s
127	**Camera W-7 Fairchild			
128	Socket Assem.—Generator Control	.....	1	E1002-3-30
129	Socket Assem.—Cowl Gun Sol. Disc.	AN9534	1	AN3102-10s-2s
130	Socket Assem.—Starter	.....	1	56A1881
131	Socket Assem.—Ignition Disc.	.....	1	E1156-5-10
132	Socket Assem.—Stick Swt. Jct.	.....	1	E1003-3-70
133	Socket Assem.—Right Wing Disc.	.....	1	55B5160
134	Socket Assem.—Left Wing Disc.	.....	1	55B5160
135	Socket Assem.—Pilot's Swt. Box	.....	1	35A5235
136	Socket Assem.—Pilot's Swt. Box	.....	1	E1003-12-10
137	Socket Assem.—Pilot's Swt. Box	.....	1	55B5160
138	Socket Assem.—Inst. Disc. Box	.....	1	56A3367
139	Socket Assem.—Rear Swt. Box	.....	1	56A3367
140	Socket Assem.—Tail Light	.....	1	E1003-18-10
141	Socket Assem.—Recog. Light	.....	1	E1003-3-70
143	Socket Assem.—Compass Light	.....	2	38A1549
144	Socket Assem.—Fuel Gage Lamp Sc.	.....	2	31A4527
145	Receptacle—External Pwr.	Thomas & Betts	1	42B3748
147	Bomb Rack (See Note No. 13)	.....	2	.....
149	Lamp Assem.—Cockpit	C-4	2	94-32294-A
150	*Lamp—6 CP., 28V., S.C., B.B., Wing Position	G-6	4	.....
151	*Lamp—3 CP., 28 V., S.C., B.B., Tail Position	T-1½	2	.....
152	*Lamp—30 C.P., 28 V., S.C., B.B., Passing Position	S-11	1	.....
153	*Lamp—3 C.P., 28 V., S.D., B.B., Fuel Signal (1 Spare)	T-3¼	2	.....
154	*Lamp—21-21 C.P., Half Silv., Half FB, 28V, D.C., B.B. Gunsight	G-9	1	Masda No. 844
155	*Lamp—21-21 C.P., 28 V., D.C., B.B., 1F Gunsight	RP-11	1	.....
156	*Lamp—19 CP., 3 V. Inst. (2 Spare)	T-1¾	4	56A3344
157	*Lamp—27 Amp., 28 V., S.C., B.B., Recognition	RP-11	4	AN3120-2
158	*Lamp—3 CP., 28 V., S.C., B.B., Fuel Gage	T-4½	2	.....
159	Lamp—4 W., 28 V., D.C. Index. Fluorescent Lights	BP-12	4	.....
160	Lamp—17 Amp., 24 V., Min., B.B., Cockpit Light	T-3¼	2	.....
161	*Lamp 450 W., 24 V., 7-in. Sealed Beam Ldg.	Paz. 56	2	.....
162	Lamp Assem.—Fuel Level Gage	NAA	2	25-54052
163	*Lamp Assem.—Recog. Upper, White	B-1	1	94-32366
164	*Lamp Assem.—Recog. Lower, Red	B-2	1	94-32374
165	*Lamp Assem.—Recog. Lower Green	B-2	1	94-32374
166	*Lamp Assem.—Recog. Lower, Amber	B-2	1	94-32374
167	Box Assem.—Landing Gear Warning Signal	NAA	1	55-54142
168	*Box Assem. Front Pilots SW	NAA	1	88-54354-4
169	Socket Assem.—Gen. Disc.	.....	1	55B5166
170	Connector Assem.—Gen. Disc.	.....	1	E1002-5-30
171	*Lamp 17 Amp., 28 V., S.C., B.B., Arm Indic.	T-3¼	1	.....
172	Box Assem.—Rat. Pwr. Recept.	NAA	1	88-54350
173	**Indicator—Consumption (Flin)	.....	1	W-7
174	Lamp Assem.—Marker Beacon	.....	1	39B2822-4
175	Connector Assembly—Marker Beacon	.....	1	37A5157
176	Circuit Breaker—30 Amp. (Klixon)	PLM	1	4AA8309
177	Braid—(Jumper—Ext. Power Box)	.....	1	88-54352
178	*Lamp—28 V., 17 Amp., S.C., Min. B.B. Marker Beacon	T-3¼	1	.....
179	Box Assem.—Generator Relay	NAA		88-541001
180	Lamp Assem. Marker Beacon		1	42-B3953-2
181	Box Assem. Front Pilots SW	NAA	1	88-54344-7
182	Box Assem. Main Power Panal		1	88-54372-4
183	Box Assem.—Generator Relay	NAA	1	88-54101-4
186	*Switch—Oxygen Pressure Ind.	G-1	1	32376
187	*Connector Assem.—Oxygen Press.	.....	1	AN3106-10SL-4s
188	*Lamp Assem.—Oxygen Pressure Amber	.....	2	42B3593-2
189	*Lamp—28V., 0.17 Amp., 3 C.P., Bay Base Oxygen	T-3-1½	2	
190	Box Assem.—Generator Control	NAA	1	88-54368-4

*GFE (Government Furnished Equipment)

system is of the single hot-wire direct-current type with the metallic structure of the airplane serving as the return, except in some instances where it is necessary to use a two-wire circuit to prevent compass interference or to obtain a more efficient ground. The main power panel on the forward face of the fire wall contains the booster coil and the starter and battery solenoids. The generator voltage regulator and reverse current relay are mounted in boxes on the left side of the front cockpit aft of the fire wall. Circuit breakers are employed for the protection of all circuits except the generator circuit and are accessible for resetting from the front cockpit only. In place of the foot pedal starter, two toggle switches are installed on the front cockpit control panel. To prevent accidental operation, these switches are protected by a guard that must be raised against spring action in order to operate the switch. One switch will energize and the other will engage the starter when held to the "ON" position. All electrical equipment is controlled from the main control panel in the front cockpit. Solenoid switches are incorporated in the bomb release and gun firing circuits. These solenoids are controlled by switches on the front cockpit switch panel only. Disconnect plugs are provided on the various power plant accessory connections to facilitate removal of the power plant from the airplane. On early airplanes, rigid and flexible conduit is used for most harnesses. Later models have all conduit removed except in the engine ignition system and between the front control stick and the stick switch junction box. Capacitors have been added to suppress radio noise and interference.

(b) MAINTENANCE REPAIRS. — The service man should not attempt either mechanical or electrical maintenance of any individual item of electrical equipment unless suitable shop and testing equipment are available, and authority to repair has been granted. When testing the complete electrical system for trouble, the proper procedure is to remove all power from the electrical equipment, make the necessary circuit changes or meter connections, and then apply the power to the equipment involved.

(c) TROUBLE SHOOTING.

BATTERY

Trouble	*Possible Cause*	*Remedy*
ELECTROLYTE CONSISTENTLY BELOW TOP OF PLATES.	Excessive evaporation.	Avoid abnormal operating temperatures.
	Lack of proper maintenance.	Enforce inspection period.
	Spilling.	Handle properly.
	Leakage.	Check container for cracks.
	Gassing.	Be careful not to overcharge.
FREEZING.	Exposure to low temperature.	Thaw slowly in a warm room.
LOSS OF CAPACITY.	Internal.	Depot inspection.
	Loss of electrolyte.	See above.
	Low temperature.	See above.
	High Discharge.	Careful operation.
	Overcharging for long periods.	Careful operation.
	Short circuits internal or external.	Careful check of wiring.
	Length of service.	None.
REVERSAL OF POLARITY.	Overdischarging a cell.	Careful check of operation procedure.
	Charging battery in wrong direction.	Check connections and operation procedure.
BATTERIES DISCHARGED.	Reverse-current relay improperly adjusted, causing generator to be connected to battery before generator voltage is in excess of battery voltage; this causes current to flow through the armature.	Readjust reverse-current relay. Flash generator field (to reverse polarity) by touching a heavy wire between the "A" terminal and the positive bus bar.

BATTERY-DISCONNECT SOLENOID

Trouble	*Probable Cause*	*Remedy*
SWITCH INOPERATIVE.	Defective control switch.	Check switch.
	Improper connection.	Check wiring diagram.
	Improper setting.	Reset.
	Energizing coil burnt out, shorted, or grounded.	Check with ohmmeter. Replace.

GENERATORS

Trouble	*Probable Cause*	*Remedy*
LOW VOLTAGE OUTPUT.	Worn brushes (less than 3/4 in. long).	Install new brushes and seat them as described below. If the brushes are safely over 3/4 in. long at the longest point, reseat them by wrapping a piece of No. 00 sandpaper around the commutator, sanded side out, and then pulling the sandpaper in the direction of the armature rotation. Be sure the sandpaper conforms to the contour of the commutator, and that brushes rest firmly on the sandpaper. The brushes may also be seated by using a brush seating stone, a soft, abrasive material which, held against the revolving comutator, disintegrates, carries under the brushes, and seats them in a few seconds. Blow out all dust after seating the brushes.
	Dirty commutator.	Clean commutator with a rag dampened with carbon tetrachloride. Do not use any grease-dissolving liquids, as they might dissolve the insulation on wiring. In extreme cases, use No. 00 sandpaper. If the commutator is still rough or pitted, replace generator.
	High mica. (Mica protruding from between the commutator bars.)	Undercut the mica to a depth of from .02 in. to .03 in., using a cutting tool not more than .027 in. wide. Blow out all particles with dry compressed air.
	Low brush spring tension.	If no adjustment is possible, replace the springs.
	Brushes binding in holders.	Remove the brushes, and clean them with carbon tetrachloride.
	Excessive brush side play.	Replace brushes, reseating them as outlined above.
	Insufficient field current. (Field current should not exceed 8 amperes as tested during a heat run to carry rated load continuously at 2500 generator rpm.)	Clean and tighten field leads.
	Faulty brush holder insulation. (Check with test lamp, shorting brush holder to commutator end frame; if lamp lights, insulation is defective.)	Replace insulation (work to be done at depot).

Trouble	*Probable Cause*	*Remedy*
(Continued) LOW VOLTAGE OUTPUT	Reversed polarity.	Momentarily jump the relay switch, allowing a quick flash of current to flow from the battery to the generator. This will correctly polarize the generator field.
	Incorrect polarity may be caused by relay cut-in point being too low. Battery water boiling may indicate that generator polarity is reversed.	Check reverse-current relay switch setting to prevent recurrence.
	Shorted or open armature.	Return to depot. (Armature resistance should be ½ to ¾ ohms.)
	Loose or high-resistance connections in generator circuit.	Clean and tighten connections.
	Improper wiring to generator.	Correct wiring to conform to wiring diagrams.
	Dirty or pitted voltage regulator points.	Clean or resurface.
	Faulty operation of reverse-current relay.	Check and adjust.
	Low brush spring tension.	Correct for brush wear by moving spring end. If tension cannot be obtained by spring adjustment, replace brush holder assembly. Replace generator.
NO VOLTAGE OUTPUT ALTHOUGH GENERATOR IS OPERATING AT RATED RPM.	Demagnetized or reverse-magnetized field.	See instructions on reversed polarity, above.
	Faulty soldered connection at generator flex plug.	Resolder connection.
	Short or open circuit in field windings. (Field should show a resistance of 3 ohms.)	Return generator to depot for repairs.
	Short or open circuit in armature windings. (Armature should show a resistance of ½ to ¾ ohms.)	Return generator to depot for repairs.
	Brushes stuck in holder and not contacting commutator.	Remove brushes and clean with carbon tetrachloride.
	Dirty or coated commutator.	Clean and polish.
	Wrong connections in external circuit between generator, control panel, and ammeter.	Check and correct according to airplane wiring diagram.
HIGH VOLTAGE WITH GENERATOR OPERATING AT RATED RPM.	Short in wiring.	Correct faulty wire or insulation.
	Voltage regualtor faulty or out of adjustment.	Check adjustment. Check for open circuit in resistance unit. Check for and correct shorted or open coil in regulator. Correct any maladjustment of contacts. Free armature if binding.
NO CURRENT, ALTHOUGH OUTPUT IS 28.5 VOLTS.	Reverse-current relay switch open.	Check for and correct relay adjustment. See that relay wiring is correct and in good condition. Remove any dirt or other foreign matter from armatures. Unless fault is obvious, relay switch will have to be replaced.
LOW CURRENT.	Overheated generator.	Correct any fault in air blast tube and connection. If over-heating is caused by armature binding, return to depot for overhaul.

Trouble	*Probable Cause*	*Remedy*
GENERATOR NOT ROTATING.	Broken shaft.	Replace generator, after inspecting accessory-drive case for possible damage or fragments which may cause trouble.
ERRATIC OPERATION DUE TO OIL IN GENERATOR.	Generator mounting gasket leaking.	Replace gasket, and if considerable oil has leaked into generator, return it to depot for cleaning.
EXCESSIVE ARCING OF GENERATOR BRUSHES.	Brush adjustment.	Readjust brushes by loosening commutator end-frame mounting screws and rotating frame in slotted holes.
	Brushes having excessive side play, or binding in holders.	Remove and clean brushes, and reseat them as outlined above.
	Loose brush holders.	Return generator to depot for repairs.
	Low brush spring tension.	Adjust brush spring tension or replace spring.
	High voltage.	Check voltage regulator adjustments. Correct any short in generator wiring.
	Dirty commutator.	Clean, as outlined above.
	Rough or pitted commutator.	Return generator to depot to have commutator turned down.
	Brushes worn too short to be held against commutator.	Replace.
GENERATOR THROWING SOLDER.	High voltage.	Check items listed under excessive arcing of generator brushes, above.
GENERATOR NOT CHARGING BATTERY, ALTHOUGH OUTPUT AS CHECKED WITH INDEPENDENT METERS IS CORRECT.	Reverse-current relay out of adjustment.	Check reverse-current relay adjustment and condition.
	Faulty battery.	Check battery water and general condition of battery and terminals.
GENERATOR CIRCUITS DEAD.	Loose connection at generator plug.	Resolder joints. Correct bent or broken contacts.
REVERSE-CURRENT RELAY FAILS TO OPERATE.	Open circuit in airplane's wiring.	Repair open circuit.
	Pitted points.	Clean with No. 000 sandpaper; readjust.
	Dirt or dust causing the contactor coil armature to stick.	Clean with moderate blast of air and readjust.
	Open circuit in coils.	Replace relay.
	Badly burned or welded contact points.	Replace relay.
	Low generator voltage.	Adjust voltage regulator.
REVERSE-CURRENT RELAY OPERATES BUT RELEASES ALMOST IMMEDIATELY.	Contactor coil armature points dirty.	Clean points.
	Reverse-current cut-out out of adjustment.	Check and correct.

GENERAL ELECTRIC REVERSE-CURRENT RELAY

Trouble	*Probable Cause*	*Remedy*
CONTACTS DO NOT CLOSE.	No generator output.	Check generator.
	Resistor open.	Replace.
	Small contacts won't touch when closed.	Readjust.
	Iron filings on magnet.	Clean.
	Large coil out of calibration.	Recalibrate.
	Small terminals shorted.	Check wiring.
	Burned-out coils.	Replace.
	Open circuit between generator and switch.	Check wiring.
CONTACTS WILL NOT OPEN.	Small contacts sticking.	Increase gap.
	Filing on permanent magnet.	Clean out.
	Out of calibration.	Recalibrate.
	Moisture between small contacts.	Clean and dry.
	Battery dead.	Replace or charge.

WESTINGHOUSE REVERSE-CURRENT RELAY

Trouble	*Probable Cause*	*Remedy*
FAILURE TO PICK UP.	Improper calibration.	Recalibrate.
	Dirt or metal chips.	Clean and recalibrate.
FAILURE TO DROP OUT.	Improper calibration	Recalibrate.
	Dirt or metal chips.	Clean and recalibrate.
FAILURE TO OPERATE.	Broken lead.	Connect.
	Burned-out coil.	Replace.
	Burned contacts.	Clean. Replace if necessary.
	Broken resistor.	Replace.
	High-resistance connection.	Clean and tighten.
CONTACTOR FAILS TO OPERATE.	High-resistance connection.	Locate and clean.
	Broken wire.	Locate and repair.
	Burned-out coil.	Replace.
	Spring out of calibration.	Recalibrate.
	Armature ears rubbing on steel frame instead of bronze bearing.	File frame until bronze bearing overhangs .005 inch. Paint filed surface.

LEECE-NEVILLE REVERSE CURRENT RELAY

Trouble	*Probable Cause*	*Remedy*
ADJUSTMENT DIFFICULT.	Battery circuit open. No load.	Check.
	Battery terminals loose or corroded.	Clean and tighten.
	Coil damaged.	Replace.
	Resistance open or disconnected.	Check and repair.

VOLTAGE REGULATOR

Trouble	*Probable Cause*	*Remedy*
GENERATOR DOES NOT PRODUCE VOLTAGE.	Faulty generator wiring.	Remove regulator from mounting base. Measure resistance of the generator field with an ohmmeter connected between "A" terminal on the mounting base and ground. The value should be 2 ohms. If reading differs greatly from the above, check generator wiring and generator. Remove the connector plug at the generator and check the field again between "A" and "E" terminals on the generator. If the value is not 2 ohms, check the condition of the generator (removing the connector plug and wiring leading to the connector plug) and replace all defective parts.
	Faulty regulator.	If the field resistance is correct, connect "B" terminal to "A" terminal on the voltage regulator base. The generator cutout switch should be in the "OFF" position. Increase the engine speed (keeping it under 1800 rpm) and watch the voltmeter. If the voltage builds up to approximately 28.5-volts, 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 to idling speed, and remove the lead between "A" and "B".
	Faulty generator.	If the generator fails to build up voltage during the above test, and an inspection of the generator indicates that it is in a satisfactory condition, the cause may be due to loss of residual magnetism and it will be necessary to flash the field of the generator. This should be done with the regulator removed or disconnected. Connect one end of a piece of No. 18 or larger wire to the source of battery voltage. With engine operating at 1800 rpm and the generator cut-out switch "OFF", touch the other end of the jumper wire to the "A" terminal of the voltage regulator mounting base and note if a voltage reading is obtained on portable voltmeter. If no voltage is obtained, the voltage regulator is faulty and must be replaced. If a generator repeatedly loses its residual magnetism, it should be replaced by a new generator.
GENERATOR PRODUCES APPROXIMATELY 2-VOLT OR RESIDUAL VOLTAGE.	Voltage regulator does not allow sufficient field current to build up voltage.	Readjust voltage regulator or replace.
	Generator field circuit is open.	Replace generator.
	Field lead to regulator "A" terminal is open.	Locate and repair.

Trouble	*Probable Cause*	*Remedy*
GENERATOR PRODUCES HIGH VOLTAGE.	Voltage regulator resistor is open at a midpoint.	Replace voltage regulator.
	Regulator is set too high.	Readjust regulator.
	Regulator is inoperative, causing full field.	Replace voltage regulator.
GENERATOR DELIVERS NO CURRENT.	Generator cut-out switch open or circuit open or relay switch set too high. Reverse connections at generator or relay switch is polarized so it will not close on a reversed voltage.	Change cut-out switch or repair open circuit. Readjust relay switch. Correct connections to generator.
	Ammeter leads broken.	Replace.
STARTER MOTOR FAILS TO OPERATE.	Wiring not properly connected.	Check wiring with wiring diagram.
	Loose and high-resistance connections.	Clean and tighten.
	Loose or corroded battery terminals.	Clean and tighten.
	Dirty commutator.	Clean and smooth.
	Rough or pitted commutator.	Replace starter.
	Shorted, grounded, or open armature.	Replace starter.
	Low voltage input.	Check and recharge battery.
	Brushes not properly seated.	When replacing a worn brush, the new brush should be properly seated by inserting a strip of No. 000 sandpaper between the brush and the commutator with sanded side next to the brush and pulling in the direction of rotation. Repeat until the brush is fully seated.
	Excessive side play.	Replace brushes.
	Starter toggle switch defective.	Replace switch.
ENGINE OIL LEAKAGE INTO STARTER.	Sealing material on baffle plate worn.	Replace baffle plate.
	Insufficient slack in engaging device linkage, preventing complete retraction of starter jaw against baffle plate seal.	Provide sufficient slack to permit seating of jaw.
FREE RUNNING TIME TOO LOW.	Engine oil leakage into starter.	See "engine oil leakage," just above.
	Overrunning clutch. Rollers not retracting.	Disassemble, inspect, clean and lubricate.
	Improper lubrication.	Disassemble and lubricate.
	Ball or roller bearings worn or turn roughly.	Disassemble and replace. Replace generator.
HAND CRANKING DIFFICULT.	Misalignment of cranking extension.	Realign and install.
	Brushes not lifted from the commutator.	Lift brushes by pulling lever on aft end of the starter or manual control located in cutout in engine cowling.

Trouble	*Probable Cause*	*Remedy*
(Continued) HAND CRANKING DIFFICULT	Improper starter lubrication.	Disassemble and lubricate.
	Engine oil leakage into starter.	See "engine oil leakage," above.
	Ball bearings worn or turn roughly.	Disassemble and replace.
	Overrunning clutch rollers not retracting.	Disassemble, inspect, clean, and lubricate.
STARTER MOTOR OPERATES BUT FAILS TO TURN FLYWHEEL.	Foreign matter is overrunning clutch.	Disasemble, clean, and lubricate.
	Overrunning clutch rotation incorrect.	Disassemble and reverse for proper rotation.
	Motor rotation incorrect.	Replace motor.
STARTER MOTOR OPERATES BUT FAILS TO CRANK ENGINE.	Slipping clutch.	Adjust or replace clutch.
	Starter rotation incorrect.	Replace starter.
	Solenoid engaging device inoperative.	Check solenoid.
FLUCTUATION IN CLUTCH SETTING WITH GRADUAL INCREASE IN VALUE.	Worn or scored discs.	Replace and test.
	Clutch adjusting nut not locked in place.	Check for broken or improper assembly of lockring.
	Clutch not properly set.	Readjust.
EXCESSIVE ARCING OF MOTOR BRUSHES.	Wiring not properly connected.	See Wiring Diagram.
	Starter control switch inoperative.	Replace switch.
	Solenoid coil grounded or burned out.	Disassemble and test.

STARTER MESHING SOLENOID

Trouble	*Probable Cause*	*Remedy*
DOES NOT OPERATE.	Open circuit.	Repair wiring.
	Dirty contacts on connector.	Clean contacts.
	Open-circuited solenoid coil.	Replace unit.
	Plunger binding.	Remove and wash plunger and housing thoroughly with carbon tetrachloride. Change spring compression only as a last resort.
	Short-circuited coil.	Replace unit.
INTERMITTENT OPERATION.	Loose electrical connection.	Clean and tighten electrical connections.
	Plunger binding.	See remedy under "plunger binding" above.
	Badly burned points.	If points cannot be dressed down, replace the unit.

OIL DILUTION SOLENOID

Trouble	*Probable Cause*	*Remedy*
SOLENOID INOPERATIVE.	Burned-out coil.	Replace solenoid.
	No power to coil.	Check switch and wiring.

MAGNETO

Trouble	*Probable Cause*	*Remedy*
NO SPARK AT ONE OR MORE CYLINDERS.	Faulty spark plug.	See "Spark Plugs."
	Faulty connection at spark plug end of cable.	See "Spark Plugs."
	Faulty connection at distributor block end of cable.	Remove magneto covers, radio shield, and distributor block. See that the end of the cable is in place and clean, and that cable-piercing screw is tight. If distributor block is cracked or faulty, replace.
	Faulty cable; short or open circuit in harness.	Check the cable with a booster magneto. Attach the high-tension terminal of the booster magneto to the distributor block electrode. Hold the spark plug end about ¼ inch from grounded object. If no spark occurs, a short or open circuit is indicated.
		Note: The distance between points when open is not important. No arcing between them is necessary. The breaker assembly merely shorts all circuits to ground, between firing time. Therefore, when the contact points are closed, they are functioning.
	Damaged cam follower, weak or broken contact breaker arm spring, worn or loose cam.	Replace part at fault, or entire assembly.
	Distributor electrodes loose, pitted, burned, or dirty.	The distributor electrodes should be free from oil or dirt. If they are loose, they should be set with the aid of gage No. 11-1322. The distributor finger segments should be checked with gage No. 11-1230. Badly pitted or burned electrodes must be replaced.
	Distributor block or finger cracked.	Replace.
	Carbon brush worn or broken.	The carbon brush projects forward from the distributor block. Remove the distributor block and remove the brush spring contact assembly, and replace.
	Moisture inside the magneto.	Remove covers, including contact breaker assembly cover, and dry with a clean cloth which does not shed lint. Blow dry compressed air through the vent opening in bottom of housing.

Trouble	*Probable Cause*	*Remedy*
NO OUTPUT.	Primary condenser burned out.	Primary condenser is located directly beneath the ground terminal. Remove coil cover and replace condenser.
	Secondary condenser burned out.	The secondary condenser is an integral part of the distributor finger disc. Remove the covers and distributor block, and take out the 4 screws holding the distributor finger assembly to the mounting flange on the distributor gear axle. Replace the unit.
	Short or open circuit in coil.	Replace coil. Primary should check 1.8 amperes at 400 rpm drive shaft speed. The drive shaft rotates at 7/8 engine speed. The secondary windings should be checked with an ohmmeter, and should have a resistance of from 5000 to 9000 ohms.
	Loose or incomplete connection at ground terminal (terminal for wires from ignition switch).	Remove connection and see that contact spring is in place. Check for faulty cable, terminal, or connection.
	No rotation.	Remove magneto, and check gears in accessory-drive case, and gear on end of magneto shaft. If damaged, replace, and check for fragments in accessory-drive case which may cause future damage.

BOOSTER COIL

Trouble	*Probable Cause*	*Remedy*
COIL INOPERATIVE.	Condenser defective.	Replace booster coil.
	Winding either burned out or open.	Replace coil.
	Points fused together.	Replace points and adjust as instructed under "Adjustments."
	High tension grounded.	Isolate high-tension wire to magneto.
CONTACTS ARCING.	Misadjusted.	Readjust; see "Test and Adjustment."
	Contacts dirty.	Clean and adjust.
	Contacts oily.	Clean and adjust.

SPARK PLUGS

Trouble	*Probable Cause*	*Remedy*
CYLINDER NOT FIRING OR FIRING ERRATICALLY.	Causes other than spark plugs.	If spark is apparent at terminal, check carburetion and sticking valves.
	Causes other than spark plug: magneto short or open circuit in cable or shielding.	Check possible causes of ignition failure listed for these items, and correct as directed.

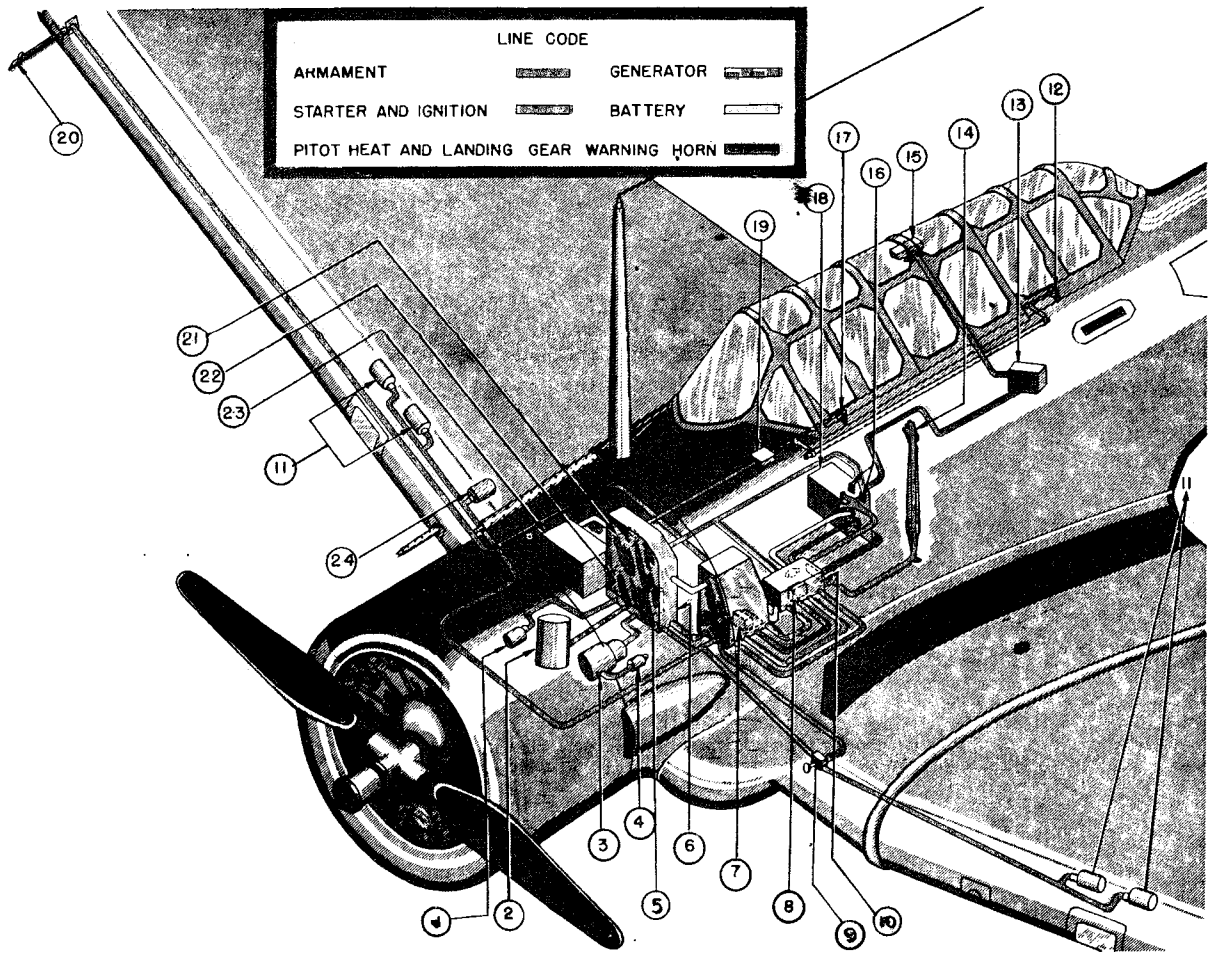
Trouble	*Probable Cause*	*Remedy*
(Continued) CYLINDER NOT FIRING OR FIRING ERRATICALLY	Terminal connection faulty or disconnected.	Remove coupling at spark plug end of elbow. Withdraw contact assembly, and see if spring contact is in place and not broken. See that rubber thread-protector washer has not been left in terminal contact well. Check for condensation of water in terminal contact well. Remove knurled contact to which spring is attached and see if cable is in good condition, clean, in place, and that sufficient (¼ inch) insulation has been removed. See that it is spread out over the contact threads. Check for breaks or shorts in wire. Be sure that the shoulder on the rubber collar is at the elbow end.
	Incorrect gap between electrodes.	Readjust gap. (See "Testing and Adjusting.")
	Electrodes fouled by prolonged idling of engine.	Operation at 30 in. Hg manifold pressure for a short interval may assist in clearing condition.
	Rust preventive in engine taken from storage and newly installed.	Remove plugs and clean with naphtha Spec. No. 4-1040. Disassembly will not be necessary.
	Electrodes fouled by other conditions.	Clean and check the cause of this condition, as it may be a sign of excessive oil consumption, or of magneto, terminal, or wire defects causing the plug not to fire.
	Soot on nose of insulator.	A thin layer of soot on nose of insulator, when plug otherwise looks quite free from deposit, may be sufficient to short plug. This may be an indication that plugs are not operating at sufficiently high temperature. Check to see that plug is of approved type.
	Plug clean, but signs of overheating.	Check engine temperature.
ROUGHNESS AT HIGH ALTITUDES WITH SMOOTH OPERATION AT LOWER ALTITUDES.	Wrong spark gap.	Readjust spark gap.
NO SPARK AT STARTING IN COLD WEATHER.	Ice forming on spark plug electrodes.	Remove ice, and dry plug thoroughly. This condition is more likely to occur in lower cylinders.

(2) STORAGE BATTERY.—*(See figure 282.)*—A type G-1, 24-volt, 34-ampere hour storage battery of the integrally shielded (lead-acid) type, is located in a covered metal case on the lower right forward side of the fire wall. It is accessible by removing the cowling at the right side of the engine compartment. The function of the battery is to provide electric energy when the generator is inoperative or malfunctioning.

WARNING

The battery must be kept in a fully charged condition at all times. If the specific gravity reads 1.240 or less, the battery must be replaced with a battery that is known to be fully charged.

The cover to the battery case is fitted with a rubber or neoprene gasket which forms a sealed air chamber inside the case to prevent the escape of acid fumes from the battery. Provision is made to neutralize and vent these battery gases outside, as they would damage the metallic structure of the airplane. This is accomplished by passing outside air through the sealed air chamber at the top of the battery and then through a glass jar containing a cellulose sponge disc 1 inch thick, saturated with a solution of tri-sodium phosphate (NA_3PO_4) to neutralize any acid in the battery gases. A felt pad saturated with a solution of bicarbonate of soda may also be used. Air is passed through the battery and neutraliz-



1. Fuselage Gun Solenoid
2. Generator
3. Starter
4. Starter Meshing Solenoid
5. Battery Disconnect Solenoid
6. Main Power Panel
7. Voltage Regulator
8. Reverse Current Relay
9. Landing Gear Warning Horn Switch Box
10. Circuit Release Solenoid
11. Bomb Release Solenoid
12. Ignition Switch Control, Rear Cockpit
13. Rear Cockpit Control Panel
14. Bomb Release and Gun Trigger Switches
15. Landing Gear Warning Horn
16. Starter Switches
17. Ignition Switch Control, Front Cockpit
18. Front Cockpit Control Panel
19. Ignition Switch
20. Pitot Head
21. Booster Coil
22. Starter Solenoid
23. Battery
24. Wing Gun Solenoid.

Figure 281 — Electrical Power System — 24-Volt

ing jar by means of rubber or neoprene tubing leading from an intake port in the bottom of the engine cowling to one side of the battery case and from the other side to the jar, and then to an exhaust tube in the bottom of the cowling. The neutralizing jar is accessible through an opening in the lower right rear side of the engine cowling. Batteries on late airplanes are equipped with a quick-disconnect plug connection to battery leads.

(3) GENERATOR SYSTEM.

(a) DECRIPTION. — *(See figures 285 and 286.)*—The type M-3, 24-volt, 50-ampere generator, mounted on the rear of the engine assembly, serves to keep the battery charged and to furnish power for operating the airplane's electrical equipment. A generator voltage regulator is mounted in a box on the left side of the front cockpit just aft of the fire wall. The voltage regulator, when properly regulated, will hold the generator voltage output to within plus or minus 2 percent of rated voltage (28.5 volts) at varying generator speeds. The voltage regulator is accessible only from the outside (when the airplane is on the ground). A reverse current relay, also connected in the generator

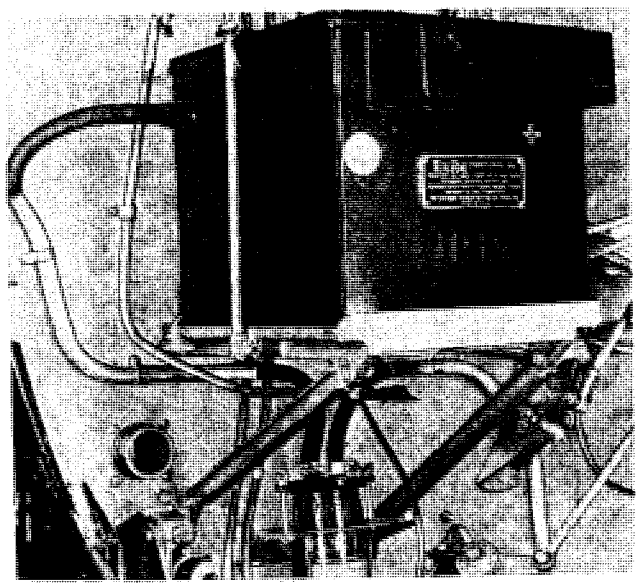


Figure 282 — Storage Battery and Vent Jar — 24-Volt

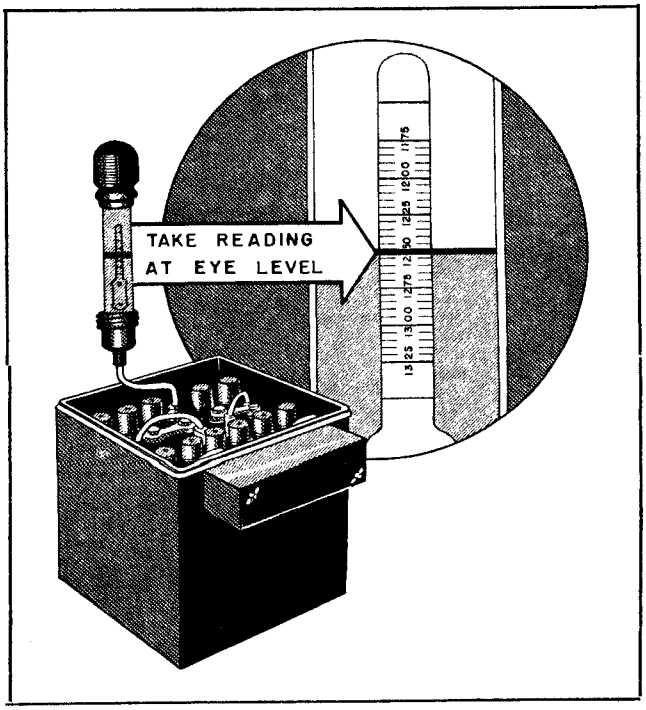


Figure 283 — Testing Battery with Hydrometer

circuit, is mounted in the box with the circuit breakers on the left side of the front cockpit just aft of the voltage regulator. The reverse current relay, when properly adjusted, will operate automatically to close the circuit and put the load on the generator when the generator voltage output reaches 26.5 volts plus or minus 0.5. When the generator voltage drops below that of the battery so that between 8 to 20 amperes would tend to flow in the reverse direction, the relay will open the circuit to isolate the generator from the system, thus preventing the flow of current from the battery to the generator. The type F-1 ammeter mounted on the control panel in the front cockpit will indicate the amount of current delivered by the generator.

(b) ADJUSTMENT.

1. VOLTAGE REGULATOR. — *(See figure 287.)*—The voltage regulator installed on the 24-volt airplane may be of the magnetic finger-type manufactured by Westinghouse or General Electric, or it may be of the carbon-pile type manufactured by Eclipse Electric or Delco Remy. While these regulators differ somewhat in physical appearance, they all have an adjusting nut that may be easily identified. Use a precision voltmeter to make the adjustments or, if a precision instrument is

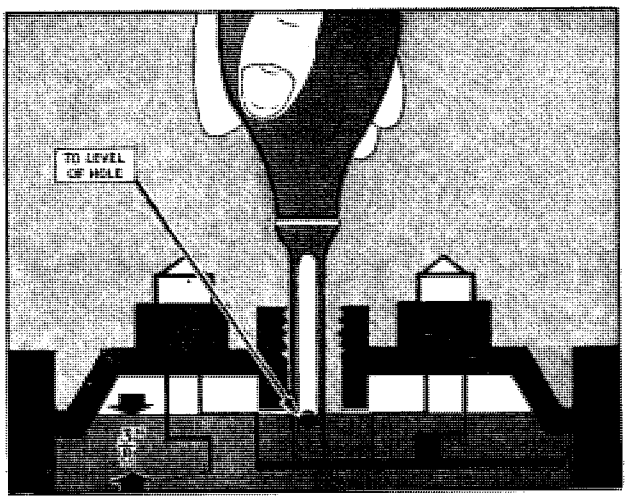


Figure 284 — Filling Battery with Self-Leveling Syringe

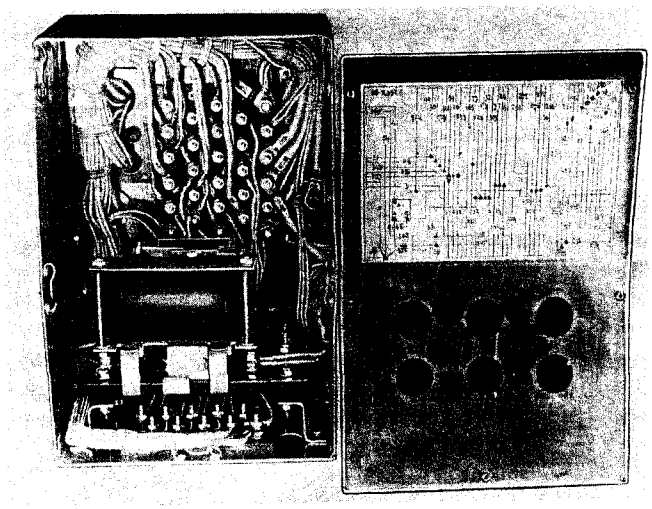


Figure 285 — Generator Regulator Panel — 24-Volt

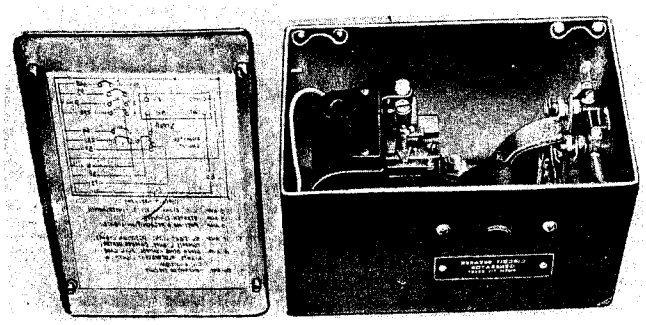


Figure 286 — Circuit Breaker Box — 24-Volt

not available, a type B-1 voltmeter may be used after it has been calibrated against a precision instrument. Adjustment instructions are as follows:

a. Test the specific gravity of the battery electrolyte with a hydrometer. If the specific gravity is above 1.240 (corrected for temperature) then the battery is sufficiently charged for making the regulator adjustment. If, however, the specific gravity of the battery is 1.240 or less, the battery must be replaced with one that is fully charged.

b. Connect the negative terminal of the voltmeter to ground at the voltage regulator and the positive terminal of the voltmeter to the "B" terminal of the regulator.

c. Start the engine with an outside battery supply and let the engine come up to operating temperature.

d. Increase the engine speed until the reverse current relay cuts in (1400 to 1800 rpm) and adjust the voltage regulator to read 28-volts on the test voltmeter. This adjustment is made by turning the adjusting nut on the regulator clockwise to increase and counterclockwise to decrease the voltage.

e. Make a final check and slight readjustments, if necessary, at different engine speeds and with some electrical load on the generator.

2. REVERSE CURRENT RELAY.—*(See figure 288.)*—Proceed to adjust the reverse current relay with engine at operating temperature and idling speed, the main line switches "ON", and the test voltmeter connected as for voltage regulator adjustment. A relay from any one of several different manufacturers may be installed in the airplane. The function of these relays is the same but they are somewhat different in physical make-up and adjustment. Adjustment instructions are as follows:

a. The General Electric relay is adjusted by inserting a screw driver through a hole in the relay shielding and turning a small screw to adjust the position of the armature inside the small coil. Turning the screw clockwise, or in, will lower the closing voltage, and turning counterclockwise will raise the closing voltage of the relay.

b. The Westinghouse relay is adjusted by turning a small slotted nut near the generator terminal. This nut controls the tension on a small spring. The closing voltage of the relay is raised or lowered by turning the nut so as to increase or decrease the tension on the spring.

c. The Leece-Neville relay is adjusted by turning a knurled nut controlling the tension on a small spring located just behind a smaller coil. Turn the nut so as to increase or decrease the tension on the spring to raise or lower the closing voltage of the relay.

d. All relays should be adjusted to close at between 26.0 and 27.0 volts. This adjustment is accomplished by gradually increasing the engine speed until the test voltmeter indicates 26.5; adjust the relay to cut in at this point. It should automatically open to isolate the generator when the generator output drops so low

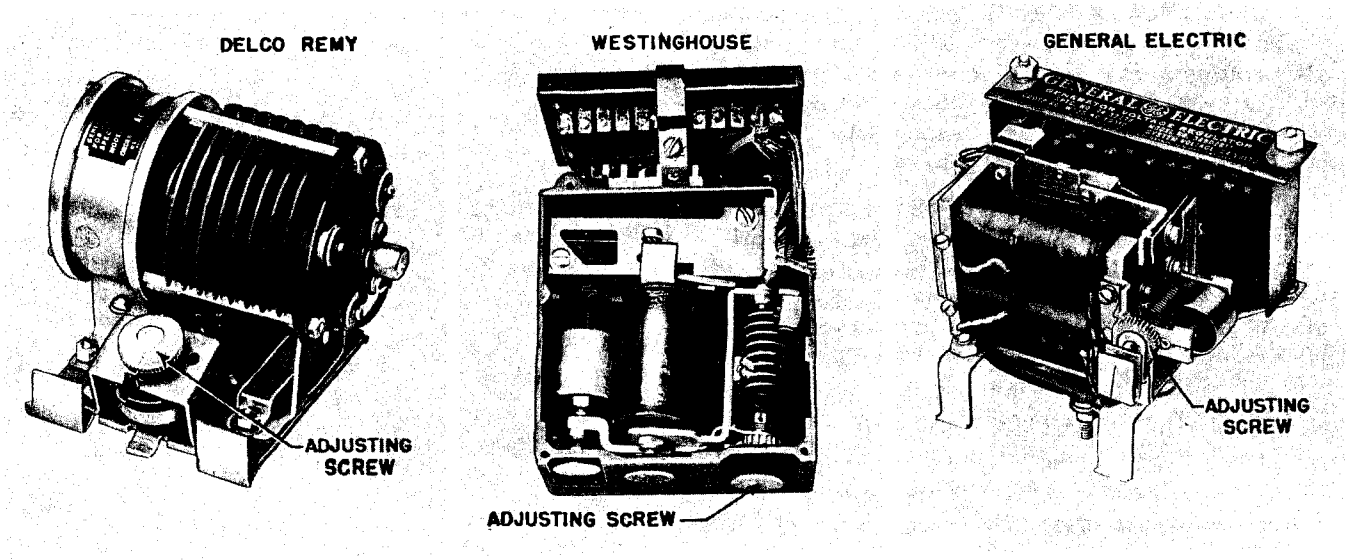


Figure 287 — Adjusting Points for Generator Voltage Regulators

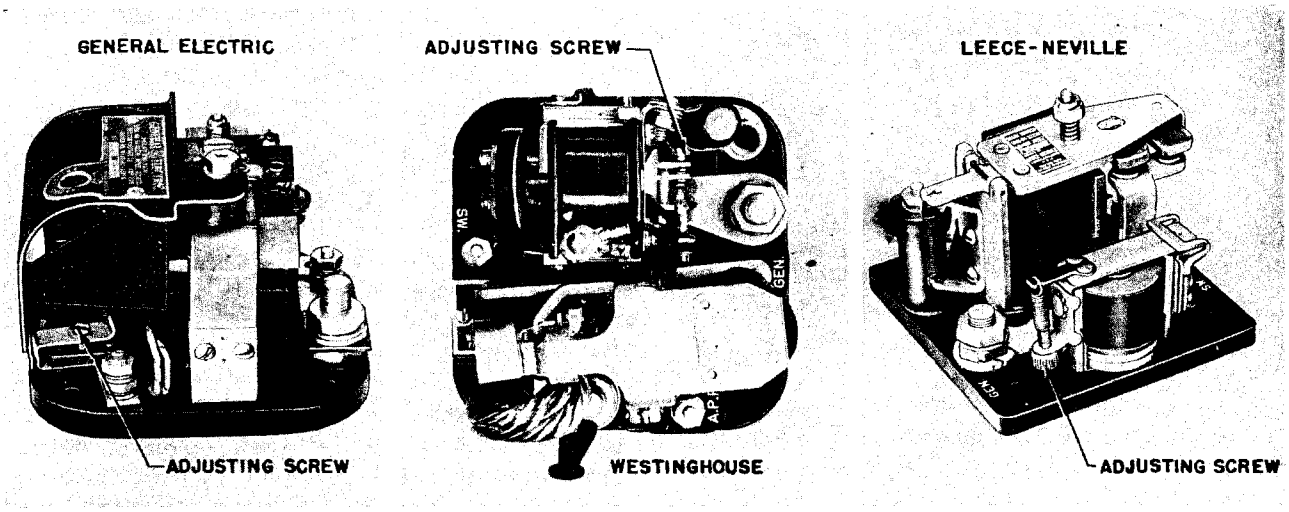


Figure 288 — Adjusting Points for Generator Reverse Current Relays

that from 8 to 20 amperes will tend to flow from the battery to the generator. Only adjustment of the closing voltage should be attempted in the field. Check the adjustment several times to make sure that the relay will close at between 26.0 and 27.0-volts.

WARNING

The battery on the 24-volt airplane is not of sufficient capacity to permit its use for testing purposes or for engine starting. Use an outside battery supply for this purpose and conserve the airplane battery for necessary flight requirements.

(4) GENERATOR MAIN LINE SWITCH.—A generator main line switch on the front cockpit switch panel provides a means of opening the generator circuit in case the automatic relay cut-out in the generator control panel fails to operate. The switch should be left in the "OFF" position when the engine is not running. It is also best to put this switch to the "OFF' position before engaging in acrobatic or inverted flight; otherwise gas from charging may accumulate in the battery cells because of the anti-spill battery caps and exert enough pressure to damage the battery.

(5) IGNITION SWITCH.—A master ignition switch box unit, wired directly to the rear of the magnetos, is located at the left side of the fuselage forward of the front instrument panel. This master switch is operated from the left side of the instrument panel in both cockpits by a lever or pointer handle mechanically interconnected with the switch.

(6) ENGINE STARTING SYSTEM.

(a) A type G-5 starter is mounted on the rear of the engine assembly. This starter was originally installed to operate as a combination electric or hand cranking inertia starter; however, to prevent engine or starter jaw breakage caused by sudden high starter torque resulting from the inertia feature, the installation has been rewired for direct cranking only. This rewiring consisted of removing wire No. 12 from engine section of starter switch on pilot's control panel and connecting with wire No. 15 at terminal on engage side of starter switch. Direct cranking periods are limited to 60 seconds duration.

WARNING

As low capacity batteries are used in these airplanes, they will not stand too much starting without being recharged by the generator. If the battery is too low it will draw a large amount of current from the generator resulting in the circuit breaker opening. When a recharged battery is installed, the circuit breaker must be closed manually if it is open, as the circuit to the generator must be completed. Earlier circuit breakers are set for 50 amps; later ones are set at 60 amps to provide greater operating limits.

(b) For emergency operation when the source of electrical energy is not sufficient to provide proper electrical operation, the starter may be operated as a hand inertia starter. To operate the starter as such, move the brush spring release to the "OFF" position. (When facing the starter, the brush spring release handle is moved clockwise to the "OFF" position and counterclockwise to the "ON" position.) This is accomplished by reaching through a small inspection door on the upper left side of engine compartment cowling. Insert hand crank (hand crank is stowed in the baggage compartment) and turn the hand crank at approximately 80 rpm or until the flywheel has attained its normal operating speed. When this speed has been attained, remove the hand crank and pull the manual engaging control cable to engage the engine and starter jaws. When the engine starts, release the cable. (This cable is accessible through the cowling at the hand crank position.)

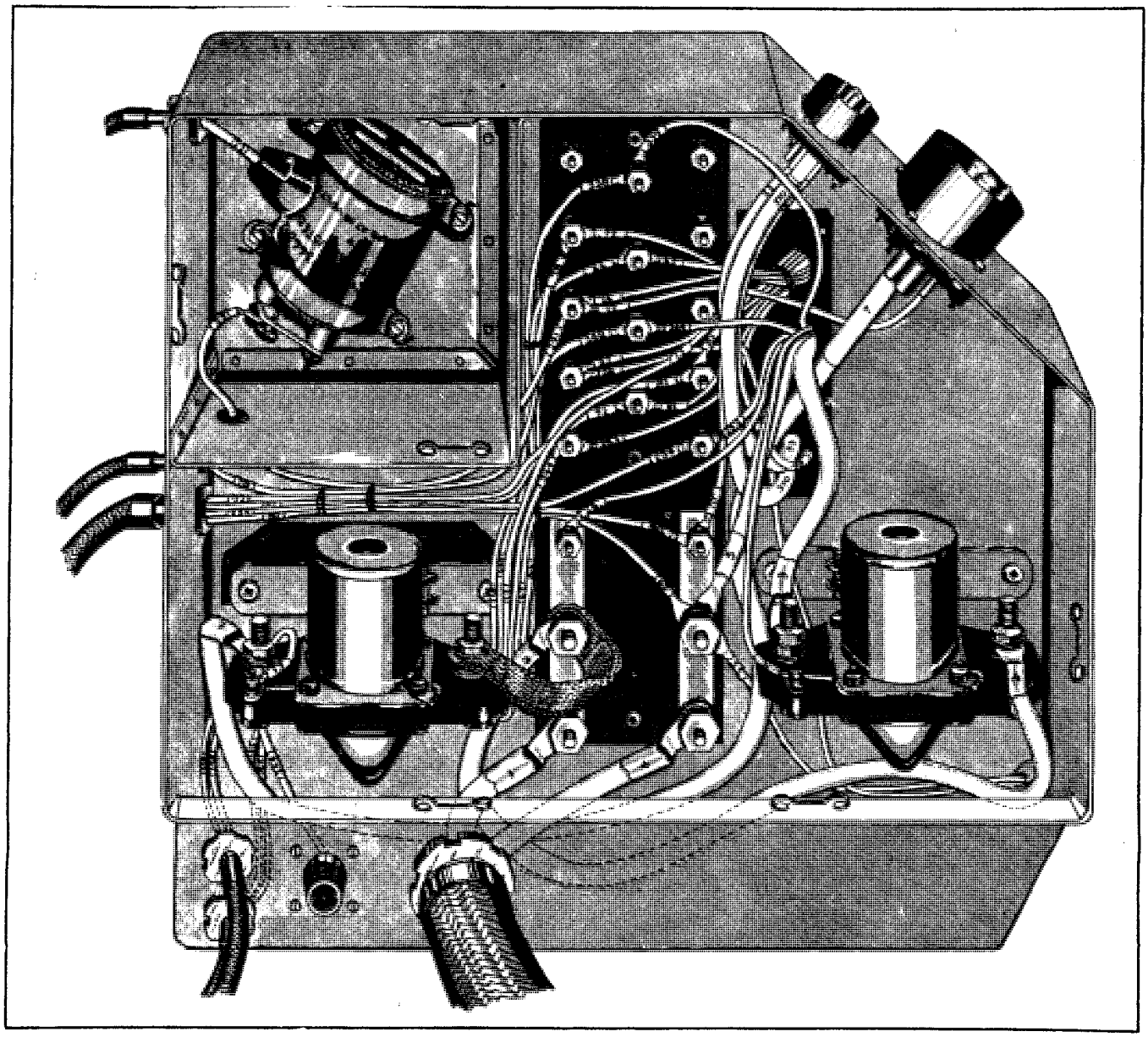


Figure 289 — Main Power Panel — 24-Volt

CAUTION

After engine is started, the brush spring release handle should always be returned to the "ON" position and safetied.

(7) MAIN POWER PANEL.—*(See figure 289.)*—The main power panel is mounted on the forward face of the fire wall. Circuits to all electrical equipment on the engine (except the ignition circuits) are routed through this panel. The battery solenoid, the starter solenoid, and the booster coil are mounted inside this panel.

(8) BOOSTER COIL.

(a) DESCRIPTION.—A type C-1 booster coil mounted in a shielded housing in the main power panel on the front face of the fire wall is energized only when the starting switch is thrown to "ENGAGE." The booster coil acts as a high-voltage step-up transformer for delivering a retarded spark through the magnetos for starting only.

(b) ADJUSTMENTS.—*(See figure 290.)*—The contact screw on the booster coil may be adjusted to obtain the correct gap setting as follows:

1. Check the contact points to see that they are clean and are seating properly.

2. Connect the primary terminals of the coil in series with a 3-ampere fuse and 0.5-ampere ammeter and control switch; then connect them to an 18-volt battery supply.

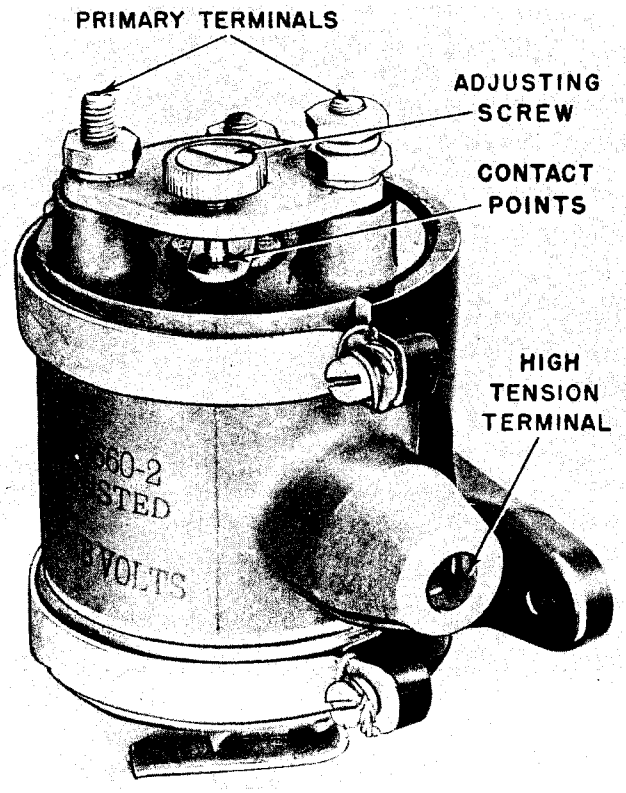


Figure 290—Booster Coil Adjustment—24-Volt

NOTE

The battery voltage must be obtained by using the required number of cells and NOT by dropping the voltage through a series resistor.

3. Connect the high tension terminal to a spark plug having a 0.022-inch gap. Connect a return lead from the spark plug case to the booster coil housing.

4. With the adjusting screw in the extreme outward position, gradually turn screw clockwise until a good hot spark is obtained across the gap. With 18 volts applied, the current drain with the plug firing the 0.022-inch gap should be 1.80 amperes.

5. If no ammeter is available, the approximate setting may be obtained by turning the adjusting screw until the spark will jump a 3/8-inch gap at the plug.

(9) BATTERY DISCONNECT SWITCH.—The type B-4 battery disconnect solenoid switch is mounted in the main power panel and is remotely controlled by a toggle switch on the switch panel in the front cockpit. This switch is used to disconnect the battery from the electrical system to prevent discharging when airplane is not in use.

WARNING

The battery disconnect switch must always be thrown to the "OFF" position before leaving the airplane.

(10) LIGHTING.

(a) DESCRIPTION.—*(See figure 291.)*

1. COCKPIT LIGHTS.—*(See figure 292.)*—Both the front and rear cockpits are provided with a type C-4 cockpit light mounted at the left side of each cockpit. The lamp mounting has a swiveling range of 360 degrees. The lamp is provided with an adjustable beam which is controlled by moving the lens housing backward or forward. The beam is continuously adjustable from a concentrated spot to a floodlight beam. The intensity of the light is controlled with the *red* knob of a rheostat on the bottom of the lamp housing. The head of the lamp housing containing the red lens may be removed to obtain a white light. A push-button switch at the back end of the lamp housing provides a means of instantaneous control of the light so that it may be used for signaling. The lamp may be removed from its holding bracket and held in any desired position.

2. INSTRUMENT LIGHTING.—*(See figure 293.)*—Fluorescent lighting is provided for the instruments in both cockpits. A type C-5 fluorescent light is mounted on both the right and left side of each cockpit. The lights have a swiveling range of 360 degrees and are adjustable to any desired angle. The head of the light housing may be rotated to give visible light or ultra-violet (invisible) light. The fluorescent lights are individually controlled by switches on the instrument panel in each cockpit. The switch must be turned to

CAUTION

After engine is started, the brush spring release handle should always be returned to the "ON" position and safetied.

(7) MAIN POWER PANEL.—*(See figure 289.)*—The main power panel is mounted on the forward face of the fire wall. Circuits to all electrical equipment on the engine (except the ignition circuits) are routed through this panel. The battery solenoid, the starter solenoid, and the booster coil are mounted inside this panel.

(8) BOOSTER COIL.

(a) DESCRIPTION.—A type C-1 booster coil mounted in a shielded housing in the main power panel on the front face of the fire wall is energized only when the starting switch is thrown to "ENGAGE." The booster coil acts as a high-voltage step-up transformer for delivering a retarded spark through the magnetos for starting only.

(b) ADJUSTMENTS.—*(See figure 290.)*—The contact screw on the booster coil may be adjusted to obtain the correct gap setting as follows:

1. Check the contact points to see that they are clean and are seating properly.

2. Connect the primary terminals of the coil in series with a 3-ampere fuse and 0.5-ampere ammeter and control switch; then connect them to an 18-volt battery supply.

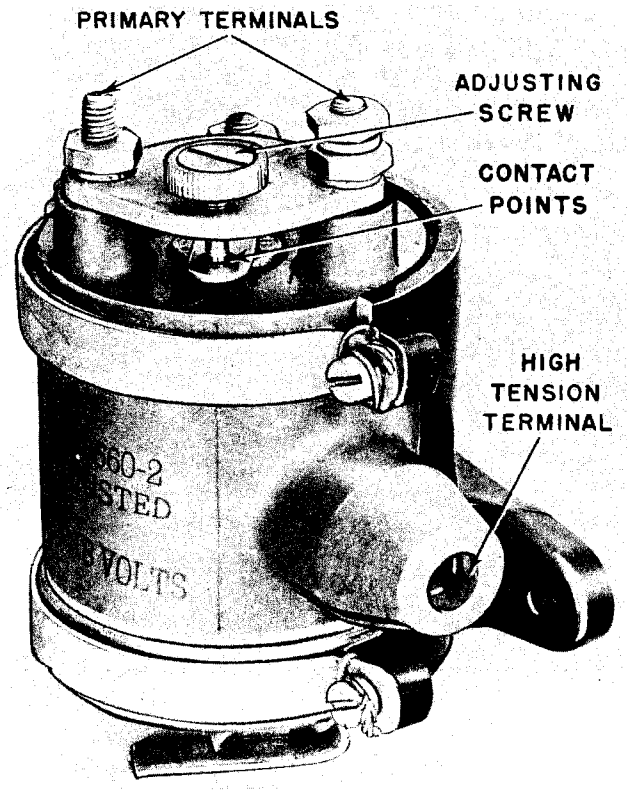


Figure 290—Booster Coil Adjustment—24-Volt

NOTE

The battery voltage must be obtained by using the required number of cells and NOT by dropping the voltage through a series resistor.

3. Connect the high tension terminal to a spark plug having a 0.022-inch gap. Connect a return lead from the spark plug case to the booster coil housing.

4. With the adjusting screw in the extreme outward position, gradually turn screw clockwise until a good hot spark is obtained across the gap. With 18 volts applied, the current drain with the plug firing the 0.022-inch gap should be 1.80 amperes.

5. If no ammeter is available, the approximate setting may be obtained by turning the adjusting screw until the spark will jump a 3/8-inch gap at the plug.

(9) BATTERY DISCONNECT SWITCH.—The type B-4 battery disconnect solenoid switch is mounted in the main power panel and is remotely controlled by a toggle switch on the switch panel in the front cockpit. This switch is used to disconnect the battery from the electrical system to prevent discharging when airplane is not in use.

WARNING

The battery disconnect switch must always be thrown to the "OFF" position before leaving the airplane.

(10) LIGHTING.

(a) DESCRIPTION.—*(See figure 291.)*

1. COCKPIT LIGHTS.—*(See figure 292.)*—Both the front and rear cockpits are provided with a type C-4 cockpit light mounted at the left side of each cockpit. The lamp mounting has a swiveling range of 360 degrees. The lamp is provided with an adjustable beam which is controlled by moving the lens housing backward or forward. The beam is continuously adjustable from a concentrated spot to a floodlight beam. The intensity of the light is controlled with the *red* knob of a rheostat on the bottom of the lamp housing. The head of the lamp housing containing the red lens may be removed to obtain a white light. A push-button switch at the back end of the lamp housing provides a means of instantaneous control of the light so that it may be used for signaling. The lamp may be removed from its holding bracket and held in any desired position.

2. INSTRUMENT LIGHTING.—*(See figure 293.)*—Fluorescent lighting is provided for the instruments in both cockpits. A type C-5 fluorescent light is mounted on both the right and left side of each cockpit. The lights have a swiveling range of 360 degrees and are adjustable to any desired angle. The head of the light housing may be rotated to give visible light or ultra-violet (invisible) light. The fluorescent lights are individually controlled by switches on the instrument panel in each cockpit. The switch must be turned to

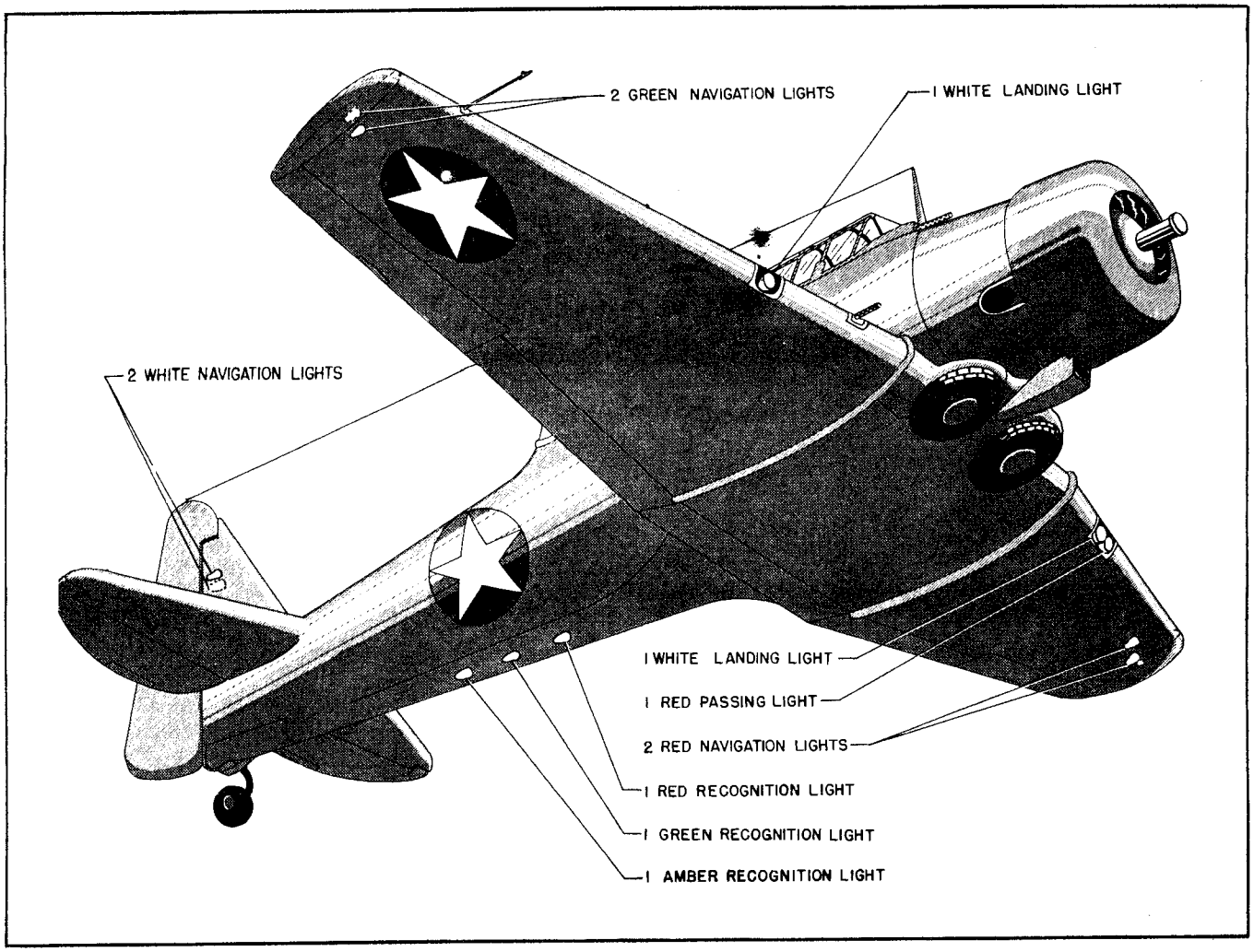


Figure 291 – Exterior Lights

"START" and held until the fluorescent bulb lights, and then may be turned to "ON" for the full light or "DIM" for subdued light.

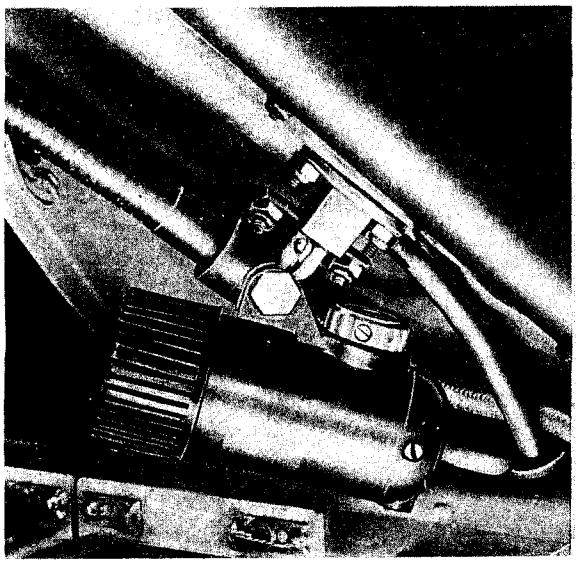


Figure 292 – Cockpit Light

3. NAVIGATION OR POSITION LIGHTS.—Type A-8 navigation lights are installed on both the upper and lower surface of each wing tip and on both sides of the vertical stabilizer. The lights on the left wing are *red,* on the right wing *green,* and on the vertical stabilizer they are *white.* The navigation or position lights are controlled by individual switches on the front cockpit control panel marked "WING" and "TAIL," with "BRIGHT," "DIM," and "OFF" positions. On late airplanes, resin lenses for the tail position lights are stowed in a canvas bag on the right-hand baggage compartment apron. They can be inserted in the lens holder from which the standard lens is removed.

4. RECOGNITION LIGHTS.—The recognition lights are installed in the outer surface of the rear fuselage section just aft of the rear cockpit. Three type E-2 lights, *red, green,* and *amber* are installed underneath the airplane. These lights are controlled by individual switches that are wired in series with a push-button switch that may be operated as a telegraph key to provide a means of using the lights for signaling in various combinations and sequences. The individual switches must be thrown to the *up* or *key* position for signaling

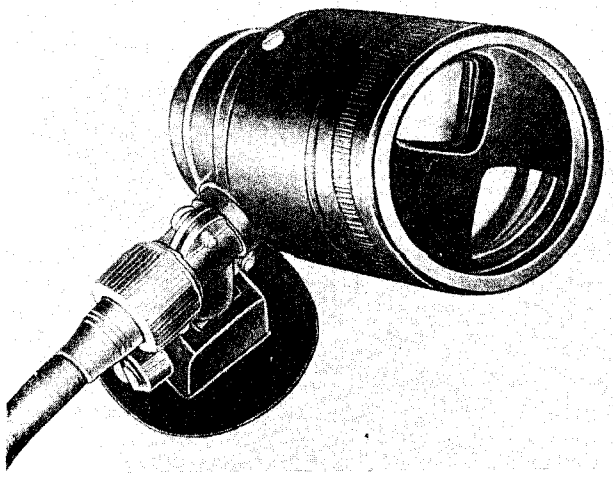


Figure 293 — Instrument Fluorescent Light — 24-Volt

with the push-button switch on top of the box. The *down* position of the switches is "STEADY" and the center position is "OFF." The recognition light switch box is mounted in the center of the front cockpit directly to the right of the control panel. The "WHITE" switch has no function in this installation.

WARNING

Do not operate the recognition lights for more than 10 seconds when the airplane is on the ground, as there must be air circulation to dissipate the heat.

5. LANDING LIGHTS.—Two type PAR-56 landing lights are installed on the airplane, one in the leading edge of each outer wing panel. These lights are of the fixed-focus type with the light beams parallel to the ground line when the airplane is in the three-point position. The lights are focused 10 degrees outboard from the center line of the airplane and are controlled by individual switches on the front cockpit switch panel. The cover glass of each light conforms to the contour of the leading edge of the wing.

WARNING

Do not operate the landing lights for more than 10 seconds when the airplane is on the ground and engine is not running.

6. PASSING LIGHT. — Type B-3 passing light is installed in the same bay with the landing light in the left outer wing panel. The cover glass of the passing light is *red,* and the light beam is parallel to the line of flight. The light is controlled from the front cockpit only.

(b) LAMP REPLACEMENT. — The following list will give information on lamps used for lighting the 24-volt airplane.

	Qty.	*Type*	*Bulb*	*Volts*	*Candle Power*	*Contact*
Fluorescent	4	C-5	RP-12	28	4-W	DC
Cockpit	2	C-4	T-3¼	24	17A	—
Compass (2 Spares)	2	B-16	T-1¼	3	19A	—
Fixed gun sight	1	N-3B	RP-11	28	21	DC*
Fuel signal (1 spare)	1	NAA	T-3¼	28	3	SC
Fuel gage	2	NAA	T-4½	28	3	SC
Bomb arm indicator	1	—	T-3¼	28	—	SC
Passing	1	B-3	S-11	28	50	SC
Position	6	(4) A-8	4-G-6	28	6	SC
		(2) —	2-T-4½	28	3	SC
Recognition	3	E-2	RP-11	28	2.7A	SC
Landing, sealed beam	2	7 in. dia.	Par-56	28	450W	—

DC—Double Contact
SC—Single Contact
*Mazda type G-9 used on later airplanes.

(11) CIRCUIT BREAKERS.—*(See figure 294.)*— All electrical circuits except the magneto ignition circuit and generator circuit are protected by circuit breakers instead of fuses. The only fuses on the airplane will be found in some of the radio equipment on earlier models. On later models two push-button type circuit breakers are installed on the right side of the circuit breaker box in the front cockpit, one 15 ampere protecting the command set and one 10-ampere for the marker beacon and interphone circuits. Fuses in the rear cockpit junction box are now removed. The circuit breakers are of two types: toggle type circuit breakers on the switch panel in the front cockpit which may be identified by the elongated slot in the face of the switch panel at the base of the toggle arm or lever; and conventional push-button reset type circuit breakers which are mounted at the left side of the front cockpit in the box containing the reverse current relay. Information on circuit breakers is given below:

(a) Toggle type circuit breakers installed in front cockpit switch panel:

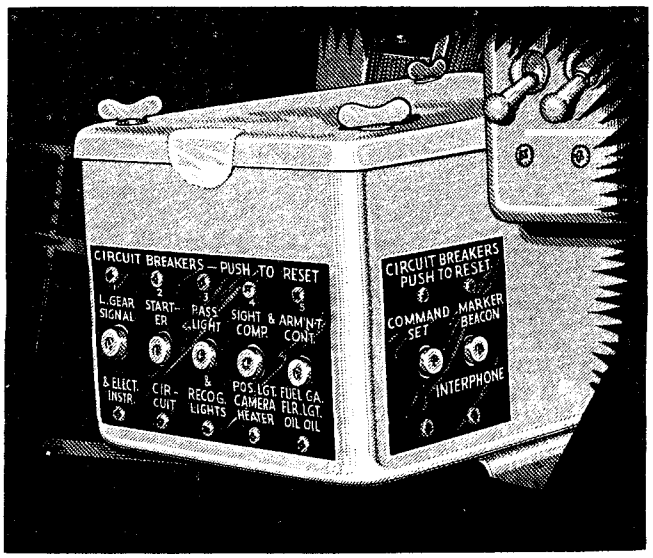


Figure 294 — Circuit Breakers — 24-Volt

Bomb arm control (Nose fuse only)	5 amp
Pitot heat	10 amp
Landing lights—Left and right	35 amp
Bomb selectors—Left wing and right wing	15 amp
Gun Selectors—Cowl gun	15 amp
Wing gun	10 amp

(b) Push-button-reset circuit protectors installed in box on left side front cockpit:

Landing gear signal and electrical inst.	15 amp
Starter circuit	15 amp
Passing light and recognition lights	15 amp
Gun sight, compass, position lights, and camera heater circuit	10 amp
Armt. control, fuel gage, fluorescent lights, and oil dilution	15 amp
Command set	15 amp
Marker beacon and interphone	10 amp

(12) CONTROL PANELS.

(a) FRONT COCKPIT CONTROL PANEL. (AT-6D)—*(See figure 295.)*—The switches and controls for operating all electrical equipment in the airplane are on the control panel in the front cockpit. All switches are plainly marked to indicate their operation and the circuit they control. In addition to the ammeter, mounted in the upper left corner, the control panel contains the following switches:

1. "ENERGIZE" and "ENGAGE" starter switches. (spring-loaded).

2. Left and right fluorescent light rheostats.

3. Oil dilution switch (spring-loaded).

4. Battery disconnect switch (toggle-type).

5. Generator main line switch (toggle-type)

6. Gun sight rheostat.

7. Compass light rheostat.

8. Cowl and wing gun selector switches (toggle circuit breaker).

9. Right and left bomb rack selector switches (toggle-type).

10. Camera, gun, and bomb safety switches (toggle-type).

11. Left and right landing light switches. (toggle-type).

12. Passing light switch (toggle-type).

13. Fuel gage switch (toggle-type).

14. Pitot heat switch (toggle circuit breaker).

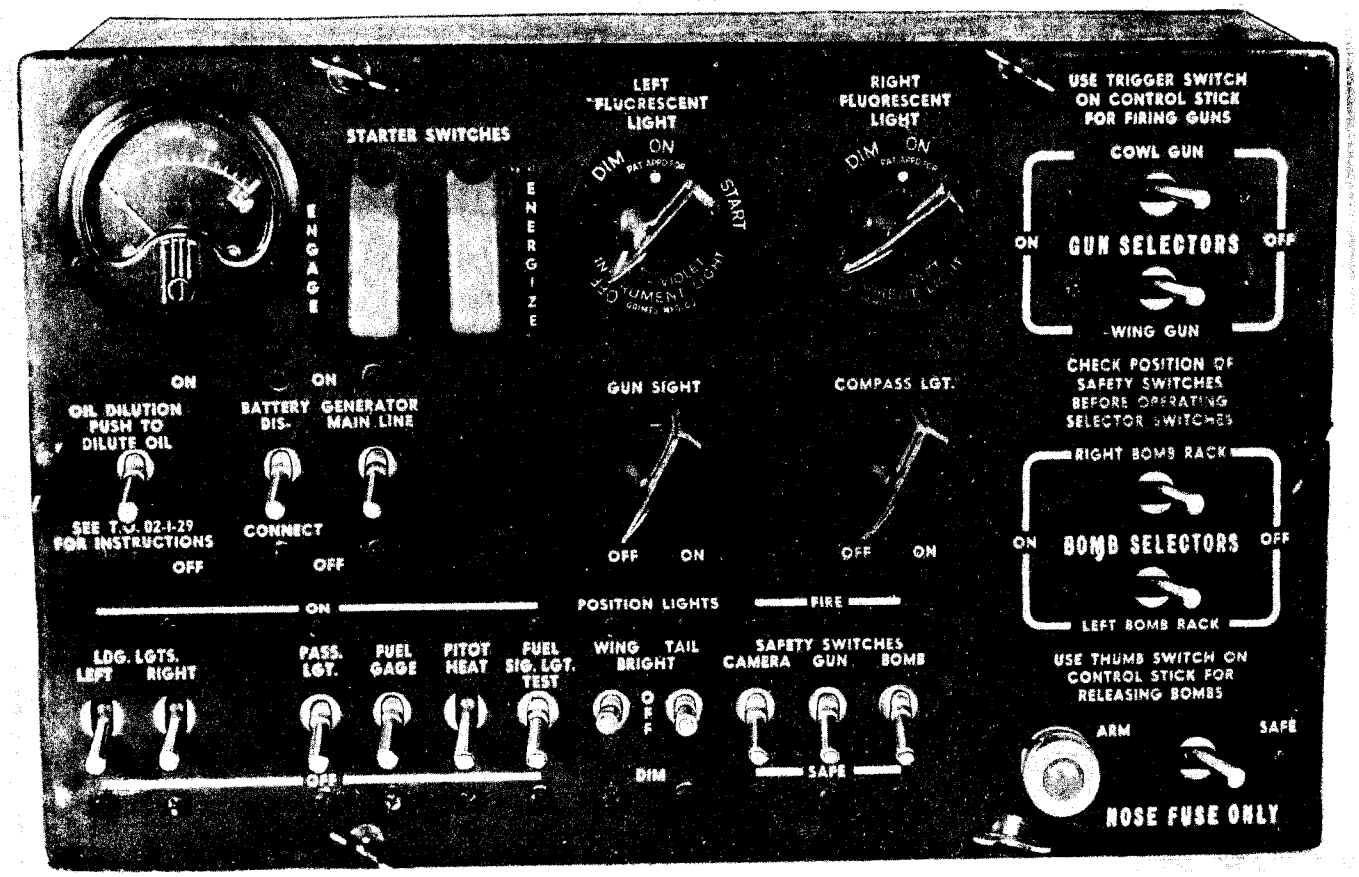


Figure 295—Front Cockpit Electrical Control Panel—AT-6D

15. Fuel signal light test switch (spring-loaded).

16. "WING" and "TAIL" position light switches (toggle-type).

17. Bomb nose fuse safety switch (toggle circuit breaker).

(b) FRONT COCKPIT ELECTRICAL CONTROL PANEL. (AT-6F) — *(See figure 295A.)* — The controls have been grouped on this standardized panel to centralize engine, armament, and lighting systems, containing the following:

1. Left and right fluorescent light rheostats.

2. Battery disconnect switch. (toggle-type).

3. Generator main line switch (toggle-type).

4. Oil dilution switch (spring-loaded).

5. "ENGAGE" and "ENERGIZE" starter switches (spring-loaded).

6. Left and right landing light switches (toggle circuit-breaker).

7. Passing light switch (toggle-type).

8. Fuel gage switch (toggle-type).

9. Pitot heat switch (toggle-type).

10. "WING" and "TAIL" position light switches (toggle-type).

11. Camera and gun safety switches (toggle-type).

12. Gun sight rheostat.

13. Cowl and wing gun selector switches (toggle circuit breaker).

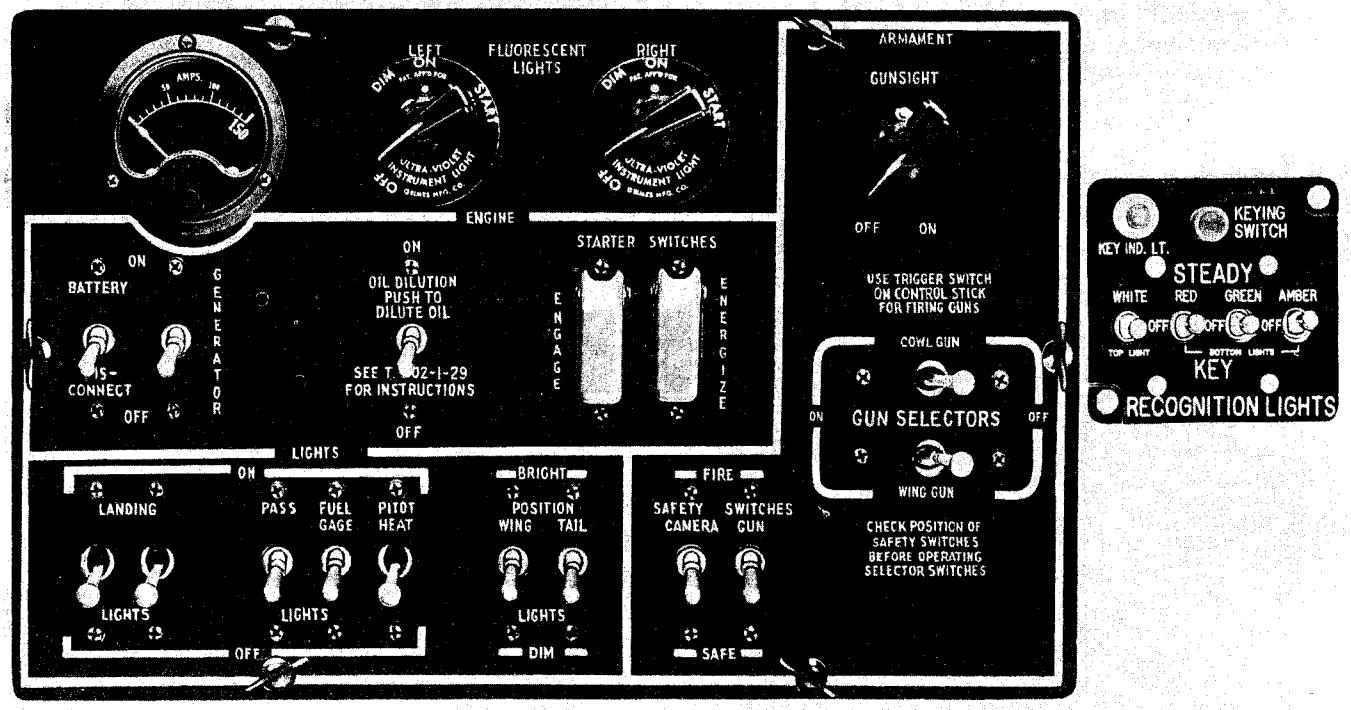


Figure 295A — Front Cockpit Electrical Control Panel — AT-6F

(c) REAR COCKPIT CONTROL PANEL (AT-6D).—*(See figure 296.)*—The rear cockpit control panel contains the following controls: compass light rheostat, left and right fluorescent light rheostats, and fuel gage light switch. The fuel gages on each side of the front cockpit seat are visible from the rear cockpit.

(d) REAR COCKPIT CONTROL PANEL (AT-6F). *(See figure 296A.)*—The following controls are on the rear cockpit control panel: left and right landing light switches, left and right fluorescent light rheostats, and fuel gage light switch.

(13) PITOT HEAT.—A pitot mast with internal heating element is located on the leading edge of the right wing tip. The heating element is controlled by a toggle switch on the control panel in the front cockpit only, and serves to prevent ice from clogging the air-speed orifice of the pitot mast.

WARNING

The pitot heat should never be turned on when the airplane is at rest on the ground except for a momentary test, as without air circulation the heating element will be damaged from overheating.

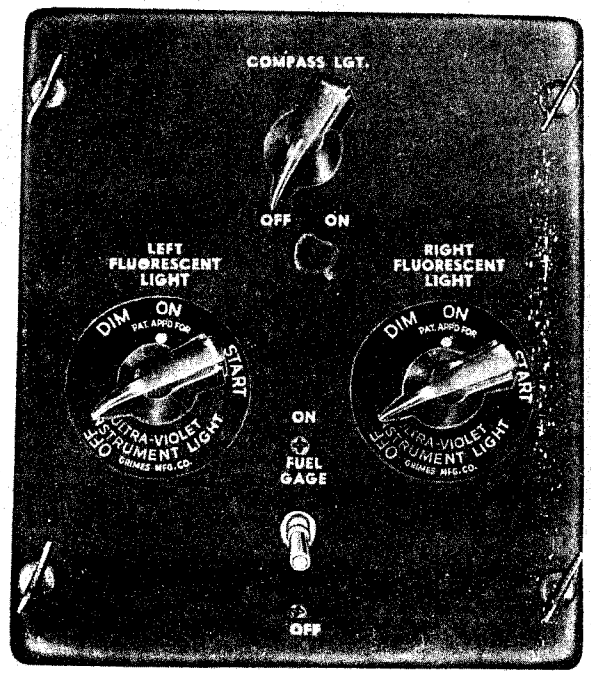


Figure 296 — Rear Cockpit Electrical Control Panel AT-6D

(14) EXTERNAL POWER RECEPTACLE.—*(See figure 297.)*—A receptacle for plugging in an outside power supply (for use when the airplane is on the ground) is located on the lower left side of the fuselage just aft of the wing trailing edge. A solenoid switch

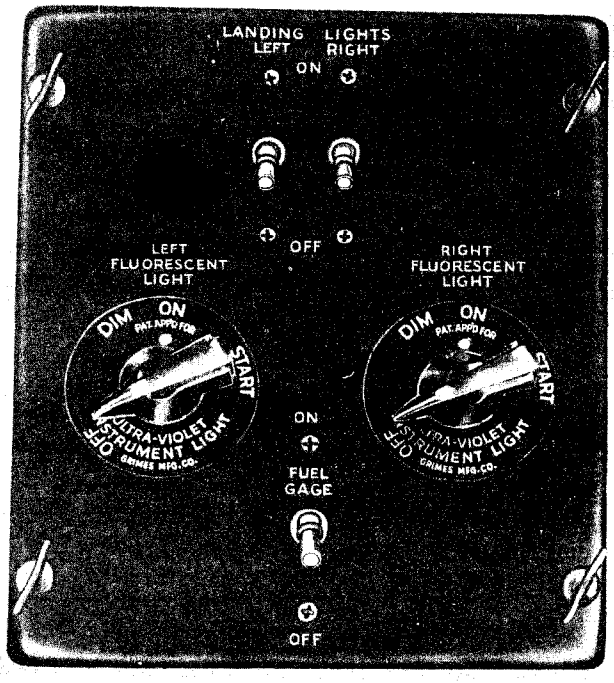


Figure 296A — Rear Cockpit Electrical Control Panel — AT-6F

mounted in the box with the external power receptacle plug will close when the outside power supply is plugged in, thus connecting the outside power supply to the airplane's common electrical system. The receptacle is accessible through a Dzus-fastened door.

NOTE

All ground starting and testing should employ an external source of power in order to conserve the airplane's battery.

(15) LANDING GEAR WARNING SYSTEM.

(a) DESCRIPTION.—The landing gear warning horn, located on the overturn structure between the cockpits, serves as a warning device to indicate unsafe landing conditions. The horn is interconnected with the landing gear "DOWN" position lockpins and the throttle control, so that when the throttle is closed for landing, the horn will sound if the landing gear is not down and the "DOWN" position lockpins in place. If the throttle should be closed during flight maneuvers, the horn will continue to sound until the throttle is opened again or the landing gear is put in the "DOWN" and "LOCKED" position.

(b) ADJUSTMENT.—To adjust this equipment, follow the procedure given for the same equipment on the 12-volt airplane, paragraph *a.*, (14).

(16) STATIC GROUND. — An external static ground wire, which provides for the discharge of static electricity accumulated and stored by the airplane, is installed approximately 1-1/2 inches aft of station 200 3/4. Some AT-6C, AT-6D, SNJ-4, and SNJ-5 (Navy) air-

planes are not equipped with this ground; instead static electricity is discharged through a specially constructed tail wheel tire.

14. FUSELAGE EQUIPMENT.

a. COCKPIT SEATS.—The front and rear cockpits contain one seat each, arranged in tandem and mounted on chrome-plated chrome-molybdenum steel tubing.

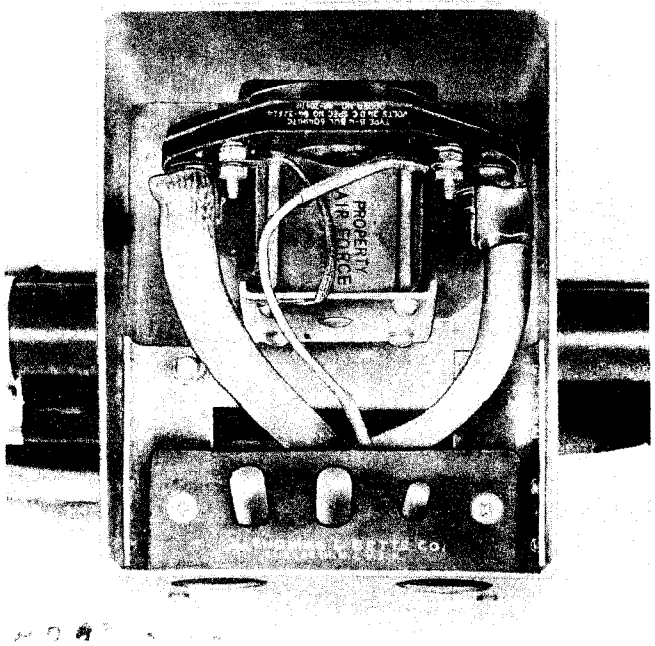


Figure 297 — External Power Receptacle

Each seat is designed to accommodate a seat-type parachute, and is equipped with a seat cushion life preserver, relief tube and a type B-11 safety belt provided with quickly detachable releases. A shoulder strap assembly is also provided, which is attached to a spring-loaded plunger at the back of each seat and passes over the shoulders of the occupant and fastens to the release on the safety belt. A spring release, which is controlled by a quadrant on the left side of each seat, is provided to permit the pilot and gunner more freedom of movement and yet be safety-strapped in. A Sutton safety harness is furnished on British airplanes in place of this shoulder strap assembly. Seats on early AT-6 series airplanes are of aluminum alloy construction. Seats on late AT-6C, SNJ-4, and early AT-6D and SNJ-5 (Navy) airplanes are of wood construction. Late AT-6D and SNJ-5 (Navy) airplanes are equipped with seats constructed of magnesium alloy. Wooden pilot's seats are provided with a safety bar assembly consisting of a horizontal steel tube member with a tubular steel sleeve welded to each end and two steel attachment clips. The safety bar is secured to the seat by means of attachment clips. The sleeves of the safety bar assembly encompass the seat support tubes, allowing vertical movement for seat adjustment. The support tubes rest in fittings attached to the wing center section and are secured at the top by aluminum alloy casting attached to the noseover structure. Added strength in the structural design of the magnesium seat obviates the need for a safety bar.

(1) FRONT COCKPIT SEAT.—*(See figure 298.)*

(a) REMOVAL.

1. Raise the seat to its uppermost position.

2. Detach the shock cords from the metal hooks at the rear lower edges of the seat.

3. Remove the three attaching screws of the urinary horn bracket.

4. On airplanes with aluminum alloy seats, remove the two bolts and nuts securing the seat support tubes to the fuselage cross members immediately behind the seat.

5. On airplanes with wood or magnesium alloy seats, remove the two aluminum alloy castings securing support tubes to noseover structure.

6. Lift the seat and support tubes as a unit out of the center section support fittings, taking care not to damage the installed cockpit equipment.

(b) INSTALLATION.

1. Pass the two seat support tubes through the two brackets on each side of the seat, and bolt the seat tube stops in place.

2. Set the lower ends of the seat support tubes in the two fittings provided on the wing center section.

3. On airplanes with aluminum alloy seats, bolt the top ends of the seat support tubes to two brackets attached to the fuselage cross member immediately behind the seat.

4. On airplanes with wood or magnesium alloy seats, secure top ends of seat support tubes to noseover structure with two aluminum alloy castings.

5. Install the shock cord assembly. This is done by attaching the two top pulleys to the fuselage cross member back of the front seat, and one pulley to the fuselage diagonal brace back of the front seat.

6. Raise the seat to its uppermost position on the support tubes. Attach the ends of the shock cord to the two metal hooks at the rear lower corners of the seat.

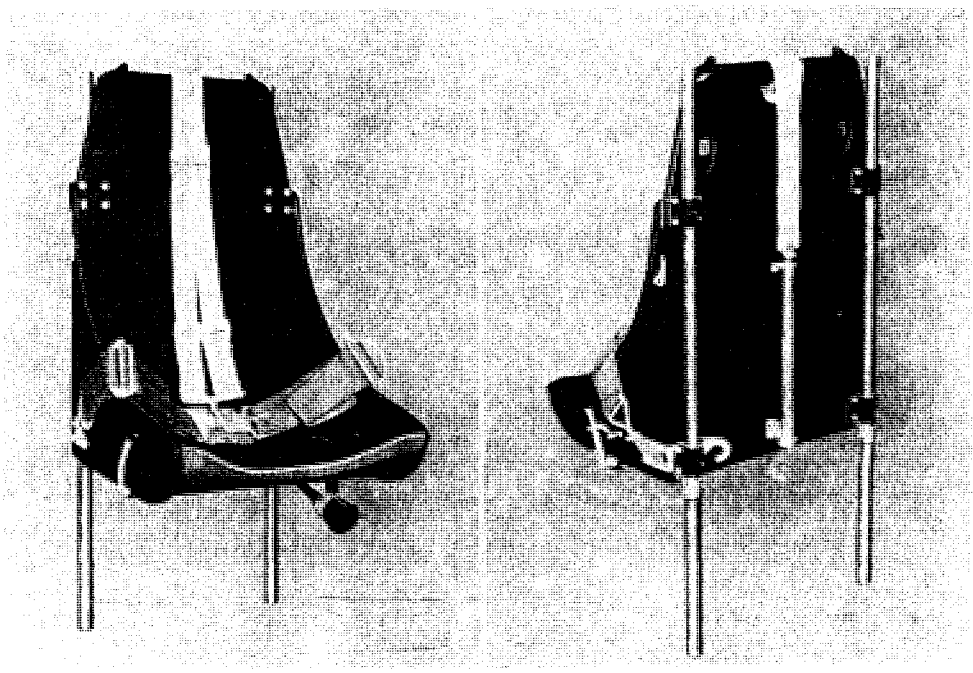


Figure 298 — Front Cockpit Seat

7. Attach the urinary horn bracket.

(2) REAR COCKPIT SEAT.—*(See figure 299.)*

(a) REMOVAL.—The rear seat may be removed by removing the large nut on the bottom of the seat support swivel housing and lifting the seat assembly clear after detaching the urinary horn bracket.

(b) INSTALLATION. — The rear cockpit seat, with its supporting base, fittings, and controls, is assembled at the factory and is usually shipped and installed as a single unit. To install, raise seat assembly and lower swivel post through swivel housing. See that bearings on swivel post are greased and properly installed. Secure with large nut, washer, and cotter on bottom end of swivel post. Attach the urinary horn bracket. The rear seat on the AT-6F is identical to and interchangeable with the front seat on AT-6D and F models.

b. BAGGAGE COMPARTMENT.—*(See figure 300.)*

(1) DESCRIPTION.—A collapsible baggage compartment with a volume of approximately 9 cubic feet of usable space is installed immediately aft of the rear cockpit. It consists of a wooden floor, which is attached to the bulkhead by a full-length hinge, and a three-sided canvas compartment wall. When the baggage compartment is in use, the floor is held down by two metal catches, one at each front corner, which attach to the two front camera rail support tubes. In earlier airplanes, aluminum alloy floors are used in the baggage compartment. The canvas compartment wall is attached to the compartment floor and to attachment plate fittings on each side of the fuselage and on the front bulkhead of the rear fuselage section. The bottom can be secured in a stowed UP position to provide space for installation of camera and radio equipment. The baggage compartment contains space for the stowage of personal baggage, engine tools, starter crank, mooring rings, and other equipment. When the rear cockpit is unoccupied. ballast can be carried in the baggage compartment. On later airplanes, a data case is mounted on the aft partition of the baggage compartment slightly below the access door openings. Access to the compartment is made through a door located on the left side of the fuselage aft of the rear cockpit. The door is equipped with a built-in flush-type lock. The keys for the lock are stowed in the front cockpit map case.

(2) REMOVAL.—The baggage compartment canvas walls and wood floor are removed as a unit. Detach the canvas part of the compartment by removing the attaching screws, first from the forward bulkhead and then from the side fuselage structure. Then remove the screws securing the full-length hinge and remove the unit from the airplane through the rear cockpit.

(3) INSTALLATION — The baggage compartment is positioned for installation from the rear cockpit. To install, first attach the wood compartment floor full-length hinge to the reinforcement angle on the forward face of bulkhead No. 2. Attach the six metal reinforced margins of the canvas side walls, three on each side, to right and left fuselage structures with screws and speed nuts. Then secure the upper forward metal reinforced margin of the front canvas wall to bulkhead No. 1 with six bolts.

c. INSTRUMENT FLYING HOOD. — *(See figure 301.)*

(1) DESCRIPTION.

(a) A quickly detachable instrument flying hood for training in blind flying may be installed in either the front or rear cockpits. The hood structure consists of three tubular aluminum-alloy bows terminating at a hinge point on a pivot arm. The bows are covered

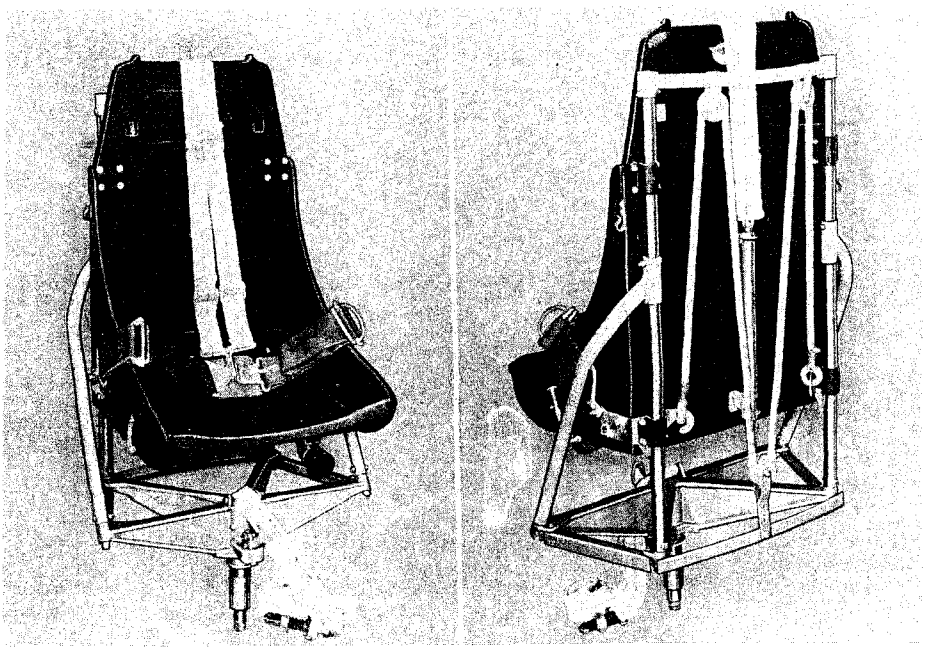


Figure 299 — Rear Cockpit Seat

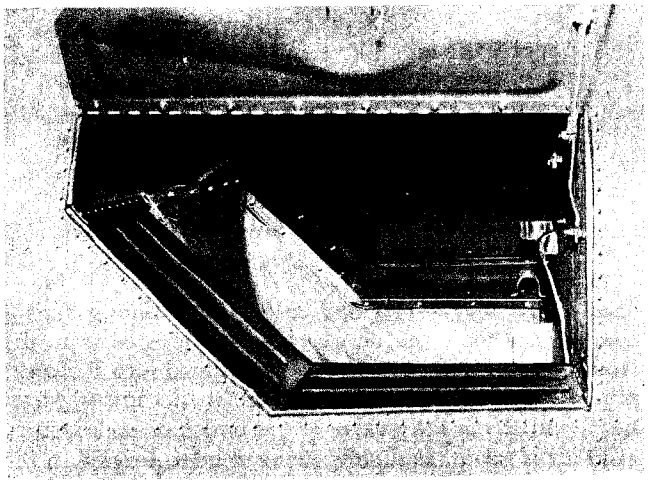


Figure 300 — Baggage Compartment

with duck to form an enclosure for the cockpit in which the hood is installed. An opening at the back of the hood provides clearance for the gum mount when the hood is installed in the rear cockpit. This opening will also provide forward vision for the rear cockpit occupant when the hood is in the stowed position in the front cockpit. The hood is secured at the back by two pieces of elastic shock cord for attaching to hooks mounted on the fuselage cross tube in the front cockpit and on the upper channel at the forward side of the baggage compartment in the rear cockpit. The hooks are located just aft of the seat in each cockpit. A spring-loaded latch assembly mounted on the instrument panel shield in each cockpit provides a means of attaching the forward bow of the hood to this shield. A strong elastic cord running from the top of the rear bow to the top of the forward bow will, when released, return the hood to its stowed position behind the seat. The hood is held in the stowed position in the front cockpit by a hold-back latch installed on the nose-over structure directly behind and above the pilot's seat.

(b) To place the hood in operating position, first make sure the seat is lowered for head clearance. Take hold of the front bow at the TOP and pull it FORWARD. When it is in the forward position, push the lock fitting on the forward hood bow into the opening at the spring-loaded latch below the edge of the instrument panel shield.

CAUTION

Make certain the latch plunger has snapped into place before releasing the hood.

(c) The hood may be released from EITHER cockpit and stowed, after first seeing that the seat is lowered for head clearance. The hood is released by pushing to the left, the lever extending from the latch assembly located below the top edge of the instrument panel shield. The hood may also be released from the adjoining cockpit by operating the control cable knob lever, located just below the trim strip at the front left side of the cockpit.

(2) INSTALLATION.

(a) FRONT COCKPIT INSTRUMENT FLYING HOOD.—To install the instrument flying hood in the front cockpit, first remove all sharp or jagged objects from the path of the hood.

1. Remove rear cockpit pivot arm assemblies if they are installed. Attach each pivot arm assembly to the hood with a grommet, screw, and a nut on the front bow, and three pins and three cotters on the center and rear bows.

NOTE

The nuts and cotters should be on the OUTBOARD side of the hood.

2. See that the rear hold-down hooks are properly installed, one at each side of the fuselage frame on the upper cross-tubes directly aft of the pilot's seat support tubes. Each hook is secured by a clamp, screw, and nut.

3. Ascertain that "hold-back" latch is properly installed on the left forward tube of the nose-over struc-

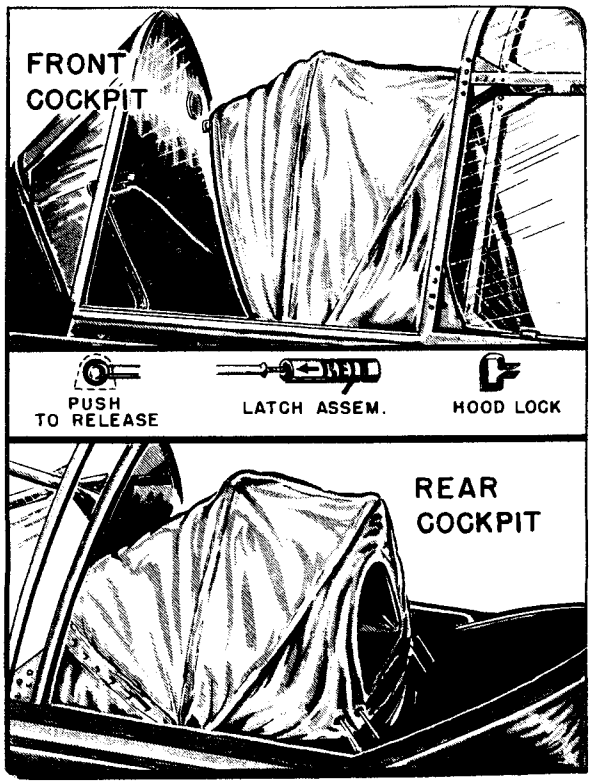


Figure 301 — Instrument Flying Hood

ture, approximately 14½ inches above the center line of the fuselage frame upper longeron.

4. Be sure the release cable assemblies are properly installed.

5. See that the pivot arm attaching bracket is properly installed so that the pivot pin center is 8 inches *below* the center line of the fuselage frame upper longeron.

6. Place the hood in position, press the lever at the bottom of the left and right pivot arms, and install the arms on pivot pins located on the fuselage diagonal tubes at the sides of the cockpit. Make sure the hood is securely engaged in place; release the lever.

7. Fasten the two elastic shock cords at the lower aft edge of the hood to the hold-down hooks on the fuselage tube located directly aft of the seat.

8. Operate the hood as outlined above. Check for proper operation, and then engage the "hold-back" latch when the hood is stowed.

(b) REAR COCKPIT INSTRUMENT FLYING HOOD.—Place flexible gun in its stowed position before installing hood. To install the rear hood, proceed as follows:

1. Remove the front cockpit pivot arm assemblies if installed. Attach pivot arm assemblies to the hood with the same attaching parts used for attaching the front cockpit pivot arms to the hood.

2. Ascertain that the rear hood hold-down hooks are properly installed on the forward side of the baggage compartment, one at each end of the forward upper channel, by screws and nuts.

3. Make sure the release cable assemblies are properly installed.

4. See that the pivot arm support bracket is properly installed on the fuselage upper longeron.

5. Attach the curtain assemblies to the forward side of the hood.

6. Place the hood in position, pull out on the locking pins in the support brackets, install pivot pins in the support brackets, and engage the locking pins in pivot pins.

7. Fasten the two elastic shock cords at the lower aft edge of the hood to the hold-down hooks on the baggage compartment channel.

8. Operate the hood as outlined above; then place it in the stowed position.

NOTE

(AT-6 Airplanes.)—When blind flying hood is in use in rear cockpit and radio control of radio compass unit is required, radio compass control box H4043235 may be installed in rear cockpit by relocating compass control box and supports in rear cockpit and connecting control box to terminals provided on panel in marker beacon junction box, as per chart in junction box cover or radio wiring diagram 59-71002. The above installation will also require a change in length of tuning shaft, type MC-124, to connect control box to receiver, when compass control box is installed in rear cockpit.

d. HEATING AND VENTILATING SYSTEM.—*(See figure 302.)*—Hot and cold air ventilating system controls are provided between the rudder pedals in the front cockpit. Hot or cold air is regulated into the cockpits as required by operating a notched control wheel fitted with a butterfly valve at the outlet of each system. Cold air is taken through a screened inlet, located in the leading edge of the wing center section at the left of the fuselage, and passes through flexible tubes and fittings that are attached to the inside structure of the wing center section, to the cold air butterfly valve in the front cockpit. The heating system consists of a two-section steel heater which completely envelopes the exhaust pipe of No. 1 and No. 9 cylinders, two insulated flexible tubes, a fitting which connects the tubes at the fire wall and the hot air butterfly valve. The air is heated by the exhaust manifold. At the left end of the heater unit is a connection and an air passage vent between the top and bottom section of the heater unit. A pipe, with an opening between the No. 1 and No. 2 cylinders, admits air to the right end of the lower heater unit section. The air passes over baffles in the lower section, through the opening to the top section of the heater unit, then over baffles in the top section, through the flexible tube to the hot air butterfly valves located in the cockpit at the right of the cold air butterfly valve. A ventilator door is located at the left rear side of the rear cockpit, and the amount of air flow is governed by moving a control handle to the desired position between the full "OPEN" and "CLOSED" position. In addition to the ventilator controls, further ventilation may be obtained by opening the sliding sections of the cockpit enclosure to any one of the intermediate positions.

e. COCKPIT COVER.—A cockpit cover designed to overspread the entire cockpit is provided for each British airplane. It is of 10-ounce waterproof army duck tapered to shape and provided with four tie-down cords on each side. It is stowed in the baggage compartment when not in use.

f. MIRROR.—An adjustable, rear-vision mirror is located at the right side of the windshield in the front cockpit.

g. ARMREST.—A pilot's armrest is provided on the left side of the front cockpit.

h. MAP AND DATA CASE. A map and data case is installed at the right side of the front cockpit below the radio shelf and is fitted with a spring-loaded door to exclude dust. A small handle is attached to the aft end of the door. The case, accommodating articles

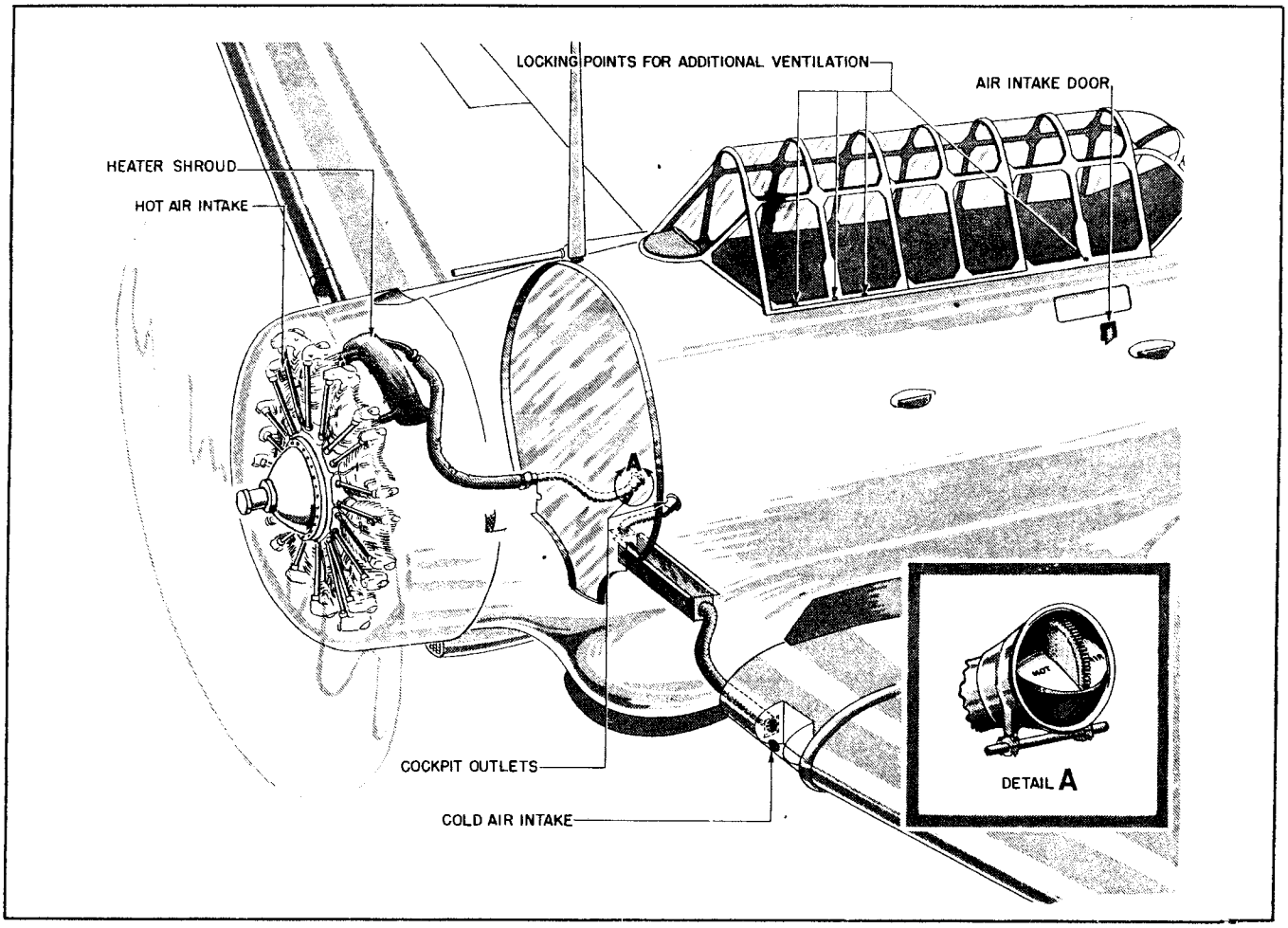


Figure 302 — Heating and Ventilating System

10 x 11 inches, provides for the stowage of maps, the airplane electrical wiring diagram, technical information and instructions pertinent to the radio equipment. The case is constructed of aluminum-alloy or plastic bonded plywood. A plastic bonded plywood data case is also provided in the baggage compartment on later airplanes.

i. FLIGHT REPORT CASE.—A flight report case is installed at the left side of the pilot's seat in the front cockpit. It incorporates a sliding guard plate for securing stowed reports, the over-all dimensions of which may be 8 x 11 inches. It is of the same construction as the map and data case.

j. REAR COCKPIT MAP CASE. — A map case is located at the left side of the rear cockpit and is provided with a detachable strap for securing maps, charts or other material. It will accommodate articles the over-all dimensions of which may be 10 x 11 inches. Like the preceding cases, it is constructed of aluminum-alloy or plastic bonded plywood.

k. FIRE EXTINGUISHER.—*(See figure 303.)*—A hand-operated carbon tetrachloride fire extinguisher is mounted on the back of a door located on the left side of the rear cockpit. It is accessible from inside or outside the airplane.

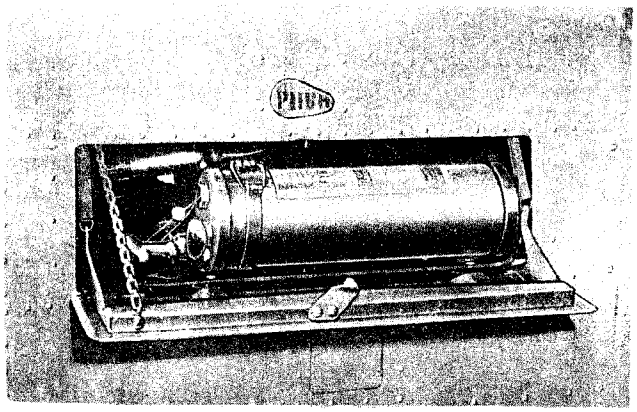


Figure 303 — Fire Extinguisher

l. URINARY EQUIPMENT. — Urinary equipment consisting of a horn, gum rubber tubing, and a stowage bracket, is provided under each seat. The rubber tubing leads from each horn to a T-fitting located below the rear seat at the bottom of the fuselage frame. From the fitting a tube terminates at a venturi mounted on the lower left side of the semi-monocoque section at the forward end.

m. PYROTECHNIC EQUIPMENT.—(Earlier AT-6 only).

(1) DESCRIPTION.—Two type A-4 flare racks are installed in the fuselage, just aft of the baggage compartment, to accommodate two type M-8 parachute flares. Two doors through which the flares are dropped are built into the bottom of the fuselage semi-monocoque rear section. These doors are individually controlled through a system of cables and pulleys by type A-3 release handles located on the right-hand side of the front cockpit near the pilot's seat. Dzus-fastened removable cowling is provided above the rack installation, so that the flares may be lowered by hand into rack chutes and hangwire swivel loops adjusted in the arming mechanism. A pyrotechnic pistol, type M-2, is stowed in a socket placed on the right-hand side of the fuselage semi-monocoque structure in the rear cockpit. Five type M-10 white star, five type M-11 red star pyrotechnic signals, and two type M-9 parachute flares are carried in racks located on the right side in the rear cockpit.

(2) INSTALLATION.

(a) TYPE A-4 FLARE RACK. — Insert racks through access door located above the fuselage semi-monocoque rear section. Screw flare racks to the bottom of fuselage structure. Attach cables to release levers on flare racks with the required pins and cotter keys. Bolt the upper support brace to fuselage bulkhead. The two halves of this brace must be bolted together.

(b) FLARE RELEASE MECHANISM.—Install the metal conduits, with the release cables inside, on the right side of the fuselage directly above the lower longeron, attaching with AC755 clips as required. Make very shallow bends in metal conduit, and only when necessary. Attach release cables to flare rack doors, and pass them around corresponding pulleys and brackets. Install the forward release pulley bracket assembly at the right side of the front cockpit seat. With two B1084-24 U-bolts, attach bracket to the vertical fuselage tube in a position that will permit the occupant of the seat to reach the release handles easily. Attach the release cables to the corresponding handles.

15. OXYGEN SYSTEMS

NOTE

All AT-6 and SNJ (Navy) series airplanes prior to serial No. 42-84202 employ a high-pressure type oxygen system. Serial No. 42-84202 and subsequent airplanes incorporate a demand-type oxygen system.

a. HIGH-PRESSURE TYPE SYSTEM.

(1) GENERAL.

(a) DESCRIPTION. — *(See figures 304 and 305.)*—The high-pressure type oxygen system as installed on airplanes of the earlier series incorporates a

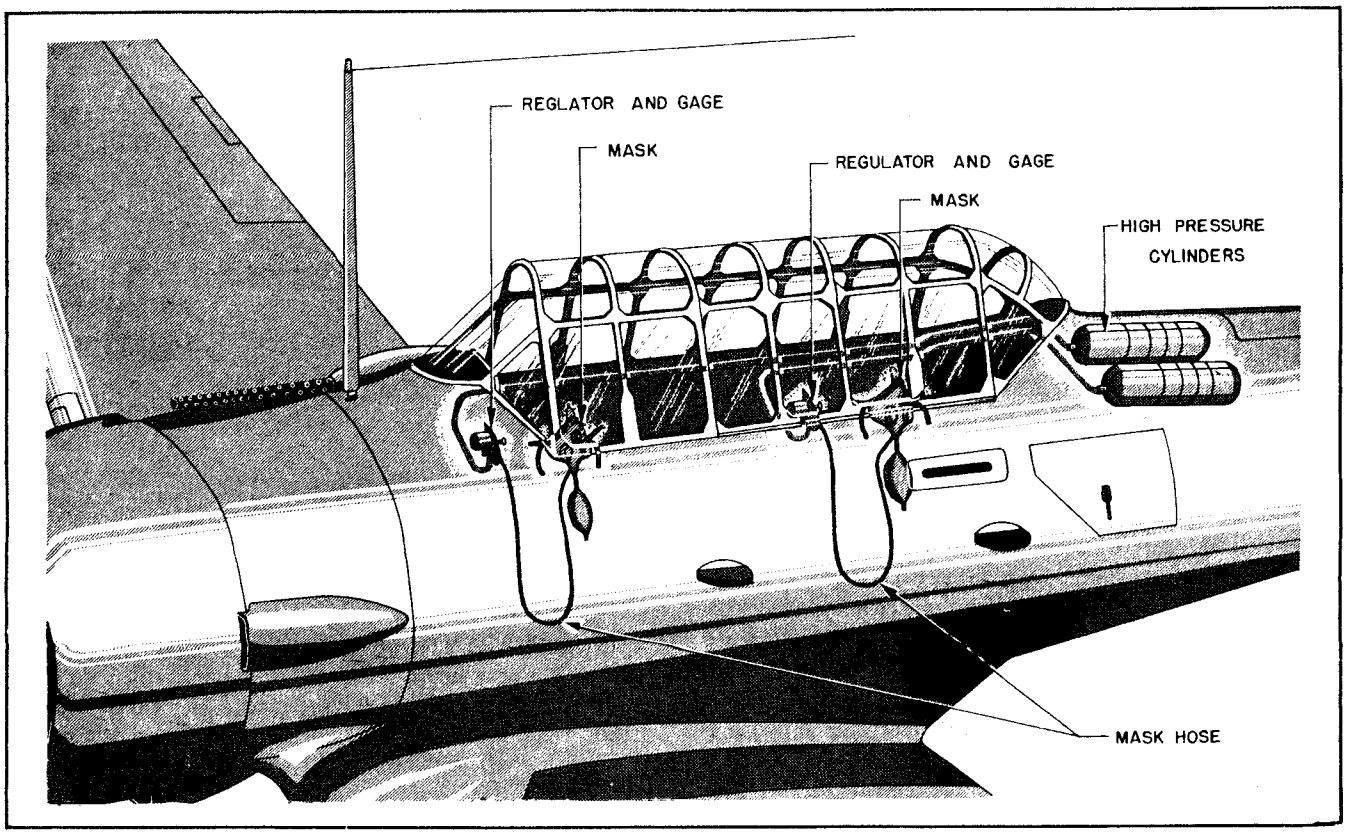


Figure 304 — Oxygen System — High Pressure Type

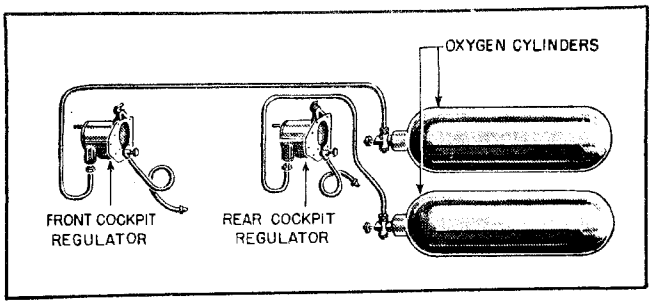


Figure 305 — Oxygen System Diagram — High Pressure Type

regulator, pressure gage, and flow indicator in each cockpit. Oxygen is supplied by two high-pressure cylinders located just aft of the gunner's deck, through check valves and into lines extending along the right side of the fuselage to the regulator assemblies.

(b) REMOVAL.—Be sure to release all of the oxygen from the system before disassembling any part of the system. This may be accomplished by opening the regulators. Line fittings at the cylinders are sealed with a compound which forms a permanent seal. Care must be taken when disassembling the lines to prevent them from twisting and breaking. Be careful not to dent the oxygen cylinders, as damage of this nature weakens them structurally.

(c) TESTING.

1. CHECKING FOR LEAKS. — In checking the oxygen system for possible leaks, every precaution must be taken to prevent oil and any foreign matter from getting into the system, as oils and greases explode spontaneously in the presence of oxygen under pressure. The oxygen equipment should be tested for operational characteristics and leaks before installation. This test will expedite installation by eliminating leaks in connections that are inaccessible after installation. Soap solution is recommended in checking the system in accordance with the following procedure:

a. In testing for leaks with soap solution, use only castile soap. Wipe connections dry after testing. Some soaps contain ingredients that will explode in the presence of oxygen under pressure. Some of the soap may get into the system during replacement of fittings. The use of castile soap will remove this danger.

b. During the replacement of defective fittings, care must be taken to prevent moisture from entering any of the open lines. Moisture freezes at high altitudes, clogging valves and stopping the flow of oxygen.

c. The apparatus used to charge the system should incorporate a pressure regulator, a pressure relief valve, and an oxygen purifier.

d. The airplane should be moved out-of-doors and cleared of all personnel while the system is being charged.

e. After charging, the pressure gages should read within 25 pounds of the correct pressure.

f. No visible leaks should be present when the system is fully charged.

g. When the system is completely charged, leakage from the mask connection fitting should be less than necessary to burst a soap bubble in 10 seconds.

2. PRESSURE TEST.—Procedure for sustained pressure testing of the system is outlined below:

a. Charge the system to 1800 pounds per square inch, and relieve the pressure in the filler line to seat check valves.

b. Wait 1 hour for the oxygen to cool to air temperature.

NOTE

When cylinders are charged to maximum permissible capacity, they become warm. As the gas cools, the pressure will drop.

c. Measure the air temperature inside the airplane in the vicinity of the cylinders; read the pressure on all gages. Record this data together with the date and the time of day.

d. At the conclusion of the test, remeasure the temperature and pressure. Record as before.

NOTE

The sustained pressure test is only continued for 24 hours and when there is a perceptible pressure drop at the end of 6 hours, and when the rate of pressure loss indicates that not more than 15 pounds per square inch will be lost in 24 hours. Otherwise, the system is rechecked for leaks and the tests repeated.

(d) INSTALLATION.

1. GENERAL.—When the oxygen system is installed, care should be exercised in handling. Because of the highly explosive nature of pressurized oxygen when in contact with oil or grease of any kind, every precaution should be taken to avoid accidents. When installing oxygen lines, make sure that the lines are securely clamped to prevent chafing and vibration. At points where chafing is likely to occur, wrap the line with three turns of friction tape and coat with clear shellac. To prevent thread seizure, use anti-seize compound, Specification No. AN-C-86.

2. LINES. — Before installing any of the oxygen system lines, ascertain that they are properly cleaned. Clean and install lines as outlined below:

a. Clean the lines in Bright Dip (Specification No. 98-20007, or approved equivalent).

b. Rinse in clean running water.

c. Dry with air pressure.

d. Apply lacquer.

e. Test the lines by forcing a dilute solution of sodium chromate through them. The sodium chromate acts as a flushing agent.

f. Dry the lines with air pressure. Be sure there is no oil in the air pressure system.

g. Cap the ends of the lines with scotch tape. Do not use friction tape.

h. Place the lines in the airplane, taking care not to bend them as this will cause difficulty in installing the lines in their proper location.

i. Connect lines and fittings to their respective cylinders and panel assemblies. Connect wiring.

(2) CYLINDERS.

(a) DESCRIPTION. — Two high-pressure type B-1 metal cylinders, each containing 4½-hours supply of oxygen for an altitude of 30,000 feet, are located just aft of the gunner's deck. These cylinders are installed parallel with the center line of the fuselage, the right cylinder furnishing oxygen for the front cockpit, and the other cylinder furnishing oxygen for the rear cockpit. Oxygen is released from the cylinders through check valves and into lines extending along the right side of the fuselage to the regulator assemblies.

(b) REMOVAL. — To remove the two high pressure cylinders, the following procedure is recommended:

1. Release oxygen from system.

2. Remove line fittings from the cylinders.

3. Remove yokes at forward ends of cylinders. Remove cylinders from cradles.

(c) INSTALLATION.—Since dents in cylinders tend to weaken them structurally, care must be exercised in handling the high-pressure type cylinders.

1. Place cylinders in cradles aft of the gunner's deck, with valve ends forward.

2. Place yokes at forward ends of cylinders. Secure.

(3) REGULATOR ASSEMBLIES.

(a) DESCRIPTION.—*(See figure 306.)*—Regulators of the type A-8 series, intended for use with masks of the A-8 series only, have been developed for use in high-altitude flying and deliver the proper mixture of air and oxygen. The regulator contains two separate scales; cylinder pressure is shown on the lower scale and flow of metered oxygen on the upper. Since the flow scale is calibrated in altitude feet, the flow is automatically regulated to supply the required quantity of oxygen at that altitude. The instrument is divided into a back chamber and a front gage compartment. Oxygen enters the back chamber from the supply cylinder through a regulating valve. This valve, operated by a spring-restrained diaphragm through a toggle link mechanism, automatically maintains a constant reduced pressure in this chamber. A small force on the diaphragm, caused by a slight variation of pressure, exerts a greater force on the valve seat, thereby insuring positive pressure control. From the back chamber, the oxygen flows through a needle valve, controlled by a knob on the front of the instrument and meters through a calibrated orifice to the mask. The flow indicator, a Bourdon tube gage, indicates the pressure differential across the calibrated orifice and is calibrated to indicate the flow corresponding to this pressure differential. Proper oxygen flow for any altitude is obtained when the pointer is set at the corresponding graduation by opening or closing the needle valve. The cylinder pressure gage, also a Bourdon tube type, is connected directly to the line from the oxygen cylinder. A fine wire mesh filter is provided in the supply connection fitting to prevent dirt from entering the unit. Large tubes and orifices permit easy flow of oxygen, eliminating the possibility of plugging by foreign materials. A relief valve on the rear cover of the case prevents over-pressure in the rear chamber and damage to the mechanism, should the regulating valve be held open temporarily.

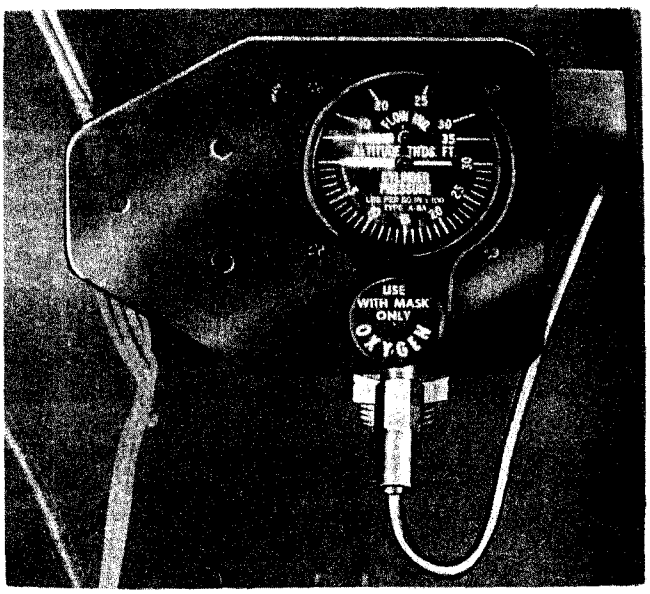


Figure 306 — High Pressure Gage, Regulator and Flow Indicator

The pressure in the back chamber is automatically controlled and has complete temperature compensation. In the capillary tube to the gage units, the pressure is static. Should a leak in the gage occur, the small bore tubing would retard the flow through the leak and prevent building up of pressure in the vented gage compartment. The gages are removable as a unit. The cover which seals the back chamber is held in place by six screws.

(b) REMOVAL.—To remove the high pressure regulator assemblies, disconnect oxygen line from units; remove four mounting bolts on each panel.

(c) MAINTENANCE REPAIRS.—The following steps should be taken to clean and paint regulators.

1. Polish all brass fittings, adapter, and nipple on an electric buffer or with fine steel wool.

2. Clean the entire instrument with benzine.

3. With masking tape, mask off the name plate and number on the back plate. Mask off the knob, the nipple, and adapter.

4. Spray the entire instrument with dull air-drying black lacquer.

5. If any changes have been made in the insert and valve assembly, the case should be clearly marked with a red "V." Red lacquer is suitable for this job. Make the "V" in an approximate half-inch square.

(d) INSTALLATION. — To install the high-pressure regulator assemblies, place each assembly in its respective panel and secure with four mounting bolts.

(4) OXYGEN MASKS.—Provisions are made for the use of types A-8, A-8A, and A-8B oxygen masks, later airplanes using the later series masks. Detailed description of the three types of masks follows:

(a) TYPE A-8 MASK. The type A-8 mask is an oronasal-type (fits over both nose and mouth) which permits rebreathing part of the oxygen expelled from the lungs and respiratory passages. This mask consists of a rubber-molded nasal cover with a rigid case of phenolic compound supporting the mask, and a turret-like protrusion containing a sponge rubber disc. At the base of the mask is a connector sleeve of phenolic compound to which is attached a flexible rubber rebreather bag provided with an oxygen intake tube. The end of the intake tube is equipped with a bayonet fitting which permits the mask to be readily attached to the

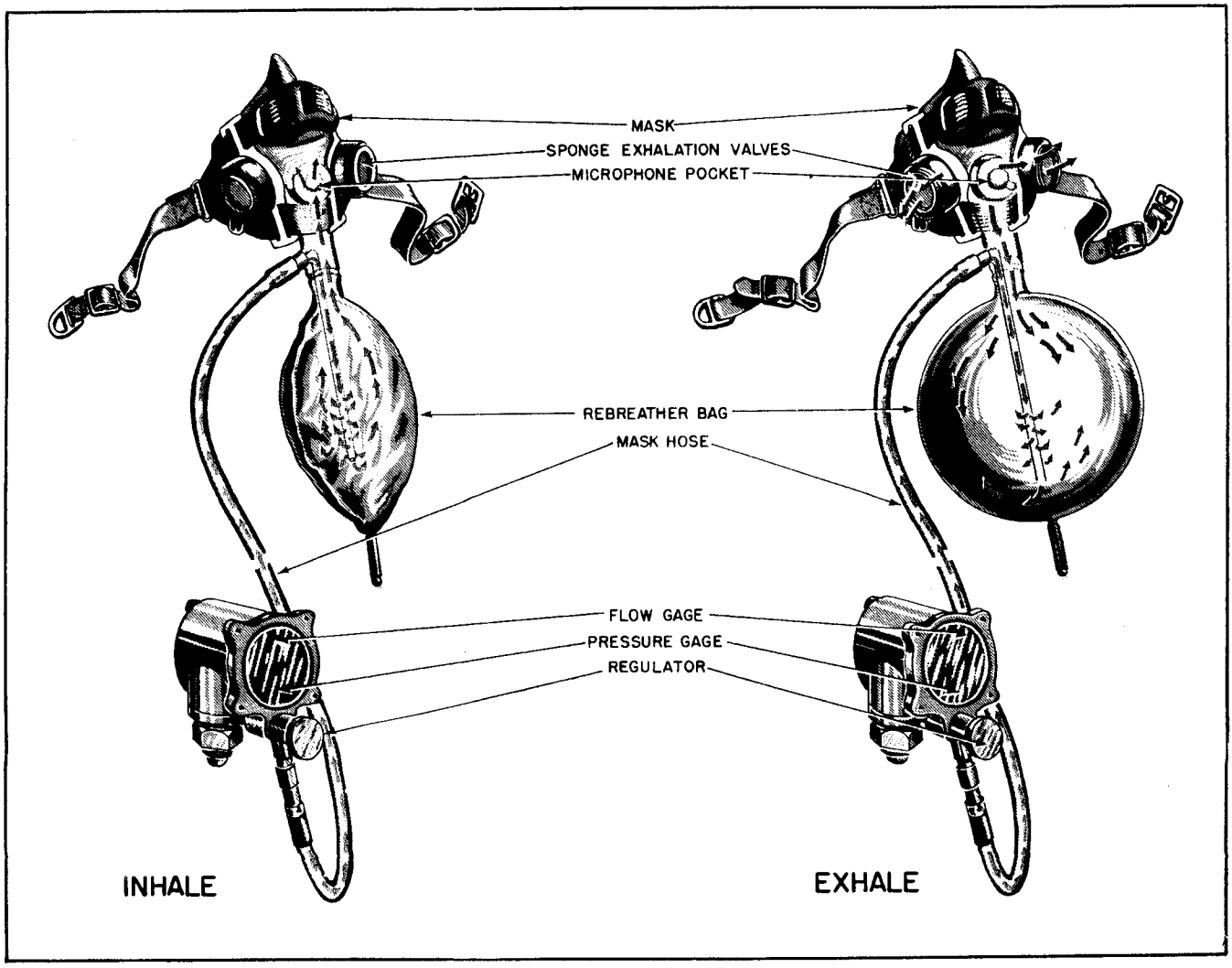


Figure 307 — High Pressure Oxygen Flow Diagram

oxygen outlet. Upon exhalation, the first part of the expelled air passes into the bag; as soon as the bag becomes distended, the remaining gases pass out through the sponge rubber disc. Upon inhalation, first the gases are taken from the bag; when the bag is depleted, an additional amount of air is drawn in from the atmosphere through the sponge rubber disc. Increasing the flow of oxygen at higher altitudes permits the flyer to breathe a richer mixture of oxygen and lesser amounts of atmospheric air. In this mask there are no portholes to manipulate, and there is no danger of anoxia in the event the flyer breathes through his mouth. The valve, which is the sponge rubber disc, will not freeze up in low temperatures.

(b) TYPE A-8A MASK.—The type A-8A mask, for the most part, is identical with the type A-8. The inlet tube which formerly was suspended from the rubber bag is connected to the phenolic connector piece, thereby relieving excessive wear on the rubber bag.

(c) TYPE A-8B MASK.—*(See figure 308.)*— This mask is essentially the same as type A-8 and A-8A. The principal differences are in the means of suspension, the incorporation of a microphone pocket and two sponge rubber disc turrets. The A-8B mask is provided with leather and elastic straps and buckle tabs for helmet suspension. An adapter is available for use of the mask without the helmet. The microphone is installed in the central pocket. The two sponge rubber discs installed in the two turrets reduce breathing resistance and lessen the chance of freezing.

Figure 308 — High Pressure Mask

b. DEMAND TYPE SYSTEM.

(1) GENERAL.

(a) DESCRIPTION.—*(See figure 309.)* — The demand-type oxygen system consists of four type D-2, low-pressure, shatter-proof oxygen cylinders mounted laterally in a vertical series in the forward portion of the rear fuselage, manifolded together and filled through a single filler valve, located in the top of the baggage compartment. Cylinders have a working pressure of from 400 pounds per square inch to a minimum of 50 pounds per square inch. A type A-12 oxygen regulator, a pressure gage, and a flow indicator are installed in each cockpit. A demand-type mask, properly fitted to the face of the user, must be used with this system.

(b) REMOVAL. — If extensive work is to be done on the system, it is advisable to release all pressure from the system before attempting to remove any of its component parts. Release pressure in the following manner:

1. Turn handle on filler valve to left and remove plug.

2. Depress valve core by inserting a screw driver into the valve.

3. Fully open the emergency supply valve in each regulator.

(c) MAINTENANCE.—Keep lines plugged at all times when they are not connected, using either metal or plastic shipping plugs and caps; do not use masking tape.

1. Tubing should be cut square and burred before flaring. After burring, but before flaring, remove all metal chips, grit, and oil from the lines by washing several times with carbon tetrachloride. After washing the tubing, blow dry with oxygen, wash with Isopropyl alcohol, and again blow dry with oxygen.

2. All flaring of oxygen tubing should be performed with tools in good working order. Give special attention to keeping the flaring cone smooth. Do not use steel wool to polish the tube flare at any time while flaring. After flaring, reclean the lines in carbon tetrachloride, blow out with oxygen, wash in Isopropyl alcohol, and then again blow out with oxygen.

(d) TESTING.

1. CHECKING FOR LEAKS. — Refer to section IV, paragraph 15, *a,* (1), *(c), 1.*

2. PRESSURE TEST. — The demand oxygen pressure test should be conducted in the following manner:

a. Check to ascertain that both oxygen regulators are turned "OFF."

b. Charge the system to 425 pounds per square inch. (For filling instructions, refer to section IV, paragraph 15, *b, (1), (e),* 2.)

c. Wait one hour for oxygen to cool.

d. Bleed a small amount of oxygen through each regulator.

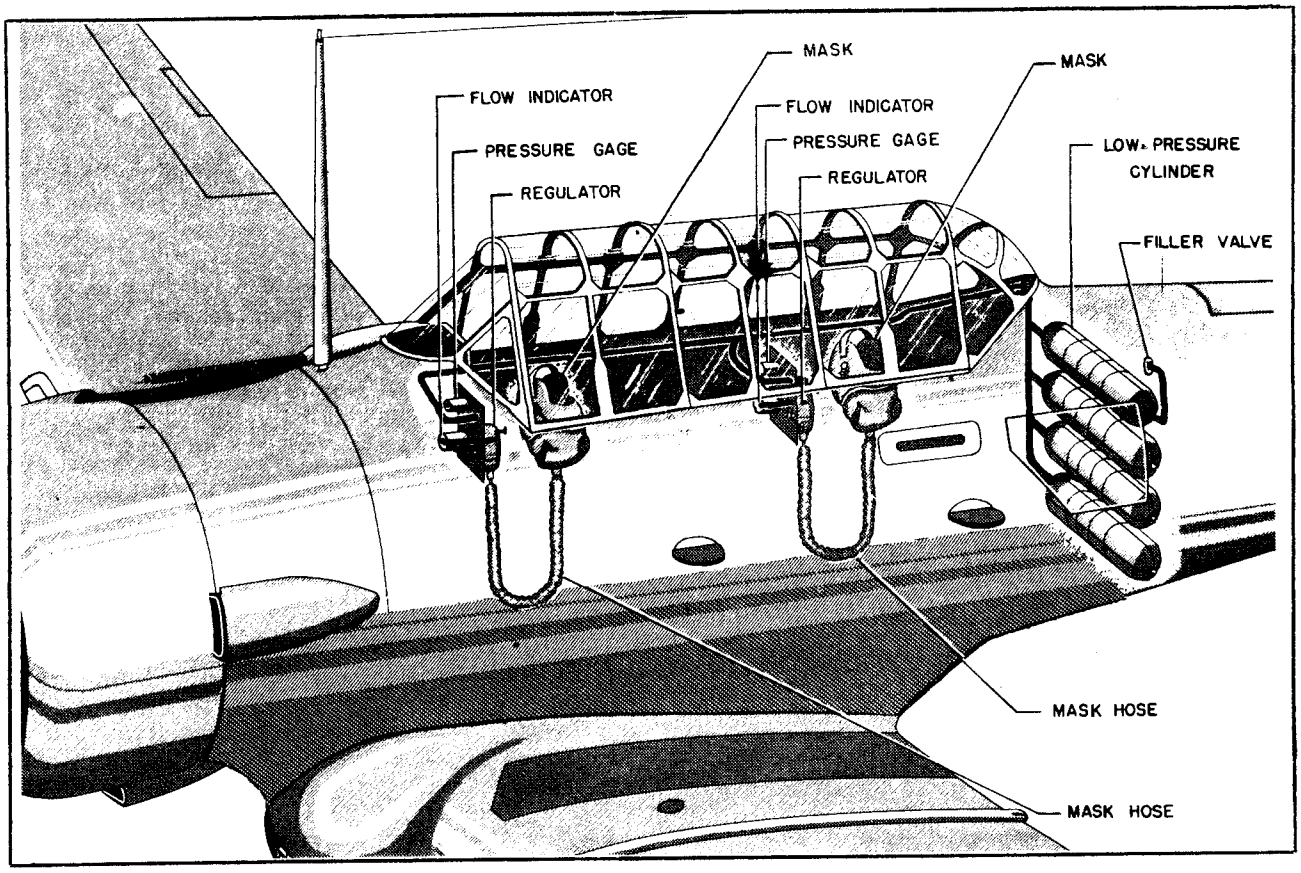


Figure 309 — Oxygen System — Demand Type

e. Record pressure readings, temperature in the airplane, date, and time of day. The pressure should have dropped to approximately 400 pounds per square inch.

f. After waiting 6 hours, remeasure the temperature and pressure; record as before.

g. In a 24-hour period the pressure drop should not exceed 15 pounds per square inch.

(e) INSTALLATION.

1. TUBING AND FITTINGS. — No substance other than an approved sealing compound will be used for sealing pipe threads at connections. An approved sealing compound is Specification AN-C-86.

CAUTION

Do not use red lead oxide (Pb_3O_4) or red lead oxide mixed with linseed oil as a sealing compound.

a. When making pipe connections with AN-C-86, apply the compound sparingly to the male threads. The compound is both a lubricant and a sealer. No drying time need be allowed. Application of excessive amounts of compound endangers the functioning of the system by introducing the compound into the lines.

b. Screw the fitting in by hand, counting the number of complete revolutions that can be made before tightening. If two and one-half turns cannot be made before the fitting tightens, the thread fit is improper and the connection will probably leak. Remove the fitting and inspect the threads for conformance with Specification AN-GGG-P-363. Do not use fittings with defective threads.

c. After screwing in fitting to hand tightness, tighten with a wrench. Two additional turns should tighten the fitting adequately.

2. FILLING OXYGEN SYSTEM.—Prior to filling the oxygen system, make sure all equipment used and mechanic's clothing are free from oil or grease. Keep the supply cylinders well back from the airplane so that, in the event of an explosion, the mechanic will be in a safer position. To fill the system:

a. Turn the filler lock handle to the left and remove the plug in the filler valve.

b. Insert fitting on end of the supply hose in the filler valve opening and turn the lock handle to

the right. Check this connection for tightness by pulling on the hose.

c. Check to make sure that each oxygen regulator in the airplane is turned "OFF."

d. Open the valve on the supply cylinder and allow oxygen to flow until pressure gage reads 425 pounds per square inch. The valve must be closed for an accurate pressure reading.

e. Bleed a small amount of oxygen through each regulator.

f. Recheck pressure in the system by using gage at the two crew stations. The pressure should have dropped to approximately 400 pounds per square inch.

g. If the pressure has dropped below this figure, add additional oxygen to the system. The procedure of bleeding oxygen through each regulator outlet not only serves as a check on the function of the regulator, but also bleeds all dead air from the lines and brings oxygen up to the regulator valve, ready for use in flight.

h. Disconnect supply cylinder and insert filler valve plug.

i. Test system for leaks.

WARNING

Keep oil away from recharging nipple!

(2) CYLINDERS.

(a) DESCRIPTION. — Type D-2 low pressure oxygen cylinders are made of stainless steel and contain welded spuds in both ends, tapped with 1/4 inch pipe threads. The cylinders are reinforced by steel bands that render them non-shatterable.

(b) REMOVAL.—Cylinders should never be removed unless damaged or contaminated. Removal is accomplished by disconnecting the lines at the tube fittings and removing the cylinders from their holdings brackets. Do not drop or otherwise dent the cylinders, as a dent may cause them to lose strength. Line fittings at the cylinders are sealed with a compound which forms a permanent seal. Care must be taken when disconnecting the lines to prevent them from twisting and breaking. If the fittings in the cylinder spuds can be removed easily, they should be reused if not damaged or contaminated.

(c) MAINTENANCE.—There is little maintenance possible on the cylinders other than keeping them clean and dry inside and out.

1. If a cylinder needs to be cleaned, tumble it with shot; then wash with carbon tetrachloride and allow it to dry thoroughly.

2. Rewash with Isopropyl alcohol, AAF Specification 14082-A.

3. Be sure all the alcohol has been evaporated by blowing out thoroughly with oxygen. *Do not* use compressed air or any other gas, as it may be contaminated with oil and moisture. The alcohol must be completely removed; otherwise there is a danger of explosion when the cylinder is filled with oxygen under pressure.

4. Examine exterior of cylinder for chipped, scored, or corroded areas. If necessary plug outlets and remove old paint with paint remover and spray with a coat of primer, zinc chromate, Specification AN-TT-P-656.

5. Examine all threads and chase them dry (without lubricant) if they are not clean.

(3) DEMAND OXYGEN REGULATORS, TYPE A-12.

(a) DESCRIPTION. — *(See figures 310, 311, 312.)* — Type A-12 demand oxygen regulator automatically mixes varying quantities of air and oxygen, the ratio depending on the altitude, and delivers the quantity demanded upon inhalation. This regulator consists of the following:

1. A manually operated shut-off for the air valve is provided to permit a complete air shut-off, allowing the regulator to deliver pure oxygen. This valve is operated by the lever on the side of the case, and is marked "AUTO-MIX."

2. A bypass manually operated emergency valve on the oxygen intake permits a steady flow of oxygen when desired. When the emergency valve knob is turned counterclockwise, a stream of oxygen is allowed to bypass the entire regulator mechanism and enter the outlet port.

3. A pressure reducer controls the pressure in the regulator to about 40 to 60 pounds per square inch so that the action of the demand valve is substantially unaffected by changes of oxygen supply tank pressure.

4. An aneroid bellows in the air valve provides an automatic progressive shut-off for air intake at high altitudes where pure oxygen is required to sustain life. A check valve on the air inlet prevents the escape of oxygen when exhaling. It also resists any flow of air until a definite suction is built up so that the air-oxygen mixture will not be too "lean" for small flows.

(b) REMOVAL AND DISASSEMBLY.

1. REMOVAL.—The demand oxygen regulator can be removed by disconnecting the line at the union on the regulator and removing three mounting screws from the base.

2. DISASSEMBLY. — Disassembly or adjustments should not be attempted by anyone other than authorized personnel.

a. Regulators are first disassembled into their ten subassemblies:

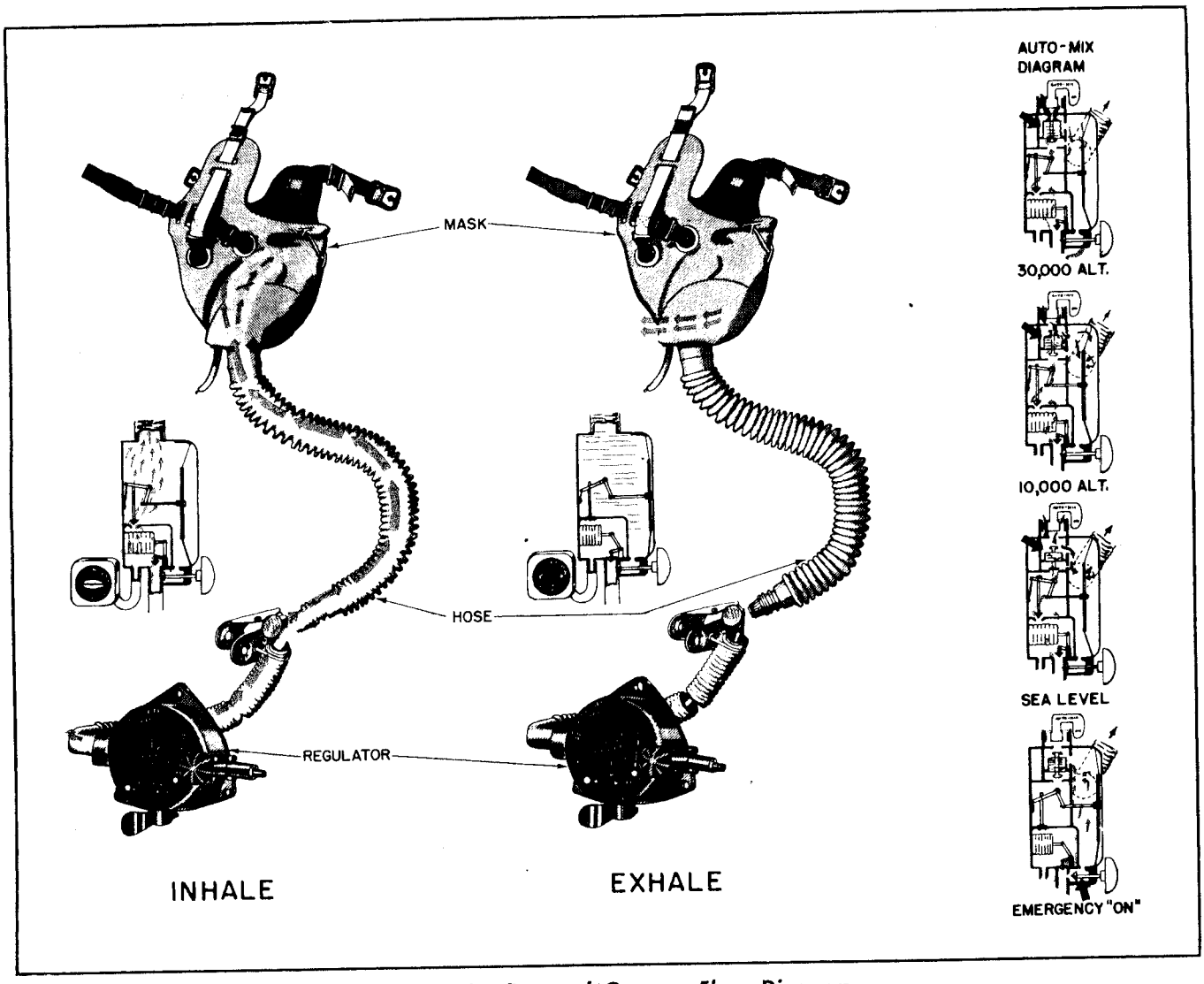


Figure 310 — Demand Oxygen Flow Diagram

(1) Emergency valve and adapter assembly.

(2) Elbow assembly.

(3) Injector assembly.

(4) Air valve lever assembly.

(5) Air valve, aneroid and throttling plate, and check valve assemblies.

(6) Diaphragm assembly.

(7) Diaphragm lever and bracket assemblies.

(8) Relief valve assembly.

(9) Bottom plate and demand valve.

(10) Pressure reducer assembly.

b. When disassembling the subassemblies, observe the following precautions.

(1) When removing the emergency valve knob, avoid damaging the knurls.

(2) When removing the emergency valve and adapter assembly from the case, avoid damaging or distorting the two dowel pins pressed into the case.

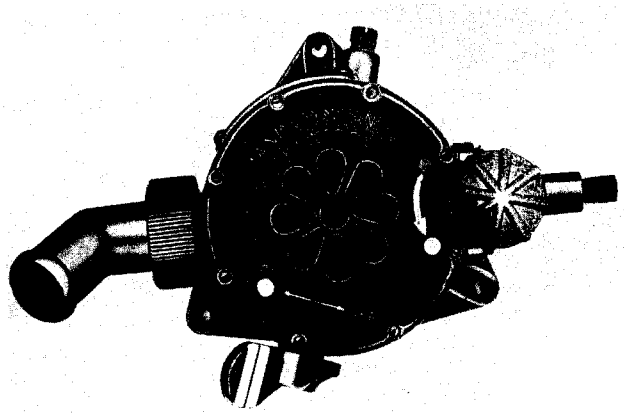
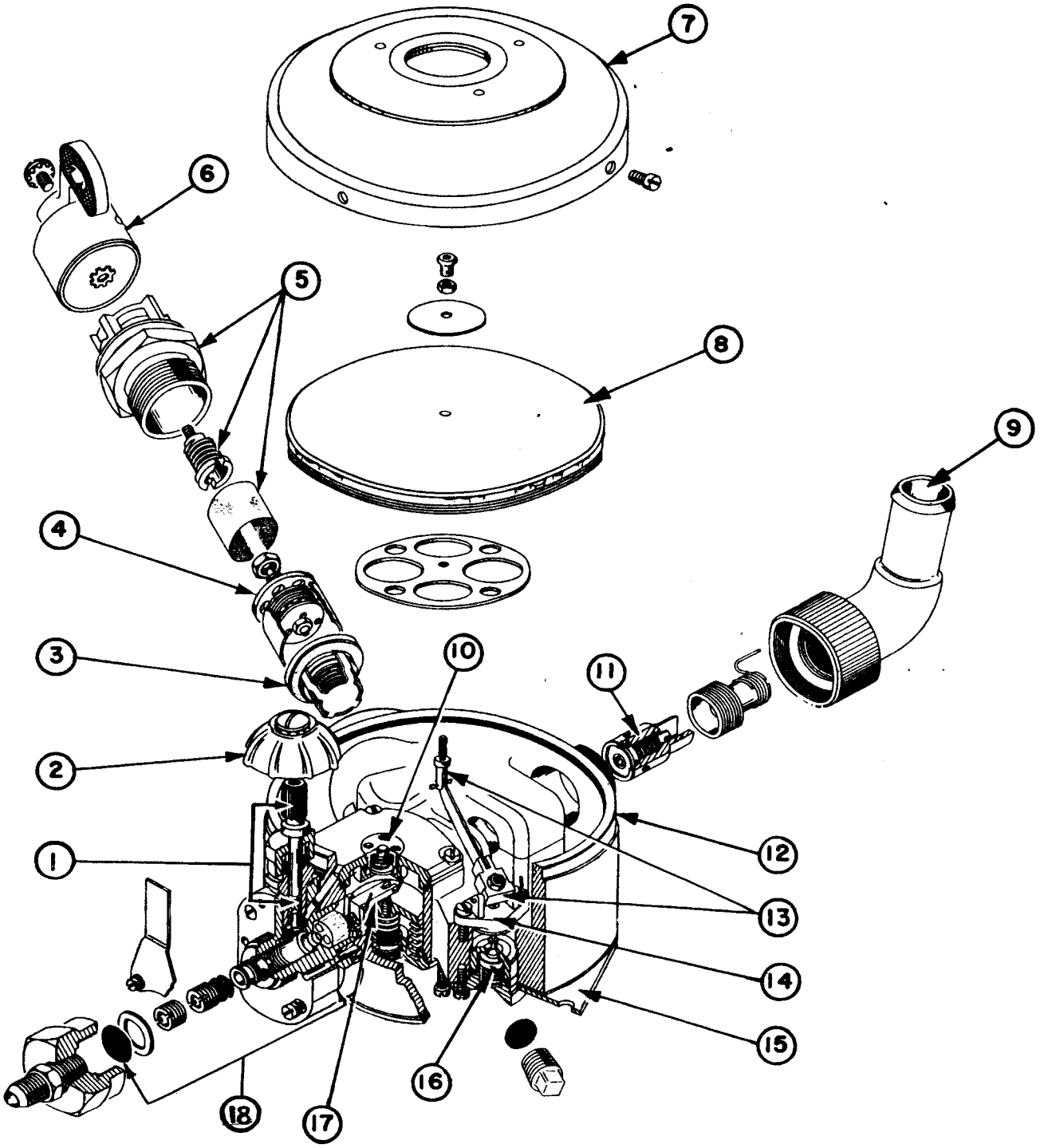


Figure 311 — Demand Oxygen Regulator



1. Emergency Valve Assembly
2. Emergency Valve and Knob
3. Check Valve Assembly
4. Aneroid and Throttling Plate Assembly
5. Air Valve Assembly
6. Air Valve Lever Assembly
7. Cover Assembly
8. Diaphragm Assembly
9. Elbow Assembly
10. Relief Valve Assembly
11. Injector Assembly
12. Case
13. Diaphragm Valve Assembly
14. Diaphragm Lever Bracket Assembly
15. Bottom Plate
16. Demand Valve Assembly
17. Pressure Reducer Assembly
18. Adapter Assembly

Figure 312—Oxygen Regulator Exploded View

(3) When removing the inlet valve from the emergency valve and adapter assembly, handle with extreme care. The valve must be kept smooth, flat, and free from nicks.

(4) Do not attempt to remove the pin from the emergency valve shaft.

(5) When removing the two inlet screens from the emergency valve adapter, avoid distortion or damage.

(6) Use extreme care when removing the oxygen inlet orifice from the emergency valve adapter. The valve seat of the orifice must be smooth, flat and free from nicks.

(7) When disasembling the elbow assembly, remove the elbow baffle assembly from the elbow. No further disassembly, however, must be attempted.

(8) In disassembling the injector assembly, be careful when handling the injector nozzle and injector seat. The surface of each making contact with the other must be smooth, flat, and free from nicks.

(9) Early models do not have a dampening spring, but do have an injector washer placed between the end of the injector spring and the injector housing. This washer can be removed from the injector housing with a pair of tweezers. Upon reassembly, discard the injector washer and use the dampening spring.

(10) When the air valve assembly is disassembled, the air valve spacer, aneroid and throttling plate assembly, and check valve seat of the unit being disassembled must be kept together so they can all be used as a unit upon reassembly. If any of these parts are interchanged with those of other units, or if a new part or assembly is used, the aneroid and throttling plate assembly must be recalibrated.

(11) In the diaphragm assembly, the dial is riveted to the cover and should not be separated since damage to either part will require replacement of the cover assembly.

(12) The diaphragm ring is cemented and tied with thread to the diaphragm. Do not attempt further disassembly. Damage to the diaphragm will necessitate replacement of the entire diaphragm assembly.

(13) The diaphragm lever insert is a tight press fit in the bracket and further disassembly must not be undertaken. Damage or wear to either part will necessitate replacement of the diaphragm lever bracket assembly.

(14) The diaphragm lever is soldered to the adapter and further disassembly must not be undertaken. Damage or wear to either part will necessitate replacement of the diaphragm lever subassembly.

(15) Since the relief valve assembly requires separate calibration and special test equipment, the guide was staked into the top cover at the factory and must not be loosened or disassembled under any circumstances.

(16) Do not change the adjustment of the adjusting screw or disassemble the pressure reducer assembly unless it is necessary to replace a damaged part; disassembly will require recalibration of this assembly.

(c) MAINTENANCE.

1. GENERAL.—After disassembly, it is essential to keep all parts absolutely clean and free from dust so that the complete instrument will function properly when reassembled.

a. Examine the check valve seat for wear. The surface making contact with the throttling plate must be flat and smooth within .003 inch. Polish with 3/o polishing paper.

b. Examine the injector seat. It must be clean, smooth, and free from burrs.

c. Examine all the screws. Wash them in carbon tetrachloride or benzine and dry with clean, dry, oil-free air.

d. Wash the case with filtered benzine and dry with clean, dry, oil-free air. Inspect all passages in the case, including the emergency bypass, and those leading to and from the pressure reducer assembly, the demand valve, and the injector assembly. Clean them with an orangewood stick.

e. Check the inside of the cover assembly for sharp edges; see that the rivets are flush and smooth on the inner surface. Any sharp edges will injure the fabric of the diaphragm when it presses against the cover.

2. TROUBLE CHART.

DEMAND OXYGEN REGULATOR.

Trouble	*Possible Cause*	*Remedy*
LEAK IN EMERGENCY VALVE ASSEMBLY.	Worn pit in the emergency valve assembly.	Rotate the knob to the extreme shut-off position. If leak persists, remove the screw, the shake-proof lock washer and emergency valve knob. Turn emergency valve shaft until pin stops flow of oxygen. Replace the knob, washer, and screw. If leak still persists, return instrument to overhaul depot for overhaul.

Trouble	*Possible Cause*	*Remedy*
FAILURE OF THE REGULATOR TO OPERATE PROPERLY.	Leaks in any of the following: Pressure reducer assembly. Demand valve unit. Emergency valve assembly.	Return the instrument to overhaul depot for overhaul.
	Clogged screen.	Return instrument to overhaul depot.
	Maladjustment of pressure reducer assembly.	Return instrument to overhaul depot.
	Dirt in inlet orifice or injection nozzle.	Return instrument to depot.
	Worn inlet valve.	Return instrument to depot.
	Faulty cover or inlet orifice.	Return instrument to depot.
	Maladjustment of diaphragm lever screw.	Return instrument to depot.
REGULATOR FAILS TO DELIVER OXYGEN.	Clogged connection line.	Disconnect instrument, blow through line.
	Clogged screens.	Return instrument to depot.
	Failure of the demand valve stem to operate.	Return instrument to depot.
	Dirt in oxygen inlet orifice.	Return instrument to depot.
REGULATOR DELIVERS ONLY PURE OXYGEN.	Broken aneroid assembly.	Return instrument to depot.
	Maladjustment of aneroid and throttling plate assembly.	Return instrument to depot.

(d) TESTS.

1. Examine the oxygen inlet orifice carefully for signs of wear or damage. The valve seat surface must be smooth, flat, and free from nicks. If the orifice does not meet these conditions, replace it.

2. Inspect the inlet valve for wear. If the valve seat is not smooth, flat, and free from nicks, replace it. In later models, the inlet valve has been redesigned, necessitating a redesign of the oxygen inlet orifice. This change affects instruments beginning with regulator serial No. 42-2800. The redesigned valve or orifice must not be interchanged with the same two parts of original design. Upon inspection and overhaul, if it is found necessary to replace either one of the parts, both of them MUST be replaced with new ones of the latest design.

3. Inspect both surfaces of the throttling plate. They must be smooth, flat, and free from nicks; otherwise replace the part.

4. Examine the pressure reducer bellows assembly. Test the assembly for leaks by immersing it upside down in water and applying a small amount of air pressure (from 5 to 10 inches of water as measured by a water manometer) to a fitting screwed in the bottom cover. If the assembly leaks, replace it with a new assembly.

5. Examine the aneroid assembly. If it is damaged, replace it with a new assembly.

6. Examine the diaphragm carefully for cracks, tears, wrinkles, or signs of excessive wear. It must be tied to the diaphragm ring tightly so that it cannot be rotated on the ring by hand pressure. It must be slack enough so that, when the diaphragm ring is placed on top of the diaphragm, a slight pressure applied to the diaphragm washer will depress the diaphragm sufficiently to contact the flat surface. Failure of the diaphragm to meet this condition, or damage to the diaphragm will necessitate replacement of the diaphragm assembly.

7. Examine the pin pressed into the emergency valve shaft. If it is worn or damaged, replace the emergency valve shaft assembly.

8. Wash the demand valve with filtered benzine and dry with clean, dry, oil-free air. Check the operation of the demand valve stem to make sure that it operates freely and does not stick. If it sticks, replace it with a new one. Examine the diaphragm lever adjusting setscrew. The bottom of the setscrew must be smooth and flat.

9. Examine all springs for signs of damage or distortion. The ends of the springs must be closed, square, and parallel. Replace springs that do not meet these conditions.

10. Replace all gaskets and the damaged valve seat with new ones to prevent leakage and assure a perfect seal.

(e) ASSEMBLY. — To assemble the type A-12 demand oxygen regulator, adhere to the following procedure.

1. Assemble the emergency valve and adapter assembly.

2. When assembling the emergency valve assembly, lightly paint the inner surface of a new gland packing with a compound made up of 70 percent tricresyl phosphate and 30 per cent Carnoba wax.

3. Secure the emergency valve adapter to the case with four lock washers and screws.

4. In replacing a new fiber washer in the hole provided in the emergency valve adapter, impregnate the washer with shellac under a vacuum of 1 inch of mercury (as measured by a mercury manometer) for ½ hour. Allow the washer to remain in the shellac for 1 hour at atmospheric pressure and then dry thoroughly.

5. Paint the threads of the connector with Compound, Anti-Seize and Sealing (for oxygen systems), Specification AN-C-86a, and screw it securely into the oxygen inlet nut. To avoid clogging the line, do not use an excess amount of the anti-seize compound.

6. Assemble the demand valve unit.

7. Secure the valve cap with the spring, seat holder, and seat to the case with the two screws, taking care to tighten the screws evenly.

8. Assemble the inlet valve.

9. In assembling the screw and nut into the inlet valve, adjust the screw so that the distance from the valve face to the screw head is .517 inch; then lock it in place by tightening the nut.

10. Holding the valve by the screw, insert the inlet valve through the pressure reducer chamber into the adapter so that the center drilled hole is aligned with the oxygen inlet orifice.

NOTE

The inlet valve has been redesigned, necessitating a change in the oxygen inlet orifice. These new parts are not interchangeable with the old types. When replacement of the inlet valve is necessary, the orifice must also be replaced.

11. Assemble the pressure reducer assembly.

12. Adjust the link screw in the pressure reducer bellows cap so that the pinhole is 9/64 inch above the surface of the bellows cap.

13. Install the pressure reducer assembly in the case.

14. Secure the emergency valve knob to the shaft with the shakeproof lock washer and screw.

15. Assemble the diaphragm lever and bracket assemblies and install in case.

16. Assemble the injector assembly and slide into the case through the opening directly opposite the pressure chamber.

17. Assemble the relief valve assembly and secure to the case with the four screws.

18. Place the new bottom plate gasket and the bottom plate with the countersunk holes facing up over the case and secure to the case with the eight screws.

19. Assemble the elbow assembly and screw to the case over the injector assembly.

20. Assemble the diaphragm assembly and screw securely to the case.

21. Assemble the cover assembly and place over the diaphragm; turn the cover until the small projection on the inside of the cover fits into the notch in the case. This provides for the correct location of the cover so that the dial, riveted to the cover, will coincide with the positions of the emergency valve and air inlet.

NOTE

If the cover assembly does not have a projection in its side, extreme care must be taken to set the cover in its correct position with relation to the emergency valve. This is done by positioning the cover so the red arrow painted on the dial is directly next to the emergency valve shaft.

22. Assemble the air valve assembly and screw into case.

(4) FLOW INDICATOR.

(a) DESCRIPTION. — *(See figures 313 and 314.)*—Type A-3 oxygen flow indicator gives a visual indication of flow by "blinking" at each inspiration of the person wearing the oxygen mask. Contained in this indicator is a bellows that moves against the pressure of

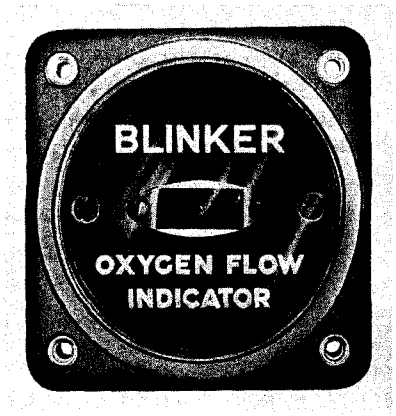
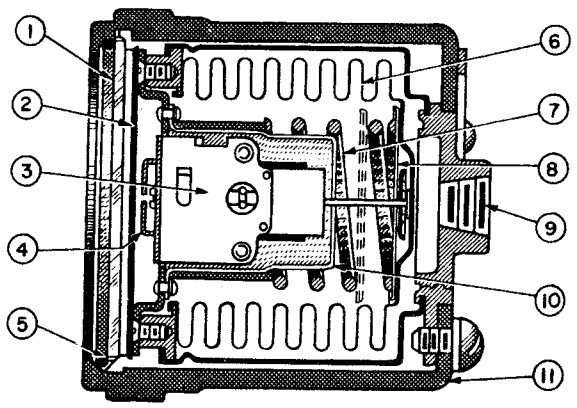


Figure 313 — Oxygen Flow Indicator

a spring when subjected to oxygen pressure. When the oxygen pressure equals spring pressure, the bellows will come to rest at some position between its limits of travel. At each inspiration, the pressure in the bellows changes approximately ½ pound, which causes the bellows to assume a new position. When the oxygen pressure returns to its original value, the bellows will assume the position previous to the ½ pound pressure change. Any movement of the bellows causes a corresponding movement of a push rod and it, in turn, operates a set of shutters by means of a friction clutch. The shutters, therefore, give the "blinking" indication of oxygen flow.



1. Glass
2. Dial
3. Shutter, Mounting Bracket and Frame Assembly
4. Shutter
5. Retainer Ring
6. Bellows
7. Spring
8. Spring Plate
9. Inlet
10. Spring Retainer Assembly
11. Body Assembly

Figure 314 — Flow Indicator Cross Section

(b) REMOVAL AND DISASSEMBLY.

1. REMOVAL.—The flow indicator and pressure gage may be removed as a unit by disconnecting all attaching lines and fittings and removing four mounting screws in the base. Disassembly of the panel is obvious upon inspection.

2. DISASSEMBLY.—To disassemble the type A-3 oxygen flow indicator, use the following procedure:

a. Remove retainer ring, glass, and gasket.

b. Remove two screws that secure dial and remove dial.

c. Remove four screws securing mounting plate and spring retainer assembly to bellows and boot assembly. This will allow shutter assembly complete to be lifted out of the indicator.

d. To disassemble shutter assembly complete, compress spring slightly and slide spring plate to one side until it is possible to remove it over washer and spring washer.

e. Remove spring plate and spring.

f. Open shutters and remove the two screws which secure the shutter, mounting bracket and frame assembly to the mounting plate and spring retainer assembly.

g. Remove shutter, mounting bracket, and frame assembly.

h. No further disassembly of the shutter assembly complete is possible.

i. Remove two screws and lock washers from rear of case and remove bellows and body assembly.

(c) MAINTENANCE. — There are no adjustments to be made on this instrument. A frequent check is advised to ascertain if the shutters are functioning properly. This unit must NEVER be tested or operated with compressed air which contains the slightest trace of oil, grease, moisture or any other foreign matter, or oxygen containing slightest trace of moisture or any foreign matter.

(d) TESTS.—Check the operation of the shutters by inserting the eraser end of a pencil through the large threaded hole in the back of the indicator and pressing gently against the bellows and releasing. Failure of the shutters to open and close indicates a weak or broken spring, or a defective shutter assembly, necessitating replacement of the entire shutter assembly mounting bracket and frame assembly. Replace all defective parts or assemblies.

(e) ASSEMBLY.—Assemble the flow indicator in the following order:

1. Reinstall the bellows and body assembly and secure.

2. Reinstall the shutter assembly and secure.

3. Reinstall dial and secure.

4. Reinstall retainer ring, glass, and gasket.

(5) OXYGEN PRESSURE GAGE, TYPE K-1.

(a) DESCRIPTION.—*(See figure 315.)*—Type K-1 pressure gages are of the Bourdon tube principle and are graduated in units of 50, from 0 to 500 pounds per square inch.

(b) DISSASSEMBLY.

1. Place the instrument face up on a bench and put a small block underneath it so that the face will be level. Place a piece of thin metal on glass to prevent its becoming damaged, and insert a small blade under

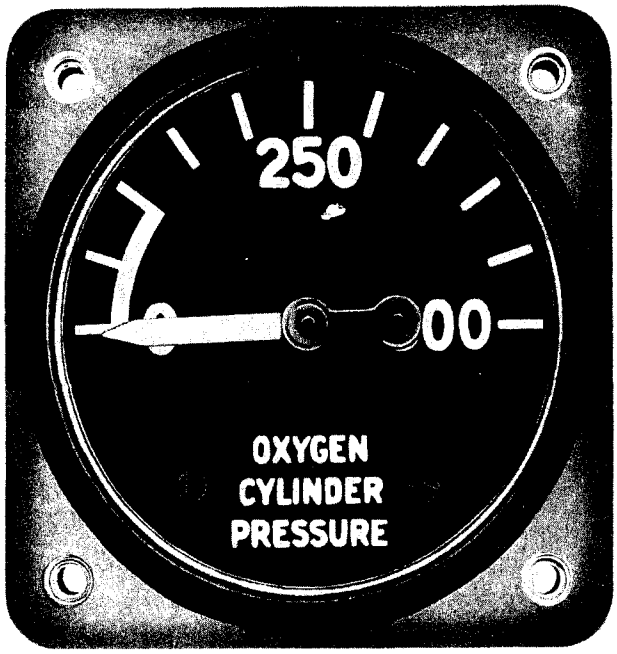


Figure 315—Oxygen Pressure Gage

the snap ring, at end of wire. This will permit removal of the snap ring. Use a vacuum cup to lift out glass.

2. To remove the mechanism from the case, hold the case in the left hand with the face down. Be careful not to damage the pointer. Remove the two screws from the back, tap the case lightly with the fingers, and carefully lift the entire case up, leaving the mechanism, complete with pointer and dial, in the left hand. Care should be taken not to damage the Bourdon tube or the pointer.

3. Pointer is attached to movement pinion shaft by force fit. Remove pointer either with special pointer jack or by means of two small screw drivers placed under each side of pointer lug.

4. Unscrew the dial screws and remove dial.

5. If necessary, movement assembly may be removed by unscrewing the two screws which attach it to the socket, and removing link screws which attach link to Bourdon tube tip.

(c) MAINTENANCE.

1. GENERAL.

a. If gages exceed tolerance, replace with serviceable instrument.

b. Replace broken cover glass. Before inserting new glass, see that the rubber gasket is properly in place.

c. Should the threaded socket connection become worn or damaged, remove the instrument and replace the socket assembly.

---

2. TROUBLE CHART.

OXYGEN PRESSURE GAGE

Trouble	*Possible Cause*	*Remedy*
DOES NOT REGISTER.	Fractured Bourdon tube.	Replace socket assembly.
	Pointer loose on staff.	Reset pointer.
	Badly damaged or corroded movement.	Replace movement assembly.
POINTER FAILS TO RETURN TO ZERO POSITION.	Foreign matter in Bourdon tube.	Replace socket assembly.
	Bourdon tube stretched.	Reset pointer.
STICKING ACTION.	Pointer bent, rubbing on obstruction.	Straighten pointer.

(d) ASSEMBLY.

1. After repair and calibration, remount socket and Bourdon tube assembly in instrument case.

2. Replace glass and set instrument in screw press. Then force the front glass against rubber-sealing gasket sufficiently to permit entry of glass snap ring. Replace one end of snap ring and gradually work rest of ring in place until it snaps under lip of case. Release pressure on glass.

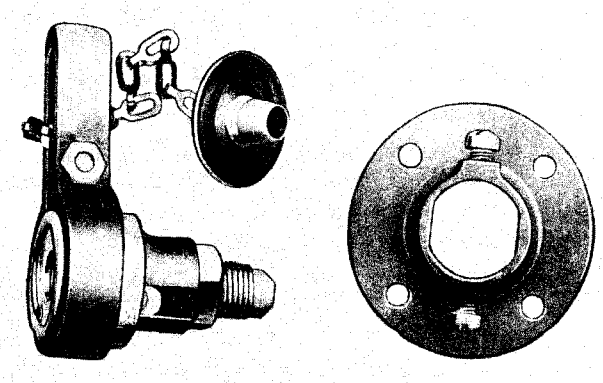


Figure 316 — Oxygen Low Pressure Filler Valve Assembly

(6) OXYGEN MASKS.—*(See figures 310 and 318.)*—Oxygen masks are issued to flying personnel by the Air Service Command and are individually fitted. Each crew member is responsible for his own mask and should never exchange it without having it refitted and tested for proper function and leaks.

(7) BAIL-OUT OXYGEN UNITS. — (If an unusually high altitude flight is anticipated, bail-out units may be provided for crew members. This is a completely self-contained unit which provides a supply of oxygen lasting from 4 to 8 minutes and consists of a high pressure cylinder, pressure gage, release valve, and "pipe-stem" mouthpiece. An auxiliary pocket is provided for securing the bail-out cylinder, which can be tied or sewed to the parachute harness, secured in a pocket of the clothing, or tied to the crew member's thigh. To use, open the valve completely before leaving the airplane. The oxygen flow will be automatic.

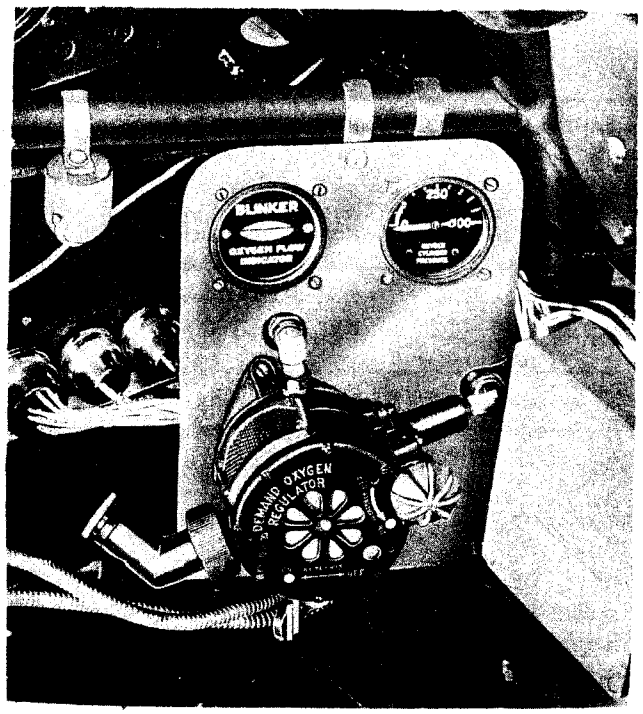


Figure 317 — Demand Oxygen Panel

Figure 318 — Demand Oxygen Mask

16. COMMUNICATIONS EQUIPMENT.

NOTE

Radio command set SCR-AL-183 with RC-27 interphone equipment is installed on the 12-volt airplane. Command set SCR-274-( ) with RC-43B or RC-193-( ) radio marker beacon equipment and RC-35 interphone equipment is installed on the 24-volt airplane. Both of these command sets are for short range communication between airplanes in flight or for contact between airplane and flying field. As these two radio sets are entirely different, they will be treated separately in this handbook.

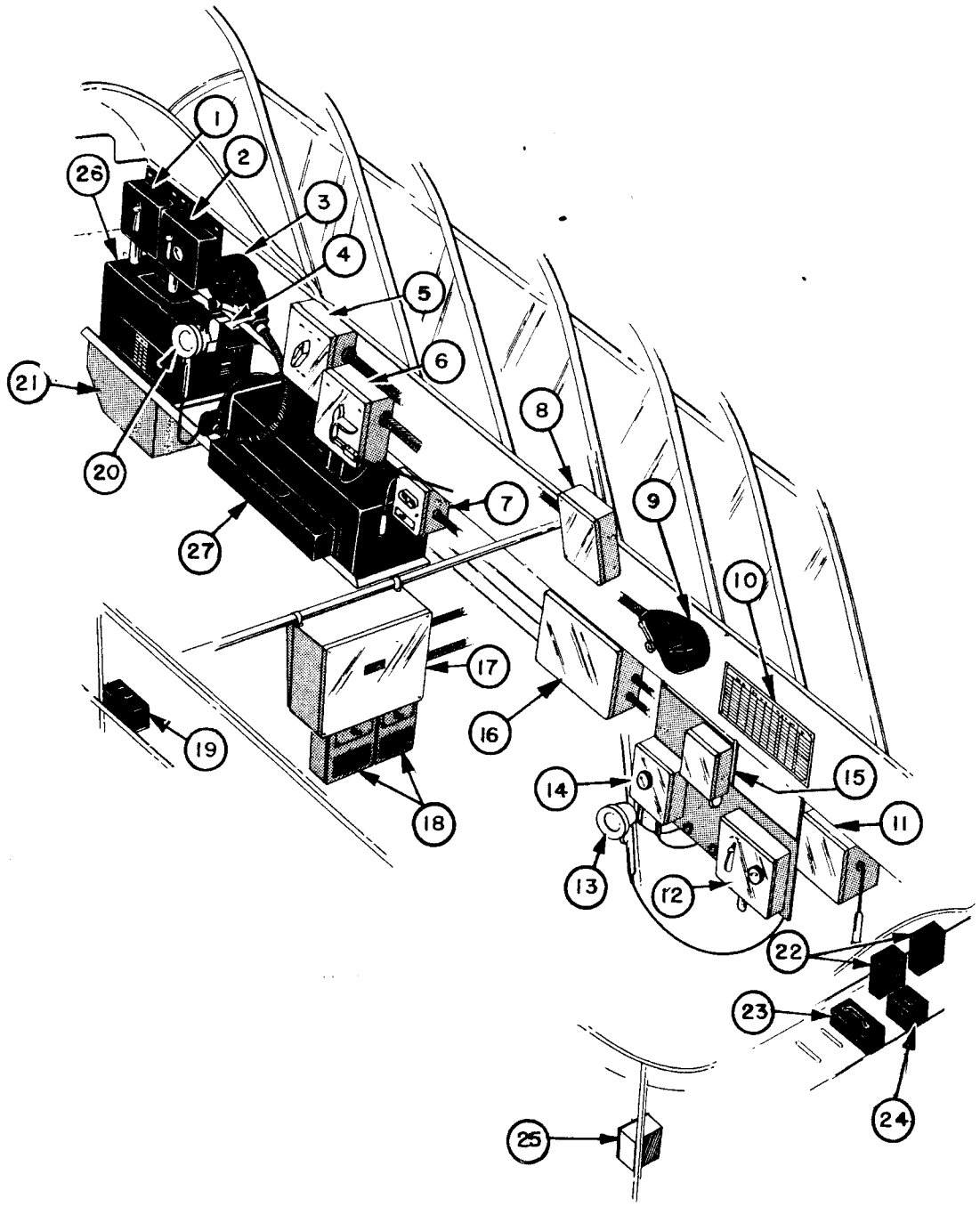
a. 12-VOLT EQUIPMENT. *(See figures 319 through 322.)*

(1) DESCRIPTION.—The communications equipment installed on the 12-volt airplane consists of a radio command set, SCR-AL-183, necessary antenna equipment, two-place interphone equipment, RC-27, and miscellaneous equipment necessary for the operation of the communication system as a whole. The command set is directly controlled from the front cockpit and remotely controlled from the rear cockpit. All controls are installed on the right side of the cockpits, and provision is made for installing the receiver control box in either cockpit to provide receiver control from the cockpit in which the instrument flying hood is installed. A complete list of communications equipment installed in the 12-volt airplane follows.

RADIO COMMAND SET SCR-AL-183

Transmitter Assembly

1 Transmitter, BC-AL-230	1 Coil Set, C-384
1 Mounting, FT-100	1 Coil Set, C-385
1 Coil Set, C-184	5 Cases, CS-47
1 Coil Set, C-381	1 Plug, PL-Q-64
1 Coil Set, C-382	1 Tube Set, Includes
1 Coil Set, C-383	2 Tubes, VT-25
	2 Tubes, VT-52



1. Transmission Control Box
2. Receiver Control Box
3. Tuning Unit-Type MC-125
4. Antenna Switching Relay
5. Filter Switch Box
6. Master Interphone Control Box
7. Control Box
8. Type EL-5 Filter Unit
9. Tuning Unit-Type MC-125
10. Calibration Chart
11. Jack Box
12. Receiver Control Unit
13. Type T-17 Microphone
14. Interphone Box
15. Interphone Control Unit
16. Interphone Junction Box
17. Command Set Junction Box
18. Interphone Amplifier-Type BC-212-( )
19. Coil Set
20. Type T-17 Microphone
21. Command Set Pull Box
22. Transmitter Coil Set
23. Receiver Coil Set
24. Transmitter Coil Set
25. Transmitter Coil Set
26. Transmitter-Type BC-AL-230
27. Receiver-Type BC-AL-229
28. Dynamotor-Type BD-AL-83 (Not Shown)

Figure 319 — Radio Equipment — 12-Volt

Receiver Assembly

1 Receiver, BC-AL-229
1 Mounting, FT-99
1 Coil Set, C-377
1 Coil Set, C-379
1 Case, CS-44
1 Plug, PL-Q-61
1 Tube Set, includes
1 Tube, VT-37
1 Tube, VT-38
4 Tubes, VT-49

Receiver Control Assembly

1 Control Box, BC-AL-231
1 Mounting, FT-118
2 Plugs, PL-Q-104

Transmitter Control Assembly

1 Control Box, BC-AL-232
1 Mounting, FT-118
1 Plug, PL-Q-63

Dynamotor Assembly

1 Dynamotor, BD-AL-83 Less Mounting
1 Mounting, FT-141
1 Plug, PL-P-62

Antenna Assembly

1 Antenna Switching Relay BC-AL-198
1 Mounting, FT-118
1 Plug, PL-P-77

Antenna Equipment

40 ft. Wire, W-106-A
3 Insulators, IN-88
1 Insulator, IN-79

Miscellaneous Items

1 Control Unit, MC-137
1 Coupling, MC-136
2 Tuning Units, MC-125-A
1 Tuning Shaft, MC-124 10-1/2 in. long
1 Tuning Shaft, MC-124 52 in. long
1 Chart, MC-261
1 Dial, MC-282
1 Dial, MC-322

INTERPHONE EQUIPMENT RC-27

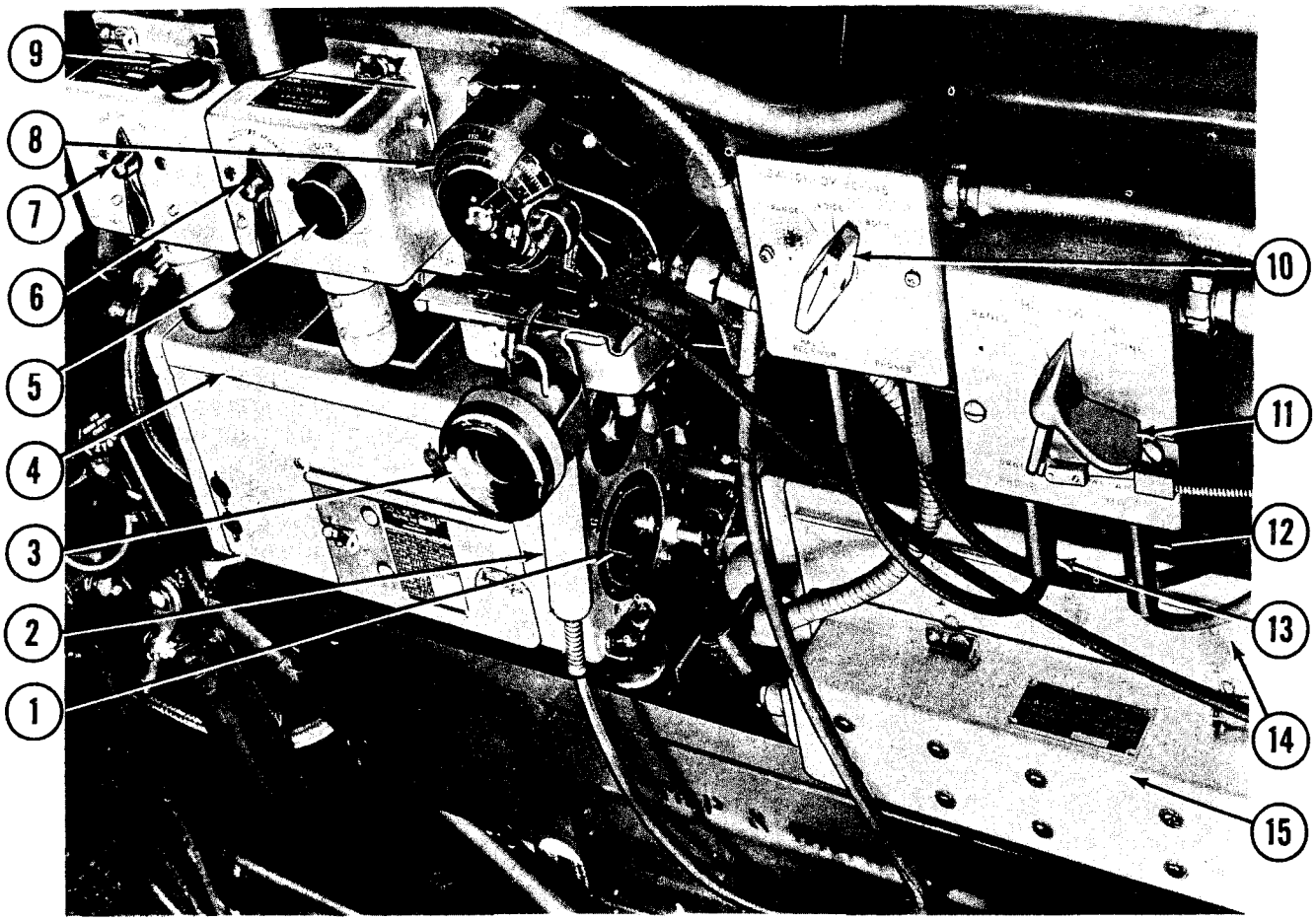
2 Interphone Amplifiers, BC-212-C (one only installed on later airplanes) includes:
4 Tubes, VT-65
1 Control Box, BC-327
1 Control Box, BC-335
1 Control Box, BC-334
1 Control Shaft, MC-166
2 Plugs, PL-55
2 Jacks, JK-26
2 Microphones, T-17
2 Sockets, Type 99, (adapted to British use)
12 ft. Cordage, CO-119-A

FILTER EQUIPMENT RC-32

1 Filter, FL-5-B
2 Plugs, PL-55
1 Switch Box, BC-345

(a) RECEIVER EQUIPMENT.—Radio receiver BC-AL-229 consists of a set-box including the supply and coupling circuits, tube, sockets, power terminals, and plug-in coil terminals required for the reception of radio signals. The receiver comprises four stages of radio frequency amplification which amplify at the incoming frequency, a detector, and one stage of audio frequency amplification. The four radio frequency amplifier stages use tubes VT-49. The detector is a tube VT-37, and the audio amplifier stage uses one tube VT-38. Each of the coil sets includes the same essential parts of the radio frequency amplifier circuit. The receiver, BC-AL-229, is installed on shock absorber mounting, FT-99, attached to the radio shelf on the right side of the front cockpit. A receiver tuning unit, MC-125A, is mounted above and forward of the receiver in the front cockpit, and in the rear cockpit the MC-125A tuning unit is mounted above the radio remote control panel. The tuning unit with dial, MC-282, mounted in the front cockpit is connected to the receiver by tuning shaft, MC-124, 10-1/2 inches long. The tuning unit with dial, MC-322, mounted in the rear cockpit is also connected to the receiver by tuning shaft, MC-124, 52 inches long. A type BC-AL-231 receiver control box is installed on a type FT-118 mounting bracket directly above the transmitter on the right side of the front cockpit. An additional mounting bracket is installed on the radio remote control panel at the right side of the rear cockpit for alternate installation of the control box. A dummy receptacle is provided on each mounting bracket to stow the receiver control box plug when the box is not installed. Two coil sets are included in the receiver assembly; coil set C-377 is mounted over the baggage compartment behind the seat in the rear cockpit, and coil set C-379 is installed on the inboard side of the receiver unit. The coil sets are easily interchanged when radio reception is desired or a frequency band not applicable to the coil set is installed in the receiver. Each coil set is applicable to two frequency bands, and a switch on the end of the unit provides for switching from one frequency band to the other.

(b) TRANSMITTER EQUIPMENT. — Radio transmitter BC-AL-230 consists of set-box, including the circuits and tuning elements required for the generation, amplification, and modification of radio frequency circuits. The transmitter is mounted forward of the receiver on a shock absorber mounting, type FT-100, attached to the radio shelf. The transmitter comprises a radio frequency oscillator, a radio frequency amplifier, a coupling circuit for transferring radio frequency power from the amplifier to the antenna, and a modulator stage for amplifying either internal or external modulation currents and modulating the radio frequency amplifier therewith. The radio oscillator and radio amplifier are tubes VT-25. The modulators are tubes VT-52. The control box, BC-AL-232, carries a selector switch, a telegraph key, and a jack for use in modulating the transmitter from a microphone or other external source. The selector switch has three positions, "VOICE," "CW," and "TONE," and is for selecting the type of emission from the transmitter. For key transmission, the selector switch must be placed at the "CW" or "TONE" position. This control box is mounted on FT-118 mounting bracket directly above the transmitter and forward of the receiver control box mounting bracket at the right side of the front cockpit. Six coil sets are included in the transmitter equipment. Coil set C-184 is installed on the left rear side of the front cockpit; coil set C-382 is installed in the transmitter; coil set C-384 is stowed at the lower left side of the rear cockpit and coil sets C-381, C-383, and C-385 are stowed over the baggage compartment behind the rear cockpit seat. (See figure 319.) Power for the transmitting equipment is supplied by a type BD-AL-83 dynamotor mounted on a shock absorber mounting type FT-141, located on a shelf in the aft section of the



1. Antenna Current Meter
2. Microphone Switch
3. Hand Microphone
4. Radio Transmitter
5. Volume Control
6. Radio Control Switch
7. Transmitter "VOICE-CW-TONE" Switch
8. Tuning Unit
9. Telegraph Key
10. Filter Selection Switch
11. Radio—Interphone Switch
12. Microphone Jack
13. Head Set Jack
14. Radio Receiver
15. Receiver Coil Unit

Figure 320 — Front Cockpit Radio Installation — 12-Volt

airplane just forward of the horizontal stabilizer. The dynamotor is of the totally enclosed type having a low voltage commutator and brushes at one end, and a high voltage commutator and brushes at the other end. Current is fed to the low voltage commutator and the common field winding from the 12-14.5-volt dc source. Current from the transmitting equipment is drawn from the high voltage commutator at 300 to 375 volts depending upon the value of the applied low voltage.

NOTE

The coil set in the transmitter may be easily changed to obtain transmission on the desired frequency band. The frequency calibration of each coil and the serial number of the transmitter with which it was tuned are shown on the back of the coil.

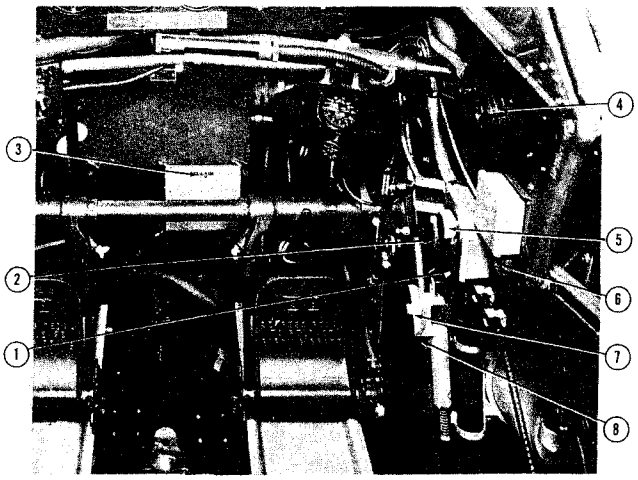
(c) INTERPHONE EQUIPMENT. — Interphone equipment RC-27 is a two-place interphone equipment for training airplanes. The equipment consists essentially of an amplifier, a master control box, a remote control box, interphone box, two microphone head sets, and the necessary tubes, cords, sockets, etc., for the proper functioning of the equipment as a whole. The two BC-212-C amplifiers with two VT-65 tubes each are mounted on the bottom of the command set junction box below the rear cockpit instrument panel. A switch with "ON" and "OFF" positions is mounted on the face of the amplifier unit.

NOTE

This switch is not operative on British equipment. On later airplanes, only one BC-212-C amplifier is used.

Master control box, BC-334, is mounted on the right side of the front cockpit above the receiver and aft of filter switch box, BC-345. This box contains the master control for switching from interphone to

radio. Remote control boxes, BC-327 and BC-335, are mounted on the right side of the rear cockpit; BC-335 is for volume control, and BC-327 is interconnected with master control box BC-334 by flexible shaft. This flexible shaft connection provides a means of switching the rear cockpit to either radio or interphone. The T-17 microphones are held in a bracket attached to the right side of each cockpit. Push-to-talk buttons are installed on the handle of the microphones and also on the throttle quadrant arm in each cockpit.



1. Microphone Jack
2. Head Set Jack
3. Interphone Amplifier Switch
4. Tuning Unit
5. Interphone Volume Control
6. Radio—Interphone Switch
7. Hand Microphone
8. Microphone Switch

Figure 321 — Rear Cockpit Radio Installation — 12-Volt

(d) FILTER EQUIPMENT. — A type FL-5-B filter is installed on the right side between the cockpits, and BC-345 switch box is installed in the front cockpit between the interphone control box, BC-334, and the receiver tuning unit, MC-125. The filter unit together with its switch box provides a means of filtering out interference between radio range signals and voice. The switch box has three positions: "RANGE" for beacon signals only; "VOICE" with no interference from beacon signals; and "BOTH" when both voice and beacon signals are heard. The "BOTH" position provides a means of listening to the "RANGE" beacon signal and at the same time listening for an expected voice message such as the weather report. When the voice message comes in, the switch may be thrown to "VOICE" to make the message audible.

(e) ANTENNA SWITCHING RELAY.—The type BC-AL-198 switching relay is mounted on mounting, FT-118, located underneath the receiver tuning unit and above the transmitter at the right side of the front cockpit. The antenna switching relay contains a two-position relay, an antenna binding post, and two binding post terminals of the receiver and transmitter, respectively. It also carries a receptacle for plug PL-P-77. The function of the antenna switching relay is to switch the common antenna between the receiver and the transmitter. The change-over between receiver and transmitter causes the power relay and the BC-AL-198 relay to perform simultaneously the respective functions of switching the dynamotor voltage between the receiver and transmitter and switching the antenna between the receiver and transmitter.

(f) ANTENNA SYSTEM.—The antenna wire, type W-106-A, for the radio equipment, extends from the top of the rudder to the spruce wood antenna mast located forward and to the right of the windshield. The wire enters the right side of the fuselage at the front cockpit. A shock cord and insulator are provided between the antenna wire and the rudder attachment point to maintain an initial tension of 15 pounds (plus or minus ½ pound).

(g) FUSES. — Active and spare fuses for the radio equipment are provided in the command set junction box located below the rear cockpit instrument panel.

(h) RADIO COMPASS (AT-6 ONLY). — A radio compass, type SCR-246, is installed in AT-6 airplanes only. The major items of the radio compass installation consist of a type LP-17-A radio compass fixed loop and a type BC-373-A radio compass receiver. The loop is mounted on a support bracket at the bottom leading edge of the wing center section, so that the plane of the loop is transverse to the line of flight. The receiver unit is installed on the shelf below the instrument panel in the front cockpit.

(i) MARKER BEACON RECEIVER (AT-6 ONLY).—A type BC-341A marker beacon receiver is installed in the forward portion of the rear cockpit, between the floor troughs, in AT-6 airplanes only.

(2) MAINTENANCE. — As the maintenance of radio equipment is of highly specialized nature, this handbook will not attempt to give detailed repair instructions. Persons not familiar with radio equipment should not attempt to operate it until they have made a thorough study of the applicable book of instructions.

WARNING

Operation of this equipment involves the use of high voltages which are dangerous. Do not change tubes or make adjustments inside any unit of equipment with the dynamotor running.

(3) TROUBLE SHOOTING.—Many good radio sets have been ruined by internal alterations when the service failure was really due to some external cause. Probably the most common cause of poor radio recep-

tion in all airplane installations of high-sensitivity receivers is electrical noises of both local and atmospheric origin. Operators of the receiver should learn by experience to identify these noises in the telephone receivers which indicate faults in the operation or installation. Such identification by ear will greatly facilitate correction of the fault.

(a) RECEIVER NOISE.—Atmospheric (static) and external man-made interference should be identified on the ground, with the engine not running. Static will be heard with some coil sets at all season of the year and at most times of the day. The general static level grows progressively lower with increasing frequency. The receiver cannot be adequately tested or inspected in ground locations where powerline interference, motor interference, etc., are excessive. Disconnecting the antenna at the receiver binding posts will generally give a satisfactory test; for if the noise encountered is static or powerline interference, it will greatly diminish or disappear when the antenna is disconnected. It is no uncommon occurrence for man-made interference to be received with destructive force when flying over certain areas, and to be of such a nature that it is easily confused with generator or dynamotor noise on the airplane itself. If machine noises are suddenly heard in flight, they may possibly be identified with a particular ground area. Also, it should be remembered that when flying through mist, rain, or snow, a noise is sometimes heard which sounds like a machine noise. It is produced by the impact of the charged particles on the receiving antenna and airplane, and is irremediable.

(b) DYNAMOTOR NOISE.—Noise caused by the dynamotor should be identified on the ground with the engine not running. This noise is usually related to the speed of the machine and can be identified by switching the power on and off at the BC-AL-231. The interruption of current in the commutators of the dynamotor machine sets up radio frequency oscillations in the connecting cords. These oscillations enter the receiver by way of the antenna and never through the conductors of the chords themselves. This fact may be verified by disconnecting the antenna at the receiver binding post. The transmission of dynamotor noise to the receiver is related to the condition of bonding of the cords, particularly at high frequencies. A dirty commutator will produce more noise than a clean one, but complete suppression can never be obtained if the shielded cords are not thoroughly bonded and grounded. When this noise occurs in an airplane installation, the bonding of all cords to the airplane should be checked for poor contacts. If the noise persists, the commutators of the machine may be cleaned with a clean dry cloth while it is turning over.

CAUTION

Never use emery on a commutator. A trace of oil or grease on a commutator may cause more trouble than any dirt deposit. The low voltage commutator is more likely to produce noise than the high voltage commutator. Under normal operating conditions the commutators of these enclosed machines should not require cleaning more often than about 300 hours.

(c) INTERMITTENT CONTACT. — Intermittent contact in phone, cord, plug, or contacts to telephone receivers should be identified on the ground with the engine not running. A loose bond or terminal plug should be identified with the engine not running.

(d) IGNITION NOISE.—Ignition noise should be identified on the ground by varying the engine speed and by switching from one magneto to the other.

(e) GENERATOR NOISE. — Generator noise may be identified on the ground, engine running, by advancing the throttle to the point where the generator cuts in. If it originates in the generator itself, it will be a characteristic machine noise. If it is in the voltage regulator, it will probably be intermittent and appear only above a certain critical engine speed (usually 800 to 1000 rpm). Noise originating in the generator and voltage regulator can be distinguished from ignition noise by the fact that generator and voltage regulator noise is usually suppressed by opening the airplane main line switch.

(f) VACUUM TUBE NOISE.—Tube noise may be identified on the ground with the engine running by a crackling or ringing sound. It will sometimes appear under sustained vibration and never be heard at all when the receiver box is jarred intermittently by hand. An intermittent contact inside a tube may be the first indication that its useful life is over. Noises originating inside the tubes are greatly accentuated by the presence of a strong incoming radio signal, particularly an unmodulated signal, and this may be used as a means of identifying such a noise. The faulty tube must be isolated by replacing the tubes one by one with new ones and observing when the disturbance vanishes.

(g) INTERNAL INTERMITTENT NOISE.—Intermittent contact in an internal circuit of the receiver may be identified with the engine running or by jarring the receiver by hand. Disconnecting the antenna and vibrating the receiver is not necessarily a test because noises of this character may be increased to audibility by a strong incoming signal. Operating the receiver at excessively high voltage tends to make it noisy during operation and to increase the residual cause of noise.

NOTE

Never allow the radio set to be operated at a supply voltage greater than 15 volts. Operation at less than 12 volts will not damage the equipment, but the radio reception will be unsatisfactory.

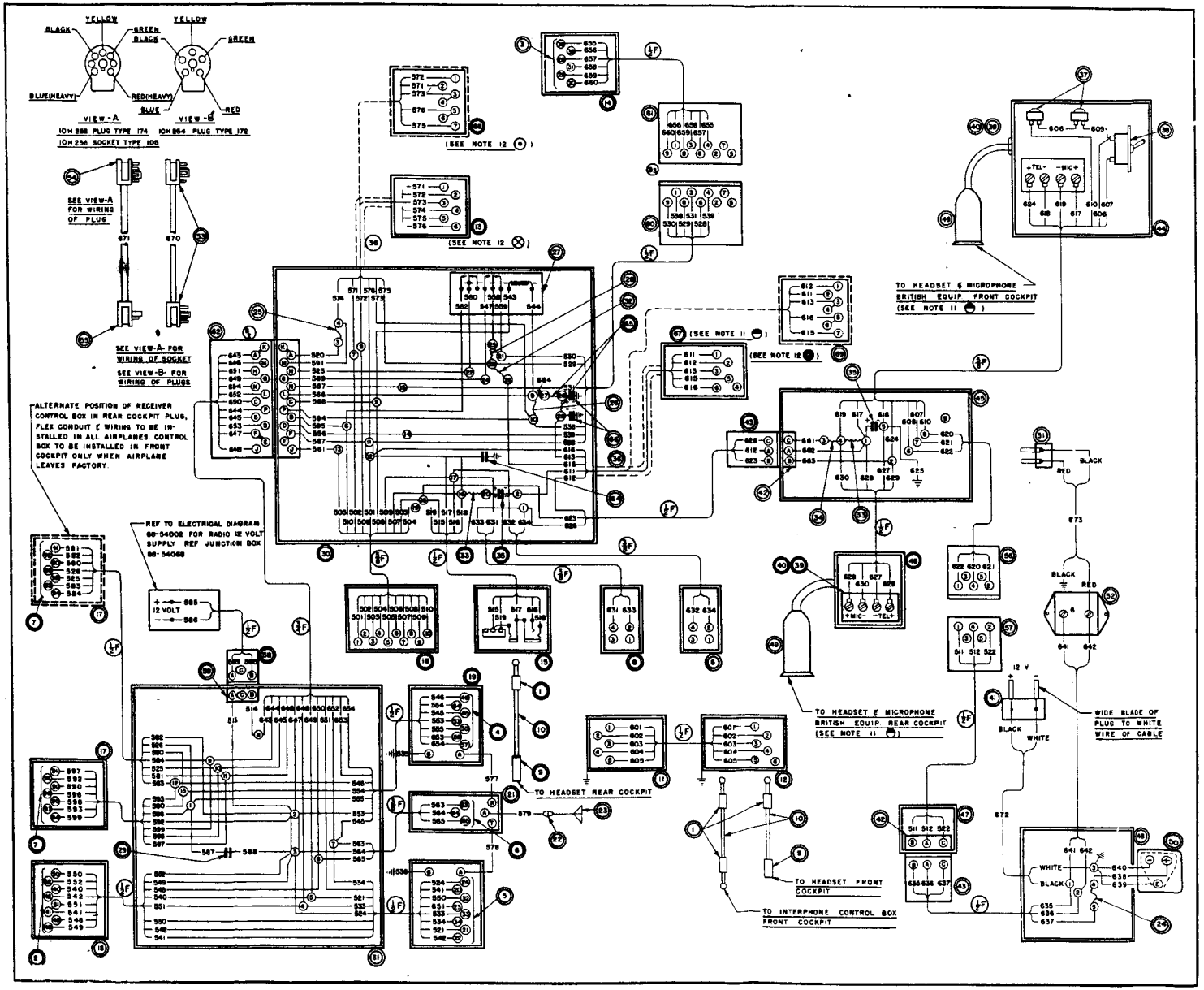


Figure 322 — Radio Wiring Diagram — 12-Volt

BILL OF MATERIAL

Item No.	Description	Type No.	Spec. No.
1	*Plug—Head set connector cord	PL-55	
2	*Plug—Transmitter control box	PL-Q63	
3	*Plug—Dynamotor	PL-P62	
4	*Plug—Receiver	PL-Q61	
5	*Plug—Transmitter	PL-Q64	
6	*Plug—Antenna relay	PL-P77	
7	*Plug—Receiver control box	PL-Q104	
8	Plug—Throttle quadrants		35A4273
9	*Jack—Head set connector cord	JK-26	
10	*Cordage—Head set connector	CO-119	
11	*Filter unit	FL-5B	H40D5671
12	*Box Assem.—Filter switch	BC-345	H39B2224
13	*Amplifier—Interphone	BC-212B	36B5857
14	*Dynamotor—Command set	BC-98- ( )	36D3530
15	*Box Assem.—Interphone remote	BC-335	H39B1571
16	*Box Assem.—Interphone master	BC-334	H39B1572
17	*Box Assem.—Receiver control	BC-231-( )	36B3526
18	*Box Assem.—Transmitter control	BC-232-( )	36B3529
19	*Receiver—Command set	BC-229-( )	
20	*Transmitter—Command set	BC-230-( )	36D3527
21	*Relay—Antenna switching	BC-83- ( )	36B3528
22	*Insulator—Antenna lead-in	IN-79	32A2329
23	*Wire—Radio antenna	W-106A	
24	Fuse—10 amp (1 spare)		32084
25	Fuse—50 amp (1 spare)		32084
26	Fuse—15 amp (1 spare)		32084
27	Relay—Strowger	ZQA	SC-D-324
28	Resistor 30 OHMS ½ WATT (Allen Bradley)	E.B.	

LEGEND—RADIO WIRING DIAGRAM—12 VOLT

Item No.	Description	Type No.	Spec. No.
29	Capacitor .004 mfd (Aerovox)	1461	
30	Box Assem.—Command set junct.	N.A.A.	88-71041
31	Box Assem.—Command set pull	N.A.A.	88-71033
32	Resistor 50,000 ohms, 2 watt (1R.C.)	BT-2	
33	Resistor 500 ohms, 1 watt (1R.C.)	BT-1	
34	Resistor 390 ohms, 1 watt (1R.C.)	BT-1	
35	Condenser 25 mfd, 25 volt (Cornell Dubilier)	BR-252A	
36	Spacer—Interphone amplifier	N.A.A.	77-71101
37	Switch—Push button		
38	Switch	B-5A	
39	Terminal—Strip (Bendix)	2727	
40	Insulator—Terminal strip (Bendix)	3218	
41	Cap—Metal-covered cord grip (Hubbel)	9102	
42	Socket—Box connector	AN3102-18-5P	
43	Plug—Connector straight	AN3106-18-5S	
44	Box Assem.—R3002 control	N.A.A.	88-71089
45	Box Assem.—Interphone junct.	N.A.A.	88-71087
46	Box Assem.—Interphone rear	N.A.A.	88-71091
47	Box Assem.—R3002 plug junct.	N.A.A.	88-71088
48	Box Assem.—R3002 junct.	N.A.A.	88-71049
49	*Socket	199	10H/625
50	*Socket	108	10H/261
51	*Socket	185	10H/460
52	*Switch		21F/374
53	*Plug	172	10H/254
54	*Plug	174	10H/258
55	*Socket	105	10H/256
56	Plug (Breeze)	E1002-7-10	
57	Bulkhead Connector (Breeze)	E1156-7-10	
58	Plug (Breeze)	E1002-4-120	
59	Box Connector (Breeze)	E1003-4-30	
60	Plug (Breeze)	E1002-5-20	
61	Bulkhead Connector (Breeze)	E1156-5-20	
62	Plug	AN3106-28-2S	
63	Box—connector	AN3102-28-2P	
64	Condenser 1 mfd 600-volt (Cornell Dubilier)	DT-6P1	
65	Resistor 2 ohms, 1 watt (1R.C.)	BW-1	
66	Condenser 250 mfd, 25 V. (Cornell Dubilier)	BRH-2525	
67	*Amplifier—Interphone	BC-212-B	36B5857
68	*Amplifier—Interphone	BC-347-C2	
69	*Amplifier—Interphone	BC-347-C2	

CODING

1. All wires marked thus "+" are to be individually shielded.
2. Parts marked thus "*" are Government Furnished Equipment.
3. Flexible conduit identified by single circles with letter "F." Item numbers appear in double circles.
4. All wire and cables to be identified by wire numbers as per drawing numbers to be taped to each end of wire with numbered cellulose tape.
5. This drawing effective only on AT-6C and SNJ-4 airplanes.
6. Parts coded as follows effective on the listed airplanes:

CODING SYMBOLS

Serial No.	Through Serial No.	Changes Made
Army	*Army*	
41-32073	41-33072	
42-3884	42-4243	
42-43847	42-44325	
42-43922	42-44038	
42-44264	42-44299	
42-44326	42-44409	
42-48772	42-49069	
Navy	*Navy*	
05527	05674	
09817	10316	
26427	27851	
51350	51376	
51477	51526	
51527	51574	
51573	51676	
British	*British*	
EX-100	EX-808	
EX-809	EX-846	

WIRE TABLE

Wire No.	Gage	Length in Inches	Sta-Kon Terminals
501	20	63	A-87G
502	20	43	A-87G
503	20	42	A-87G
504	20	41	A-87G
505	20	42	A-87G
506	20	42	A-87G
507	20	47	A-87G
508	20	42	A-87G
509	20	39	A-87G
510	20	49	A-87G
511	12	30	—
512	18	30	—
513	12	13	C-25
514	12	18	C-25
515	20	48	A-87G
516	20	38	A-87G
517	20	58	A-87G
518	20	46	A-87G
519	20	41	A-87G
520	12	10	C-25
521	20	27	A-87G
522	12	36	—
523	20	12	A-87G
524	16	25	B-87G
525	20	103	A-87G
526	20	98	A-87G
528	12	87	C-25
529	20	89	A-87G
530	20	86	A-87G
531	20	83	A-87G
533	20	26	A-87G
534	16	28	B-87G
535	16	6	B-87G
536	16	6	B-87G
538	12	100	C-25
539	20	88	A-87G
540	20	44	A-87G
541	20	48	—
542	20	48	—
543	20	9	A-87G
544	20	18	A-87G
545	16	56	B-87G
546	20	34	A-87G
547	20	20	A-87G
548	20	43	A-87G
549	20	41	A-87G
550	20	48	—
551	20	42	A-87G
552	20	41	A-87G
553	16	33	B-87G
554	20	32	A-87G
555	20	32	A-87G
556	20	20	A-87G
557	20	20	A-87G
558	20	10	A-87G
559	20	7	A-87G
560	20	20	A-87G
561	20	17	A-87G
562	20	12	A-87G
563	20	42	A-87G
564	20	40	A-87G
565	20	41	A-87G
566	14	10	B-87G
567	12	14	C-25
568	20	26	A-87G
569	20	11	A-87G
571	20	21	A-87G
572	20	24	A-87G
573	12	14	C-25
574	12	14	C-25
575	20	131½	A-87G
576	16	18	B-87G
*577	W106	12	—
*578	W106	12	—
*579	W106	12	—
580	20	100	A-87G
581	12	100	C-25
582	20	99	A-87G
583	20	101	A-87G
584	12	102	C-25
585	12	63	C-25
586	12	62	C-25
587	20	9	A-87G
588	20	9	A-87G
590	20	44	A-87G
591	12	11	C-25
592	20	42	A-87G
593	20	44	A-87G
594	12	10	C-25
595	20	25	A-87G
596	20	41	A-87G
597	12	45	C-25
598	20	46	A-87G
599	12	47	C-25
601	20+	36	—
602	20+	33	—
603	20+	35	—
604	20+	34	—
605	20	35	—
606	18	8	A-87G
			A-85G
607	12	28	C-25
608	12	27	C-25
			A-87G
609	18	4	A-85G
610	18	24	A-87G
611	20	22	A-87G
612	20	33	
613	16	8	B-87G
615	20	27	A-87G
616	16	14	B-87G
617	20	22	A-87G
618	20	23	A-87G
619	20	20	A-87G
620	18	51	A-87G
621	12	53	C-25
622	12	51	C-25
623	20	48	A-87G
624	20	21	A-87G
625	20	9	A-87G
626	20	51	A-87G
627	20	26	A-87G
628	20	27	A-87G
629	20	28	A-87G
630	20	29	A-87G
631	20	40	A-87G
632	20	44	A-87G
633	20	40	A-87G
634	20	44	A-87G
635	12	28	C-25
636	18	28	A-87G
637	12	28	C-25
638	12	6	C-25
639	12	6	C-25
640	12	6	C-25
641	18	24	A-87G
642	18	24	A-87G
643	12	89	C-25
644	12	87	C-25
645	20	86	A-87G
646	12	86	C-25
647	12	81	C-25
648	20	83	A-87G
649	20	84	A-87G
650	20	83	A-87G
651	20	83	—
652	14	86	B-87G
653	20	90	—
654	20	90	—
655	20	101	—
656	12	101	—
657	12	101	—
658	20	101	—
659	20	101	—
660	20	101	—
661	20	7	A-87G
662	20	10	A-87G
663	20	8	A-87G
664	16	6	B-87G

b. 24-VOLT EQUIPMENT.

(1) DESCRIPTION. — *(See figures 323 through 326.)*

(a) GENERAL. — The communication equipment on the 24-volt airplane consists of radio set, SCR-274-( ), marker beacon equipment, RC-43-B, or RC-193-( ) two-place interphone equipment, RC-35, and the necessary cordage, flexible shafts, jacks, plugs, and miscellaneous equipment necessary for the proper functioning of the communication system as a whole. A single antenna is used for both receiving and transmitting, and an antenna relay provides a means of switching the antenna between transmitter and receiver. The command set consists of one transmitter and two receivers with the controls for both transmitter and receivers located on the right side of the front cockpit only. The rear cockpit interphone, however, may be switched to radio by means of a control shaft from the rear cockpit to the interphone control box in the front cockpit. A telegraph key on top of the transmitter provides a means of transmitting keying signals. The command set is controlled by push-button controls (push-to-talk switches) on the throttle quadrant arm and on the hand-held microphone in each cockpit. The push buttons are connected to the command set so that when either button is pressed, the command set will change from receive to transmit. Command set SCR-274-( ) is a short range communication system used principally for ship to ship or ship to field contact. A receiver mounting shelf is installed aft of the rear cockpit, and a receiver control box support is installed on the right side of the front cockpit to provide for the installation of SCR-515 and SCR-535 radio equipment. A list of radio equipment installed on the 24-volt airplane follows.

COMMAND SET SCR-274-( )

Transmitter Assembly

1 Transmitter, BC-696-A (3000 to 4000 kc)
1 Mounting, FT-232
1 Rack, FT-234
1 Plug, PL-154
1 Plug, PL-156
1 Tube Set consisting of:
2 Tube, VT-136
1 Tube, VT-137
1 Tube, VT-138

Receiver Assembly

1 Receiver, BC-453-A (190 to 550 kc) Includes: 1 Adapter, FT-230-A
1 Receiver, BC-454-A (3.0 to 6.0 mc) Includes: 1 Adapter, FT-230-A
2 Dynamotor, DM-32-A
1 Mounting, FT-279-A
1 Rack, FT-277-A
1 Plug, PL-147
1 Plug, PL-151
2 Plug, PL-152
2 Tube Set each consisting of:
3 tube, VT-131
1 Tube, VT-132
1 Tube, VT-133
1 Tube, VT-134

Transmitter Control Assembly

1 Control Box, BC-451-A
1 Mounting, FT-228-A
1 Plug, PL-153

Receiver Control Assembly

1 Control Box, BC-496-A Include: 1 Dial, MC-212 (190 to 550 kc)
1 Dial, MC-213 (3.0 to 6.0 mc)
1 Mounting, FT-240-A
2 Plug, PL-152

Antenna Relay Unit Assembly

1 Antenna Relay Unit, BC-442-A
1 Mounting, FT-229-A
1 Plug, PL-156

Antenna Equipment

4 Insulator, IN-81
1 Insulator, IN-84
1 Insulator, IN-88
40 ft. Wire, W-106-A

Modulator Assembly

1 Modulator, BC-456-A
1 Dynamotor, DM-33-A
1 Mounting, FT-225-A
1 Plug, PL-148
1 Plug, PL-151
1 Plug, PL-153
1 Plug, PL-154
1 Tube Set consisting of:
1 Tube, VT-135
1 Tube, VT-136
1 Tube, VT-139

Miscellaneous Items

4 Couplings, MC-211-A
1 Tuning Shaft, MC-215 (59 inches)
1 Tuning Shaft, MC-215 (61 inches)

MARKER BEACON RC-43-B or RC-193-( )

Receiver Assembly

1 Receiver, BC-357-B or BC-1033 or BC-1333
1 Mounting, FT-161
1 Plug, PL-108
1 Tube Set consisting of:
1 Tube, VT-104
1 Tube, VT-153

Antenna Assembly

3 ft. Cable, WC-549
1 Coupling, MC-227
1 Terminal, TM-201
1 Nut, M-275
1 Plug, PL-219
12 ft. Wire, W-106-A
2 Insulator, IN-88

INTERPHONE RC-35

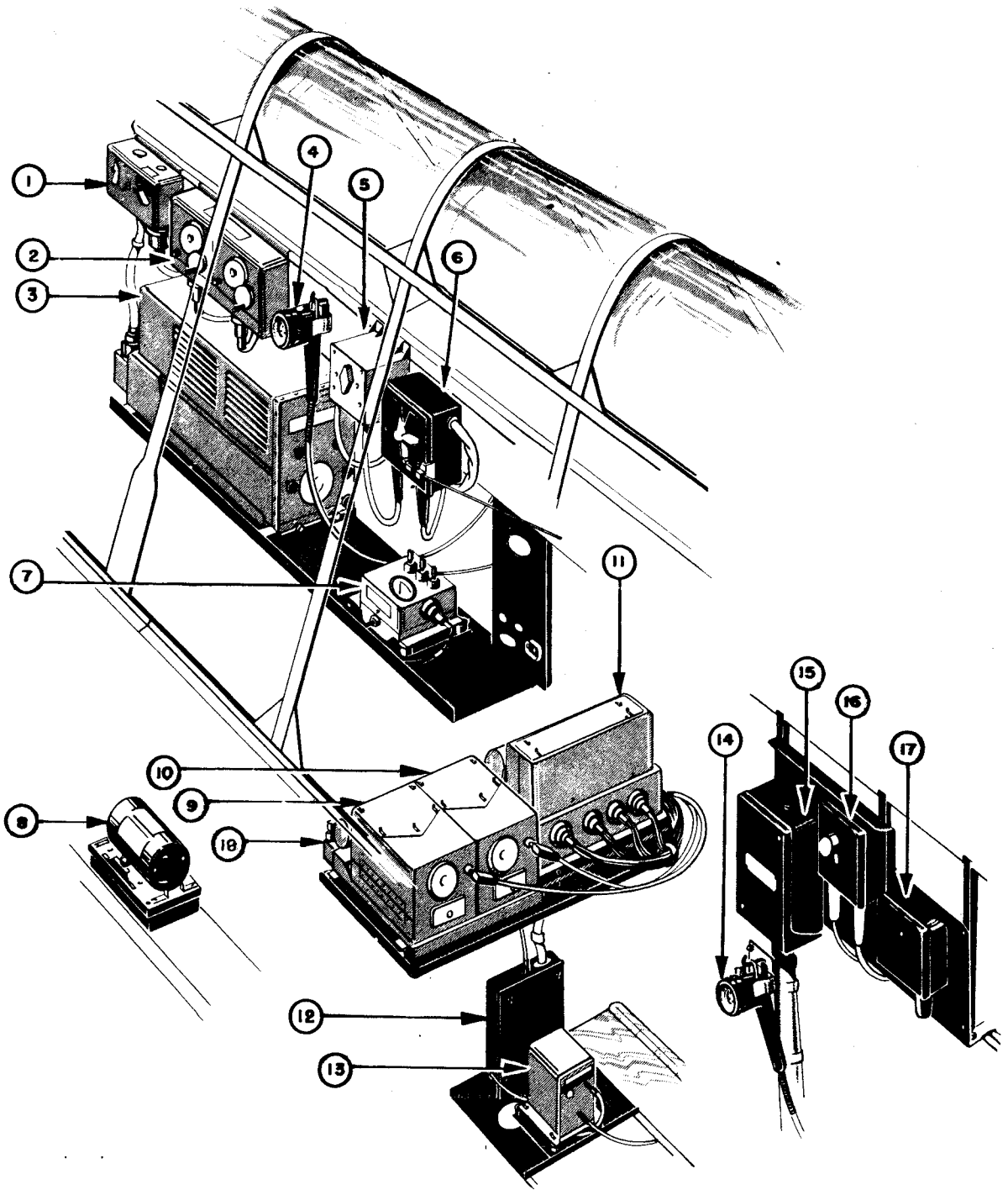
1 Interphone Amplifier, BC-347 Includes:
1 Tube, VT-99
1 Dynamotor Unit, PE-86-A
1 Interphone Control Box, BC-334
1 Interphone Box, BC-335
1 Control Box, BC-327
1 Control Shaft, MC-166
2 Microphone, T-17
2 Head sets, HS-23 or HS-33
2 Plug, PL-55
2 Jack, JK-26
12 ft. Cordage, CO-119-A

FILTER EQUIPMENT RC-198

1 Filter, FL-8

(b) RECEIVER EQUIPMENT.

1. RECEIVERS, — The two receivers, BC-453-A and BC-454-A, attached to rack, FT-277-A, mounted on shock absorber mounting, FT-279-A, are located on a shelf just below the rear cockpit instrument panel. A dynamotor for supplying plate power for the command receivers is mounted on the rear of each receiver. A covered fuse box mounted on the rack

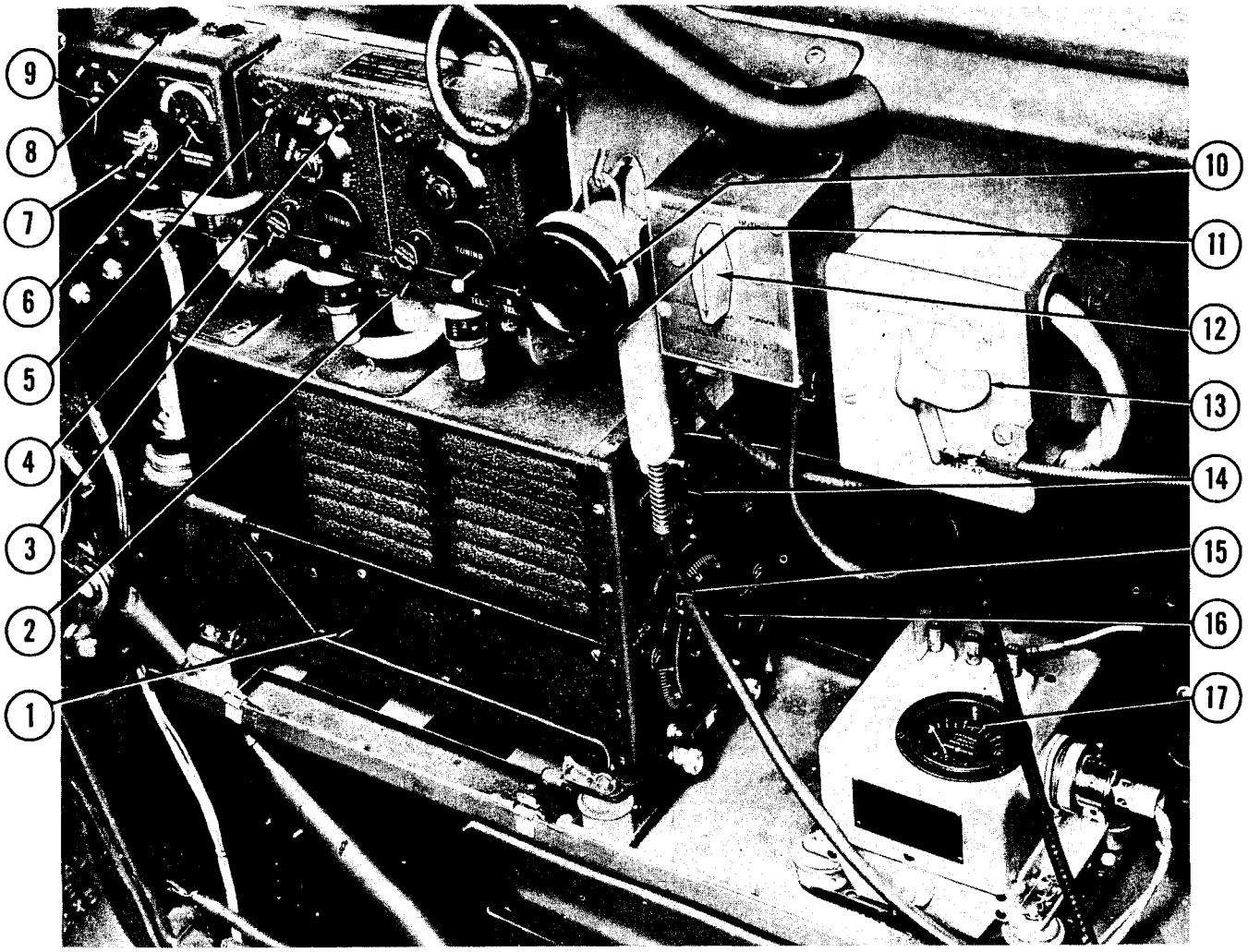


1. Transmitter Control Box
2. Receiver Control Box
3. Transmitter
4. Microphone-Type T-17
5. Filter Unit
6. Interphone Control Box
7. Antenna Relay
8. Interphone Dynamotor-Type PE-86
9. Receiver (3-6 mc)
10. Receiver (190-550 kc)
11. Modulator Unit
12. Radio Equipment Junction Box
13. Marker Beacon Receiver
14. Rear Cockpit Microphone-Type T-17
15. Interphone Amplifier
16. Rear Cockpit Interphone Control
17. Radio and Interphone Selector Box
18. Command Receiver Dynamotor-Type DM-32-A

Figure 323 — Radio Equipment — 24-Volt

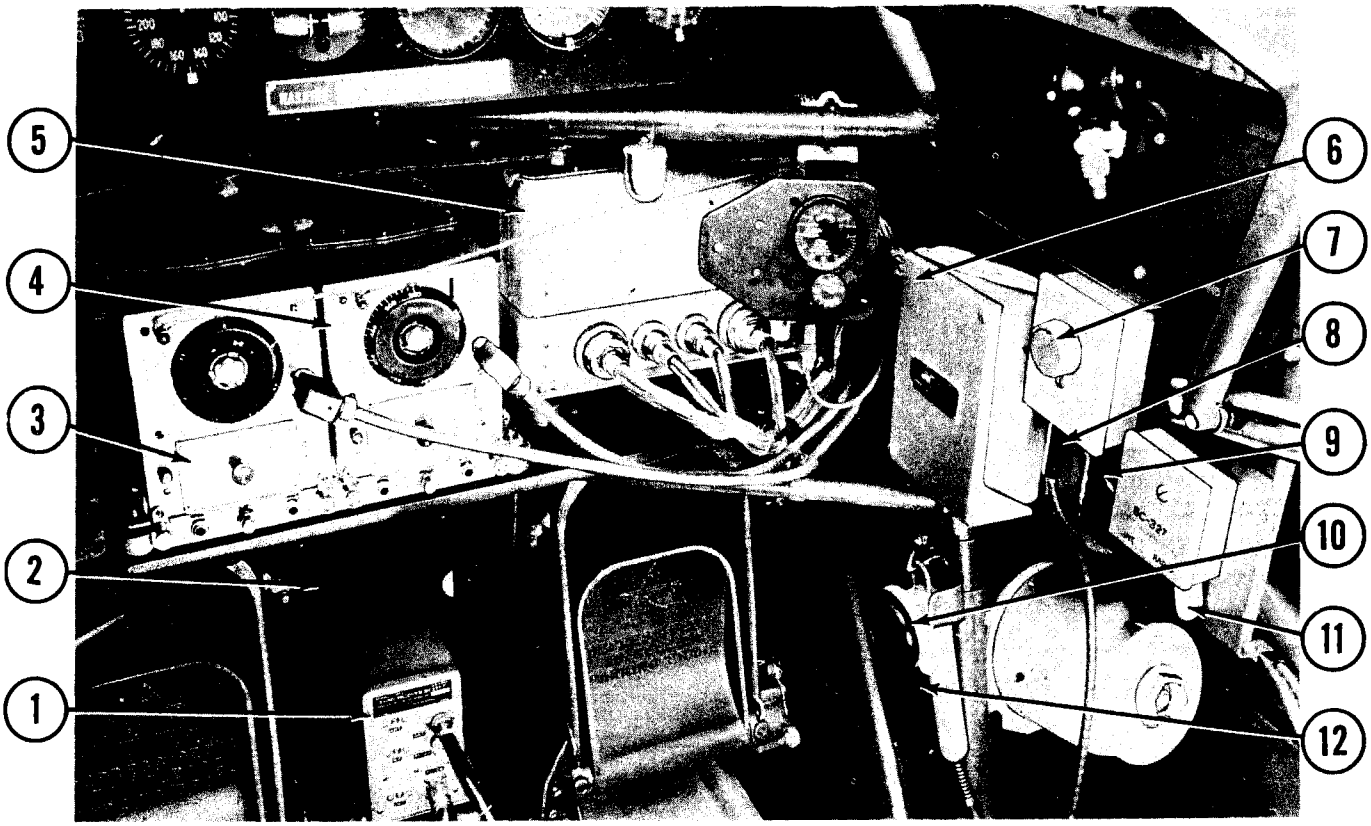
behind the dynamotors contains active and spare fuses for the dynamotor circuits. Primary power for operating the dynamotors is obtained from the 24-28-volt supply of the airplane. The receivers are designed for satisfactory operation over a range of 22- to 30-volts input. The receivers are remotely controlled from receiver control box, BC-496-A, mounted in the front cockpit.

2. RECEIVER CONTROL BOX. — The receiver control box, BC-496-A, is mounted on the right side of the front cockpit directly above the transmitter on FT-240-A mounting bracket. This control box is divided into two sections: one section has dial MC-212 for receiver BC-453-A (190 to 550 kc); and the other receiver has dial MC-213 for receiver BC-454-A (3.0 to 6.0 mc). The receiver control box in the front cockpit is connected to the receivers in the rear cockpit by tuning shaft MC-215 (59 inches) and tuning shaft MC-215 (61 inches). These shafts are connected to the receiver at one end and to the control box at the other end by means of type MC-211-A couplings. The receiver must be equipped with a type FT-211-A adapter when so connected for remote control. The receiver control box contains the following controls for each receiver: a "CW-OFF-MCW" switch, a tuning knob, a gain-control marked "INCREASED OUTPUT," and an "A-B" switch. Each receiver is independently controlled, and each control box contains two head set jacks marked "A-TEL." or "B-TEL." With the interphone installa-



1. Transmitter
2. Receiver Tuning Unit
3. Volume Control
4. Receiver "CW-OFF-MCW" Switch
5. "A-B" Switch
6. Transmitter Selection Switch
7. Transmitter Power Switch
8. Telegraph Key
9. Transmitter "TONE-CW VOICE" Switch
10. Hand Microphone
11. Microphone Switch
12. Filter Selection Switch
13. Radio—Interphone Switch
14. Antenna Inductance Control Dial
15. Antenna Coupling Control
16. Transmitter Tuning Control Dial
17. Antenna Current Meter

Figure 324 — Front Cockpit Radio Installation — 24-Volt



1. Marker Beacon Receiver
2. Radio Junction Box
3. 3-6 mc Receiver
4. 190-550 kc Receiver
5. Transmitter Modulator
6. Interphone Amplifier
7. Volume Control
8. Head Set Jack
9. Microphone Jack
10. Microphone
11. Radio—Interphone Switch
12. Microphone Switch

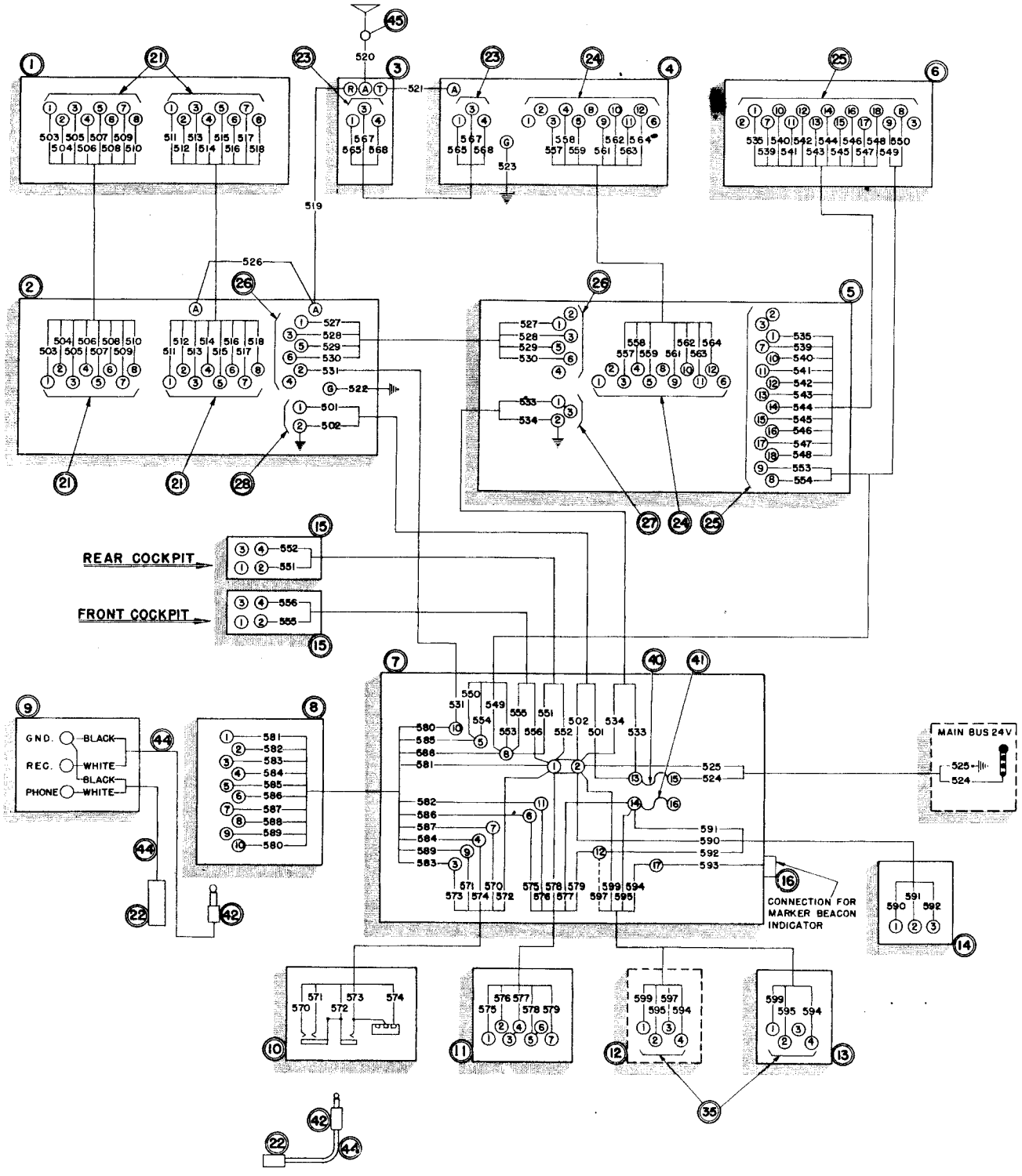
Figure 325 — Rear Cockpit Radio Installation — 24-Volt

tion, however, only the jacks in the interphone boxes are normally used, and the "A-B" switch is operative only at the "A" position.

(c) TRANSMITTER EQUIPMENT. — The transmitting equipment consists of radio transmitter, BC-696-A or BC-457-( ); dynamotor, DM-33-A, and modulator unit, BC-456-A, for supplying the high voltage dc and the modulating power for the transmitters; radio control box, BC-451-A, for control of the transmitters; and antenna relay unit, BC-442-A, for switching the common antenna between the receivers and transmitter. This equipment also includes the racks, mountings, cords, plugs, etc., necessary for the proper functioning of the receiving equipment as part of command set, SCR-274-N.

1. TRANSMITTER.—The BC-696-A or BC-457-( ) transmitter covering a range of 3000 kc to 4000 kc is attached to rack FT-234-A mounted on shock absorber mounting FT-232-A on the radio shelf at the right side of the front cockpit. There are three controls on the front of the transmitter: the "FREQUENCY" control knob in the lower right corner; the "ANT INDUCTANCE" control in the upper right section; and the "ANT COUPLING" control in the middle left section. The transmitter is also supplied with a special frequency checking circuit which includes a plug-in crystal resonator. This crystal circuit is used for checking the frequency at one point on the dial and not for controlling the frequency.

2. CONTROL BOX. — The transmitter control box, BC-451-A, is mounted on the right side of the front cockpit directly above the transmitter on mounting bracket, FT-228-A. This control box contains all the controls for operating the pretuned transmitter. The toggle switch marked "TRANS POWER" on the face of this box is for turning "ON" or "OFF" the primary power for the transmitting equipment. The three-position switch marked "TONE-CW-VOICE" controls the circuits which determine the type of emission from the transmitter. Only position No. 1 of the four-position transmitter selector switch is used as there is only one transmitter in the radio installation on this airplane. A data plate just above the switch is for marking the frequency to which the transmitter is tuned. A telegraph key on top of the box provides for transmitting keying signals when the three-way switch is in "TONE" or "CW" positions.



NOTE—This diagram is for reference only for AT-6D. For specific details refer to NAA Drawings 88-71002 or 121-71002. Refer to circuit diagram book NA 71005 for AT-6F models.

Figure 326 — Radio Wiring Diagram — 24-Volt

LEGEND — RADIO WIRING DIAGRAM — 24 VOLT

BILL OF MATERIAL

Item No.		Type No.	Spec. No.
1	*Plug	PL-156	
2	*Plug	PL-154	
3	*Plug	PL-153	
4	*Plug	PL-152	
5	*Plug	PL-151	
6	*Plug	PL-148	
7	*Plug	PL-147	
8	*Plug	PL-108	
9	*Control Shaft (61 in.)	MC-215	
10	*Control Shaft (59 in.)	MC-215	
11	*Coupling	MC-211-A	
12	*Control Shaft	MC-166	
13	*Insulator	IN-88	
14	*Insulator	IN-84	
15	*Insulator	IN-81	
⊗16	*Transmitter	BC-457-( )	
17	*Adapter	MC-385-C	
18	*Rack	FT-277-A	
19	*Rack	FT-234-A	
20	*Adapter	FT-230-A	
21	*Filter	F1-8-A	
22	*Dynamotor	DM-33-A	
23	*Dynamotor	DM-32-A	
◭24	Connector Assembly		36-71061-9
25	*Receiver Control Box	BC-496-A	
26	*Transmitter	BC-696-( )	
27	*Modulator Unit	BC-456-A	
28	*Receiver	BC-454-A	
29	*Reciever	BC-453-A	
30	*Transmitter Control Box	BC-451-A	
31	*Antenna Relay Unit	BC-442-A	
◐32	*Marker Beacon Receiver	BC-357-B	
33	*Antenna Wire	W-106-A	
◑34	*Receiver (Marker Beacon)	BC-1033	
35	*Dial	MC-213	
36	*Dial	MC-212	
37	Connector Assembly		97-71098
38	Antenna Assembly		82-71719
39	Mast Assembly		79-71027
40	Interphone Control Box	BC-334	77-71098
41	Interphone Volume Control Box (remote)	BC-335	77-71099
42	Microphone	T-17	77-71096
43	Interphone Control Box	BC-327	77-71093
44	Antenna Wire Assembly		88-71210-2
45	Antenna Wire Assembly		88-71210
46	Separator		73-71046
47	Clip		77-54188
48	Plug Cover		88-71209
49	Plug Cover		88-71208
50	Connector Assembly		36-71061-7
51	Connector Assembly		88-71299-5
52	Wiring Diagram		88-71202
53	Cable Assembly		88-71271
54	Connector Assembly		88-71299
55	Interphone Amplifier Box Assembly BC-347		88-71298
52	Dynamotor	PE-86	88-71297
57	Box Assembly (radio junction)		88-71241

CODING SYMBOLS

◐1. AC-42-44412 to AC-42-44588, 51715 to 51818, EX-847 to EX-908.

◑2. AC-42-44589 to AC-42-44728, AC-41-34127 to AC-41-34668, AC-42-84202 and subsequent serial numbers, 51822 to 52049, 43638 and subsequent serial numbers, EX-925 to EX-989, EZ-118 and subsequent serial numbers.

⊗3. Effective on all British alocated airplanes, beginning with EZ-259 radio receiver BC-457-( ) replaces BC-696-( ).

*4. Indicates government furnished equipment permanently installed.

WIRE TABLE

Wire No.	Gage	Length in Inches	Sta-Kon Terminals
501	18	28	A-85G
502	18	30	A-85G
503	18	59	
504	20	59	
505	20	59	
506	18	59	
507	20	59	
508	18	59	
509	20	59	
510	20	59	
511	18	62	
512	20	62	
513	20	62	
514	18	62	
515	20	62	
516	18	62	
517	20	62	
518	20	62	
519	16	51	
*520	W-106A	10	
*521	W-106A	10	
522	18	5	A-87G
523	18	5	A-87G
524	12	120	C-25
525	12	116	C-25
526	16	6	A-85G
527	20	37	
528	18	37	
529	18	37	
530	18	37	
531	20	25	A-85G
533	12	46	C-25
534	12	48	C-25
535	20	66	
539	18	66	
540	20	66	
541	20	66	
542	20	66	
543	20	66	
544	20	66	
545	18	66	
546	20	66	Sta-Kon
547	20	66	
548	18	66	
549	18	69	A-85G
550	20	73	A-85G
551	20	65	A-85G
552	20	64	A-85G
553	18	54	A-85G
554	20	58	A-85G
555	20	54	A-85G
556	20	52	A-85G
557	20	68	
558	18	68	
559	18	68	
561	20	68	
562	20	68	
563	20	68	
564	20	68	
565	20	43	
567	20	43	
568	20	43	
570	20	55	A-85G
571	20	54	A-85G
572	20	59	A-85G
573	20	51	A-85G
574	20	53	A-85G
575	20	56	A-85G
576	20	58	A-85G
577	18	54	A-85G
578	18	54	A-85G
579	20	58	A-85G
580	20	61	A-85G
581	20	57	A-85G
582	20	63	A-85G
583	20	59	A-85G
584	20	59	A-85G
585	20	63	A-85G
586	20	60	A-85G
587	20	60	A-85G
588	20	59	A-85G
589	20	60	A-85G
590	18	55	A-85G
591	18	54	Sta-Kon. Na-85G
592	20	55	A-85G
593	20	16	A-85G
594	20	18	A-85G
595	20	21	A-85G
◐597	20	22	A-85G
599	20	22	A-85G

(d) INTERPHONE EQUIPMENT.—The RC-35 two-place interphone equipment consists of an amplifier, a filter, and a dynamotor, with interphone control boxes and microphones in both cockpits. The BC-347 amplifier is installed on the right side of the rear cockpit and the FL-8 filter unit is mounted on the right side of the front cockpit. The function of the interphone amplifier is to amplify the interphone messages so that they may be heard with ease; the function of the filter is to separate voice and range signals. The PE-86-A dynamotor is installed on the hydraulic shelf at the left side of the front cockpit. Interphone control box BC-334, installed on the right side of the front cockpit, is connected by control shaft MC-166 to control box BC-327 in the rear cockpit. This provides a means of switching the rear cockpit interphone to radio by remote control. Interphone control box BC-335 is installed on the right side of the rear cockpit to provide a means of radio volume control for the rear cockpit interphone. The T-17 microphones are held in a bracket attached to the right side of each cockpit. Push-to-talk buttons are installed on the handle to the microphones and also on the throttle quadrant arm in each cockpit. The push-to-talk buttons may be used as a key for transmitting code when the control box switch is turned to "CW" or "TONE" positions.

NOTE

Head set adapters to modify radio equipment for use with low impedance head sets are included in later AT-6D and SNJ-5 airplanes.

(e) ANTENNA SWITCHING RELAY.—The antenna switching relay unit, BC-442-A, is mounted on shock absorber mounting, FT-229-A, just aft of the transmitter, on the radio shelf at the right side of the front cockpit. This antenna relay unit provides a means of switching the common antenna between the receivers and the transmitter. This relay is operated simultaneously with the high-voltage keying relay in modulator unit BC-456-A and will ground the antenna lead to the receivers, during transmission.

(f) ANTENNA EQUIPMENT.—The W-106-A antenna wire for both the transmitter and the receivers extends from the top of the rudder to the antenna mast located forward and to the right of the windshield. The antenna wire is brought into the fuselage at the right side of the front cockpit. A spring-type shock connector and an insulator are installed between the antenna wire and the rudder attachment point to maintain an initial wire tension of 15 pounds (plus or minus ½ pound).

(g) MARKER BEACON EQUIPMENT.—The radio marker beacon equipment consists of a receiver and antenna equipment supplied by power from the same dynamotor supplying the interphone equipment. The BC-357-B receiver is mounted between the rudder pedals in the rear cockpit on mounting, FT-161, attached to the support between the floor boards. The antenna for the marker beacon equipment is mounted on short masts underneath the wing center section of the fuselage, extending fore-and-aft along the center line of the airplane. A marker beacon signal indicator light is installed on the instrument panel in the front cockpit only. In the AT-6F the light is located on both instrument panels. The marker beacon receiving equipment will enable the pilot to determine when he is flying over a 75-megacycle marker transmitter. This transmitter may be of the Army instrument landing type or a cone of silence or fan marker found along commercial airways. The receiver will respond to any 75-megacycle signal, which is horizontally polarized and modulated at an audio rate. The sensitivity of the receiver increases as the modulation rate increases, up to 3000 cycles. A signal many times greater is required at 60-cycle modulation than at 3000-cycle modulation to give normal output. This receiver was designed because the 60-cycle modulating transmitter used in some of the Army instrument landing systems is too powerful to use with the sensitive receiver required for cone of silence operation. The indicator lamps will give the pilot a visual signal in accordance with the output of the receiver. When the receiver is over a keyed transmitter, such as a CAA marker or cetrain types of Army transmitters, the indicator lamp will identify the transmitter by flashing in definite sequence.

On AC-42-44588, 51825, EX-925, and subsequent airplanes, the RC-43-B marker beacon equipment was changed to RC-193 marker beacon equipment. The latter unit is self contained and operates entirely on a 24-28-volt power supply and does not require a dynamotor for its grid voltage. This change was made to reduce the current load on the PE-86-A interphone dynamotor which heretofore supplied the grid voltage for the marker beacon equipment.

(2) MAINTENANCE. — The operation, maintenance, and repair of radio equipment is of a highly specialized nature. First and second echelons of communication maintenance personnel should not attempt any maintenance not recommended in this section or the inspection section of this book except in emergency.

WARNING

Dynamotor DM-33-A on the modulator unit of this radio set generates 600 volts, dc. This is sufficient to cause severe shock or even death. Make absolutely certain that the dynamotor is not running before making any adjustment whatever, with the exception of tuning up the transmitters.

Opening up the tube covers on the transmitters and modulator unit exposes the high voltage plate connections to the top caps of tubes, VT-136. These covers are safety-wired in place at the time of installation. Do not attempt to connect or disconnect a transmitter or a power plug while dynamotor DM-33-A is running. Do not depend alone upon hearing the dynamotor or upon observing the several switch

positions to determine whether the dynamotor is running—feel it. In tuning up the antenna circuit of the transmitters, be careful to avoid touching the antenna when the power is on, as severe, irritating burns will result. Warn anyone who may be working near antenna of your intention to turn on the power. Dynamotor DM-32-A on each of the receivers generates 250 volts dc. The danger of exposure to this voltage must not be ignored. Make certain that all control switches are OFF before performing any adjustment to the equipment other than antenna alignment.

(3) TROUBLE SHOOTING.—The following list is not intended to be complete, as it only takes up troubles due to external causes. No internal adjustments of individual units should be made by unauthorized personnel. If the unit is found to be defective it should be removed and sent to the Signal Corps Radio Section of the proper air depot for overhaul.

Trouble	*Possible Cause*	*Remedy*
RECEIVER OR TRANSMITTER FAILS TO OPERATE OR OPERATES IMPROPERLY.	1. Switches off or faulty.	1. Check to see that switches are "ON". Check to see that proper current is reaching switch terminals. If current is OK, remove switch and replace or repair.
	2. Loose or poor connections and plugs. Open fuses or circuit breakers.	2. Check and fasten securely; repair or replace. Replace open fuses or reset circuit breakers.
	3. Battery voltage low.	3. Check terminals for corrosion. Check cell voltages and charge. Charge or replace if necessary.
	4. Dynamotor not operating properly.	4. Check supply circuit fuse. Check brushes to determine that they are making proper contact with the commutator. Remove bottom plate of the modulator unit and examine contacts on relay K-50. Clean them, if necessary, using fine sandpaper. (Emery cloth should not be used.) If dynamotor still fails to operate or runs at too low a speed, replace it with one known to be in good condition.
	5. Antenna not in good condition or improperly connected.	5. Check condition of wiring. Replace if necessary. Check to see that all connections are tight and properly made. Check insulators and make sure that antenna is not grounded.
	6. Poor or broken ground connections.	6. Check to see that ground circuits are complete and that connections are tight and properly made to transmitter and receiver racks.
	7. Faulty receiver unit.	7. Interchange plugs PL-152 connecting the receivers to their respective control units and see whether the fault is in the receiver or the control unit. (See step 9.)
	8. Faulty transmitter unit.	8. Use the same procedure as step 7, to determine whether fault is in the transmitter, its control circuit, or rack connection. (See step 9.)
	9. Defective vacuum tubes.	9. If receiver or transmitter is determined to be at fault in steps 7 or 8, try replacing vacuum tubes one at a time, using proper tubes that are known to be in good condition. If necessary, replace all tubes with good ones and then reinsert old tubes one at a time to determine which ones are defective. Several tubes may burn out at one time.

Trouble	*Possible Cause*	*Remedy*
(Continued) RECEIVER OR TRANSMITTER FAILS TO OPERATE OR OPERATES IMPROPERLY.	10. Faulty modulator unit.	10. If transmitter operates properly on "CW", switch to "TONE". If normal sidetone operation is observed on "TONE" but antenna circuit meter indicates the antenna current is below normal, the trouble is probably due to a fault in the modulator tube or its associated circuits. Replace tube. If this does not help, the modulator itself is probably at fault. Replace it.
	11. Faulty microphone circuit.	11. If transmitter operates normally on "CW" and "TONE" but the "VOICE" sidetone is weak or absent and the antenna current does not increase during speech, check the microphone circuits, switches and connections. Correct as necessary.
ELECTRICAL NOISE AS OF MOTOR RUNNING OR EXCESSIVE MACHINE STATIC IN RECEIVER.	1. Loose connections in receiver unit or circuits.	1. Check all terminal connections and ground wires.
	2. Cable and set shields not grounded properly.	2. Check and fasten all shield ground connections properly.
	3. Bad brushes on commutator of dynamotor or generator.	3. Check to see that brushes are making proper contact with commutators and that there is no excessive sparking or arc in their operation.
	4. Frequency filters on ignition system or voltage regulator circuit shorted out or defective.	4. Replace filter condensers and check circuits to determine that they are not improperly grounded.
NOISY OPERATION OF RECEIVER (OSCILLATION).	1. Contacts on tuning condenser dirty.	1. Clean and tighten.
	2. Receiver aligned too sharply.	2. Realign.
ANTENNA FAILS TO LOAD PROPERLY.	1. Antenna grounded.	1. Check and clean.
	2. Antenna open.	2. Check and repair.
	3. Meter burned out.	3. Check; replace relay.
	4. Antenna relay condenser faulty.	4. Replace condenser. Check for faulty relay and replace if necessary.
	5. Transmitter at fault.	5. Check transmitter as above and replace if necessary.

17. PHOTOGRAPHIC EQUIPMENT.

a. GENERAL. — *(See figure 327.)* — Provisions are made in all AT-6C and SNJ-4 (Navy) airplanes for the installation of a K-3B aerial camera, type A-8 camera mount, type A-2 viewfinder, type B-2 intervalometer, camera power junction box, camera vacuum valve and a warning light. All provisions for installing the K-3B camera and vertical photographic equipment have been removed on the later airplanes.

CAUTION

Only photographic section personnel should remove or disassemble any of the items of actual photographic equipment, such as the viewfinder, cameras, camera lens cones, film magazines, etc.

b. CAMERA AND CAMERA MOUNT.

(1) DESCRIPTION.

(a) Support rails for the camera mount are located at the bottom of the fuselage, immediately aft of the rear cockpit.

(b) The K-3B Camera is designed for making both oblique and vertical photographs and produces a

7 x 9 negative. However, in AT-6 series airplanes provisions are made only for vertical photography. The K-3B camera may be operated either manually or automatically by simply adding or removing certain camera accessories. When operated automatically, the camera is driven by a motor that derives its power from the storage battery. With the exception of the action of the vacuum system, it then becomes an entirely electrically operated photographic unit through the electric cable connections of the power supply box to the intervalometer and the camera, and the connection of the camera and intervalometer.

(c) A selector valve in the vacuum system regulates the vacuum action that holds the film to the focal plane contact glass. The intervalometer which governs the automatic operation of the camera provides for exposures from 6 to 75 seconds apart. Electric cables make the connections between the camera, intervalometer, signal lights, and the electric power. Two signal lights, one on the power junction box and one on the pilot's instrument panel, are connected to the intervalometer and warn the pilot and camera operator to level the airplane and the camera for the next exposure. The shutter-retard regulator located on the camera body may be adjusted for speeds of 1/30, 1/50, 1/100, and 1/150 of a second. When the camera is operated manually, the winding is done by using the manual wind; and the tripping, by using the trip lever located on the right side of the camera body. The interval of time between exposures may be timed by using the speed timer.

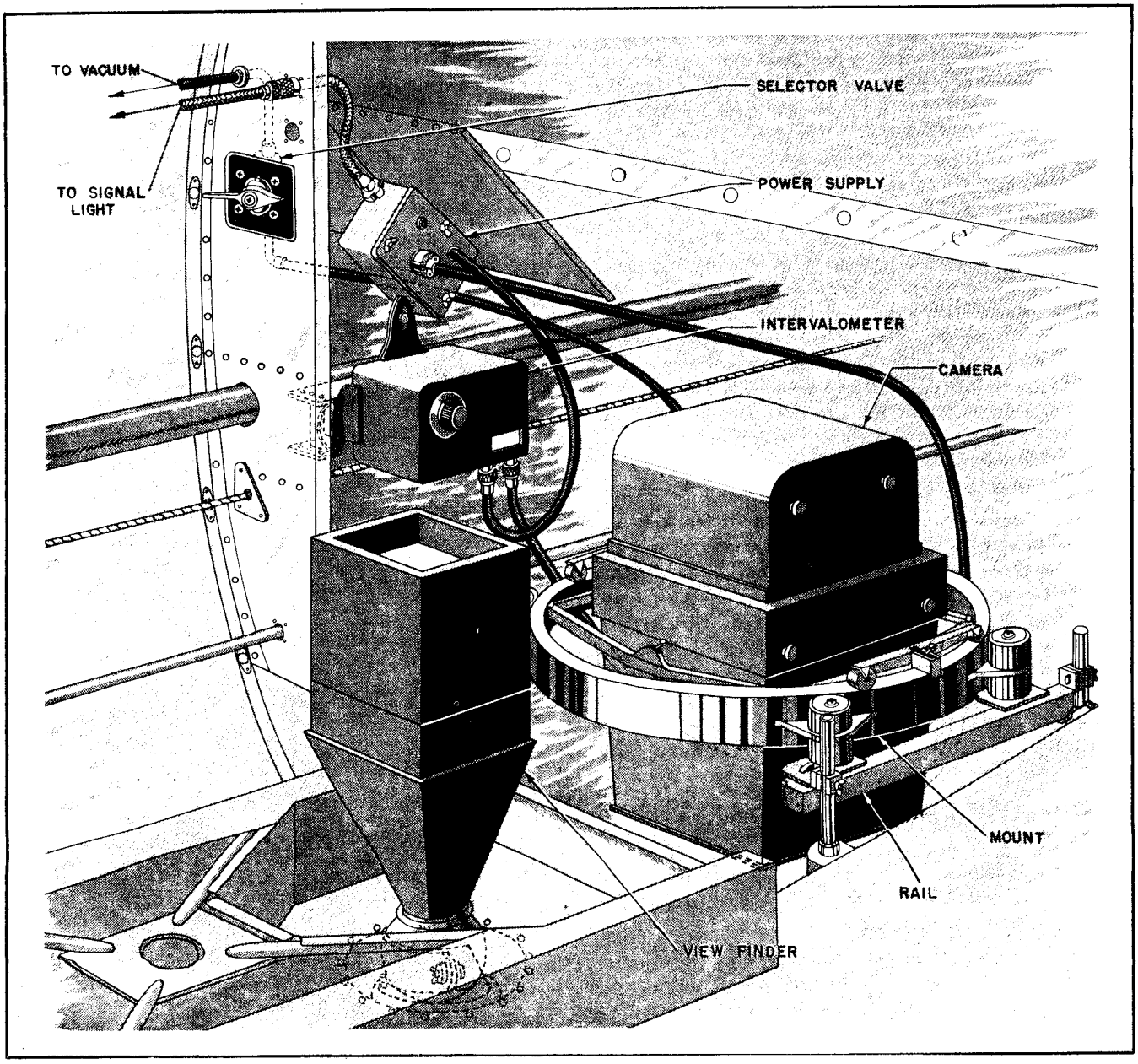


Figure 327 — Photographic Equipment

(d) The type A-1A roll film magazine is used with the K-3B aerial camera. It is detachable and light-tight when not attached to the camera. The number of photographs that can be made on a single flight is limited only by the number of fully loaded extra magazines carried. When necessary, the type A-1A roll film magazine may be replaced by the type B-1 cut-film magazine for use with 8 x 10 cut-film holders.

(e) The lens cone containing the lens and shutter is detachable and interchangeable with lens cones containing lens of other focal length. Provisions are made for the use of either a 12-inch cone or an 8¼-inch cone; no adjustment is necessary after attaching either lens cone, as it will be in focus as soon as it is in place. Only a few minutes are required to remove one lens cone and replace it with another. The lens and shutter assembly of each lens cone is a standard unit by itself and can be interchanged with other lens and shutter assemblies containing a lens of the same focal length. Trunnions are provided on each lens cone so that the camera can be suspended in a standard camera mount that is supplied for use when taking vertical aerial photographs.

(2) INSTALLATION.

(a) To install the camera, remove the rear control stick and instrument flying hood, if installed, and place the control stick in the stowed position. Rotate the seat to the aft position. Raise the baggage compartment bottom; secure it to the baggage compartment rear bulkhead by means of the strap provided. Position the camera support rails for the size lens cone to be used. The top position of the rails is used when operating the camera with a 12-inch cone; the bottom position is used when operating with an 8¼-inch cone.

(b) The type A-8 camera mount is installed on the camera support rails by positioning the mount so that the bolts beneath the corners of the mount will go into the keyhole slots provided for them at the top of the camera support rails. Push the mount forward to lock it in position. To remove the mount, depress the spring-loaded catch lock just aft of each of the two rear keyhole slots, slide the mount back, and lift it off the rails. The mount acts as a gimbal ring, leveling the camera during flight. The camera is orientated by means of a horizontal vernier scale on the mount.

(c) The following camera connections are applicable:

1. Connect the camera to the large outlet in the camera junction box by means of the camera power cable.

2. Connect the intervalometer to the camera by means of the camera-to-intervalometer cable; insert the bayonet plug of the intervalometer-to-warning light cable in the small socket in the camera power junction box.

3. Connect the camera to the vacuum connection tube by means of the camera vacuum hose.

4. See that all connections are securely made and that the cables are laid in such a manner that sufficient slack is allowed for free operation of the equipment.

5. When a cable is not connected, it should be coiled and secured so that it will not interfere with the operation of other equipment.

NOTE

When the vacuum connection is not used, the vacuum selector valve must be placed in the "OFF" position.

(3) MAINTENANCE.

(a) GENERAL.—When not in use, the camera and its accessories should be kept in the carrying cases provided for them. This prolongs the life of the camera, preventing damage from dust, grit, and other foreign matter. The camera should be given a general inspection before use to make sure that everything is in its proper place and is operating properly. Handle the camera and its accessories carefully, as they are precision instruments.

(b) CLEANING THE LENS.—For the best results, the lens must be clean at all times. Before each flight both surfaces should be wiped with a soft lintless cloth. Under no circumstances should water or liquid of any kind be used. If rubbing with a dry cloth is not sufficient, it may be necessary to moisten the surface of the lens by breathing on it.

(c) CLEANING THE MAGAZINE CONTACT GLASS. — The magazine contact glass must be kept clean, and all grit and dust must be kept from between the contact glass and the film. Before the magazine is attached each time, both sides of the glass should be thoroughly cleaned with a soft lintless cloth.

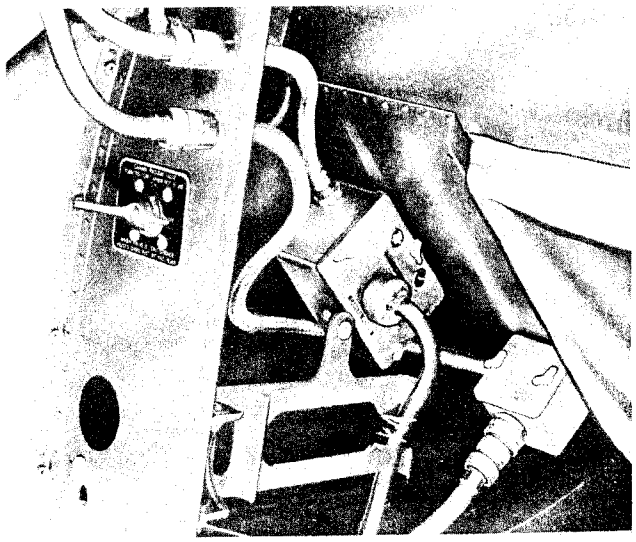


Figure 328 — Camera Controls

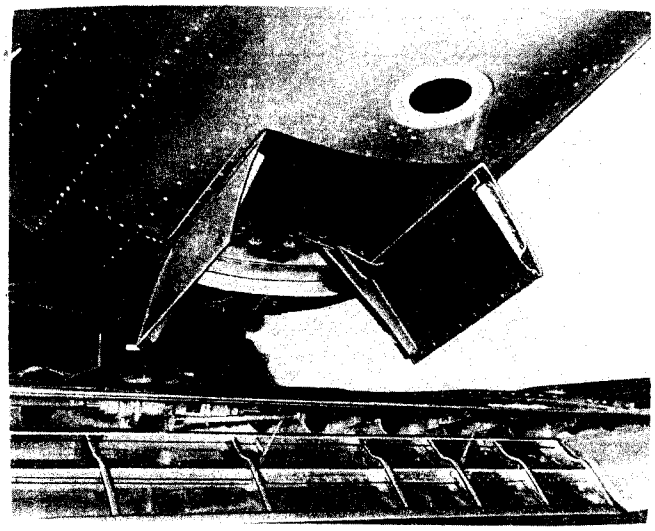


Figure 329 — Camera Doors

The inside of the glass should be cleaned each time the magazine is loaded.

c. CAMERA DOORS.—On early airplanes two camera doors are provided in the bottom of the rear fuselage below the baggage compartment. They are attached to longerons at each side of the door by full length hinges. To open or close the camera doors, push down on the knob-type door handle; then push or pull the handle with a quick firm movement to engage the doors in an open or closed position. These doors are sealed shut in airplanes that do not have provisions for installing photographic equipment.

d. VIEWFINDER.

(1) DESCRIPTION. — The purpose of the type A-2 vertical viewfinder is to give a clear and distinct view of objects beneath the airplane and to provide accurate means for determining correct exposure intervals. It is installed in the floor of the front fuselage immediately aft of the rear cockpit seat. Secure the cover plate over this opening when the viewfinder is not installed.

(2) INSTALLATION.—Insert the three attaching lugs in the holes in the installation ring with the locking knob forward. Rotate the entire assembly in a clockwise direction, and turn locking knob to secure.

e. INTERVALOMETER.—The type B-2 intervalvometer is an instrument for automatically operating the camera at any predetermined interval and is electrically operated. It is installed by mounting on a bracket secured to the right side of the rear fuselage structure aft of the right forward bulkhead.

f. POWER JUNCTION BOX.

(1) DESCRIPTION. — The power junction box which supplies the power connection for the camera, the intervalometer connection, and camera signal lights is attached by clamps to the fuselage immediately above the intervalometer.

(2) REMOVAL.—To disassemble and remove the camera power junction box, consult the electrical diagram in the map and data case.

g. WARNING LIGHT.—A warning light located on the camera junction box and on the front instrument panel flashes 3 seconds before each exposure when the intervalometer is in use.

h. VACUUM VALVE. — The vacuum valve is installed on the right side of the fuselage aft of the rear cockpit.

i. GUN CAMERA. — An electrically operated type W-7B gun camera, suitable for fixed operation only, may be installed in the inboard end of the outer wing

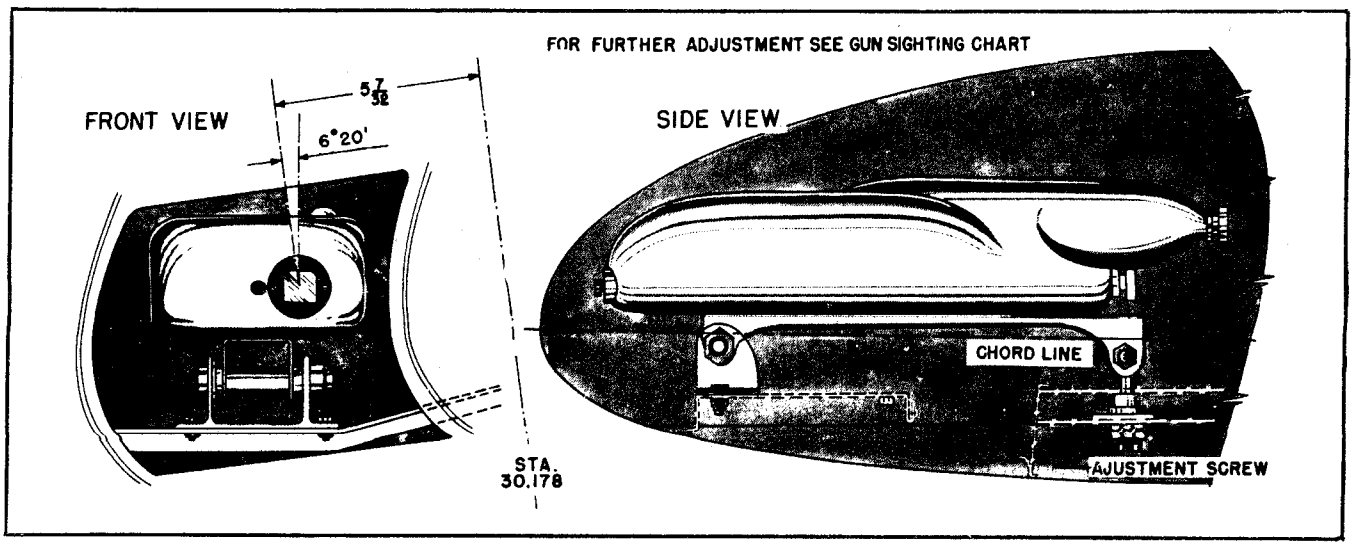


Figure 330 — Fixed Gun Camera Installation

leading edge on earlier AT-6 series airplanes. A gun camera safety switch is provided on the front cockpit control panel; when it is in the "FIRE" position, the camera automatically operates when either or both fixed gus are fired. A solenoid in the camera circuit is built into the rear of the gun camera itself. Provisions for installation include a bracket immediately aft of the camera opening in the leading edge for mounting the forward camera attachment, a rear connector assembly, and all the wiring and electrical fixtures and connections required for operation. The rear connector assembly provides for horizontal and vertical adjustment and is reached by removing an access plate in the bottom of the wing surface immediately below this assembly. Late airplanes are equipped with provisions for mounting a standardized type N-2 G.S.A.P. instead of the wing gun camera. This camera attaches to a sheet steel plate mounted on the N-3B gun sight. The camera-gun sight unit is attached to the front cockpit windshield cowl by means of a ball-and-socket-clamp. This permits the unit to rotate, within limits, about the horizontal and vertical axis, affording easy adjustment of the camera-gun sight unit for sychronizing with the gun angle of attack. Operation is identical to the wing-installed camera.

18. BOMBING EQUIPMENT.

a. GENERAL.—Complete provisions have been incorporated in the airplane for a flush-type bomb rack and other bombing equipment on the lower surface of each outer wing panel (not on AT-6, AT-6A, and AT-6F airplanes). Bomb equipment kits provide the necessary bomb racks, shackles, cables, and bombing control equipment. The bomb racks in each outer wing panel will carry five M-5, 30-pound fragmentation bombs, or five M-41, 20-pound fragmentation bombs, either U.S., or British. Two auxiliary bomb shackles may be added to each of these racks for carrying a total of four Mark 1, 100-pound bombs, either U.S. or British, in place of the smaller bombs. The smaller bombs are armed at the nose only, and the 100-pound bombs are armed at the tail by arming levers on the bomb rack. Four type B-1 bomb arming units are provided in the wing to nose-arm the 100-pound bombs. Electrical control switches, which consist of one bomb safety switch, two bomb selector switches, and one nose fuse switch, are grouped on the pilot's electrical control panel in the front cockpit. The bomb safety switch, when "OFF," prevents accidental electrical release of the bombs. The switch must be "ON" before any electrical release can be accomplished. The bomb selector switches provide selection of the rack to be employed. "LEFT" or "RIGHT," or "LEFT" and "RIGHT" can be used as desired. The nose fuse switch operates the four type B-1 bomb arming units to nose-arm the 100-pound bombs. A signal lamp adjacent to this switch will glow when the 100-pound bombs are nose-armed. Release of the bombs, as selected, is accomplished by the push-button type thumb switch located on the control stick in the front cockpit. Bombs may be dropped selectively by pushing the control stick release button consecutively. The

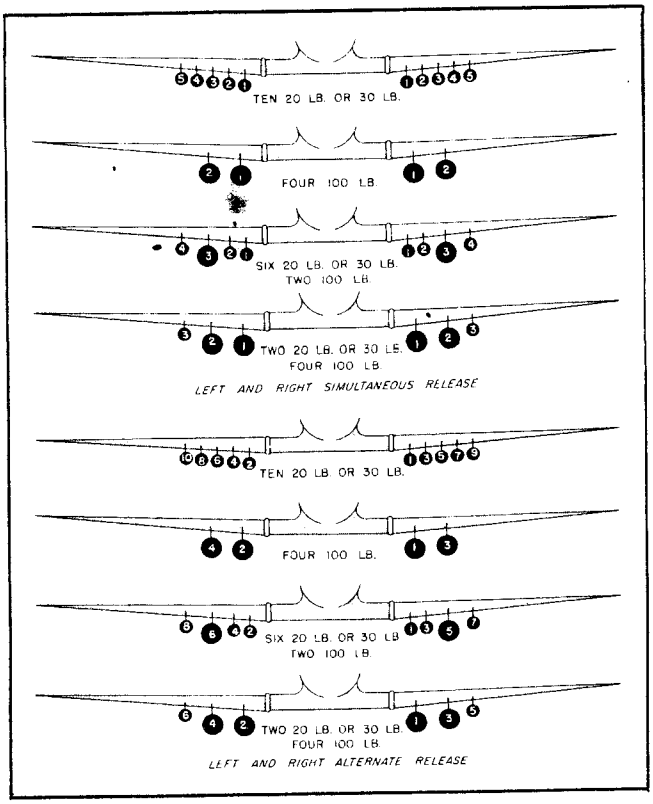


Figure 331 — Bomb Release Order Diagram

bombs are released in a definite order (figure 331), from inboard to outboard and on alternate sides of the airplane when both racks are used together. The bomb selector circuits and the nose fuse circuits are protected from current overloads by integral toggle-type circuit breakers. The bomb safety switch circuits and the firing switch circuits on the control stick are protected from current overloads by the push-button type circuit protector ("ARMAMENT CONT. — PUSH-TO-RESET") located just above the pilot's control shelf and to the left of the electrical control panel. Provisions are made for a bomb control quadrant (figure 332) on the con-

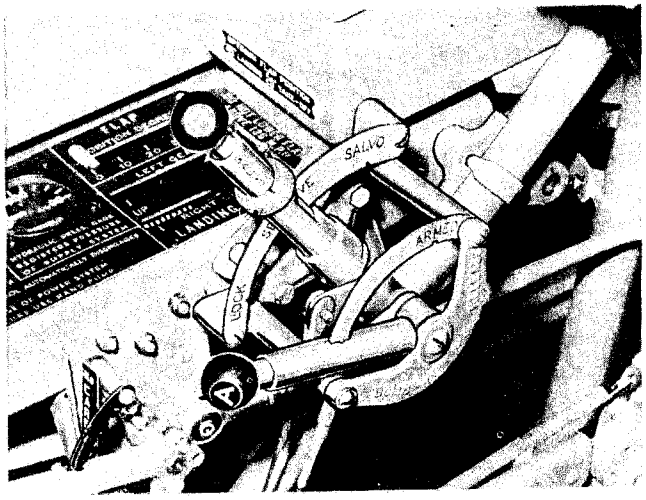


Figure 332 — Bomb Control Quadrant — Front Cockpit

trol shelf on the left side of the front cockpit. This quadrant provides an arming and release handle, stamped "A" and "R," respectively. The arming handle, by means of a cable to each of the wing bomb racks, will arm the 20-and 30-pound bombs at the nose, and the 100-pound bombs at the tail. Except for nose-arming the 100-pound bombs, which is accomplished by the toggle switch on the electrical control panel, all arming must be done through this arming handle. The release handle, when at "LOCK" position, locks the entire system and will prevent release, either electrically or manually, of all bombs. The handle must be moved to "SELECTIVE" position before electrical release can be accomplished. In moving the release handle to "SALVO," all bombs are dropped simultaneously, either in the armed or safe condition according to the setting of the arming handle and the electrical toggle switches on the control panel. Provision is also made for a release handle in the rear cockpit (figure 333) beneath the control shelf on the left side, which will only SALVO all bombs. This is for use in an emergency and will release bombs either in the safe or armed condition, according to the position of the arming handle and the electrical toggle switches in the front cockpit.

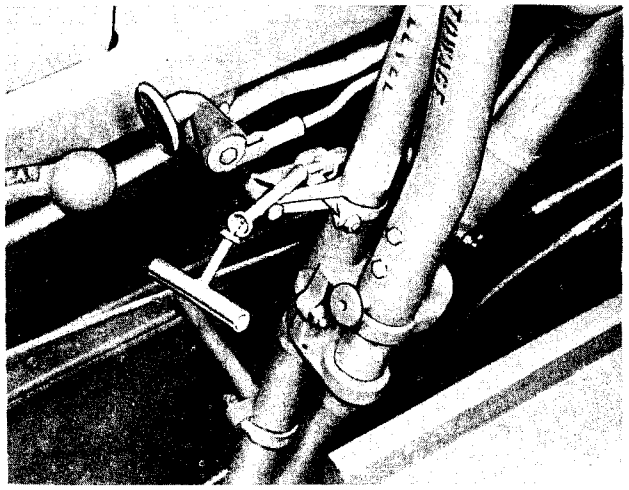


Figure 333 — Bomb Salvo Handle — Rear Cockpit

b. BOMB RACKS.

(1) DESCRIPTION.—The bomb rack bays are located within the lower surface of each outer wing panel. The bays are sealed with an Alclad cover plate when the racks are not installed and protected by an Alclad cover plate with cut outs, allowing for the bomb support hooks and charging cable, when the racks are installed. The bomb rack can be operated selectively with the electrical bomb release switch on the pilot's control stick or in salvo with the manual bomb release handle in the front cockpit.

(a) TYPE NA 84-63005 BOMB RACKS.—*(See figure 334.)*—On earlier models of this airplane, a 12-volt electrical system is employed. The bomb racks installed therein are designed for use only in a 12-volt electrical system. The bomb rack mechanism is illustrated in figure 335. There are five such units in each rack.

1. LOCK POSITION.—The bomb is carried by the bomb support hook "D," which is held in the closed and locked position, as illustrated in view "A," by the notch of the spring-loaded trigger "H." Movement of the release pin "J" is controlled by the bomb release rod, which, in turn, is connected by a cable to the release handle of the bomb control quadrant in the front cockpit. When the release handle is placed in "LOCK" position, the release pin "J" will engage the notch in the bomb support hook "D," thus preventing its rotation about pivot point "K." At the same time, the movement of the bomb release rod will depress a micro-switch, which will break all electrical connections to the rack. This will prevent release, either manually or electrically, of the bomb load.

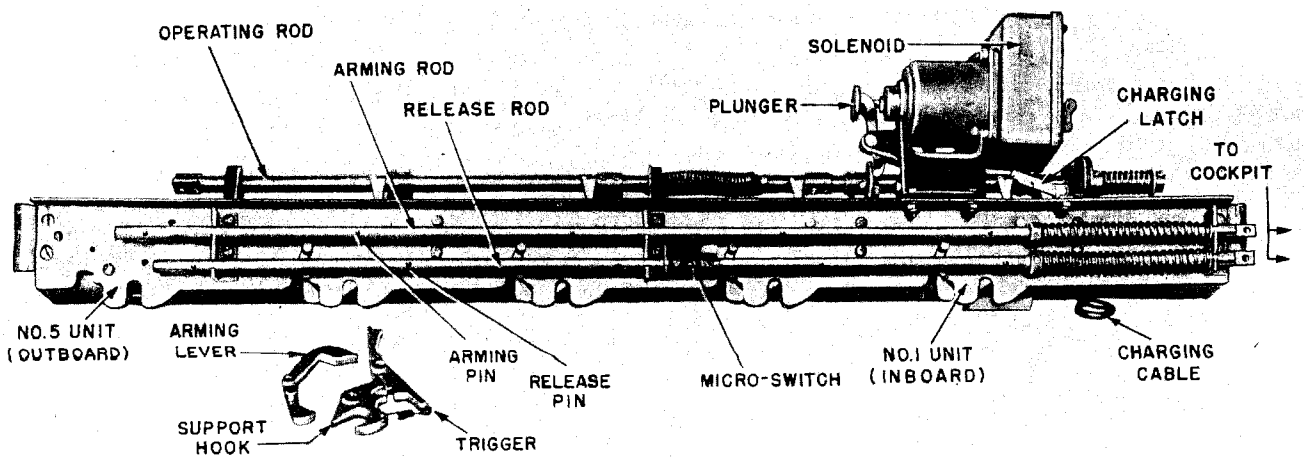


Figure 334 — Bomb Rack (Type NA 84-63005)

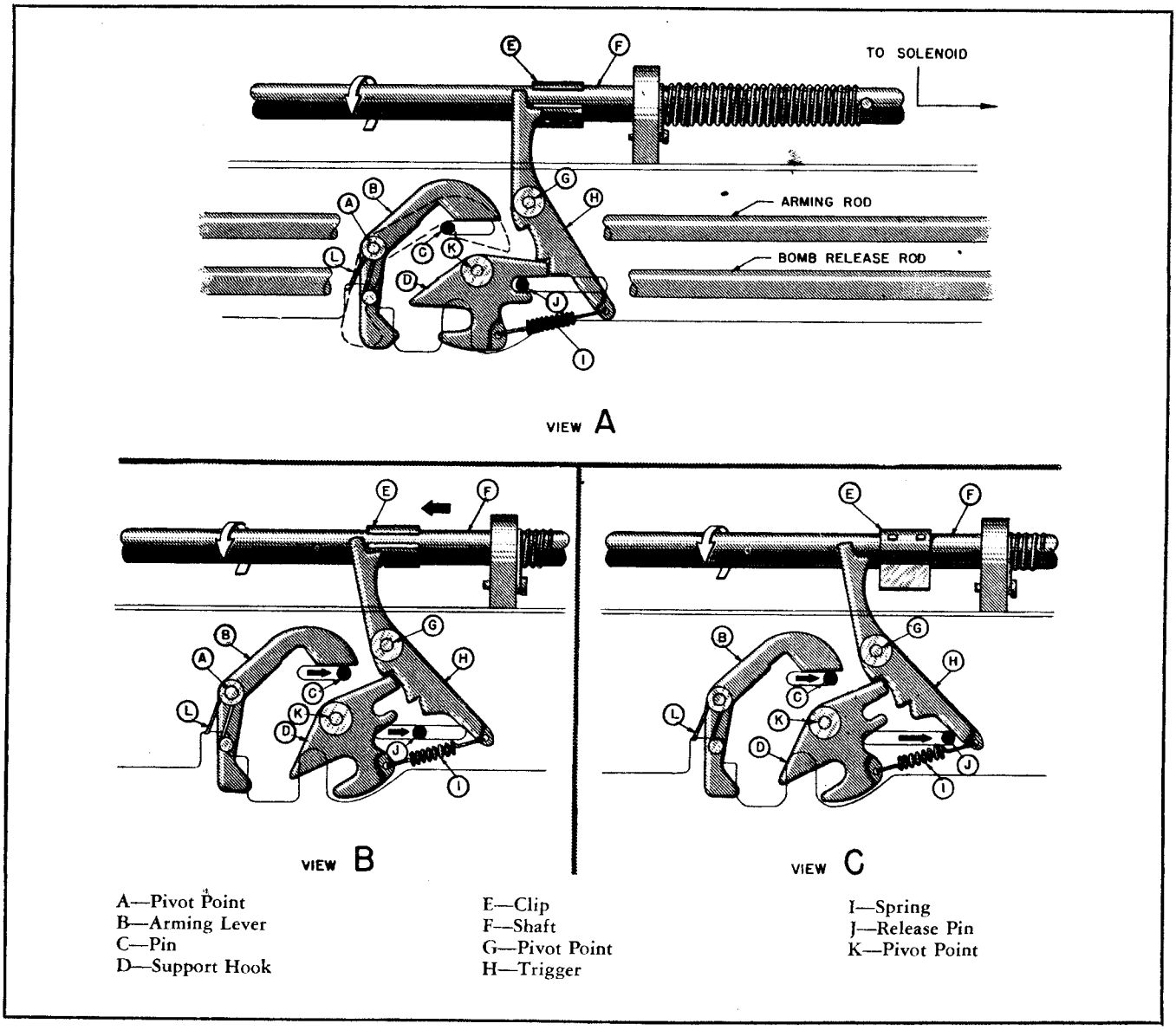


Figure 335 — Bomb Rack Operating Diagram (Type NA 84-63005)

2. SELECTIVE POSTION. — As the release handle is moved to the "SELECTIVE" position, the release pin "J" will move out of the notch in hook "D" (view "B"). An electrical impulse, started as the release switch on the pilot's control stick is depressed, will cause the solenoid to move the shaft "F" outboard, or to the left, as illustrated in view "B." Clip "E" will engage trigger "H" and move it about its pivot point "G." This movement will release the bomb support hook "D" and allow it to open. The bomb will drop free. Shaft "F" is spring-loaded to rotate as indicated. As the first bomb is dropped, the shaft will rotate, bringing another clip into position to fire the second bomb and each of the remaining bombs consecutively, starting inboard and proceeding outboard. This provides selective firing, and one bomb will drop each time the bomb release switch on the pilot's control stick is depressed.

3. ARMING POSITION.—The arming lever "B" retains or releases the bomb arming cable when the arming handle, located on the bomb control quadrant in the front cockpit, is in the "ARMED" or "SAFE" position, respectively. The arming pin "C" is connected to the arming rod, which in turn is connected by a cable to the arming handle of the bomb control quadrant. When the arming handle is in the "SAFE" position, the arming lever "B" is free to move about its pivot point "A." In this condition, the weight of the bomb dropping free of the airplane is sufficient to pull the bomb arming cable free of the arming lever "B." Thus, the bomb drops unarmed or safe. As the arming handle moves to the "ARMED" position, pin "C" moves as illustrated in view "B," to a position which will prevent any rotation of the arming lever "B." In this condition, the bomb arming cable is held by the arming

lever "B" as the bomb drops free. The bomb drops armed; at the nose in the case of the 20- or 30-pound fragmentary bombs, or at the tail in the case of the 100-pound bombs.

4. SALVO POSITION. — As the release handle on the bomb control quadrant is moved to the "SALVO" position, the release pin "J" will move as illustrated (view "C"), rotating trigger "H" and releasing the bomb support hook "D." By this operation, all bombs contained in the same rack are released simultaneously. They are released either in the armed or safe condition, depending upon the position of the arming handle on the bomb control quadrant and the toggle switches on the pilot's electrical control panel.

(b) TYPE R-1502 BOMB RACKS.—*(See figure 336.)*—On later airplanes, with the 24-volt electrical system, a type R-1502 bomb rack is being used. This rack is of such design that it may be used on either 12- or 24-volt systems and is interchangeable with the NA 84-63005 rack. The rack mechanism is illustrated in figure 337.

1. LOCK POSITION.—The bomb is carried by the bomb support hook "C" which is held in the closed, or cocked position, as illustrated in view "A," by the trigger "D" through the link "B" and latch "E" assembly. As the hook "C" is rotated about its pivot point into the cocked position, latch "E" is also rotated by the action of the connecting link "B" until it is held in the notch of the trigger "D." Pin "A" is controlled by the movement of the bomb release rod, which, in turn, is connected by a cable to the release handle of the bomb control quadrant in the front cockpit. As the release handle is moved to the "LOCK" position, the bomb release rod and pin "A" will move inboard or to the right, as illustrated, preventing trigger "D" from being tripped. This will prevent either manual or electrical release of the bomb load.

2. SELECTIVE POSITION. — As the release handle on the bomb control quadrant is moved to the "SELECTIVE" position, the pin "A" will move as illustrated in view "B," releasing the trigger "D" for movement. An electrical impulse, started as the release switch on the pilot's control stick is depressed, will cause the solenoid "G" to move the plunger "F" as indicated. Trigger "D" will rotate, tripping the spring-loaded latch "E" and opening the bomb support hook "C" by the action of the connecting link "B." The bomb will drop free. With the release handle in "SELECTIVE" position, bombs will drop consecutively starting inboard and proceeding outboard. One bomb will drop each time the release button on the pilot's control stick is pressed. The electrical impulse for dropping the first, or inboard bomb, is transmitted through contacts "1" and "2" of the unit's switch block "H" to the solenoid "G." When the unit is in the cocked position (view "A"), contacts "1" and "2" are moved together by the pressure of the spring-loaded contact "2." As the unit is tripped (view "B"), contacts "1" and "2" are separated and contacts "2" and "3" are moved together by the pressure of spring "I" on spring "J." This action automatically transfers the electrical impulse to the "1" and "2" contacts on the second switch, which will fire the second bomb and each bomb thereafter in consecutive order as the release button is operated.

3. ARMING POSITION.—The spring-loaded arming pin "L" (view "C") retains or releases the bomb arming cable when the arming handle, located on the bomb control quadrant in the front cockpit, is in the "ARMED" or "SAFE" position, respectively. The spring-loaded plunger "K" when depressed (view "C") will lock the arming pin "L;" and as the bomb falls from the rack, the arming cable will be retained. Thus, the bomb will fall armed. When the plunger is not depressed (view "A"), the weight of the falling bomb will be sufficient to pull the cable free of the arming pin "L." The bomb will then fall safe, or unarmed. The plunger "K" is controlled by the rotation of the arming pawl "M," which, in turn, is controlled by the bomb arming rod. The bomb arming rod is connected

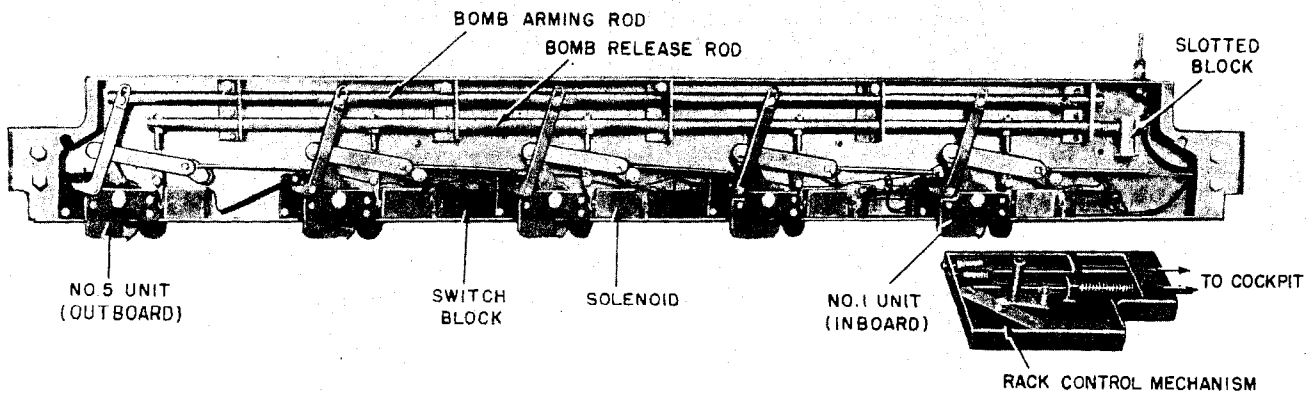


Figure 336 — Bomb Rack (Type R-1502)

by a cable to the arming lever on the bomb control quadrant in the front cockpit. When the arming handle is at "SAFFE" position, the plunger "K" is not depressed (view "A"). As the handle is moved to the "ARMED" position, the bomb arming rod causes the arming pawl "M" to rotate. Thus, the plunger "K" is depressed (view "C"), the arming pin "L" is locked, and the unit is armed.

4. SALVO POSITION.—As the arming handle on the bomb control quadrant is moved to the "SALVO" position, the pin "A" will move as illustrated (view "C"), tripping the trigger "D" and opening the bomb support hook "C" through the action of link "B." This operation will release all bombs contained in the rack simultaneously. They will be released either in the armed or safe condition, depending upon the position of the arming handle on the bomb control quadrant, and the toggle switches on the pilot's electrical control panel.

(2) REMOVAL.—Removal from the airplane of either of the two types of bomb racks will be substantially the same, and any differences will be obvious upon inspection. The procedure is as follows:

(a) Remove the cover plate.

(b) Disconnect the lower cable at the turnbuckle.

(c) Disconnect the upper cable at the turnbuckle.

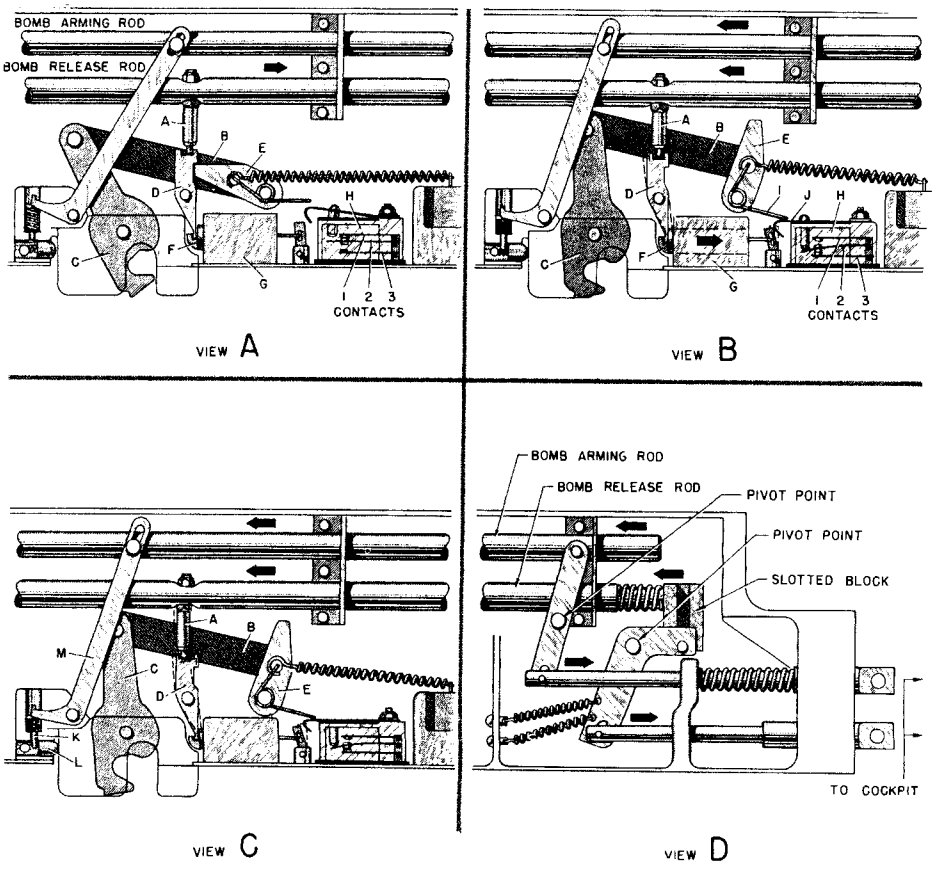
(d) Hold the rack in place; remove the nut at each end.

(e) Lower the rack; remove the flexible conduit and electrical wires at their connections on the rack.

CAUTION

Great care should be exercised in the handling of bomb racks. If the rack is dropped or damaged in any way, a thorough check must be made to insure operational perfection.

(3) INSTALLATION.—Both types of bomb racks are installed, as instructed below:



A—Pin
B—Link
C—Bomb Support Hook
D—Trigger
E—Latch
F—Plunger
G—Solenoid
H—Switch Block
I—Spring
J—Spring
K—Plunger
L—Arming Pin
M—Arming Pawl

Figure 337—Bomb Rack Operating Diagram (Type R-1502)

(a) Raise the racks into place; secure them at each end. Add washers, as required, above the attachment fittings of the rack to position the lower surface of the rack frame with the lower surface of the outer panel.

(b) Connect the upper control cable to the clevis end of the upper rod on the rack by means of a turnbuckle.

(c) Connect the lower cable to the lower rod on the rack with a turnbuckle.

(4) MAINTENANCE.

(a) The bomb racks are designed to operate without lubrication and must be kept free from oil and dirt. If an appreciable amount of dirt or oil is found on the mechanism, clean with kerosene and thoroughly dry with air pressure. The mechanism must be completely dry before being reinstalled or placed in storage.

(b) Repairs to this equipment will consist of the replacement of parts when necessary, or such straightening or alignment as may be required. Whenever repairs which are beyond the facilities of the service personnel are required, the repairable mechanism should be appropriately marked and returned to the control depot for repair.

(5) ADJUSTMENT.

NOTE

No adjustments are necessary, in service, on the type R-1502 bomb racks.

Before installation in the airplane, the type NA 84-63005 bomb racks should be adjusted as follows:

(a) Adjust the spring on the operating cam shaft so that it is wound up 1-7/8 turns when rack is in the "charged" position.

(b) Adjust bomb release trigger with .031 clearance between the trigger and the release cam.

(c) Adjust solenoid plunger and bomb release solenoid trigger to .015 clearance before contact.

(6) TESTING. — Cock all bomb rack support hooks. With the release handle on the bomb control quadrant set at "SELECTIVE," press the firing switch on the control stick. Racks should operate as selected by the operator on the electrical control panel, and in the order indicated by figure 331.

(a) On the type R-1502 bomb racks, cock only the outboard support hooks, operate the racks electrically, and check operation of the skip-unit feature. The last support hook should operate without hesitation.

(b) Attach bomb shackles to the No. 2 and 4 bomb support hooks on each rack. Shackles should attach easily, and the bomb release lever on the shackle should engage the bomb support hook in the rack readily. Operate electrically to check function of the shackles.

(c) With all support hooks in both bomb racks cocked and the release handle on the bomb control quadrant at "LOCK," try electrical release. No bomb racks should operate.

(d) With all support hooks in both bomb racks cocked, move the release handle on the bomb control quadrant to "SALVO." All support hooks should release simultaneously.

(e) Check the release handle on the control quadrant to see that a satisfactory stop has been installed to prevent unintentional movement of the handle to "SALVO" position.

c. BOMB SHACKLES. *(See figure 338.)*

(1) DESCRIPTION.—When it is desired to carry the 100-pound bombs, two bomb shackles (type NA 84-63020) are attached to each bomb rack at the second and fourth bomb support hooks. Each shackle has two heavy brackets which are bolted to the lower surface of the wing just forward of the bomb rack. The bomb release lever "C" on the shackle should fall directly beneath the bomb support hook in the rack. Each shackle has two bomb support hooks, "A" connected by means of a link "B" in the shackle channel "D" and controlled by the bomb release lever "C" through the channel in the center of the shackle. The ring in the bomb release lever "C" is held up (view "A") by the bomb support hook in the bomb rack when the hook is in the closed, or cocked position. With the lever "C" in the up position and support hooks "A" opened, it will engage the spring-loaded dog "E" (view "A"). Then, as the bombs are loaded into position and the bomb support hooks "A" are closed manually, link "B" will move in the direction indicated, causing the dog "E" to lock against the release lever "C" (view "B"). This operation will prevent further movement of the link "B," and the hooks "A" will remain closed until lever "C" is released by the firing of the bomb rack and the subsequent opening of the bomb support hook in the bomb rack. As lever "C" is released, it will rotate downward (view "C"). The link "B" is again free to operate, and the weight of the bomb will pull the support hooks "A" open.

(2) INSTALLATION. — Prior to installing the bomb shackles, wind in the 20- and 30-pound bomb sway braces at the second and fourth stations as far as possible, and lock into place. Attach the shackles with screws.

(3) MAINTENANCE. — The bomb shackles are designed to operate without lubrication and must be kept free from oil and dirt. Clean the mechanism with kerosene when necessary and dry thoroughly with air pressure. Repairs will consist only of replacement of parts and such straigthening or alignment as may be accomplished with the facilities available to the service personnel.

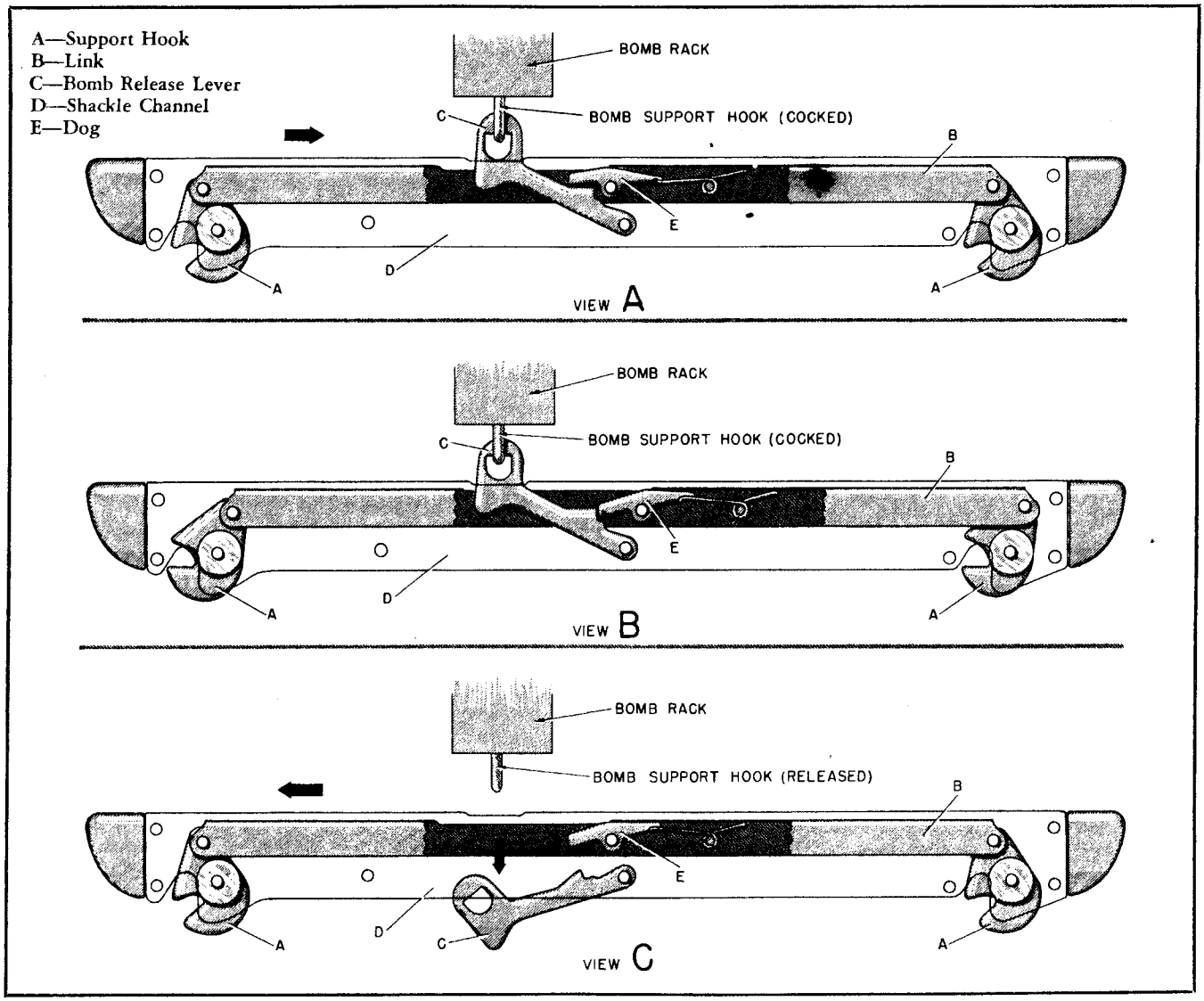


Figure 338 — Bomb Shackle Operating Diagram

d. AUXILIARY ARMING UNITS (TYPE B-1).

(1) DESCRIPTION.—Two of these auxiliary arming units are provided for each bomb rack to nose-arm the 100-pound bomb, when installed. They are mounted within the wing on the wing lower surface forward of the bomb rack mechanism. This arming unit has a spring-actuated ball catch which retains the arming wire swivel loop. This ball catch may be locked in the "ARMED" position by energizing the integral solenoid. The solenoid is energized by the nose fuse toggle switch mounted on the electrical control panel in the front cockpit.

(2) REPAIR.—Minor repairs should be made by regular mechanics. In the case of major damage, such as a burned out solenoid or a broken part, complete replacement should be made.

(3) ADJUSTMENT. — The bomb arming control unit must be adjusted so that when it is not energized, it will support a 3-pound load without releasing the arming wire swivel loop, and will fail to support a 4-pound load. Also, adjust the unit so that when it is energized it will support a 50-pound load.

e. CONTROL CABLES.

(1) REMOVAL.—In the event that any or all of the control cables must be removed for repair or replacement, the procedure is as follows:

(a) Disconnect the cables attached to the upper and lower bomb rack operating rods.

(b) Remove the clevis pin from the pulley bracket just inboard of the bomb rack.

(c) Disconnect the cables attached to the bell cranks just forward of the pulley bracket, and remove the outboard cables.

(d) Pull the cables into the cockpit.

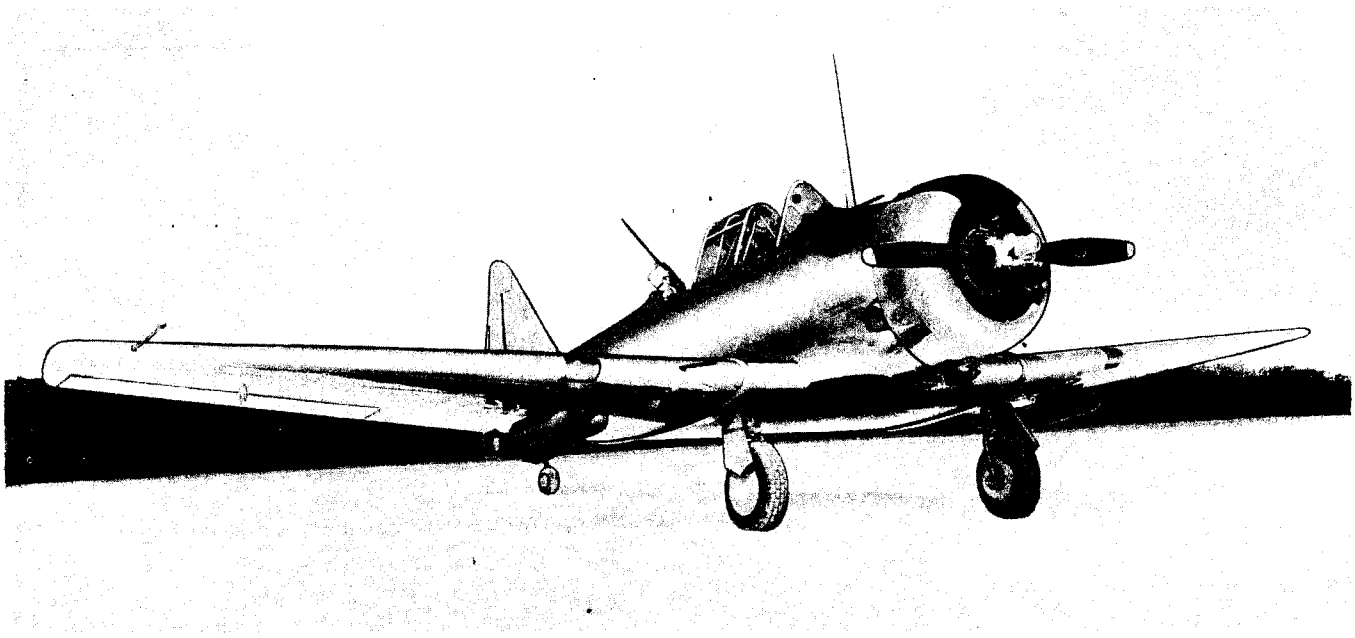


Figure 339—Bombs and Guns Installed

(e) Disconnect the cables at the links just below the quadrant in the cockpit.

(f) Disconnect the two inboard cables at the bomb release operating quadrant.

(g) Disconnect the rear cockpit salvo release cable.

(2) INSTALLATION.

(a) Inspect cables for frayed splices, broken strands, and insecure attachment fittings before installation.

1. Attach the arming cable to the arming handle on the bomb control quadrant in the front cockpit with a clevis pin.

2. Attach the release cable to the release handle with a clevis pin.

3. Attach a link to the free end of the arming cable and the release cable with clevis pins.

4. String the cables over the pulleys at the bottom of the cockpit. Locate the cables from the arming control handle over the aft pulleys, and the cables from the release handle over the forward pulleys.

5. Run the arming cables through the aft tube on each side into the wing.

6. Run the release cables through the forward tube on each side into the wing.

7. Two bell cranks are installed inboard and forward of the bomb rack bay in each wing. Attach the release cables and arming cables to the forward and aft bell cranks, respectively, at the upper arm of each bell crank. Secure with clevis pins.

8. Attach the rack release rod, or cable, and the rack arming rod, or cable, to the forward end of the bell cranks, at the lower arm of each bell crank, respectively. Secure with clevis pins.

9. String both cables over the pulleys just below and aft of the bell cranks in each wing; the arming cable over the upper pulleys, and the release cable over the lower pulleys. Insert clevis pins through the holes provided in the outboard corner of each bracket to act as pulley guards.

(b) Only the emergency salvo release cable extends to the rear cockpit. Rig as follows:

1. Attach the rear cockpit bomb salvo handle to the fuselage frame tube with a clamp and bolts.

2. String the cable over the bracket just above the connecting point; install the pulley guard and pulley.

3. Connect cable to the release cable in the front cockpit at the clip just above the link, with clevis pins.

19. GUNNERY EQUIPMENT.

a. GENERAL.—*(See figures 339 and 340.)*—The gunnery equipment consists of complete provision for the installation and operation of three model M-2, caliber .30 Browning machine guns (two in AT-6, AT-6A, late AT-6D, and AT-6F). Two of the guns are fixed and one is flexible. The fixed guns are located one on the right side of the fuselage forward of the front cockpit and the other one in the right outer wing panel. The flexible gun is mounted on a track attached to the aft end of the rear cockpit. Installed in AT-6 series air-

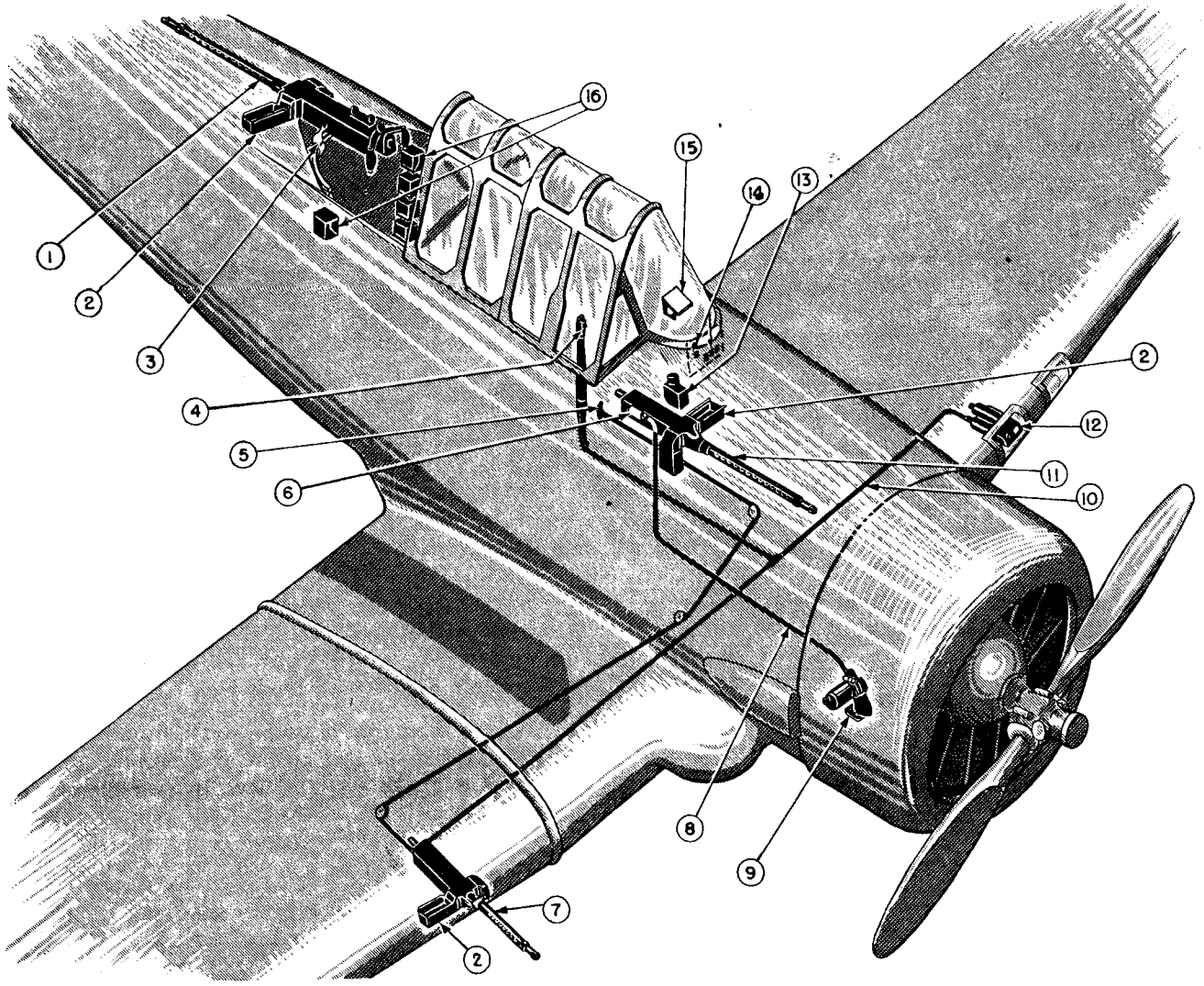


Figure 340 — Gunnery Equipment

planes are one fixed fuselage gun and one flexible gun. Airplanes allocated to the United Kingdom have only a wing gun installed. SNJ (Navy) series airplanes have only the fixed fuselage gun installed. Provisions are made for manually charging the fixed guns from the cockpit. A type W-7B gun camera may be installed on the leading edge of the left wing and operated by the firing button on the control stick grip. A gun camera film consumption indicator may be installed on the bracket provided in the front cockpit. For further details on the gun camera, refer to paragraph 17, "Photographic Equipment." Late AT-6D and SNJ-5 (Navy) airplanes contain provisions for a G.S.A.P. camera in the windshield cowling, aft of the front instrument panel. An optical gun sight (figure 341), type N-3B, type N-2A, or N-3A on earlier airplanes, is installed. A gun synchronizing unit, type E-4, is installed to permit firing the fuselage gun through the propeller arc. (See figure 353.) Later AT-6D and SNJ-5 (Navy) airplanes are equipped with a sheet metal blister (figure 342) to be installed on the lower surface of the right wing for the purpose of retaining cartridge cases and links ejected

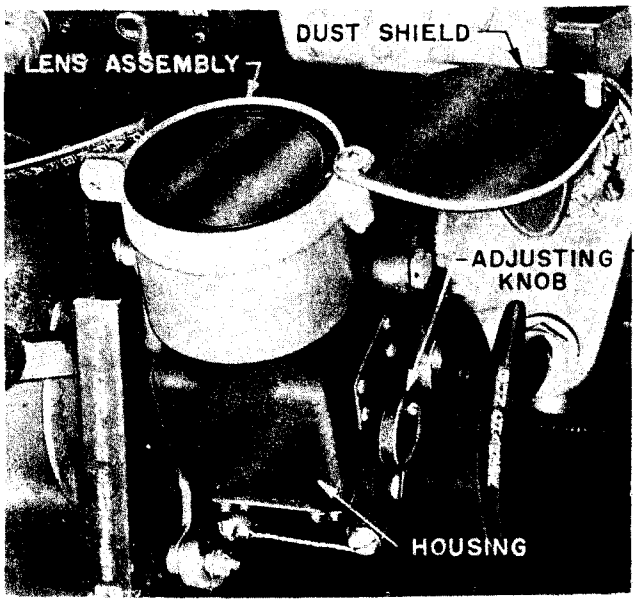


Figure 341 — Gun Sight

from the wing fixed gun. It is to be attached to the wing with anchor nuts and screws and is equipped with a phenolic shield, to protect the under surface of the wing, and a removable access door for removing shells and links without removing the blister. The blister will hold approximately 250 cases and links with ample space remaining so that in the event the wing gun is fired while the airplane is in a steep dive, the cases and links will not become congested in the chute assembly.

b. M-2 MACHINE GUNS.

(1) TROUBLE-SHOOTING. — During operation, an improper action of some part of the gun may result in a stoppage or accidental cessation of firing. Stoppages may be prevented by proper care of the gun and attention to preflight and afterflight inspection. (See "Inspection," section X.) However, stoppages may occur in spite of all that can be done to prevent them. Stoppages are classified according to the position in which the bolt is found when the gun stops firing.

(a) BOLT FORWARD.—When the bolt is all the way forward, malfunction can develop from the following causes:

1. Misfire due to defective primer.

2. Short or broken firing pin.

3. Weak or broken firing pin spring.

4. Faulty engagement of firing pin and sear notch.

5. Worn or bent cocking lever.

6. Belt improperly loaded (may cause a second position stoppage).

7. Short cartridge.

8. Bent or worn belt feed lever (may cause a second position stoppage).

9. Belt feed pawl spring weak or out.

10. Cover extractor spring weak or out.

11. Defective bolt switch (stud on end of belt feed lever jumps out of cam groove).

12. Damaged extractor (may cause a second position stoppage).

13. Belt-holding pawl out or spring weak.

14. Belt-holding pawl fails to depress (may cause a third position stoppage).

15. Front end of trigger bar bent downward.

16. Tip of trigger broken.

17. Early timing.

Figure 342 — Ammunition Blister

(b) BOLT HALFWAY BACK—When the bolt is between the forward position and halfway back, malfunction can develop from the following causes:

1. Separated case which stays in the chamber when bolt is pulled to rear.

2. Separated case which is partially removed from the chamber by the new round when bolt is pulled to the rear.

3. Separated case, due to too much head space (may cause either condition *1.* or *2.* preceding).

4. Head space adjustment too tight.

the adjusting screw plunger and spring from flying out when screw is part way out.

5. Punch out the buffer discs and buffer plate through rear end of buffer tube.

6. The plunger and spring will pop out; if they do not, merely lift them from the aperture.

(c) BACKPLATE WITH HORIZONTAL BUFFER FOR FIXED-TYPE GUN. — The fixed-type gun has no trigger safety or spade grips. It is practically identical with the backplate horizontal buffer for flexible guns.

1. Remove cotter pin and washer from backplate latch spring stop pin.

2. Push out stop pin. Remove stop, latch lock, and latch lock spring.

3. Drive out backplate latch pin. Remove latch, spring, and plunger.

4. Unscrew adjusting screw. Remove buffer discs and buffer plate through rear end of buffer tube.

5. Remove adjusting screw plunger and spring from adjusting screw.

(d) BOLT GROUP. — Do not disassemble the driving spring rod assembly unless it is necessary to replace the driving spring. If this is necessary, remove the driving spring rod.

1. Remove the extractor by rotating it upward and pulling it out from the bolt.

2. If the ejector pin is not staked, the ejector and ejector spring can be removed by driving out the ejector pin.

3. If the extractor pin is not staked, the extractor plunger and spring can be removed.

4. Remove bolt switch.

5. Then, remove the bolt switch plunger and bolt switch plunger spring from bolt. There is a bolt switch pin in guns of recent manufacture.

CAUTION

Before going any farther, press in one end sear to snap firing pin forward.

6. Rotate the cocking lever pin fully backward then pull out on it. Remove cocking lever.

7. With the thin end of cocking lever, swing the sear stop out of its grove in top of bolt, then swing it into center of bolt.

8. Turn bolt over and, using combination tool, push sear stop out of engagement with firing pin spring. Reverse bolt. Lift sear stop out of slot.

9. Slide the sear holder with its spring and plunger out of the bolt.

10. Remove sear assembly from bolt by sliding it laterally a short distance, then pulling it out from rear of bolt.

11. Drift out the plunger pin to remove sear plunger and spring from the sear assembly.

12. The firing pin will drop out by tipping the bolt. Then remove it.

(e) LOCK FRAME GROUP.—Push out accelerator pin. Remove accelerator. If it is a flexible gun, drift out trigger bar pin and remove trigger bar. Remove trigger bar spring. Hold the lock frame with left hand with projection upward, slot to left, and first finger gripping end of barrel plunger. Press down and out with thumb of right hand on the combination tool. Disengage barrel plunger guide pin from slot. Allow spring carrying the plunger to rise slowly.

CAUTION

Protect your finger with a glove or piece of rag. This spring is under strong tension. If they do not fly out, lift out plunger and spring.

(f) BARREL AND BARREL EXTENSION GROUP.

1. With the combination tool, raise end of barrel locking spring.

2. Remove barrel by unscrewing from barrel extension.

3. Remove barrel locking spring by sliding it forward out of its seat in the barrel extension.

4. Push out the breech lockpin. Remove the breech lock.

(g) COVER GROUP.

1. Remove the cover pin cotter pin, drive out cover pin and lift the cover free from the trunnion block.

2. Remove belt feed lever pivot stud cotter pin.

3. Using the combination tool, pry the belt feed lever off its stud. Ascertain that the belt feed lever spring plunger and spring do not fly out. In removing the belt feed lever, see that the toe of the lever is in line with the slot in the cover; otherwise it will not pass out.

4. Remove the belt feed lever spring plunger and belt feed lever plunger spring from the belt feed lever.

5. Pull the complete belt feed slide group from its guides in the cover.

6. Drift out the belt feed pawl pin.

7. This will permit separating the belt feed pawl and pawl arm. Do not remove belt feed pawl arm pin from the pawl unless necessary for repairs. If it is

necessary, drive out the cover latch pin and pull out the cover latch lever assembly. This allows the cover latch to drop out. Do not disassemble cover latch lever assembly.

8. Remove cover latch spring.

9. Remove cover extractor spring.

(h) CASING GROUP.

1. Pull out cover detent pawl cotter pin. Remove cover detent pawl and spring.

2. On one side of the feed-way, remove the belt-holding pawl retainer pin. Then pull out the belt-holding pawl pin.

3. Pull out the belt-holding pawl and spring. Be careful that the spring does not fly out.

4. On the other side of the gun, remove the belt-holding pawl retainer pin and the belt-holding pawl pin.

5. Pull out the front and rear cartridge stops.

NOTE

On mounted guns: Pull out co ter pins from front mount adapter bolts. Unscrew front mount adapter bolt nuts from bolts. Pull out front mount adapter bolts, and remove mount adapter. Unscrew rear mount adapter screws. Remove rear mount adapter.

6. Turn gun over. Pull out breech lock cam cotter pin.

7. Unscrew nut from stud and remove breech lock cam from inside of casing.

8. To remove the front barrel bearing assembly for cleaning, apply the strap pipe wrench with enough force to cam the crimped flanges out of the locking recesses. An adjustable wrench may be used. The front barrel bearing assembly is locked to the barrel jacket after assembly by crimping the flange of the special lock washer into recesses in the forward end of the barrel jacket and rear end of the front barrel bearing.

9. With the combination tool, remove the front barrel bearing.

10. Remove plug from the front barrel bearing.

11. To remove the barrel jacket, unscrew the locking plate screw, and lift off the lock washer, and locking plate. Then unscrew the barrel jacket with the strap pipe wrench.

NOTE

Do not remove the barrel jacket from the trunnion block unless absolutely necessary. Frequent removal will cause loose fitting threads.

(i) OPERATING SLIDE GROUP — FIXED-TYPE GUN.

1. Withdraw locking wires from front-and-rear-bracket screw heads. Remove screws.

2. Lift slide assembly from the casing of the gun.

3. Lift rear bracket from housing tube.

4. Draw cotter pin from hole in operating slide handle. Unscrew handle from operating slide rod. Remove handle stop from rod.

5. Unscrew hook stop nut and remove front bracket from tube.

6. Hold hook against spring tension and unscrew hook stop.

7. Ease hook, rod and spring out of tube. Remove spring and hook from rod. Remove head for repair only. To remove, drive out pin and remove head from rod.

(j) RETRACTING SLIDE GROUP—FLEXIBLE-TYPE GUN.

1. Pull out locking wires and unscrew retracting slide bracket screw.

2. Lift off retracting slide bracket.

3. To remove retracting slide from retracting slide bracket, unscrew retracting slide handle from retracting slide, which is staked in, and drive out the retracting slide plunger stop pin.

4. Remove the retracting slide plunger and plunger spring from the retracting slide bracket. Do this only to replace plunger or spring.

(3) DEGREASING.—If the gun has come from storage coated with rust-preventive compound or has been covered with the wrong type of grease, adhere to the following procedure to degrease the gun:

(a) Disassemble the gun completely and place all parts except the oil buffer assembly and blackplate assembly in a vat of soda ash solution (½ to 1 pound of soda ash to each gallon of water) or boiling soap and water (sufficient soap to make good suds) and allow them to remain in the solution approximately 30 minutes.

(b) After the parts have been thoroughly cleaned as above, they should be swirled in dry cleaning solvent to remove any traces of rust-preventive compound, thoroughly dried, and oiled.

(c) The oil buffer assembly and backplate assembly will be cleaned separately by hand with dry cleaning solvent to prevent damage to the oil buffer packing and backplate fiber discs.

(d) The surfaces must be thoroughly dried immediately after removal of the solvent. Since finger

marks are ordinarily acid and induce corrosion, gloves should be worn by persons handling the parts after cleaning them.

NOTE

Dry-cleaning solvent will attack and discolor rubber.

(4) CLEANING.—To clean the gun after it has been fired, adhere to the following procedure:

(a) Place the gun barrel, muzzle down, in a vessel containing hot water. Add soap or sal soda solution to the water if either of them is available.

(b) Insert into the breech a cleaning rod with a flannel patch attached. Move the rod forward and back for about 1 minute to pump water in and out of the bore.

(c) While the bore is wet, run a brass or bronze brush through the barrel three or four times.

(d) Pump water through the bore again to clean it.

(e) Dry the cleaning rod and remove the barrel from the water. Using dry, clean flannel patches, thoroughly swab the bore until it is prefectly dry and clean. Dry and clean the chamber thoroughly, using a flannel patch on a stick if necessary.

(f) After cleaning, oil the guns with oil, lubricating preservative, special, US Army Specification No. 2-120, latest issue.

(g) Clean the gun not later than the evening of the day on which the gun is fired, preferably as soon as possible after cessation of firing.

(h) Inspect and clean the guns again 3 days following cessation of firing.

(i) Wipe the receiver clean, carefully removing all dirt from the belt-holding pawl.

(j) Thoroughly clean the cover, bolt, barrel extension, oil buffer, and backplate, using a small stick covered with a flannel patch to remove dirt from all recesses, firing pin holes, etc.

(k) Wipe all of the parts with clean oily rag.

c. WING GUN.

(1) DESCRIPTION.—*(See figure 343.)*—Provisions are incorporated in the airplane for the installation and operation of a model M-2, .30-caliber Browning fixed machine gun in the right outer wing leading edge

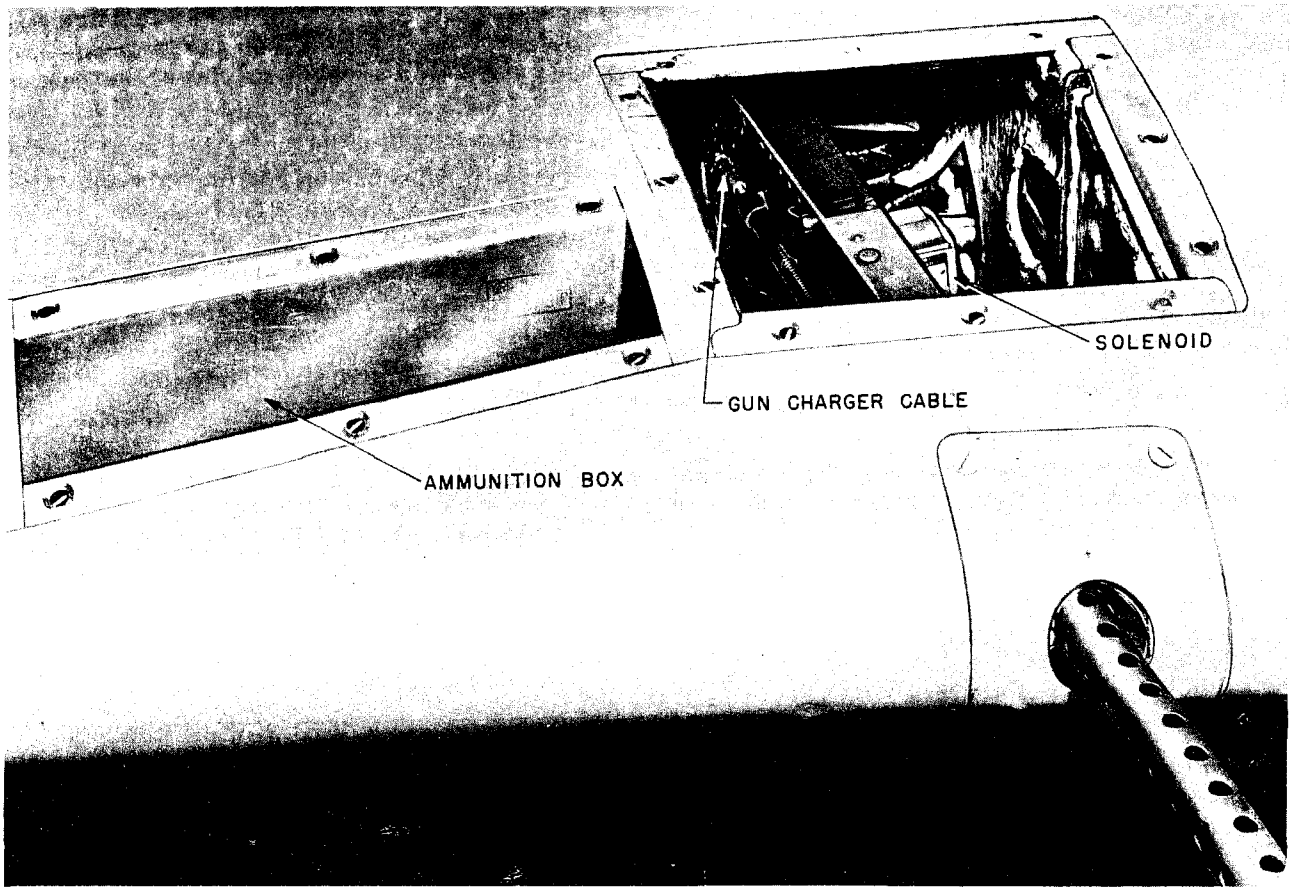


Figure 343 — Wing Gun

near the center section. Charging the wing gun is effected by a charging cable assembly terminating in a charging control handle located in the pilot's cockpit to the right and below the pilot's electrical control panel. On some earlier airplanes, preflight charging was provided and was accomplished by removing the gun bay cover plate and charging the gun directly with the charging handle. However, this feature has been changed to a remote charging system as used on later airplanes. A safety switch on the pilot's electrical control panel controls the electric current to both the wing gun and the fuselage gun. The gun is selectively controlled by means of a gun selector switch also located on the pilot's electrical control panel, and either gun may be selected or both guns may be fired at the same time. A gun firing trigger is provided on the forward side of the control stick grip, which also operates the gun camera when it is selected. A gun sighting chart for the wing gun is cemented to the back of the gun bay cover plate. A wing gun ammunition box accommodating 200 rounds of .30-caliber ammunition is located on the outboard side of the wing gun.

(2) REMOVAL.—To remove the wing gun, adhere to the following instructions:

(a) Remove the solenoid installed on the gun; revolve the solenoid one-half turn to remove.

(b) Remove the pilot's charging cable from the gun by unscrewing the turnbuckle.

(c) Take out the outboard attachment pin on the top of the gun through the inboard side of the feed chute. Detach the feed chute from the yoke.

(d) Remove the yoke at the outboard side of the gun bay. Detach the yoke from the bracket by removing the bolts.

(e) Take out the inboard attachment pin on the top of the gun.

(f) Detach the gun from the gun posts, pull the gun to the rear through the blast tube and remove the gun from the gun bay.

(g) Remove the post assemblies on the forward and aft gun supports.

(3) INSTALLATION.

NOTE

Extreme care must be exercised before and after installing the gun to prevent any foreign matter getting in or on the gun parts.

Install the wing gun as per the following procedure:

(a) Install the post assembly in the aft gun support.

(b) Install the post assembly in the forward gun support.

(c) Install the ejection chute at the outlet on the inboard side of the gun.

(d) Place the gun in the gun bay by inserting the barrel through the aft end of the blast tube; attach the gun to the gun posts.

(e) Insert the inboard attachment pin on top of the gun through the ejection chute clips.

(f) Install the yoke at the outboard side of the gun bay; attach the yoke to the bracket provided.

(g) Insert the outboard attachment pin on top of the gun through the inboard end of the feed chute; attach the feed chute to the yoke with the attachment pins.

(h) Attach the pilot's charging cable to the gun by means of the turnbuckle barrel attached to the cable.

(i) Remove the solenoid from the bracket on the inboard side of the gun bay, revolve the solenoid horizontally one-half turn, and install it on the gun with the same parts that held it on the bracket.

(4) ADJUSTMENTS.—*(See figure 344.)*

(a) GUN MOUNTS.—After the installation of fixed guns is completed, minor adjustments may be made in order to accomplish accurate bore sighting.

1. Adjust gun on mounts so that distance from center line of gun to the center line of attachment on fuselage frame will be 9-$\frac{5}{16}$ inches for normal position.

2. By adjusting the adjustment stud on the mounting bracket, an elevation of 1 degree above or 2 degrees 15 minutes below center line may be acquired.

3. Azimuth adjustment of 1 degree to left or right of center line may be had by adjusting front gun post and bracket.

(b) GUN TIMING.—Check the timing of the gun by means of the headspace timing gage, ordnance part No. A-351217. Adjust the solenoid if necessary.

(5) BORESIGHTING FIXED GUNS.—*(See figures 345 and 346.)*—To boresight the fixed guns, proceed as follows:

(a) Jack up airplane, using wing jacks placed under the jack points of each panel and tail jacks sta-

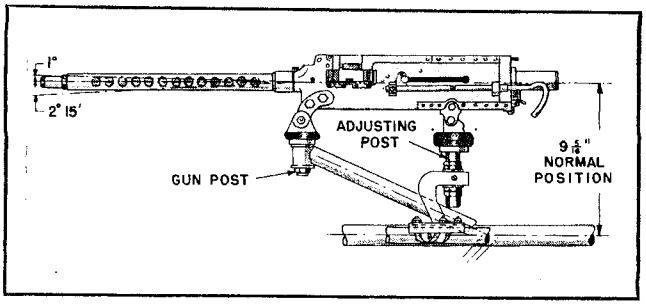


Figure 344 — Wing Gun Adjustment

marks are ordinarily acid and induce corrosion, gloves should be worn by persons handling the parts after cleaning them.

NOTE

Dry-cleaning solvent will attack and discolor rubber.

(4) CLEANING.—To clean the gun after it has been fired, adhere to the following procedure:

(a) Place the gun barrel, muzzle down, in a vessel containing hot water. Add soap or sal soda solution to the water if either of them is available.

(b) Insert into the breech a cleaning rod with a flannel patch attached. Move the rod forward and back for about 1 minute to pump water in and out of the bore.

(c) While the bore is wet, run a brass or bronze brush through the barrel three or four times.

(d) Pump water through the bore again to clean it.

(e) Dry the cleaning rod and remove the barrel from the water. Using dry, clean flannel patches, thoroughly swab the bore until it is prefectly dry and clean. Dry and clean the chamber thoroughly, using a flannel patch on a stick if necessary.

(f) After cleaning, oil the guns with oil, lubricating preservative, special, US Army Specification No. 2-120, latest issue.

(g) Clean the gun not later than the evening of the day on which the gun is fired, preferably as soon as possible after cessation of firing.

(h) Inspect and clean the guns again 3 days following cessation of firing.

(i) Wipe the receiver clean, carefully removing all dirt from the belt-holding pawl.

(j) Thoroughly clean the cover, bolt, barrel extension, oil buffer, and backplate, using a small stick covered with a flannel patch to remove dirt from all recesses, firing pin holes, etc.

(k) Wipe all of the parts with clean oily rag.

c. WING GUN.

(1) DESCRIPTION.—*(See figure 343.)*—Provisions are incorporated in the airplane for the installation and operation of a model M-2, .30-caliber Browning fixed machine gun in the right outer wing leading edge

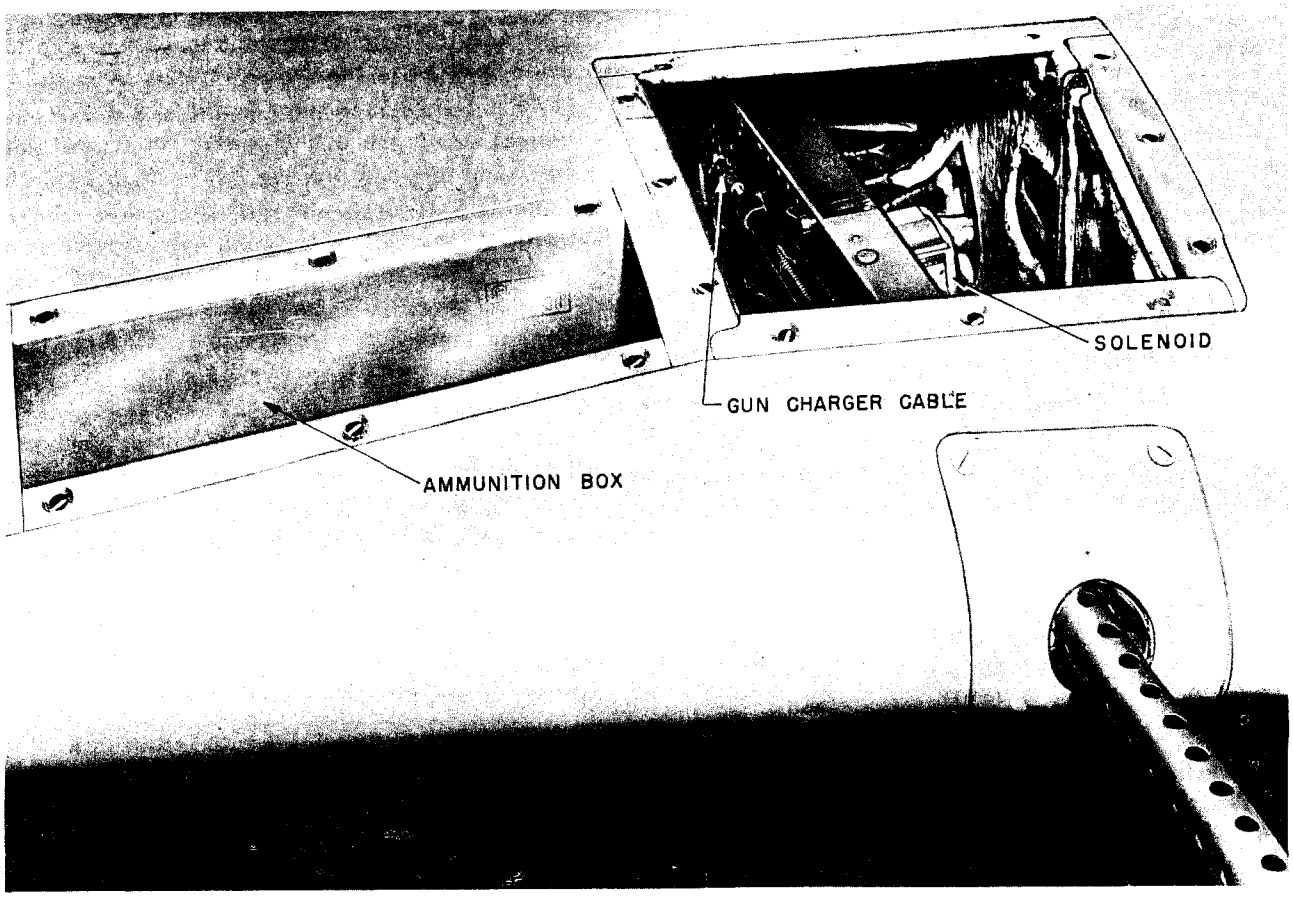


Figure 343 — Wing Gun

near the center section. Charging the wing gun is effected by a charging cable assembly terminating in a charging control handle located in the pilot's cockpit to the right and below the pilot's electrical control panel. On some earlier airplanes, preflight charging was provided and was accomplished by removing the gun bay cover plate and charging the gun directly with the charging handle. However, this feature has been changed to a remote charging system as used on later airplanes. A safety switch on the pilot's electrical control panel controls the electric current to both the wing gun and the fuselage gun. The gun is selectively controlled by means of a gun selector switch also located on the pilot's electrical control panel, and either gun may be selected or both guns may be fired at the same time. A gun firing trigger is provided on the forward side of the control stick grip, which also operates the gun camera when it is selected. A gun sighting chart for the wing gun is cemented to the back of the gun bay cover plate. A wing gun ammunition box accommodating 200 rounds of .30-caliber ammunition is located on the outboard side of the wing gun.

(2) REMOVAL.—To remove the wing gun, adhere to the following instructions:

(a) Remove the solenoid installed on the gun; revolve the solenoid one-half turn to remove.

(b) Remove the pilot's charging cable from the gun by unscrewing the turnbuckle.

(c) Take out the outboard attachment pin on the top of the gun through the inboard side of the feed chute. Detach the feed chute from the yoke.

(d) Remove the yoke at the outboard side of the gun bay. Detach the yoke from the bracket by removing the bolts.

(e) Take out the inboard attachment pin on the top of the gun.

(f) Detach the gun from the gun posts, pull the gun to the rear through the blast tube and remove the gun from the gun bay.

(g) Remove the post assemblies on the forward and aft gun supports.

(3) INSTALLATION.

NOTE

Extreme care must be exercised before and after installing the gun to prevent any foreign matter getting in or on the gun parts.

Install the wing gun as per the following procedure:

(a) Install the post assembly in the aft gun support.

(b) Install the post assembly in the forward gun support.

(c) Install the ejection chute at the outlet on the inboard side of the gun.

(d) Place the gun in the gun bay by inserting the barrel through the aft end of the blast tube; attach the gun to the gun posts.

(e) Insert the inboard attachment pin on top of the gun through the ejection chute clips.

(f) Install the yoke at the outboard side of the gun bay; attach the yoke to the bracket provided.

(g) Insert the outboard attachment pin on top of the gun through the inboard end of the feed chute; attach the feed chute to the yoke with the attachment pins.

(h) Attach the pilot's charging cable to the gun by means of the turnbuckle barrel attached to the cable.

(i) Remove the solenoid from the bracket on the inboard side of the gun bay, revolve the solenoid horizontally one-half turn, and install it on the gun with the same parts that held it on the bracket.

(4) ADJUSTMENTS.—*(See figure 344.)*

(a) GUN MOUNTS.—After the installation of fixed guns is completed, minor adjustments may be made in order to accomplish accurate bore sighting.

1. Adjust gun on mounts so that distance from center line of gun to the center line of attachment on fuselage frame will be 9-$\frac{5}{16}$ inches for normal position.

2. By adjusting the adjustment stud on the mounting bracket, an elevation of 1 degree above or 2 degrees 15 minutes below center line may be acquired.

3. Azimuth adjustment of 1 degree to left or right of center line may be had by adjusting front gun post and bracket.

(b) GUN TIMING.—Check the timing of the gun by means of the headspace timing gage, ordnance part No. A-351217. Adjust the solenoid if necessary.

(5) BORESIGHTING FIXED GUNS.—*(See figures 345 and 346.)*—To boresight the fixed guns, proceed as follows:

(a) Jack up airplane, using wing jacks placed under the jack points of each panel and tail jacks sta-

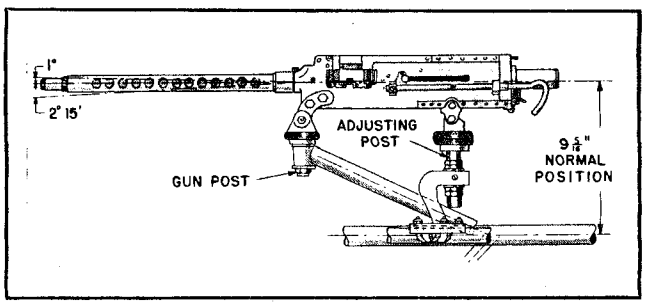


Figure 344 — Wing Gun Adjustment

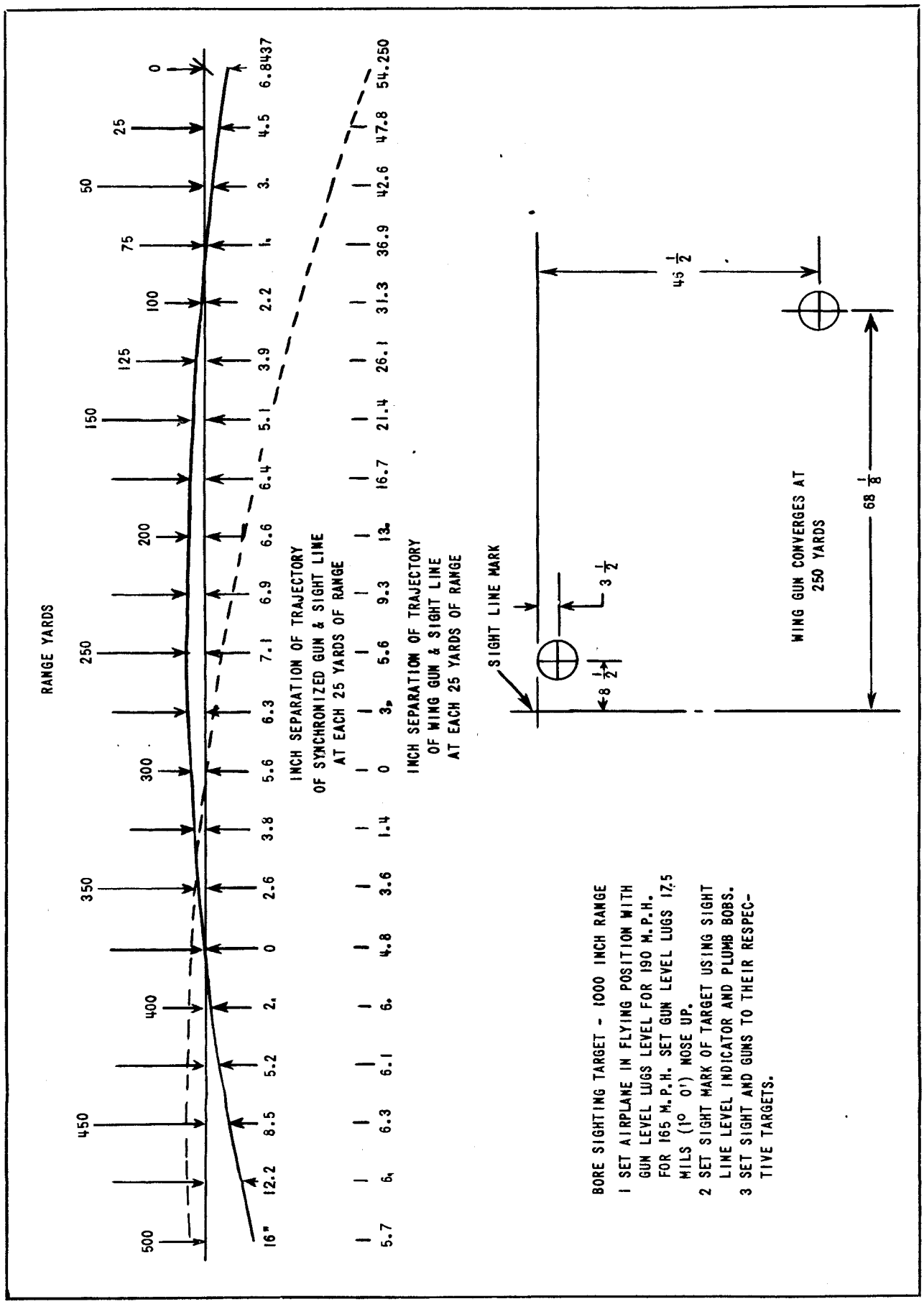


Figure 345 — Boresighting Target

tioned at either side of the airplane resting against a lift bar. Each end of the lift bar should be loaded with a 100-pound sandbag as an extra precaution. Screw type jacks shall be used whenever possible, as hydraulic jacks have a tendency to creep.

(b) Select desired target; set airplane at proper attitude indicated on the target. Use airplane level lugs unless otherwise specified on the target.

(c) Set up target 1000 inches from the approximate mean of the gun trunnion bolts.

(d) Attach plumb bobs to 10-32 screws. Insert screws into the two red-circled nut plates located on under surface of the nose and tail of the fuselage.

(e) Align target so that plumb bob strings line up with plumb bob line on target.

(f) Attach an A-2 sight line level indicator, part No. 41D3689, to the gun sight reflector. Adjust indicator until bubble and reference line of indicator coincide. Raise target until sight line mark of target coincides with bubble and reference mark of indicator.

(g) Remove indicator and adjust gun sight to align with the sight line mark on target.

(h) Using the proper fixture from a boresighting kit, stock No. 5200-383515, boresight the guns and make adjustments so that they line up with the target.

d. FUSELAGE GUN.

(1) DESCRIPTION.—*(See figure 347 and 348.)*— Provisions are incorporated in the airplane for the installation and operation of a model M-2, caliber .30 Browning fixed machine gun at the right upper side

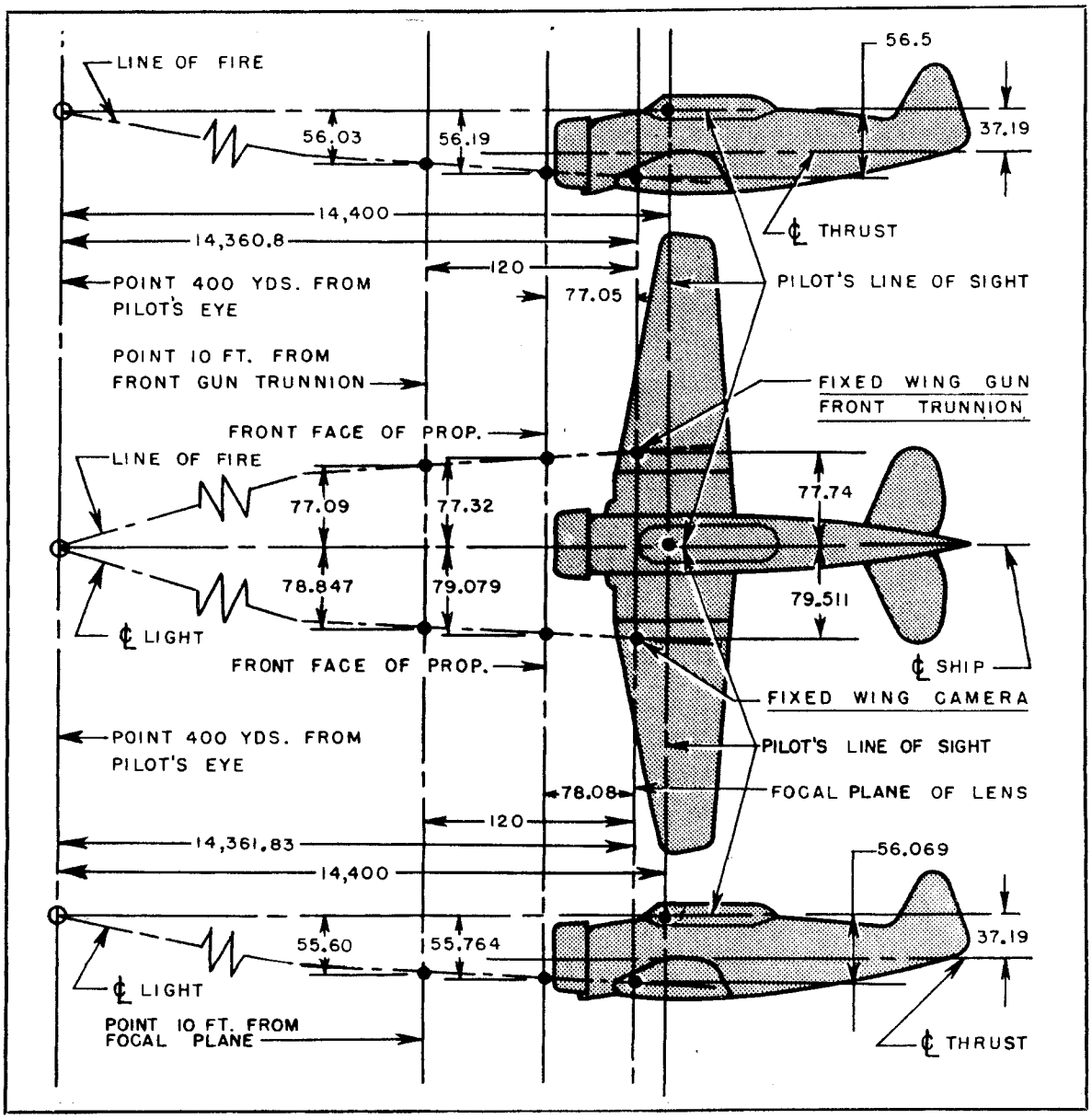


Figure 346 — Wing Gun Sighting Diagram

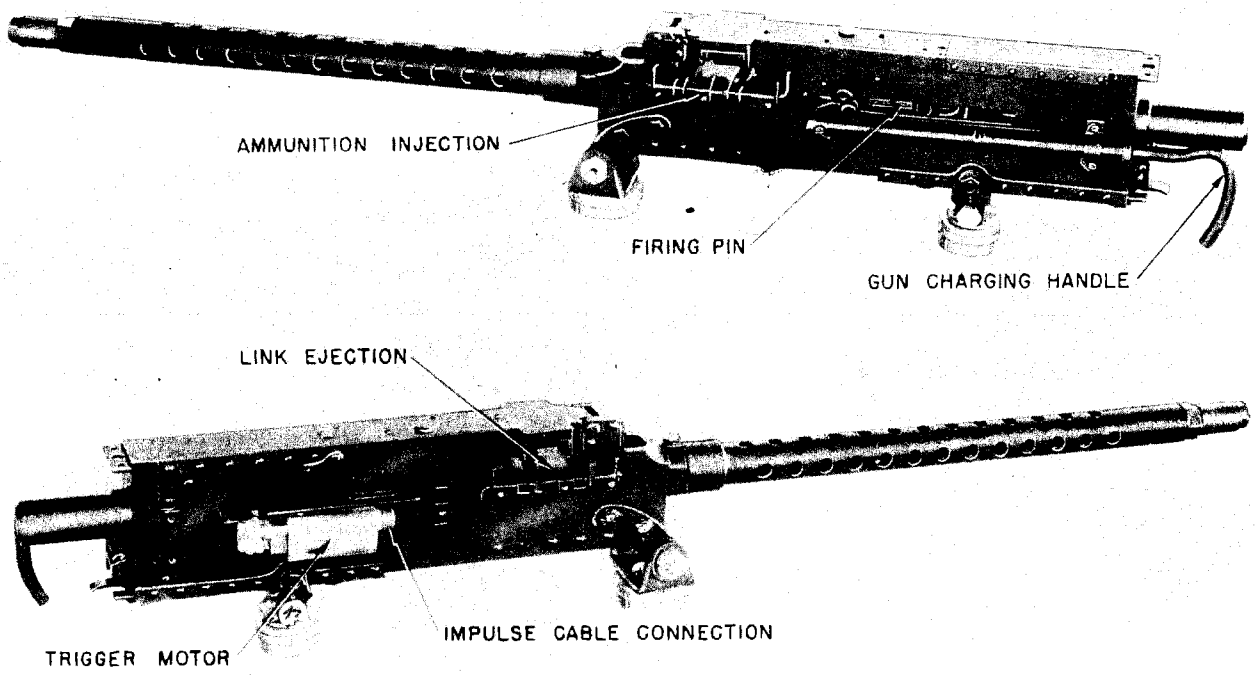


Figure 347 — Fixed Fuselage Gun

of the fuselage forward of the front cockpit, firing through the propeller arc. The fuselage gun is installed in a manner to provide direct charging with charging handle accessible from right side of front cockpit. A safety switch on the pilot's electric control panel controls the electric current to the fuselage gun and the wing gun. Both wing and fuselage guns are controlled by means of gun selector switches also located on the pilot's electrical control panel. Either gun may be selected, or both may be fired at the same time by means of a gun firing trigger located on the forward side of the control stick grip. The fuselage gun is fired by action of the impulse cable assembly from the synchronizer, mounted in the engine section, to the type E-3A trigger motor, mounted on the gun. A gun sighting chart (figure 350) for the fuselage gun is cemented to the cowl at the upper left side of the fuselage just aft of the fire wall. The fuselage gun ammunition box, accommodating 200 rounds of caliber .30 ammunition is located on the inboard side of the gun. A gun synchronizing unit, type E-4, is installed to permit firing the fuselage gun through the propeller arc.

(2) REMOVAL.—Remove the fuselage gun according to the following instructions:

(a) Remove the solenoid electrical conduit from the solenoid socket.

(b) Remove the trigger motor from the outboard side of the gun; detach it from the impulse unit.

(c) Take out the gun attachment pin; slide out the feed chute.

(d) Loosen the knurled rings; remove the gun from the gun posts.

(e) Remove the ammunition box by taking out the screws and nuts at the bottom of each of the four corners.

(f) Detach the hinge at the outboard opening of the intermediate chute.

(g) Remove the case ejection chute by removing the nuts and screws between the gun posts.

(h) Remove the lower ejection chute.

(i) Remove the intermediate ejection chute below the gun.

(j) Remove the forward gun posts at the forward support.

(k) Remove the aft gun support and posts.

(3) INSTALLATION.—*(See figure 351.)*—Install the fuselage gun according to the following procedure:

(a) Install the aft gun support.

(b) Install the aft gun post in the gun support with an adapter and a setscrew. When the gun is set properly, the top of the upper lock is even with the zero reading on the post. Tap the casting lightly to lock the set screw.

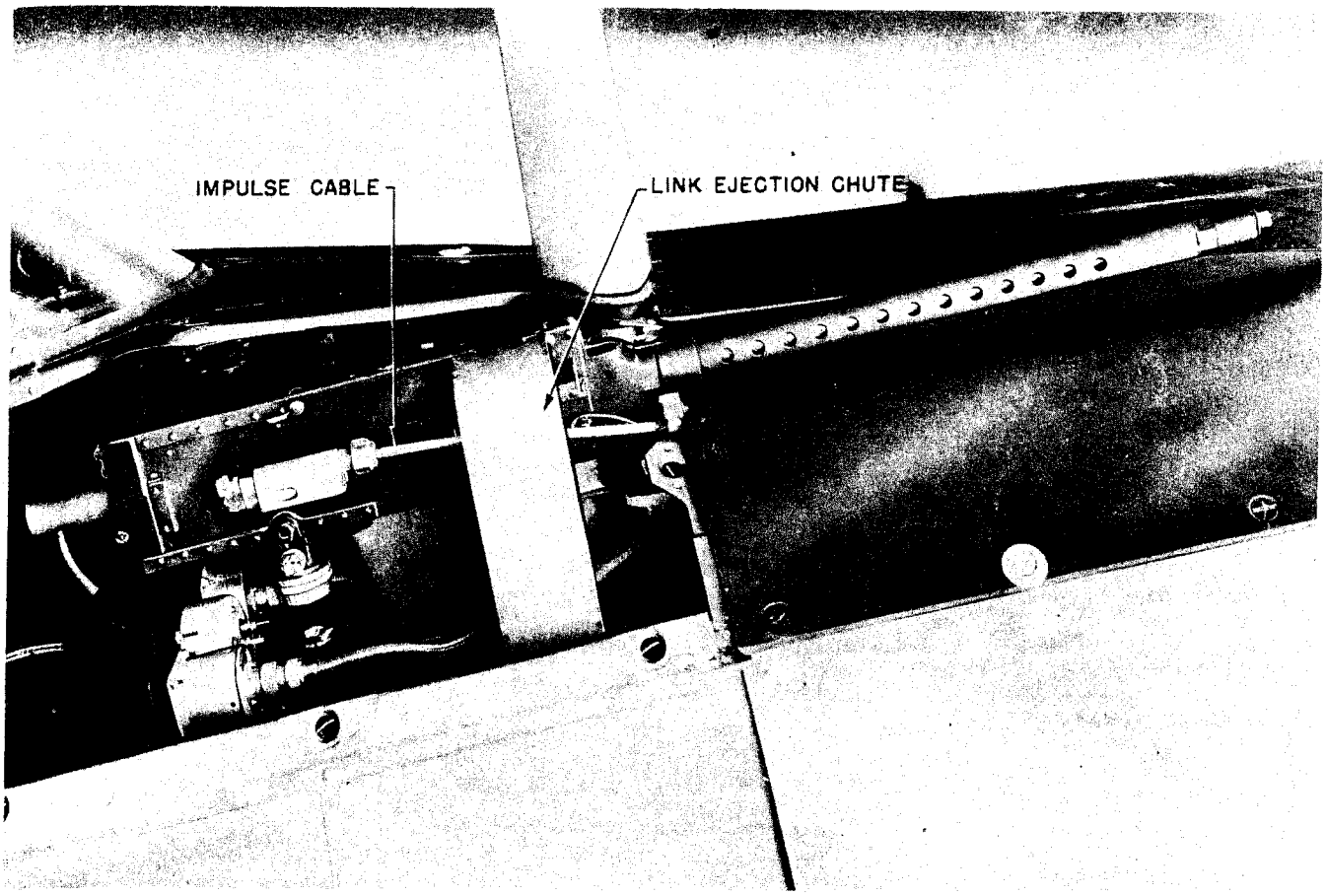


Figure 348 — Fixed Fuselage Gun Installation

(c) Install the forward gun post at the forward support.

(d) Install the intermediate ejection chute below the gun. Attach the chute to the fuselage frame tubing at the otuboard side of the gun and at the gun support.

(e) Install the lower ejection chute.

(f) Install the case ejection chute between the gun posts.

(g) Attach the hinge at the outboard opening of the intermediate chute.

(h) Secure the ammunition box with two screws and nuts at the bottom in each of the four corners.

(i) Install the gun. Lock it in place on the gun posts by turning the knurled ring.

(j) Slide the feed chute on the outer edge of the ammunition box top, and insert the gun attachment pin through the chute attachment holes.

(k) Remove the lubricator fitting from the impulse unit, and attach it to the trigger motor on the outboard side of the gun.

(l) Take the solenoid electrical conduit from the dummy socket; insert it into the solenoid.

(4) ADJUSTMENTS.—For adjustments to the fixed fuselage gun, see "ADJUSTMENTS," paragraph *c.* (4), preceding.

(5) BORESIGHTING.—For boresighting procedure, see "BORESIGHTING FIXED GUNS," paragraph *c.* (5), preceding.

e. FLEXIBLE GUN.

(1) DESCRIPTION.—Provisions are made in the rear cockpit frame for the installation of a model M-2, caliber .30, Browning flexible machine gun. The gun is mounted on a type G-1A or G-5 (interchangeable) gun mount that trains on a track attached to the aft end of the rear cockpit. A truck-locking handle is provided to secure the gun truck to the track. The locking handle must be raised before the gun truck can be moved along the track. The gun is equipped with a gun yoke locking device to secure it in the stowed position. Ammunition boxes located below the gun, one on the right side and four on the left side of the fuselage, contain 500 rounds of caliber .30 ammunition. The gun is equipped with a type A-1 or A-5 (interchangeable) holder assembly and a type A-3 container assembly. Earlier airplanes use a type A-5 container. The mount and track will permit the gun to rotate approximately 160 degrees radius, facing aft of the airplane. The rear seat may be rotated 180

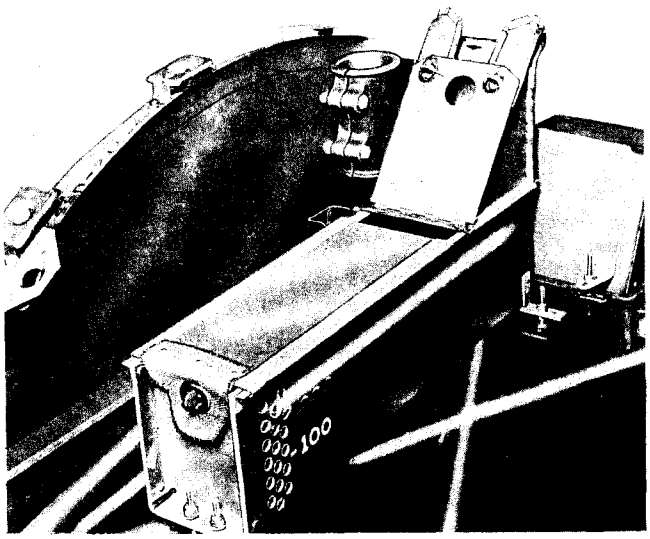


Figure 349 — Ammunition Box and Chutes for Fixed Fuselage Gun

degrees so that it faces the gun. A foot-operated latch releases the seat from its fore-and-aft positions. A type A-3 gunner's belt with a quick release buckle is attached to the swivel point of the cockpit seat. Releasing or removing the belt can be effected by pulling up on the handle provided on the buckle, thus allowing the shoulder straps and belt to fall free. The gun may be stowed in a special compartment or trough aft of the rear cockpit by centering the gun truck on the track, releasing the yoke and pushing the gun into the trough.

(2) REMOVAL.—To remove the flexible gun from the rear cockpit, proceed as follows:

(a) Remove the gun truck by removing the bolts from the aft bracket and side supports.

(b) Remove the gun truck from the gun track.

(c) Remove the gun from support on each side of the cockpit.

(d) Remove the gun track attaching brackets from the aft edge of the rear cockpit.

(3) REMOVAL FROM STOWED POSITION.—*(See figure 352.)*—To remove the flexible gun from its stowed position and operate it, adhere to the following procedure:

(a) Pull outward on the gun yoke locking knob.

(b) Pull up and back on the gun until the locking knob snaps into place.

(c) Raise the truck-locking handle to move the gun truck along the track.

(d) Lower the handle at the desired position.

(e) Pull back on the charging handle and then release it.

(f) Press the trigger on the hand grip.

(4) INSTALLATION.—Install the flexible gun as per the following procedure:

(a) Install the gun track attaching bracket on the aft edge of the rear cockpit.

(b) Install a gun track support on each side of the cockpit with U-bolts and nuts. Do not tighten the nuts until the track is installed and the proper position of each support is located by the bolt holes in the track.

(c) Install the gun track with an AN5-33A bolt through the aft bracket and one AN5-32A bolt through each side support. Use AN365-524 nuts on all of the attaching bolts.

(d) Install the gun truck on the track.

(e) Install gun on track.

f. GUN SYNCHRONIZER.

(1) DESCRIPTION.—*(See figures 353 and 354.)*—A type E-4 gun synchonizer is interconnected with a type E-3A trigger motor by means of a 55-61004 impulse unit on AT-6 airplanes, and a 77-61004 impulse unit on subsequent models of the AT-6 series. A 19A-53415 special lubricator fitting (figure 390) is furnished, attached to the end of the impulse unit that connects to the trigger motor. The engine-driven gun synchronizing unit consists of a gear and cam assembly, a spring loaded cam follower, and a G-18 solenoid which, when not electrically energized, will engage the cam follower and lock it in a neutral position out of contact with the moving cam. The cam follower roller rides upon the cam which, in turn, is rotated from the engine-drive. The impulse of the resulting movement in the cam follower is transmitted through the impulse cable to the trigger motor mounted on the fuselage gun. Thus the gun is fired at each low point on the cam, or twice with each revolution of the propeller, the ratio between synchronizer and engine drive being 1:1. Normally, the solenoid plunger engages the cam follower thereby holding the roller out of contact with the cam, and the gun is idle. As the trigger is depressed, the solenoid is energized, the plunger is removed from the recess in the cam follower, and the gun is fired. The synchronizer is mounted on the right-hand engine accessory section above the oil tank drain line connection. On earlier airplanes G-10 solenoids are reworked and installed instead of type G-18.

NOTE

When trigger motor is not installed, the lubricator fitting should be installed on the impulse tube. Also, when impulse generator is not installed, the electrical conduit to the solenoid should be stowed in the dummy socket provided on the nearby engine mount tube.

(2) REMOVAL.—Disconnect the trigger motor impulse tube from the impulse generator located on the right engine vertical drive pad. Remove the impulse

generator, with the aid of special wrench, 36-61039, and the electrical control unit solenoid. Immediately after removing these units, install the cover plates specified for this particular engine.

CAUTION

Do not rotate or move the crankshaft during this operation.

(3) DISASSEMBLY. — Disengage impulse cable and solenoid connections and remove the gun synchronizing unit from its mounting pad on the left-hand engine accessory section.

(a) Unscrew the solenoid assembly from the side of the synchronizing unit.

(b) Remove four screws holding the two sections of the housing together and pull the two sections apart.

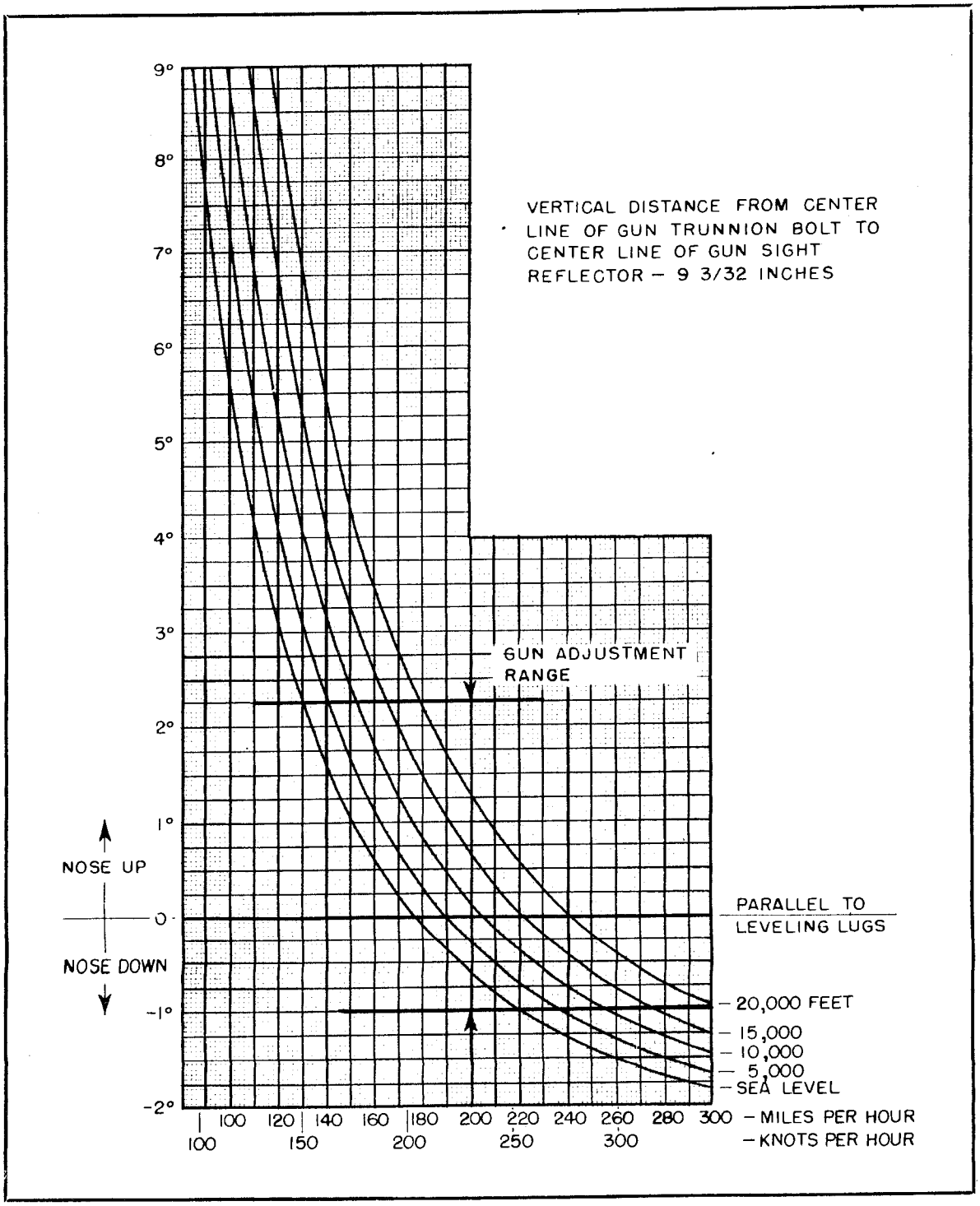


Figure 350 — Fixed Fuselage Gun Sighting Chart

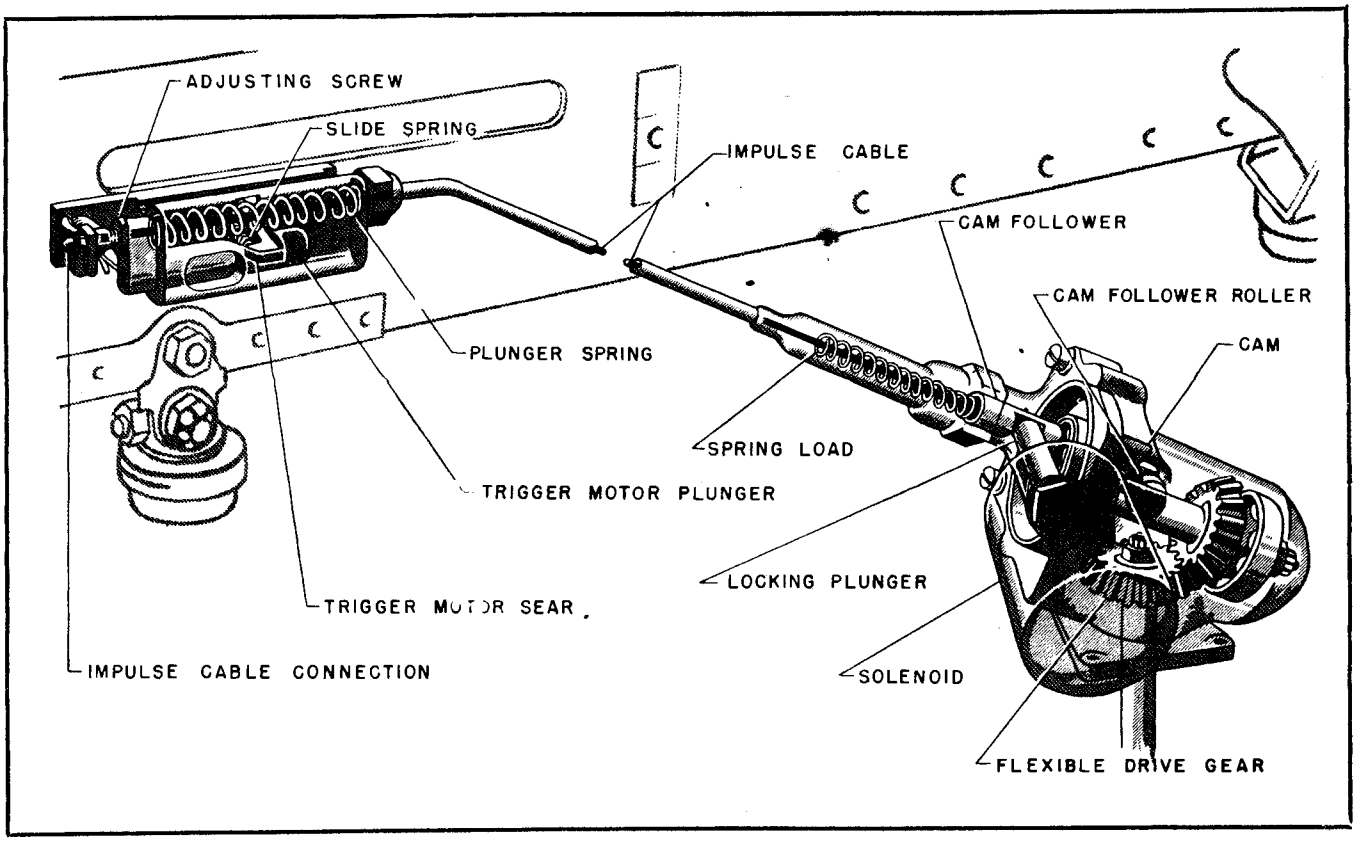


Figure 351 — Fixed Fuselage Gun Synchronization Diagram

(c) The bearing assembly is pressed into the gear housing and may be removed by pulling firmly on the cam follower. This will remove the entire assembly from the housing. Further disassembly is obvious upon inspection.

(4) INSTALLATION.—To engage mounting flange of synchronizer with studs on engine mounting base, it is necessary to tip the top of synchronizer to the right. Due to synchronizer casting design, it is necessary to lower base of synchronizer as nuts are drawn up. A special wrench, 36-61039, is required for the forward inboard attachment bolt. Secure nuts with lock wire. A lock washer may be utilized to secure the right forward nut in lieu of a lock wire. Connect gun impulse tube and solenoid cable to synchronizer.

g. TRIGGER MOTOR—TYPE E-3A.

(1) DESCRIPTION. — *(See figure 355.)* — The trigger motor consists of a steel housing containing a trigger motor slide, a slide spring, a trigger motor plunger, a plunger spring, and an adjusting screw. The slide is operated by the angular face of the plunger acting against the angular face of the slide. As the plunger moves forward, the end of the slide is forced through the slot in the mounting plate of the housing. When the bolt of the gun is forward, in the firing position, the projecting end of the trigger motor slide forces the gun's sear inward, releasing the firing pin so the gun is fired. The firing pin is held in the locked position by means of a notch provided in the side of the firing pin extension into which the sear engages directly. Movement of the plunger is controlled by the impulse cable from the synchronizer. The adjusting screw is used to vary the distance the trigger motor slide projects into the gun.

(2). DISASSEMBLY. — Disengage the impulse wire and remove trigger motor unit from gun. Press forward on rear end of plunger until slide extends out of housing and, with a pair of pliers, pull it out sufficiently to release the plunger. Draw out plunger and plunger spring. Remove trigger motor slide and slide spring.

h. GUN SIGHT.

(1) DESCRIPTION.—*(See figure 356.)*—A bracket, an adjustment stud, and a shield are provided directly below the front cockpit instrument panel for installation of a type N-3B, N-3A, or N-2A optical gun sight. On late airplanes the gun sight, with reflector attached, is mounted in the center of the windshield cowling aft of the front instrument panel. The gun sight, consisting of a main housing containing the lamp and lamp socket, the reticle, mirror assembly and lens assembly, is installed so that the reflected image shall be free of movement. A reflector glass is mounted on a bracket below the windshield on the fuselage, level

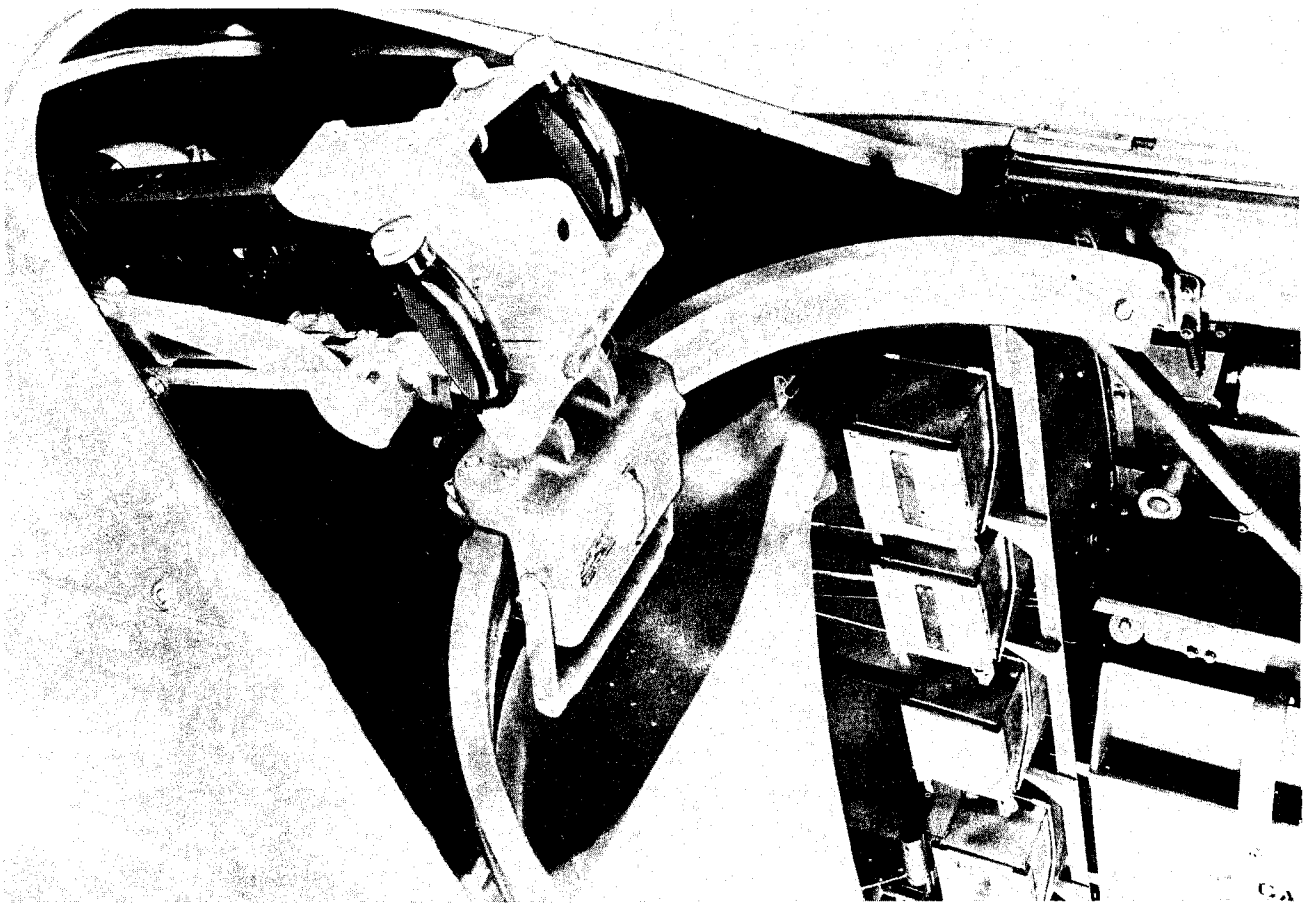


Figure 352 — Flexible Gun (Stowed)

with the pilot's line of sight; a reticle pattern is projected on the reflector from the lens assembly, with the light intensity regulated by a rheostat or switch located on the electrical control panel. Normally the N-3B, N-3A, or N-2A gun sight is properly adjusted by the manufacturer, and it should not be necessary to readjust either the reticle or main lens throughout the life of the sight. If the reticle image is not projected on the vertical center line with the reflector, an adjusting knob located on the right side of the sight housing is provided to focus the reticle in the center of the reflector glass. Sights equipped with a switch to decrease light intensity for day use are identified by a red spot painted on the sight body above the electrical connector. On the late AT-6D and all AT-6F airplanes a three-way canopy switch is installed on the N-3B gun sight to provide alternate lighting of the G-9 Mazda 844 bulbs filaments.

(2) DISASSEMBLY.

(a) REFLECTOR PARTS.—The reflector may be removed by loosening the setscrew which secures the

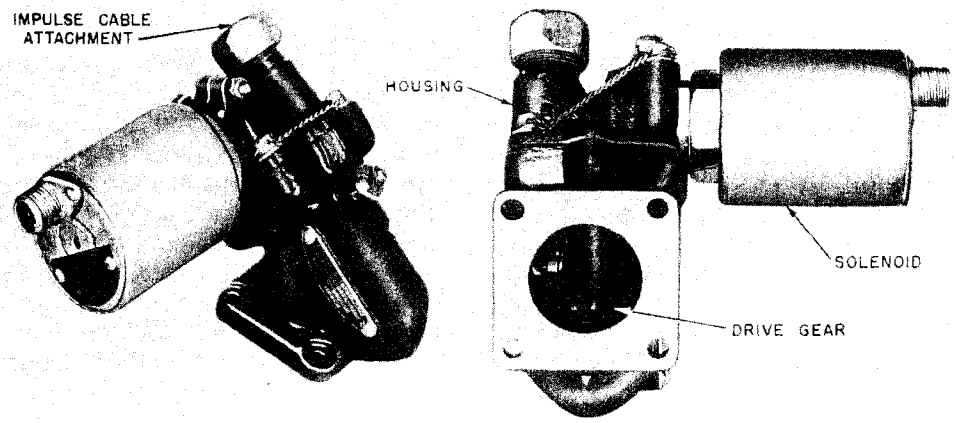


Figure 353 — Gun Synchronizer

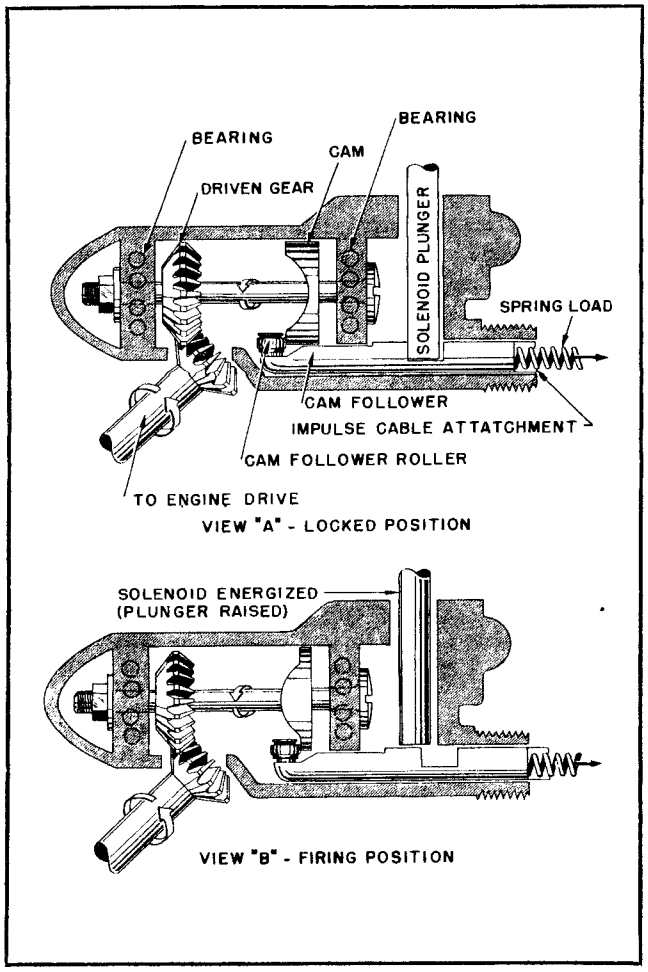


Figure 354 — Gun Synchronizer Function Diagram

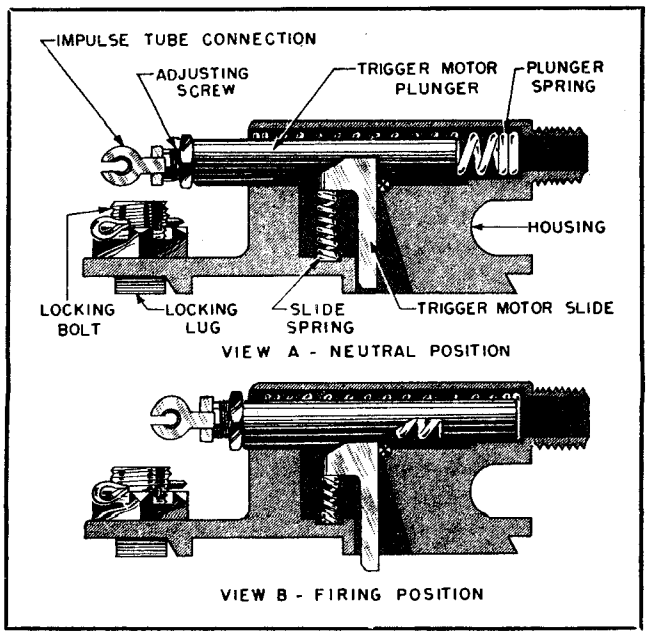


Figure 355 — Trigger Motor

housing to the sight and then re moving the four nuts and bolts holding the reflector to the housing.

(b) LAMP. — The lamp may be removed by hand from the gun sight by first removing the four screws from the lamp housing cover and removing the cover.

(c) RETICLE.—Remove the sight reticle by taking out the two retaining plates and attaching screws and tilting the sight until the reticle slips out.

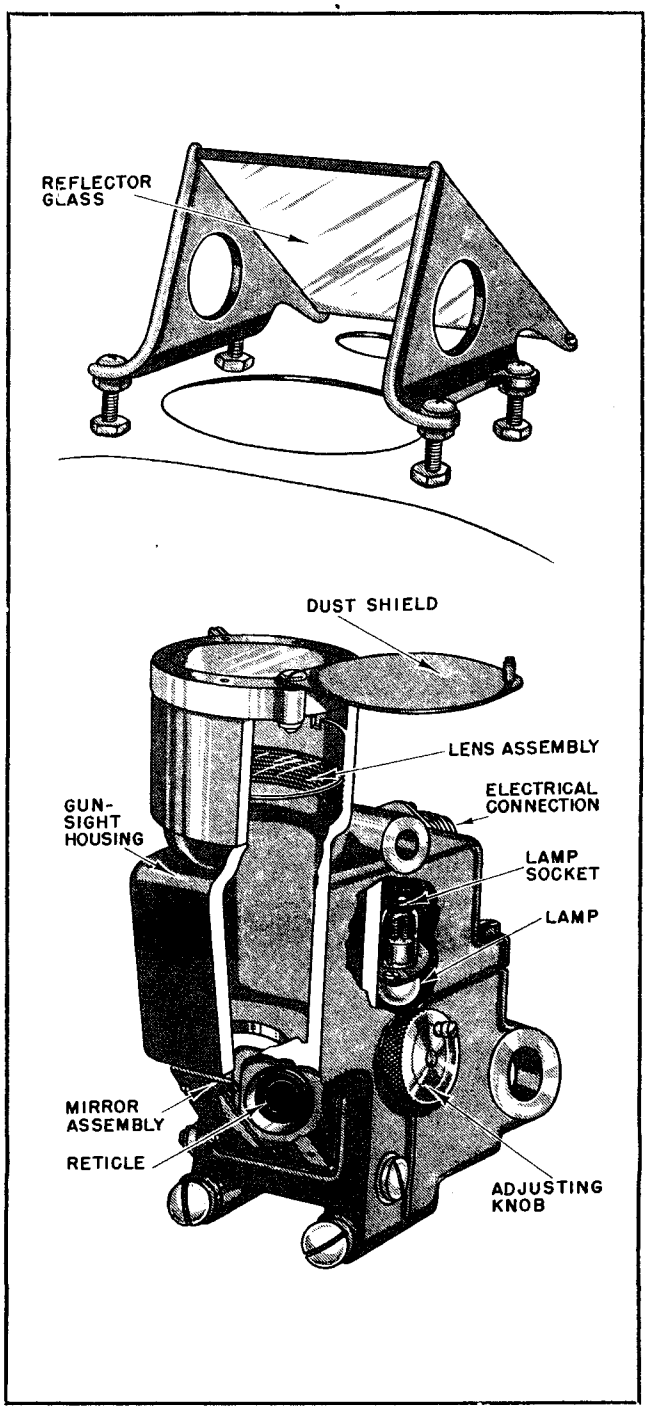


Figure 356 — Gun Sight and Reflector

(d) RETICLE CARRIAGE AND ELECTRICAL ASSEMBLY.—Unscrew the nut on the reticle slide, remove the slide and then proceed as follows:

1. Knock out the pin holding the deflection knob. Unscrew the deflection knob lock, then unscrew the knob and the long screw which passes through the reticle mount.

2. Remove the four screws holding the electrical connector housing on the sight. Detach the socket pin mounted in the moulded phenolic base, but do not break the cable connection.

3. Remove the socket assembly from the sleeve by pushing in the small locator button projecting from the sleeve.

4. Remove the reticle mount by unscrewing the two screws which pass through the slide spacer and hold the reticle carriage to the sleeve spacer.

(e) MIRROR.—Remove the four screws which hold the mirror assembly to the sight housing. Pry the mirror assembly loose, exercising care so as not to scratch the mirror. Remove the two lugs which hold the mirror in the well, and remove the mirror.

(f) LENS.—Remove the dust shield by unscrewing retaining screw. Remove lens cell set-screw on front of barrel. Warm the sight to overcome sluggishness of the sealing compound. Then insert the sight wrench in the two slots in the lens barrel and remove lens by turning the lens assembly firmly in a counterclockwise direction.

(3) ADJUSTMENTS.—Unless the pattern of the reticle as reflected upon the reflector glass is out of focus, it should not be necessary during the life of the sight to adjust the main lens assembly. If adjustment is necessary, the following procedure must be followed:

(a) Unscrew the dust shield assembly, which is provided to keep dust and other particles from the main lens assembly.

(b) Back out locking screw which holds lens cell from turning.

(c) Turn lens assembly until reticle image is viewed as reflected through the reflector glass and superimposed upon a target approximately 500 yards distant, and until it does not change in relation to the target as the head is moved over the field of vision of the sight.

(d) Turn lens cell until nearest notch lines up with hole for locking screw. Lock screw tightly, being careful that the end of the screw engages one of the four notches provided in the lens cell. Assemble dust shield assembly.

SECTION V
USEFUL OR MILITARY LOAD

1. BOMB LOADING.

(See figure 331.)

a. 20- AND 30-POUND BOMBS.—The sequence of operations necessary for loading 20- or 30-pound bombs is as follows:

(1) Move the release handle, located on the bomb control quadrant in the front cockpit, to the "SALVO" position and then to the "SELECTIVE" position. Move the arming handle, also in the bomb control quadrant, to the "SAFE" position.

CAUTION

Do not move the release handle to "SALVO" if any bombs are installed. If it is desired to remove any support hooks, it should be accomplished by moving the handle to the "SELECTIVE" position and manually tripping the release triggers at the rack.

(2) Screw the 20- and 30-pound bomb sway braces far enough into the lower surface of the wing panels to facilitate loading.

(3) (Type NA 84-63005 rack only.) Pull and hold down charging cable ring, and install bomb No. 1 at the inboard end of the rack.

NOTE

The inboard bomb must be loaded first and the fins rotated to 45 degrees from the perpendicular center line of the bomb.

(4) Push the bomb support hook closed until it snaps into place. *Do not* engage any support hooks that are not used, since bombs will not release consecutively, under these conditions, as the firing switch is operated.

(5) (Type NA 84-63005 rack only.) Pull and hold charging cable. The rack operating shaft should remain in the charged position. If this is not the case, release the bomb by pushing inboard on the lower end of the trigger until the support becomes disengaged. Repeat the above operation; and if the charging cable will not stay in the right position, check the rack thoroughly for accumulation of foreign matter or visible defects. Replace the rack if necessary.

(6) Engage the fin braces with the fins of the bombs; screw the sway braces out until they press evenly and firmly against the sides of the bomb.

(7) Install the arming wire loop in the arming lever.

(8) Pass the arming wire between the bomb and the sway brace; connect it to the bomb as required.

NOTE

When the arming wire is attached, fold excess wire and tape to the surface of the bomb. Use thin paper tape wrapped around the bomb once only.

(9) Install the remaining bombs in the same manner. Loading order, after the inboard bomb has been installed, is optional.

b. 100-POUND BOMBS. — The sequence of operations necessary for loading 100-pound bombs is as follows:

(1) Move the release handle on the bomb control quadrant in the front cockpit to "SALVO" position and then to the "SELECTIVE" position. Move the arming handle to the "SAFE" position.

(2) Bolt the two 100-pound bomb shackles on the lower surface of each outer wing panel directly under the second and fourth bomb support hooks on the bomb rack.

(3) Unscrew the two special adjustments bolts, one at each outer point of the sway brace, to facilitate loading.

(4) Push up the inboard bomb shackle lever by means of a screw driver inserted through the bottom of the shackle so that the lever will engage the support hook of the bomb rack when the hook is pushed closed. (Refer to figure 338.) Make sure that the bomb support hooks on the shackle are held open.

NOTE

The inboard bomb shackle must be charged first.

(5) Pull out and hold the bomb rack charging cable (type NA 84-63005), and push the bomb rack support hook closed until it snaps into engagement with the shackle lever.

(6) Release the charging cable (type NA 84-63005). The rack operating shaft should remain in the charged position. If this is not the case, release the support hook by pushing inboard on the lower end of the trigger until the support hook becomes disengaged. Repeat operations (4) through (6) above.

(7) Charge the outboard bomb shackle in the same manner as described in paragraphs (4) through (6)

above. It is not necessary to pull down on the charging cable after the first support hook is properly engaged.

(8) Install the inboard bomb first, engaging the carrying lugs of the bombs with the support hooks of the bomb shackle.

(9) Push the support hooks closed until they snap into place.

(10) Engage the tail arming wire with the arming lever located adjacent to the support hook in the bomb rack.

(11) Pass the arming wire between the bomb and the bomb shackle, and connect it to the tail of the bomb as required.

(12) Engage the nose-arming wire with the auxiliary arming control unit located within the wing, forward of the bomb rack.

(13) On a U.S.-type bomb, pass the arming wire back through the forward lug on the bomb, and connect it to the nose of the bomb as required. On a British-type bomb, the arming wire will reach only from the nose direct to the arming control unit.

(14) Adjust the special sway brace bolts evenly to hold the bomb firmly. Do not tighten bolts excessively.

(15) Safety the adjusting bolts to the sway braces, using .040-inch brass wire.

(16) Move the release handle on the bomb control quadrant in the front cockpit to the "LOCK" position.

2. GUN LOADING.

a. FUSELAGE GUN. — Check to see that the cowl gun selector switch, located on the switch panel to the left and below the instrument panel, is in the "OFF" position. Load the 200 rounds of .30 caliber ammunition for the fuselage gun according to the following instructions:

(1) Remove the gun and ammunition bay access plate from the cowl just forward of the cockpit.

(2) Check the ammunition belt to ascertain that the cartridges are properly arranged in the links.

(3) Lift the ammunition box cover.

(4) Starting with the single loop end of the belt, load the belt in the smooth layers in the ammunition box.

(5) Lift the feed chute; cover and thread the double loop end of the belt through the feed chute and to the feedway of the gun.

(6) Push the double loop end of belt and the first cartridge into the feedway until it is held by the belt-holding pawl.

(7) Charge the gun by pulling the upper gun charger handle, on the right side of the front cockpit, to the full rear position and then release it. Repeat this operation and the gun is loaded.

b. WING GUN.—Check to see that the wing gun selector switch, located on the switch panel to the left and below the instrument panel, is in the "OFF" position, then load the gun with its 200 rounds of .30 caliber ammunition in the following manner:

(1) Remove the ammunition bay and gun bay access doors from the upper surface of the right wing.

(2) Check to ascertain that the cartridges are properly arranged in the links.

(3) Start with the single loop end, and lay the ammunition belt into the ammunition compartment in smooth layers. Load the compartment up to the feed chute opening.

(4) Thread the belt through the feed chute to the gun feedway.

(5) Push the double loop end of belt and first cartridge into the feedway as far as possible so the cartridge is held by the belt-holding pawl. This prevents the belt from slipping back out of the gun.

(6) Charge the gun by pulling the lower gun charger handle on the right side of the cockpit to the full rear position and release. Repeat this operation and the gun is ready to fire.

c. FLEXIBLE GUN. — There are five ammunition container storage boxes installed aft of the rear cockpit seat: four on the gunner's right and one on his left when in combat position (facing aft). To load the ammunition, proceed as follows:

(1) Load each of the five type L-4 ammunition boxes with a 100-cartridge .30 caliber ammunition belt, being careful to keep the cartridges and links uniform, and the belt in a smooth layer. Load the belt into the box with the single loop end of the belt first.

(2) Stow four of the loaded ammunition boxes in the four storage boxes located on the left side. Place the other one in the ammunition box holder, attached to the right side. The cartridge must be pointing in the same direction the gun is pointing.

(3) Push the double loop end of the belt and first cartridge into the feedway of the gun until the first cartridge is held by the belt-holding pawl.

(4) Charge the gun by pulling the bolt handle all the way back and releasing it; repeat this operation and the gun is ready to fire. If the gun is not to be fired immediately, set the trigger safety to lock the trigger.

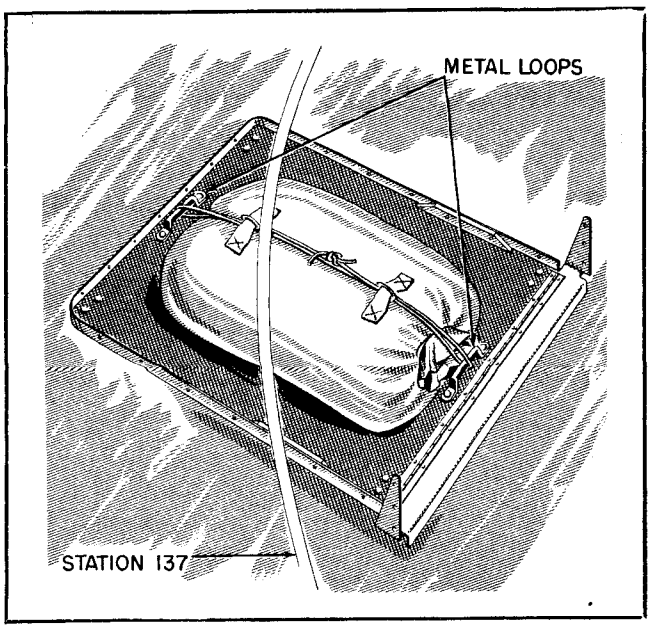


Figure 356A — Stowage of One Sandbag

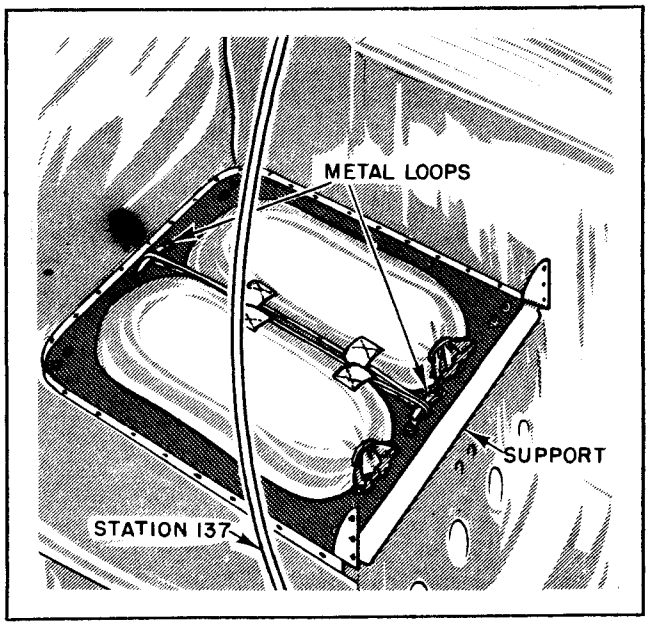


Figure 356B — Stowage of Two Sandbags

3. STOWING OF SANDBAGS.

(See figures 356A and 356B.)

Ballast sandbags are installed in the following manner:

a. Secure the baggage compartment floor by pushing the two adjustable catches on the two front corners of the floor to the fully locked position under the support plates. Tighten the two wing nuts.

b. Place the bag, or bags, in a longitudinal position on the floor.

c. Place a rope through the canvas loops on the bags and then through the metal loops provided on the fore and aft surfaces of the floor.

d. Draw the rope tight and tie the ends in a slip-proof knot.

SECTION VI
MATERIALS OF CONSTRUCTION

1. GENERAL.

The following list of heat-treated parts includes only heat-treated castings, forgings, and steel members used in the construction of the airplane. Generally, the repair of these parts is not recommended, and any extent of damage necessitates complete replacement of the damaged member. However, it is to be noted that in the event of an improvised replacement, the heat treatment of the fabricated member must produce the tensil strength given on the subsequent pages in the "HEAT TREAT" column.

2. MATERIAL CODE.

The following code used in the heat-treated parts list simplifies the identification of materials and their physical properties:

AA-E—Aluminum-Alloy Extrusion	24S	Federal Specification No. QQ-A-354A
AA-F—Aluminum-Alloy Forging	14S	Federal Specification No. QQ-A-367B Gr. 5
AA-F—Aluminum-Alloy Forging	17S	Federal Specification No. QQ-A-367B GR. 1
AA-F—Aluminum-Alloy Forging	A51S	Federal Specification No. QQ-A-367B GR. 3
AA-T—Aluminum-Alloy Tube	24S	Federal Specification No. WW-T-785
CM-B—Chrome-Molybdenum Steel Bar	4140	AN-QQ-S-752A
CM-F—Chrome-Molybdenum Steel Forging		AC Specification No. 57-105B
CM-R—Chrome-Molybdenum Steel Rod	X4130	AN-QQ-S-684A
CM-S—Chromé-Molybdenum Steel Sheet	X4130	AN-QQ-S-685
CM-T—Chrome-Molybdenum Steel Tube	X4130	AN-WW-T-850a
MA-C—Magnesium-Alloy Casting		AN-QQ-M-56, Condition HT
MC-F—Mild Carbon Steel Forging		AC Specification No. 57-105B
MW—Music Wire		AN-QQ-W-441
NS-R—Nickel Steel Rod	2330	AN-QQ-S-689

3. HEAT-TREATED PARTS LIST.

Part No.	*Title*	*Material Code*	*Heat Treat to Tensile Strength in lb/sq in. or as Noted*
5B10	Eye-bolt—Ball bearing	CM-F	125-145,000
5R9	Ring—Airplane mooring	CM-F	125-140,000
66-13013	Angle—Wing center section upper bolting	AA-E	58,000
66-13104	Angle—Wing center section front bolting	AA-E	58,000
77-13303	Angle—Wing center section fuel tank cover bolting	AA-E	58,000
55-14027	Angle—Outer wing upper bolting	AA-E	58,000
54-14028	Angle—Outer wing nose bolting	AA-E	58,000
88-14029	Angle—Outer wing lower front bolting	AA-E	58,000
54-14030	Angle—Outer wing lower rear bolting	AA-E	58,000
55-14065	Bracket—Aileron outboard hinge	AA-F (17ST)	55,000
55-14066	Bracket—Aileron inboard hinge	AA-F (14ST)	65,000
55-14069	Bracket—Aileron center hinge	AA-F (14ST)	65,000
55-14244	Support—Aileron bell crank bearing	AA-F (17ST)	55,000
55-16080	Bracket—Aileron inboard hinge	AA-F (14ST)	65,000
55-16081	Fitting—Aileron center hinge	AA-F (17ST)	55,000

HEAT-TREATED PARTS LISTS (Continued)

Part No.	*Title*	*Material Code*	*Heat Treat to Tensile Strength in lb/sq in. or as Noted*
55-18022	Hinge Fitting—Flap	AA-F (A51ST)	43,000
55-18024	Eye-bolt—Wing flap	CM-B	125,000
52-21018	Fitting—Elevator center hinge support	AA-F	65,000
52-21019	Fitting—Elevator center hinge support	AA-F	65,000
55-21020	Fitting—Stabilizer attaching	AA-F (A51ST)	43,000
52-21026	Bracket—Elevator inboard hinge support	AA-F	65,000
55-22037	Hinge Fitting—Trim tab	AA-F (17ST)	55,000
52-23012	Fitting—Rudder upper hinge support	AA-F	65,000
52-23013	Fitting—Rudder center hinge support	AA-F	65,000
52-23014	Fitting—Rudder lower hinge support	AA-F	65,000
28-31053	Fastener—Engine ring cowling rear	AA-S	62,000
66-31058-2	Catch—Fire extinguisher door release	AM-S	125,000
66-31010-2	Hook—Engine ring cowling	AA-E	62,000
57-31103-2	Tube—Fuselage station No. 1 lower cross	CM-T	Normalize
19-31105	Fitting—Fuselage connection	CM-F	Normalize
55-31174	Fitting—Fuselage connection	CM-B	125-140,000
55-31220	Step—Cockpit	MA-C	32,000
19-31231	Bracket—Fuselage pilot's seat support	CM-F	Normalize
55-31383	Guide—Fuselage front step tube	CM-B	125,000
55-31385	Spring—Fuselage front step tube keeper	MW	*(10 Minutes)
49-31894	Finger—Enclosure release handle	CM-S	160-180,000
25-31902	Fitting—Engine mount attaching	CM-F	Normalize
66-33109	Pin—Landing gear retract arm attaching	CM-B	145-160,000
36-33112	Pin—Landing gear pivot	CM-T	160-180,000
36-33117	Bushing—Landing gear support	CM-B	160-180,000
36-33119	Bushing—Landing gear attaching fitting	CM-B	125-140,000
36-33120	Nut—Landing gear pivot pin	CM-B	125,000
19-33447	Wrench—Special	CM-S	180-200,000
55-33467	Spring—Brake cylinder ext.	MW	*(20 Minutes)
36-33515	Latch—Landing gear lock cam	CM-S	125,000
55-33525	Pin—Landing gear lock	CM-B	160-180,000
44-33534-2	Fitting—Landing gear lock and hoist	CM-F	160-180,000
44-33534-3	Fitting—Landing gear lock and hoist	CM-F	160-180,000
66-33536	Bolt—Landing gear lock and hoist fitting attaching	NS-R	160-180,000
36-33541	Rod—Landing gear lockpin push	CM-F	Normalize
36-33542	Bolt—Landing gear mechanism	CM-B	125,000
55-33544	Bell Crank Assembly—Landing gear locking mechanism	CM-F	125,000

*—Heat treated spring at 260°-288°C (500°-550°F) for period noted.

HEAT-TREATED PARTS LISTS (Continued)

Part No.	*Title*	*Material Code*	*Heat Treat to Tensile Strength in lb/sq in. or as Noted*
66-42012	Shaft—Carburetor mixing chamber	CM-T	125,000
51-47032	Stud—Oil tank sump	NS-R	125,000
49-51047	Support—Oil separator outer	AA-S	62,000
55-52119	Spring—Surface lock	MW	*(20 Minutes)
55-52302	Bell Crank—Aileron	AA-F (17ST)	55,000
55-52316	Clevis—Aileron control rod	CM-F	125,000
55-52428-2	Rod—Rudder brake pedal	CM-R	125,000
19-52440	Spring—Tension coil	MW	*(20 Minutes)
49-52441	Spring—Rear cockpit rudder pedal adjusting	MW	*(20 Minutes)
55-52610	Arm—Flap indicator	MA-C	32,000
55-52649-2	Rod—Flap connecting	CM-B	125,000
55-52653	Plunger—Flap control handle lock spring	NS-R	Carburize 1/32-inch
58-53004-3	Tube—Pilot's cockpit seat support	CM-T	160-180,000
49-53060	Clamp—Alemite grease gun	SS-S	Spring Temper
55-53061	Pin—Observer's seat latch	CM-B	160-180,000
49-53073	Plunger—Seat adjusting	CM-R	125-140,000
55-53075	Tube—Observer's seat adjusting	CM-T	160-180,000
55-53076	Brace Assembly—Observer's seat	CM-T	150-170,000
55-53096	Spring—Observer's seat latch	MW	*(10 Minutes)
55-53104	Axle—Observer's seat	CM-B	160,000
36-54029	Bearing—Landing gear position indicator switch box	CM-B	125,000
36-54033	Guide—Landing gear position indicator switch box	CM-B	125,000
55-54083	Bracket—Ignition switch hand support	MA-C	32,000
55-54125	Spring—Landing gear position indicator switch	MW	*(10 Minutes)
36-55009	Fitting Assembly—Wing center section hoist	CM-F	125-140,000
36-58008-2	Fitting—Landing gear hydraulic strut	CM-B	125,000
88-58101	Body—Hydraulic landing gear and flap control unit	AA-F (17ST)	55,000
55-58137	Spring—Hydraulic one-way valve	MW	*(5 Minutes)
55-58143	Spring—Hydraulic landing gear and flap relief outer	MW	*(20 Minutes)
55-58144	Spring—Hydraulic landing gear and flap relief inner	MW	*(10 Minutes)
55-58152	Spring—Control unit one-way valve	MW	*(20 Minutes)
55-58196	Spring—Pressure control return	MW	*(20 Minutes)
55-61040	Screw—Ammunition box and ejection chute adjusting	NS-R	125,000
59-73006	Bow—Instrument flying hood	AA-T	62,000
59-73007	Bow—Instrument flying hood	AA-T	62,000

*—Heat treated spring at 260°-288°C (500°-550°F) for period noted.

SECTION VII
FINISH SPECIFICATIONS

1. GENERAL REQUIREMENTS.

The requirements stated herein are a minimum. In the finishing of areas where color only is specified, the number of coats shall be such as to give complete hiding, except where the number of coats is noted in detail below. The finish for exterior (exposed) surfaces or parts of this airplane shall be as follows:

Ailerons, exterior	Aluminum
Ailerons, interior and interior parts	No finish*
Anti-glare	Olive drab No. 613 or black No. 604
Castings, forgings	To match
Cockpit, front	Yellow-green
Cockpit, rear	Yellow-green
Compartment, landing light	Flat black
Compartment, baggage	Yellow-green
Cowling, exterior	Aluminum
Cowling, interior	No finish*
Elevators, exterior	Aluminum
Elevators, interior and interior parts	No finish*
Fairing, fin to fuselage	Aluminum
Fairing, landing gear	Aluminum
Fairing, stabilizer to fuselage	Aluminum
Fairing, tail wheel	Aluminum
Fairing, wing to fuselage	Aluminum
Fin, exterior	Aluminum
Fin, interior and interior parts	No finish*
Flaps, exterior	Aluminum
Flaps, interior and interior parts	No finish*
Fuselage, exterior	Aluminum
Fuselage, frame	Yellow-green
Fuselage, interior parts, cockpits	Yellow-green
Nose-over structure	Aluminum
Fuselage, interior parts, aft of baggage compartment	No finish*
Horns, control	To match
Instrument panels	Flat back
Landing gear	Aluminum
Propeller, rear face	Flat black
Rudder, balance portion	Aluminum
Rudder, interior and interior parts	No finish*
Rudder, rear of hinge	Aluminum
Seats, wood	Dull dark green
Seats, metal	Aluminum
Stabilizer, exterior	Aluminum
Stabilizer, interior and interior parts	No finish*
Steps, plates	Aluminum
Struts, landing gear	Aluminum
Tail wheel fork	Aluminum
Tanks, exterior	Aluminum
Walkways	Black
Wheels	Aluminum
Wings, exterior	Aluminum
Wings, interior and interior parts	No finish*

*Finish for corrosion-prevention shall be in accordance with the detail sections listed below. Whenever the peculiarity of a particular part or assembly prohibits the employment of the specified finish, the part or assembly shall be given as high a degree of protection as is consistent with its proper functioning for its intended use.

NOTE

Finishes for the Navy airplanes shall be the same as for the Army airplanes except as noted below, in final finishes only. All pre-finish treatments, e.g., priming, protective treatment for magnesium, cadmium plating, etc., and all finishes not noted are the same as those for the Army airplanes.

2. FINISH AND FINISH MATERIAL SPECIFICATIONS.

a. The following publications, of the issue specified in the U. S. Army Materials and Processes Specifications Bulletin 23 in effect at the date of the contract, shall govern this specification except as specifically excepted in detail below:

ARMY AIR FORCES SPECIFICATIONS:

14115	Surfacer; Wood, Liquid

ARMY-NAVY AERONAUTICAL SPECIFICATIONS:

AN-T-8	Tolune substitute
AN-V-26	Varnish: phenolformaldehyde spar
AN-E-3	Aircraft Enamel
AN-1-9	Insignia for aircraft
AN-P-32	Zinc Plating**
AN-P-39	Chromium Plating
AN-C-52	Corrosion-Preventive Compound (AT-6D and SNJ-5 Only)
AN-P-61	Cadmium Plating
AN-TT-T-256	Thinner, Dope and Lacquer (AT-6D and SNJ-5 Only)

FIGURE 357 FORMERLY APPEARING ON THIS PAGE DELETED.

AN-TT-A-461	Aluminum Paste
AN-TT-D-514	Dope, Cellulose Nitrate, Clear
AN-TT-D-551	Dope, Cellulose Nitrate, Clear (For Aluminum Dope)
AN-L-29	Lacquer, Cellulose Nitrate
AN-TT-P-656	Primer, Zinc Chromate
AN-V-26	Varnish; Spar, Phenol Formaldehyde
AN-L-21	Camouflage Lacquer

**Zinc Plating may be used in lieu of cadmium plating on all parts except:

(1) Control cable terminals.

(2) Steel sheets 0.0625-inch or thinner used structurally.

U. S. ARMY SPECIFICATIONS:

57-O-2	Finishes protective on iron and steel parts
3-100	Finishes for metal parts**
98-20007	Cleaning prior to finishing
AN-M-12	Protective treatment for magnesium
98-24105	Marking for aircraft and aircraft parts

**Yellow-Green finish shall be formulated with a suitable tinting material.

FEDERAL SPECIFICATIONS:

JJJ-O-336	Raw Linseed Oil

3. FINISH CODE.

The following code of finishes applicable to this airplane and conforming in detail to the above finish specification, is used in specifying the complete finish and color on all North American Aviation, Inc., drawings.

CODE

F—Finish, prefix designation.
A—Aluminum and aluminum alloys.
C—Copper and copper alloys.
G—General.
M—Megnesium and magnesium alloys.
P—Plastics.
S—Steel.
T—Textile.
W—Wood.
Examples; FS-20—Finish No. 20 for steel.

4. ALUMINUM AND ALUMINUM ALLOYS.

FA-0-GENERAL.

Do not anodize

FA-20-INTERIOR OF CLOSED MEMBERS.

Do not anodize
No finish required

FA-21-INTERIOR SURFACES, PARTS AND OPEN MEMBERS.

Do not anodize

PRIME:

One coat zinc chromate primer. ALCLAD 2S, 3S, 52S, 53S, 43 AND 356 shall receive no primer except when subsequently to be finished with lacquer.
Carburetor air scoop interior shall receive no prime regardless of alloy.

FINISH:

Ailerons, Elevators, Rudder, and/or Parts Attaching:
ALCLAD 2S, 3S, 52S, 53S, 43, AND 356: No further requirements. OTHER SURFACES CONTACTING DOPED FABRIC shall receive one coat of zinc chromate primer.

Bolting Angle Cover Strip:
No further requirements.

Carburetor Air Scoop:
Shall not be finished on the interior.

Cockpits, Baggage Compartment, and/or Parts Attaching:
Yellow-green finish.

Cockpit Enclosure:
Finish entire frame (53S and corner castings) by buffiing.

Fuselage Rear of Baggage Compartment, Wings, and Tail Group:
No further requirements.

Landing Light Compartment:
Flat black lacquer.

Wheel Wells:
OTHER SURFACES: Two coats clear lacquer containing a minimum of 12 ounces of aluminum paste per unthinned gallon.

FA-23-ENGINE COMPARTMENT SURFACES.
Do not anodize.

PRIME:

One coat zinc chromate primer. ALCLAD 2S, 3S, 52S, 53S, 43 AND 356 shall receive no primer or other finish.

FINISH:

No further requirements.

FA-25-EXTERIOR SURFACES, PARTS, AND MEMBERS.

Do not anodize.

PRIME:

One coat zinc chomate primer. ALCLAD 2S, 3S, 52S, 53S, 43 AND 356 shall receive no primer or other finish except where it forms a part of a finished member or surface.

FINISH:

Anti-glare:
Olive drab or black.

Cowling, Fairing, Fuselage, Landing Gear, Tail Group, Wings and/or Parts Attaching:
Two coats clear lacquer containing 12 ounces of aluminum paste per unthinned gallon.

Exception:
ALCLAD 2S, 3S, 52S, 53S, 43 AND 356 shall receive no finish.

Propeller:
Rear surface (4 inches from tip to hub): Two coats flat black lacquer.
Tips (tip to 4 inches from tip): Two coats No. 48 identification yellow painted on both sides.

FA-28-INSTRUMENT PANELS.

Do not anodize

PRIME:

One coat zinc chromate primer.

FINISH:

Direct Lighting Portion:
Flat black lacquer.

Indirect Lighting Portion:
Gloss white lacquer.

FA-29-ELECTRICAL AND RADIO JUNCTION BOXES AND CONDUIT.

Do not anodize.
Do not prime

FINISH:

Boxes and Conduit in Cockpits and Baggage Compartment Only:
Yellow-green finish.

Others:
No finish required.

5. COPPER AND COPPER ALLOYS.

FC-0-GENERAL.

AN Standard Parts:
Finish as specified on AN standard drawings.

Brass and Bronze Parts (Other Than AN Standard Parts):
All brass or bronze parts contacting dissimilar metals shall be cadmium plated.

Exceptions:
Brass or bronze nuts and screws in the vicinity of the compass shall not be cadmium plated.
Internal brass or bronze parts contacting hydraulic fluid or anti-icing fluid shall not be cadmium plated.
Brass or bronze turnbuckles and safety lockwire shall not be cadmium plated.
Bus bars, fuse clips, terminals and similar electrical parts shall not be cadmium plated.

FC-20-COPPER LINES.

No finish required.

FC-23-DISSIMILAR METALS.

Cadmium Plate

PRIME:

Dissimilar metals shall be protected in accordance with FG-5.

6. GENERAL FINISHES.

FG-0-CHROMIUM PLATE.

INTERNAL STEEL PARTS contacting hydraulic fluid, and communicating to exterior except corroision-resistant steel shall be hard chromium plated.

FG-2-CONTROL CABLES.

Corrosion-Resistant Steel Control Cables and Terminals:
No protective treatment required.

Tinned or Galvanized Steel Control Cables:
Dip in AN-C-52 compound.

Carbon and Low Alloy Steel Swaged Cable Terminals:
Cadmium plate prior to swaging. Dip in AN-C-52 compound subsequent to swaging.

FG-5-DISSIMILAR METALS.

PRIME:

Dissimilar metals shall be insulated from mutual contact by one coat of zinc chromate primer applied to either of the contacting surfaces.

Exceptions:
Cadmium plated nut plates in contact with alclad require no prime.
Electrical bonding contacts shall not be primed.
Bearing surfaces shall not be primed.
Bolts, screws, nuts, and similar fasteners require no prime coat.

FINISH:

Finish to match adjacent surfaces.

FG-7-STEPS (PLATES):

Steps made from magnesium alloy shall be finished in accordance with FM-20.
Steps made of aluminum or aluminum alloy shall be finished in accordance with FA-25.

FG-8-WALKWAYS.

Cover with No. 30 carborundum grits applied either with Plyosyn cement or as TRI-M-ITE No. 30 Grit Wet-or-Dry cloth walkway material (Minnesota Mining and Manufacturing Company), or equivalent, attached with suitable cement.

FG-10-COIL SPRINGS and FG-11-FLAT SPRINGS.

Do not cadmium plate.

PRIME:

One coat zinc chromate primer.

Exception:

Springs contacting hydraulic fluid shall not be primed or otherwise finished.

FINISH:

Cockpits and Baggage Compartment:
Yellow-green finish.

Fuselage Rear of Baggage Compartment:
No further requirements.

Wings and Tail Group:
No further requirements.

FG-12-HEATING AND VENTILATION DUCTS.

HEATER TUBES covered with insulating material shall be treated with a suitable fire, water, oil, and fuel-resistant material.

FG-13-ARMAMENT PROTECTION.

EJECTION CHUTES, GUN BARRELS, AND BLAST TUBES shall be weather sealed by covering with suitable water-resistant temporary dust covers.

FG-21-MARKINGS: LINES (refer to chart in section VIII).

FG-22-MARKINGS: CABLES, CRANKS, AND HORNS (refer to chart in section IV, paragraph 11).

FG-23-MARKINGS: MISCELLANEOUS (refer to figure 358).

FG-24-MARKINGS: ENGINE DISCONNECT POINTS (refer to chart in section IV, paragraph 6).

Area Adjacent to Relief Tube Outlet—The area adjacent to the relief tube outlet will be protected with one coat of clear lacquer, Spec. AN-L-29. This area is conical shaped, nine inches wide at relief tube outlet, extending aft from outlet for approximately five feet and increasing in width to 18 inches.

7. MAGNESIUM AND MAGNESIUM ALLOYS.

FM-0-GENERAL.

Protective treatment (Spec. 98-20010).

PRIME:

Two coats zinc chromate primer.

FM-20-EXTERIOR SURFACES, PARTS, AND MEMBERS.

Protective treatment (Spec. 98-20010).

PRIME:

Two coats zinc chromate primer.

FINISH:

Anti-glare:

Olive drab or black.

Cowling, Fairing, Fuselage, Landing Gear, Tail Group, Wings, and/or Parts Attaching (including Flaps and Flap Bays):

Clear lacquer containing a minimum of 12 ounces of aluminum paste per unthinned gallon.

FM-23-ENGINE COMPARTMENT SURFACES, PARTS, AND MEMBERS PROTECTIVE TREATMENT (Spec. 98-20010).

PRIME:

Two coats zinc chromate primer.

FINISH:
No further requirements.

FM-25-INTERIOR SURFACES, PARTS, AND MEMBERS PROTECTIVE TREATMENT. (Spec. 98-20010).

PRIME:
Two coats zinc chromate primer.

FINISH:

Cockpits, Baggage Comparment, and/or Parts Attaching:
One coat yellow-green finish.

Fuselage Rear of Baggage Compartment, Wings, and Tail Group:
No further requirements.

Landing Light Compartment:
Flat black lacquer.

Wheel Wells:
No further requirements.

Note

For AT-6D and SNJ-5 Airplanes: One coat clear lacquer containing a minimum of 12 ounces of aluminum paste per unthinned gallon.

8. PLASTICS.

FP-21-INTERIOR SURFACES, PARTS, AND MEMBERS.

FINISH:

One finish coat to match adjacent surfaces.

Exception:
Parts not normally visible require no finish.

FP-23-EXTERIOR SURFACES, PARTS, AND MEMBERS.

FINISH:

One coat clear lacquer containing a minimum of 12 ounces of aluminum paste per unthinned gallon.

FP-24-INTERIOR OF CLOSED MEMBERS.

No finish required.

9. STEEL.

FS-0-GENERAL.

Corrosion-resistant steel shall not be plated, primed nor finished.
Cadmium Plate (Spec. AN-QQ-P-421).

Exception:
Parts contacting hydraulic fluid shall not be cadmium plated.

FS-20-EXTERIOR SURFACES, PARTS, AND OPEN MEMBERS THAT CAN BE PLATED.

Corrosion-resistant steel shall not be plated, primed nor finished.
Cadmium plate (Spec. AN-QQ-P-421).
Do not prime.

Exceptions:
Parts subsequently finished shall receive one coat zinc chromate primer.
Dissimilar metals shall be protected as per FG-5.

FINISH:

Anti-glare:
Olive drab or black flat.

Cowling, Fuselage, Landing Gear, Tail Group, Wings, and/or Parts Attaching (including Flaps and Flap Bays):
No further requirements.

FS-21-EXTERIOR CLOSED MEMBERS THAT CAN BE PLATED.

Corrosion-resistant steel shall not be plated, primed, or finished.
Cadmium plate (Spec. AN-QQ-P-421).

Interior of Members:
Fill with hot (165°F) raw linseed oil, drain thoroughly and close with cadmium plated self-tapping screws.

Exception:
Flash welded parts require no oiling.
Do not prime.

Exception:
Dissimilar metals shall be protected in accordance with FG-5.

FINISH:

Cowling, Fuselage, Landing Gear, Tail Group, Wings and/or Parts Attaching (including Flaps and Flap Bays):

No further requirements.

FS-22-EXTERIOR CLOSED MEMBERS THAT CANNOT BE PLATED.

Corrosion-resistant steel shall not be primed or finished.

Interior of Members:
Fill with hot (165°F) raw linseed oil, drain thoroughly, and close with cadmium plated self-tapping screws.

Exception:
Flash welded parts require no oiling.

Exterior of Members:

PRIME:

One coat zinc chromate primer.

FINISH:

Cowling, Fuselage, Landing Gear, Tail Group, Wings and/or Parts Attaching (including Flaps and Flap Bays):
Two coats clear lacquer containing a minimum of 12 ounces of aluminum paste per unthinned gallon.

FS-23-ENGINE COMPARTMENT SURFACES.

Corrosion-resistant steel shall not be plated, primed or finished.

Interior of Closed Members:
Fill with hot raw linseed oil, drain thoroughly, and close with cadmium plated self-tapping screws.

Exception:
Flash welded parts require no oiling.

Interior of Open Members:
One coat zinc chromate primer.

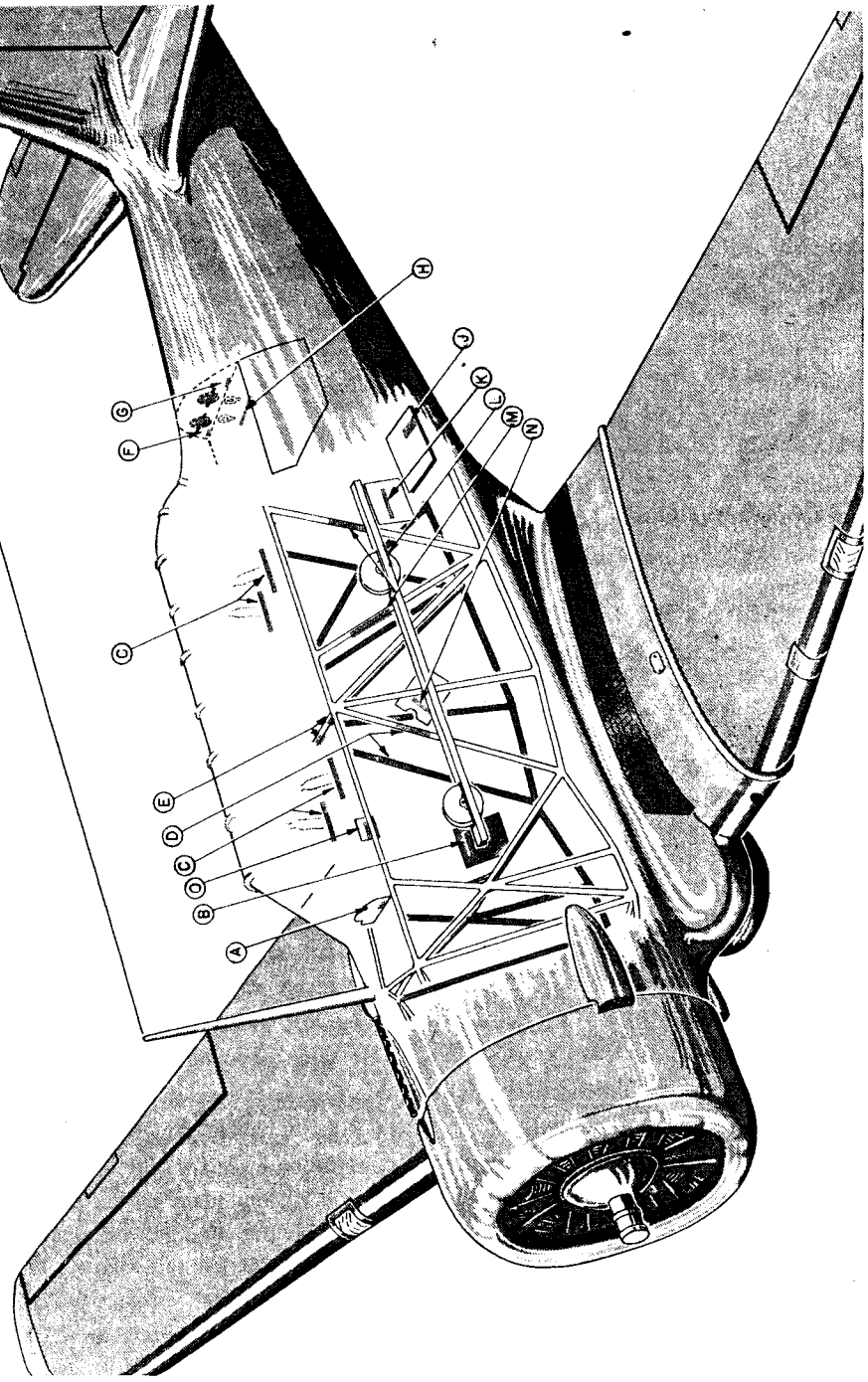
Exterior of Members:
Cadmium Plate (Spec. AN-QQ-P-421).

Exception:
Do not plate motor mount.
Do not prime.

Exception:
Dissimilar metals shall be protected in accordance with FG-5.
Motor mount shall receive one coat of zinc chromate primer.

FINISH:

No further finish.



A 1/8 in. "Service this airplane with 87 octane fuel only. If not available, the next higher grade will be used in emergency."
B 1/2 in. "Map and data case, keys inside."
C 1/2 in. "Emergency release handle."
D 1/2 in. "Hood."
E 1/2 in. "Level."
F 1/2 in. "Front."
G 1/2 in. "Rear."
H 1/2 in. "Mooring rings."
J 1/2 in. "R3002 radio shelf on camera rails."
K 1/2 in. "Map case."
L 1/2 in. "Down only."
M 1/2 in. "Gun and fus. level."
N "Flight report."
O "Arm rest."

Figure 358—Interior Airplane Markings

FS-26-INTERIOR SURFACES, PARTS, AND OPEN MEMBERS THAT CAN BE PLATED.

Corrosion-resistant steel shall not be plated, primed, or finished.
Cadmium plate (Spec. AN-QQ-P-421).
Do not prime.

Exceptions:
Parts subsequently finished, other than with yellow-green, shall receive one coat zinc chromate primer.
Dissimilar metals shall be protected in accordance with FG-5.

FINISH:

Cockpits, Baggage Compartment, and/or Parts Attaching:
Yellow-green finish.

Fuselage Rear of Baggage Compartment, Wings, and Tail Group:
No further requirements.

Landing Light Compartment:
Flat black lacquer.

Wheel Wells:
No further requirements.

FS-27-INTERIOR CLOSED MEMBERS THAT CANNOT BE PLATED.

Corrosion-resistant steel shall not be primed or finished.

Interior of Members:
Fill with hot (165°F) raw linseed oil, drain thoroughly, and close with cadmium plated self-tapping screws.

Exception:
Flash welded parts require no oiling.

PRIME:

One coat zinc chromate primer.

FINISH:

Cockpits, Baggage Compartment, and/or Parts Attaching:
Yellow-green finish.

Fuselage Rear of Baggage Compartment, Wings, and Tail Group:
No further requirements.

Landing Light Compartment:
Flat black lacquer.

Wheel Wells:
No further requirements.

NOTE

For AT-6D and SNJ-5 Airplanes: One coat lacquer containing a minimum of 12 ounces of aluminum paste per unthinned gallon.

FS-28-INTERIOR CLOSED MEMBERS THAT CAN BE PLATED.

Corrosion-resistant steel shall not be plated, primed or finished.

Interior of Members:
Fill with hot (165°F) raw linseed oil, drain thoroughly, and close with cadmium plated self-tapping screws.

Exception:
Flash welded parts require no oiling.

Exterior of Members:
Cadmium plate.
DO NOT PRIME.

Exceptions:
Parts subsequently finished, other than with yellow-green, shall receive one coat zinc chromate primer. Dissimilar metals shall be protected in accordance with FG-5.

FINISH:

Cockpits, Baggage Compartment and/or Parts Attaching:
Yellow-green finish.

Fuselage Rear of Baggage Compartment, Wings, and Tail Group:
No further requirements.

Landing Light Compartment:
Flat black lacquer.

Wheel Wells:
No further requirements.

FS-29-INTERIOR OPEN MEMBERS THAT CANNOT BE PLATED.

PRIME:

Zinc chromate primer (one coat).

FINISH:

FINISH TO MATCH ADJOINING SURFACES.

FS-30 EXTERIOR OPEN MEMBERS THAT

CANNOT BE PLATED.

PRIME:

Zinc chromate primer (one coat).

FINISH:

FINISH TO MATCH ADJOINING SURFACES.

10. TEXTILES.

FT-20-TANK PADS AND STRAPS.

Cover with "Tolex 205 DC-FP" cloth (Textile Leather Corp.), or equivalent.

FT-21-WINGS AND/OR TAIL SURFACES EXCEPT RUDDER
And
FT-23-RUDDER.

Ailerons, Elevators, and Rudder:
Two brush coats and one spray coat of clear nitrate dope followed by two spray coats of clear nitrate dope containing a minimum of 8 ounces of aluminum paste per unthinned gallon.

FT-24-ANTENNA MAST.

Three coats of clear dope followed by two coats clear dope containing a minimum of 8 ounces of aluminum paste per unthinned gallon.

FT-25-COTTON WEBBING AND FABRIC.

No treatment required.

11. WOOD.

FW-21-INTERIOR PARTS, SURFACES, AND MEMBERS.

Sealer:
One coat sealer (Specification AN-V-26).

Filler:
One brush coat of filler on all open grain woods, and for sealing of all nail holes, etc., regardless of wood type. Where filler is not required a second coat of sealer shall be applied.

FINISH:

One finish coat to match adjacent surfaces. Finish coat shall be one of the following:
Enamel, Aircraft (Specification AN-E-3).
Lacquer, Cellulose Nitrate (Specification AN-L-29).

Exceptions:

Finish color on pilot's seat shall be dull dark green

FINISH FOR FLOORBOARD SHALL BE AS FOLLOWS:

One coat clear sealer.
Two coats clear floorboard varnish (underside requires one varnish coat only over sealer).

FW-23-EXTERIOR PARTS, SURFACES, AND MEMBERS.

MONOCOQUE AND STABILIZERS:

Sealer:
Two coats sealer (Spec. AN-V-26).

Adhesive:
One coat clear dope.

Fabric:
Grade A fabric.

Dope:
Four coats clear dope.

FINISH:

Two coats of clear dope containing a minimum of 8 ounces of aluminum paste per unthinned gallon.

Small Surfaces Other Than Monocoque and Stabilizers:

Sealer:
Two coats sealer (Spec. AN-V-26).

Filler:
One coat filler (Spec. TT-F-336).

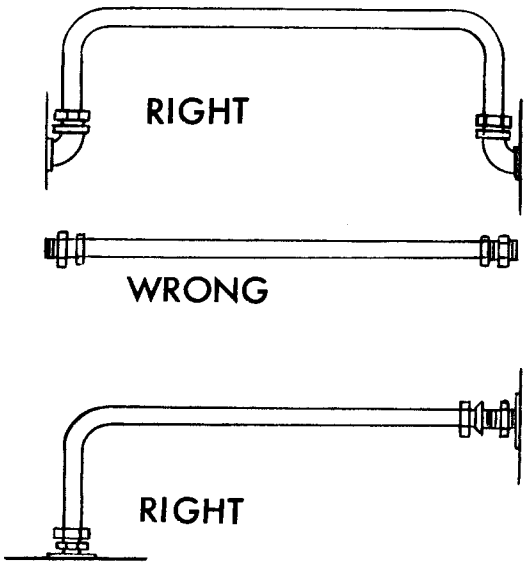
Surfacer:
One coat surfacer (Spec. 14115).

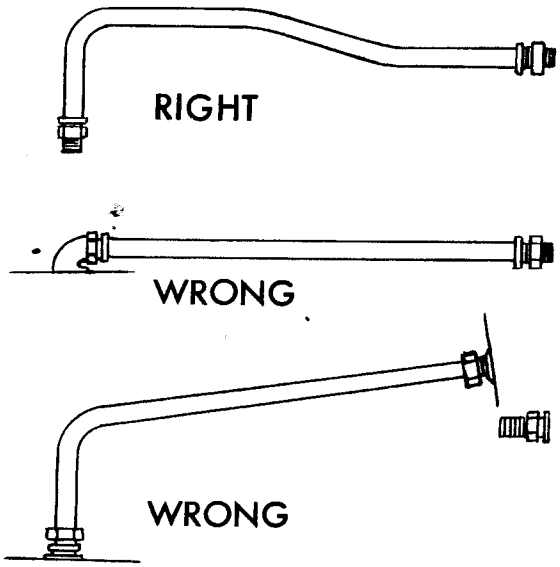
FINISH:

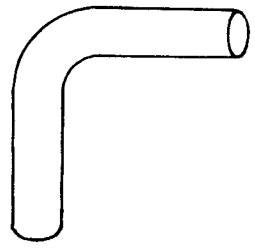
One coat clear lacquer pigmented with 12 ounces of aluminum paste per gallon of unthinned lacquer.

FW-24-INTERIOR OF CLOSED MEMBERS.

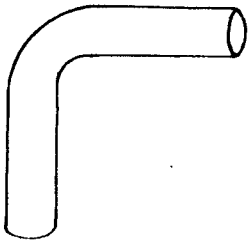
Sealer:
Two coats sealer (Spec. AN-V-26). Second coat may be aluminized with 16 to 20 ounces of aluminum paste per gallon of varnish.





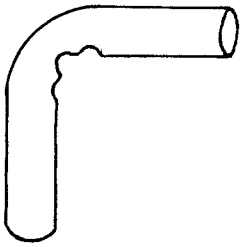


PERFECT BEND



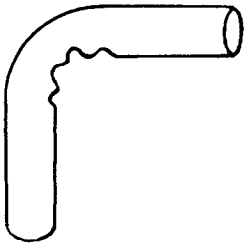
FLATTENED BEND

Caused by having mandrel not far enough forward in tube or by working without a mandrel.



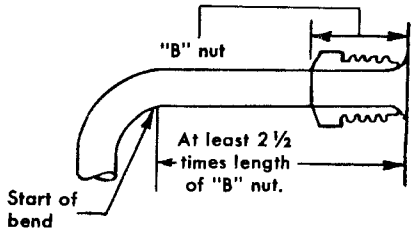
KINKED AND FLATTENED BEND

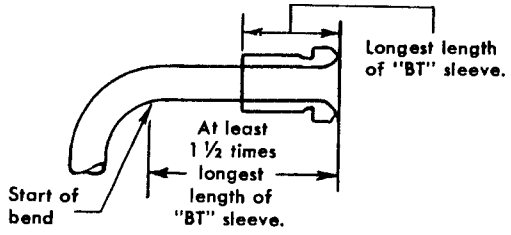
Caused by slipping of the tube in the bender.



WRINKLED BEND

Sometimes produced when thin-walled tube is bent without a supporting mandrel.





MINIMUM BEND RADII

(Soft Aluminum Alloy Tubes)

TUBE O.D.	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4
RADII	7/16	9/16	11/16	15/16	1 3/8	1 1/2	2	2 1/2

Figure 359 — Tube Bending Chart

SECTION VIII
TUBING CHARTS

HYDRAULIC TUBING CHART

Part Name	Part Number	Material	Material Spec.	O.D.	Gage	True Tube Length	Fitting, (Left or Front)	Fitting (Right or Rear)
Line Assem. Hyd. Front Inb'd Port Sel. Valve to Top of Ratchet Valve—Flaps Up	77-58536	AL.AL. Tubing	52SO	5/16	.042	16 7/8	AC811T-5 AC811BT-5CS	AC811T-5 AC811BT-5CS
Line Assem. Hyd. Rear Inb'd Port Sel. Valve to Bottom of Ratchet Valve—Flaps Down	77-58532	AL.AL. Tubing	52SO	5/16	.042	18 7/8	AC811T-5CS AC811BT-5	AC811T-5CS AC811BT-5
Line Assem.—Hyd. Rear Out'b. Port Sel. Valve to Restrictor L. G. Up	77-58526	AL.AL. Tubing	52SO	3/8	.042	50	AC811T-6CS AC811BT-6CS	AC811T-6CS AC811BT-6
Line Assem.—Hyd. L. G. Down Tee to Outboard Port Wing Block	77-58521	AL.AL. Tubing	52SO	3/8	.042		AC811BT-6 AC811T-6CS	AC811BT-6 AC811T-6CS
Line Assem.—Hyd. L. G. Down Fore Outboard Port of Sel. Valve to Tee	77-58520	AL.AL. Tubing	52SO	3/8	.042	12	AC811BT-6 AC811T-6CS	AC811BT-6 AC811T-6CS
Line Assem.—Hyd. Snubber to Pressure Gage	77-58514	AL.AL. Tubing	52SO	1/4	.035	11 3/4	AC811BT-4 AC811T-4CS	AC811BT-4 AC811T-4CS
Line Assem.—Hyd. Cent. Side Port to Sel. Valve to Tee	77-58513	AL.AL. Tubing	52SO	5/16	.042	28 5/8	AC811BT-5 AC811T-5CS	AC811BT-5 AC811T-5CS
Line Assem.—Hyd. Lower Tee to Hand Pump Suction	77-58511	AL.AL. Tubing	52SO	1/2	.042	22 3/4	AC811BT-8 AC811T-8CS	AC811BT-8 AC811T-8CS
Line Assem.—Reservoir to Upper Tee Pump Suction	77-58510	AL.AL. Tubing	52SO	1/2	.042	21	AC811T-8CS AC811BT-8	AC811T-8CS AC811BT-8
Line Assem.—Hyd. Firewall Union to Sel. Valve Pressure	77-58508	AL.AL. Tubing	52SO	3/8	.042	70 1/2	AC811T-6CS AC811BT-6	AC811T-6CS AC811BT-6
Line Assem.—Hyd. Pump Flex. Line to Disconnect Fitting Pressure	77-58506	AL.AL. Tubing	52SO	3/8	.042	5 1/4	AC811T-6CS AC811BT-6	AC811T-6CS AC811BT-6
Line Assem.—Hyd. Fire Wall Union to Reservoir Suction	77-58505	AL.AL Tubing	52SO	5/8	.042	71 1/2	AC811BT-10 AC811T-10CS	AC811T-6CS AC811BT-6
Line—Hyd. Pump to Disconnect Fitting Suction	77-58502	AL.AL. Tubing	52SO	1/2	.042	38		
Line Assem.—Hydraulic Disconnect Fitting to Fire Wall Union Suction	77-58503	AL.AL Tubing	52SO	5/8	.042	14 1/2	AC811T-10CS AC811BT-10	AC811T-10CS AC811BT-10
Line Assem. Hyd. Rear Port Ratchet Valve to Center Port Strut Flap—Up	72-58510	AL.AL. Tubing	52SO	5/16	.042	13 3/4	AC811T-5CS AC811BT-5	AC811T-5CS AC811BT-5
Line Assem.—Hyd. Front Port Ratchet Valve to Tee Flap Down	72-58508	AL.AL. Tubing	52SO	5/16	.042	13 3/4	AC811T-5CS AC811BT-5	AC811T-5CS AC811BT-5
Line Assem.—Hyd. Disconnect Fitting to Fire Wall Union Pressure	77-58507	AL.AL. Tubing	52SO	3/8	.042	13	AC811T-6SC AC811BT-6	AC811T-6CS AC811BT-6
Line Assem.—Hyd. Tee to Flap Operating Strut End Port Down	69-58507	AL.AL. Tubing	52SO	5/16	.042	5 7/8	AC811T-5CS AC811BT-5	AC811T-5CS AC811BT-5
Line Assem.—Restrictor Valve to Connect Block Landing Gear Up	55-58527	AL.AL. Tubing	53SW	3/8	.035	26 1/4	AC811T-6CS AC811BT-6	AC811T-6CS AC811BT-6
Line Assem.—Hyd. Union to Right Landing Gear Operating Strut Up	55-58531	AL.AL. Tubing	52SO	3/8	.042	13 3/4	AC811T-6CS AC811BT-6	AC811T-6CS AC811BT-6

HYDRAULIC TUBING CHART (Continued)

Part Name	Part Number	Material	Material Spec.	O.D.	Gage	True Tube Length	Fitting (Left or Front)	Fitting (Right or Rear)
Line Assem.—Hyd. Union to Left Landing Gear Operating Strut Up	55-58529	AL.AL. Tubing	52SO	3/8	.042	25 7/8	AC811T-6CS AC811BT-6	AC811T-6CS AC811BT-6
Line Assem.—Hyd. Union to Right Landing Gear Operating Strut Down	55-58525	AL.AL. Tubing	52SO	3/8	.042	26 3/8	AC811T-6CS AC811BT-6	AC811T-6CS AC811BT-6
Line Assem.—Hyd. Union to Left Landing Gear Operating Strut Down	55-58523	AL.AL. Tubing	52SO	3/8	.042	13 3/4	AC811T-6CS AC811BT-6	AC811T-6CS AC811BT-6
Line Assem. Hydraulic Reservoir Filler Drain	55-58519	AL.AL. Tubing	52SO	1/4	.035	51	AC811T-4CS AC811BT-4	
Line Assem.—Hyd. Reservoir Vent	55-58518	AL.AL. Tubing	52SO	1/4	.035	55 3/4	AC811T-4CS AC811BT-4	
Line Assem.—Hyd. Hand Pump to Tee Pressure	55-58512	AL.AL. Tube	52SO	5/16	.042	5 5/8	AC811T-5CS AC811BT-5	AC811T-5CS AC-811BT-5
Line Assem.—Hyd. Ratchet Valve Rear Port to Flap Strut Center Flaps Up	78-58537	AL.AL. Tube	52SO	5/16	.042	11 3/4	AC811T-5CS AC811BT-5	AC811T-5CS AC811BT-5

OXYGEN SYSTEM TUBING CHART

Part Name	Part Number	Material	Material Spec.	O.D.	Gage	True Tube Length	Fitting (Left or Front)	Fitting (Right or Rear)
Oxygen line from rear regulator to station 106-31/32	88-73328-2	Copper tubing	WW-T-799	3/16	.032	48 1/2	AC 046368	AC 811T-3CS AC 811BT-3
Oxygen line from front regulator to station 106-31/32	88-73328-4	Copper tubing	WW-T-799	3/16	.032	107	AC 046368	AC 811T-3CS AC 811BT-3
Oxygen line from right cylinder to station 106-31/32	88-73327-4	Copper tubing	WW-T-799	3/16	.032	53	AC811T-3CS AC 811BT-3	AC 041710 AC 041709
Oxygen line from left cylinder to station 106-31/32	88-73327-2	Copper tubing	WW-T-799	3/16	.032	42	AC 811T-3CS AC 811BT-3	AC 041710 AC 041709

INSTRUMENT SYSTEM TUBING CHART

Part Name	Part Number	Material	Material Spec.	O.D.	Gage	True Tube Length	Fitting (Left or Front)	Fitting (Right or Rear)
Instruments Front Cockpit								
Line Assy—Altm to Rate of Climb (static)	88-51833	Al. Alloy 52S0	57-187-3	1/4	.035	10 1/4	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Line Assy — Gyro Horizon to Suct Gage	88-51810	Al. Alloy 52S0	WW-T-787	1/4	.035	12 7/8	AC811BT-4D AC811-T-4CS	AC811BT-4D AC811-T-4CS
Line Assy—Altm to Airspeed (static)	88-51832	Al. Alloy 52S0	57-187-3	1/4	.035	8 1/2	AC811T-4CS AC811-BT-4D	AC811T-4CS AC811BT-4D
Line Assy—Manif Block to Suct Gage	88-51866	Al. Alloy 52S0	WW-T-787	1/4	.035	13 1/8	AC811BT-4D AC811T-4CS	AC811BT-4D AC811-T-4CS
Line Assy—Manif Block to Gyro Horizon	88-51865	Al. Alloy 52S0	WW-T-787	3/8	.035 or .042	18 1/2	AC811BT-6D AC811T-6CS	AC811BT-6D AC811T-6CS
Line Assy—Manif Block to Direct. Gyro	88-51864	Al. Alloy 52S0	WW-T-787	3/8	.035	12 1/4	AC811BT-6D AC811T-6CS	AC811BT-6D AC811T-6CS
Line Assy—Manif Block to Bank and Turn Indic.	88-51867	Al. Alloy 52S0	WW-T-787	1/4	.035	15	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Line Assy—Altm to Rate of Climb (static)	88-51809	Al. Alloy 52S0	WW-T-787	1/4	.035		AC811T-4CS AC811BT-4D	AC811T-4CS AC811BT-4D
Instruments Rear Cockpit								
Line Assy—Manif Block to Direct. Gyro	88-51860	Al. Alloy 52S0	WW-T-787	3/8	.035	11	AC811BT-6D AC811T-6CS	AC811BT-6D AC811T-6CS

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INSTRUMENT SYSTEM TUBING CHART (Continued)

Part Name	Part Number	Material	Material Spec.	O.D.	Gage	True Tube Length	Fitting (Left or Front)	Fitting (Right or Rear)
Line Assy—Manif Block to Gyro Horizon	88-51861	Al. Alloy 52S0	WW-T-787	3/8	.035 or .042	8 3/4	AC811BT-6D AC811T-6CS	AC811BT-6D AC811T-6CS
Line Assy—Rate of Climb to Altim	77-51838	Al. Alloy 52S0	57-187-3	1/4	.035	10 1/2	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Line Assy—Altim to Airspeed	77-51839	Al. Alloy 52S0	57-187-3	1/4	.035	8 1/2	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Line Assy—Manif Block to Bank and Turn Indic.	88-51863	Al. Alloy 52S0	WW-T-787	1/4	.035	13 5/8	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Line Assy—Gyro Horizon to Suction Gage	88-51819	Al. Alloy 52S0	WW-T-787	1/4	.035	13 1/4	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Line Assy—Manif Block to Suct Gage	88-51862	Al. Alloy 52S0	WW-T-787	1/4	.035	15 3/4	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Oil Press Line—Front Gage to Rear Gage	77-51831	Copper Tubing	WW-T-790 Type N	1/4	.032	49 1/2	AC811-BT-4 AC811-T-4CS	AC811-BT-4 AC811-T-4CS
Oil Press Line—Fire Wall to Engine Gage	77-51830	Copper Tubing	WW-T-799 Type N	1/4	.032	12	AC811-BT-4 AC811-T-4CS	AC811-BT-4 AC811-T-4CS
Fuel Press Line—Front Gage to Rear Gage	77-51828	Copper Tubing	WW-T-799 Type N	1/4	.032	49	AC811-BT-4 AC811-T-4CS	AC811-BT-4 AC811-T-4CS
Fuel Press Line—Fire Wall to Engine Gage	77-51827	Copper Tubing	WW-T-799 Type N	1/4	.032	12 1/2	AC811-BT-4 AC811-T-4CS	AC811-BT-4 AC811-T-4CS
Manif Press to Drain Line	77-51824	Copper Tubing	WW-T-799 Type N	1/4	.032	20	AC811-BT-4 AC811T-4CS	
Manif Press to Valve Line	77-51823	Copper Tubing	WW-T-799 Type N	1/4	.032	22	AC811-BT-4 AC-811-T-4CS	AC811-BT-4 AC811-T-4CS
Fire Wall to Manif Press Gage Line	77-51822	Copper Tubing	WW-T-799 Type N	1/4	.032	13	AC811-BT-4 AC811-T-4CS	AC811-BT-4 AC811-T-4CS
Vac Line—Rear Dist Block to Fire Wall	77-51813	Al. Alloy 52S0	57-187-3	5/8	.042	61		
Vac Line—Fire Wall to Dist Block	77-51806	Al. Alloy 52S0	57-187-3	1/2	.042	7 3/4		
Line—Rear Tee to Front Ckpt Flex Air Filter No. 1	88-51871	Al. Alloy 52S0	WW-T-787	5/8 and 1/2	.042	55 3/4		AC819T-8CS AC818BT-8D
Rear Tee to Front Flex Air Filter Line (No. 1)	88-51869	Al. Alloy 52S0	WW-T-787	5/8	.042	23 3/4		
Line—Air Filter to Rear Ckpt Tee	88-51868	Al. Alloy 52S0	WW-T-787	5/8	.042	32 1/4		
Line—Front Rate of Climb to Wing Ctr Sect (S)	88-51852	Al. Alloy 52S0	WW-T-787	1/4	.035	33 1/2	AC811T-4CS AC811BT-4D	AC811T-4CS AC811BT-4D
Line—Front Airspeed to Wing Ctr Sect (Press)	88-51851	Al. Alloy 52S0	WW-T-787	1/4	.035	43 1/2	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Line—Wing Ctr Sect to Rear—Rate of Climb (Static)	88-51847	Al. Alloy 52S0	57-187-3	1/4	.035	64 1/2	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS
Line—Ctr Sect to Rear Airspeed (Press)	88-51846	Al. Alloy 52S0	57-187-3	1/4	.035	72		
Line—Exh Analyzer Outlet (1st Sect)	88-51845	Copper Tubing	WW-T-799 Type N	3/8	.035	27 1/2		
Line—Exh Analyzer Outlet (2nd Sect)	55-51845	Stainless Steel Tube	WW-T-858	3/8	.035	21 5/8	AN800-6 51-51075	
Line—Fuel Press Sig Switch to Fire Wall	88-51826	Copper Tubing	WW-T-799 Type N	1/4	.032	37 1/4		
Line—Rear Vac Throt Valve to Rear Vac Dist Block	88-51814	Al. Alloy 52S0	57-187-3	1/4	.035	11-9/16	AC811-BT-4D AC811-T-4CS	AC811-BT-4D AC811-T-4CS
Line—Front Vac Throt Vlv to Front Vac Dist Block	88-51808	Al. Alloy 52S0 Tubing	57-187-3	1/4	.035	10-13/16	AC811-BT-4D AC811-T-4CS	AC811-BT-4D AC811-T-4CS

INSTRUMENT SYSTEM TUBING CHART (Continued)

Part Name	Part Number	Material	Material Spec.	O.D.	Gage	True Tube Length	Fitting (Left or Front)	Fitting (Right or Rear)
★Line—Rear Dist Block to Camera Vlv (2nd)	88-51850	Al. Alloy 52S0	57-187-3	3/8	.035	8		
★Line—Rear Dist Block to Camera Vlv (1st)	88-51817	Al. Alloy 52S0	57-187-3	3/8	.035	69 3/4		
Line—Exh Analyzer Inlet Coll to Collec Ring (1st)	77-51844	Copper Tubing	WW-T-799	3/8	.035	76 1/2	AC811-T-6CS 49-51054	
Line—Exh Analyzer Inlet (Section 2)	88-51844	Corrosion Resist. Steel Tubing	WW-T-858	3/8	.035	14 1/4	AC811T-6CS 49-51054	AN800-6 51-51075
Line—Oil Press Eng to Fire Wall	77-51829	Copper Tubing	WW-T-799-N	1/4	.032	53	AN995C40-3 3 Turns Copper Wire	AN995C40-3 3 Turns Copper Wire
Line—Fuel Press Carbtr to Sig Switch	77-51825	Copper Tubing	WW-T-799-N	1/4	.032	23 3/4		
Line—Eng to Fire Wall —Manif Press	77-51821	Copper Tubing	WW-T-799-N	1/4	.032	46 1/2		
Line—Vac Pump to Vac Relief Vlv	77-51804	Al. Alloy 52S0	57-187-3	5/8	.042	14 3/4		
Line—Oil Separator to Vac Pump	77-51803	Al. Alloy 52S0	57-187-3	5/8	.042	33 1/2		
★Line—Oil Separator to Eng—Vac	77-51802	Al. Alloy 52S0	57-187-3	1/2	.042	17 3/4		
Line—Oil Separator to Drain—Vac	77-51801	Al. Alloy 52S0	57-187-3	5/8	.042	62		
Line—Vac Pump By-Pass	58-51810	Copper Tubing	WW-T-799-N	1/4	.032	9	AC811BT-4 AC811T-4CS	AC811BT-4 AC811-4CS
Line—Vac Relief Vlv to Fire Wall	88-51805	Al. Alloy 52S0	WW-T-787	5/8	.042	17		
Line—Vac Check Vlv to Fire Wall	77-51805	Al. Alloy 52S0	57-187-3	5/8	.042	10 1/4		
Connecting Hose	AN884-10-11	Synthetic Rubber	AN-ZZ-H-456	1"	3/16	2 3/4		
Connecting Hose	AN884-10-10	Synthetic Rubber	AN-ZZ-H-456	1"	3/16	2 1/2		
Connecting Hose	AN884-8-9	Synthetic Rubber	AN-ZZ-H-456	7/8	3/16	2 1/4		
Connecting Hose	AN884-8-12	Synthetic Rubber	AN-ZZ-H-456	7/8	3/16	3		
Connecting Hose	AN884-4-10	Synthetic Rubber	AN-ZZ-H-456	5/8	3/16	2 1/2		
Hose Assy—Flex	39B3481-414	Synthetic Rubber	AN-ZZ-H-626	1/2	1/8	14		
Hose Assy—Flex	39B3480-816	Synthetic Rubber	AN-ZZ-H-626	3/4	1/8	16		
Hose Assy—Flex	39B3480-614	Synthetic Rubber	AN-ZZ-H-626	5/8	1/8	14		
Hose Assy—Flex	39B3480-414	Synthetic Rubber	AN-ZZ-H-626	1/2	1/8	14		
Line—Air Speed Static Outer Wing Sect	88-51839	Al. Alloy 52S0	WW-T-787	1/4	.035	195	AC811T-4CS AC811BT-4D	AC811T-4CS AC811BT-4D
Line—Air Speed—Press Outer Wing Sect	88-51837	Al. Alloy 52S0	WW-T-787	1/4	.035	195	AC-811T-4CS AC811BT-4D	AC811T-4CS AC811BT-4D
††Line—Oil Separator to Eng—Vac	88-51802	Al. Alloy 52S0	57-187-3	1/2	.042	19		
Line—Air Speed Static Inner Wing Sect	88-51835	Al. Alloy 52S0	WW-T-787	1/4	.035	56	AC811BT-4D AC-811T-4CS	AC811BT-4D AC811T-4CS
Line—Air Speed Press Inner Wing Sect	88-51836	Al. Alloy 52S0	WW-T-787	1/4	.035	54 3/4	AC811BT-4D AC811T-4CS	AC811BT-4D AC811T-4CS

★Deleted on serial No. 42-44412 and subsequent subject airplanes.
††Installed on serial No. 42-44412 and subsequent subject airplanes.

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FUEL SYSTEM TUBING CHART

Part Name	*Part Number*	*Material*	*Material Spec.*	*O.D.*	*Gage*	*True Tube Length*	*Fitting (Left or Front)*	*Fitting (Right or Rear)*
Line Assy. — Fuel R. Main to Union	77-48801	Al Alloy Tube	52SO	5/8	.042	33 3/8		AC811T-10 AC811BT-10
*Line Assy. — Fuel R. Main Union to Selector Valve	77-48802	Al Alloy Tube	52SO	5/8	.042	12	AC811BT-10 AC811T-10	AC811T-10 AC811BT-10
*Line—Fuel L. Main to Selector Valve	77-48803	Al Alloy Tube	52SO	5/8	.042	10 1/8		
*Line—Fuel L. Tank Res. to Selec Vlv.	77-48804	Al Alloy Tube	52SO	5/8	042	18 1/2		
*Line Assy.—Fuel Selec. Vlv. to Union	77-48805	Al Alloy Tube	52SO	5/8	.042	16	AC811BT-10 AC811T-10	AC811BT-10 AC811T-10
*Line Assy. — Fuel Union to Blkd. Fitt.	77-48807	Al Alloy Tube	52SO	5/8	.042	52 5/8	AC811BT-10 AC811T-10	AC811BT-10 AC811T-10
*Line—Fuel Fire Wall to Fuel Unit	77-48808	Al Alloy Tube	52SO	5/8	.042	18 3/8		
*Line—Fuel Unit to Pump	77-48810	Al Alloy Tube	52SO	5/8	.042	29		
*Line—Fuel Pump to Carburetor	77-48811	Al Alloy Tube	52SO	5/8	.042	11 1/4		
*Line—Fuel Carbtr. to Fuel Unit	77-48812	Al Alloy Tube	52SO	5/8	.042	13		
*Line—Fuel L. Tank Filler Cap Drain	77-48813	Al Alloy Tube	52SO	3/8	.035	30		
*Line—Fuel R. Tank Filler Cap Drain	77-48814	Al Alloy Tube	52SO	3/8	.035	30		
*Line Assy. — Fuel L. Tank to Hose Vent	77-48815	Al Alloy Tube	52SO	3/8	.035	20 3/8		AC311T-6 AC311BT-6
*Line Assy. — Fuel R. Tank to Hose Vent	77-48817	Al Alloy Tube	52SO	3/8	.035	20 1/2		
*Line — Fuel L. Tank Hose to Hose Vent	77-48818	Al Alloy Tube	52SO	3/8	.035	21 3/4		
*Line — Fuel R. Tank Hose to Vent	77-48820	Al Alloy Tube	52SO	3/8	.035	22		
Line—Fuel Pump Drain	88-48821	Al Alloy Tube	52SO	3/8	.035	42-15/16		
Line—Fuel Pump Drain	77-48823	Copper Tube		1/4	.032	50 1/2		
Line — Fuel R. Tank Tose to Vent Outlet	88-48822	Al Alloy Tube	52SO	3/8	.035	42-11/16		
Line — Fuel Tee to Fire Wall Primer	55-48826	Copper Tube		1/4	.032	15 1/4		
Line Assy.—Fuel Fire Wall to Eng. Primer	55-48827	Copper Tube		1/4	.032	22		AC811T-4CS AC811BT-4
Line Assy. — Fuel Eng. Primer to Fire Wall	55-48828	Copper Tube		1/4	.032	25	AC811T-4CS AC811BT-4	AC811T-4CS AC811BT-4
Line—Fuel Fire Wall to Eng. Outlet Distrb.	55-48829	Copper Tube		1/4	.032	44 3/4		
Line—Fuel L. Main to Selec. Valve	88-48803	Al Alloy Tube	52SO	5/8	.042	10 1/8		
Tube — Fuel Tank Vent Line Guard Rubber	36-48015-2	Synthetic Rubber Tube		3/8	1/8	2		
Tube — Fuel Tank Vent Line Guard Rubber	36-48015-3	Synthetic Rubber Tube		3/8	1/8	8		
†Line — Fuel Tank Reserve to Selec. Vlv.	88-48804	Al Alloy Tube	52SO	5/8	.042	17-15/16		
†Line — Fuel L. Main Selec. Valve	88-48806	Al Alloy Tube	52SO	5/8	.042	10		
†Line—Fuel Fire Wall to Fuel Unit	88-48808	Al Alloy Tube	52SO	5/8	.042	9 3/4		
†Line — Fuel L. Tank Hose to Vent Outlet	88-48809	Al Alloy Tube	52SO	5/8	.035	43		
†Line—Fuel Pump to Carbtr.	88-78811	Al Alloy Tube	52SO	5/8	.042	23-3/16		
†Line — Fuel Carbtr. to Fuel Unit	88-48812	Al Alloy Tube	52SO	5/8	.042	11-3/9		

FUEL SYSTEM TUBING CHART (Continued)

Part Name	Part Number	Material	Material Spec.	O.D.	Gage	True Tube Length	Fitting (Left or Front)	Fitting (Right or Rear)
†Line — Fuel Tank Filler Cap Drain	88-48813	Al Alloy Tube	52SO	3/8	.035	27-15/16		
†Line—Fuel R. Tank Filler Cap Drain	88-48814	Al Alloy Tube	52SO	3/8	.035	27-11/16		
†Line—Fuel R. Tank Hose to Vent	88-48816	Al Alloy Tube	52SO	3/8	.035	42-11/16		
†Line—Fuel L. Hose to Hose Vent	88-48818	Al Alloy Tube	52SO	3/8	.035	21 1/2		
‡Line—Fuel R. Tank Hose to Vent	88-48822	Al Alloy Tube	52SO	3/8	.035	42-11/16		
†Line—Fuel Pump Drain	88-48823	Copper Tube		1/4	.032	51 5/8		
†Line—Fuel Tee to Fire Wall Primer	88-48826	Copper Tube		1/4	.032	15 1/4		
†Line—Fuel Fire Wall to Eng. Outlet Distrb.	88-48829	Copper Tube		1/4	.032	45-1/16		

OIL SYSTEM TUBING CHART

Part Name	Part Number	Material	Material Spec.	O.D.	Gage	True Tube Length	Fitting (Left or Front)	Fitting (Right or Rear)
†Line—Oil Eng. to Oil Tank L. Vent	88-48810	Al Alloy Tube	52SO	1/2	.042	28 3/4		
Line—Oil Tank to Drain Valve	77-47801	Al Alloy Tube	52SO	1	.049	14 1/8		
Line—Oil Eng. to Drain Valve	77-47802	Al Alloy Tube	52SO	1	.049	11		
Line—Oil Eng. to Oil Cooler	77-47803	Al Alloy Tube	52SO	1	.049	22 3/8		
Line—Oil Cooler to Tank	77-47804	Al Alloy Tube	52SO	1	.049	49		
Line—Oil Drain	77-47805	Al Alloy Tube	52SO	1	.049	8-7/16		
‡Line—Oil Filler Neck Overflow	77-47806	Al Alloy Tube	52SO	5/8	.042	63 1/2		
Line—Oil to Oil Tank L. Vent	77-47807	Al Alloy Tube	52SO	1/2	.042	28 3/8		
Line—Oil Eng. to Oil Tank Vent	77-47808	Al Alloy Tube	52SO	1/2	.042	24 3/4		
Line—Oil Dilution Sig. Switch to Solenoid	77-47809	Copper Tube		1/4	.032	49 1/2		
Line—Oil Dilution Fuel Sig. Switch to Solenoid	77-47810	Copper Tube		1/4	.032	45 1/2		
Line—Eng. Crankcase Breather	55-42801	Al Alloy Tube	52SO	3/4	.049	37 1/4		
Line—Oil Cooler to Tank	88-47804	Al Alloy Tube	52SO	1	.049	49		
Line—Oil Eng. to Oil Cooler	88-47803	Al Alloy Tube	52SO	1	.049	27 7/8		
‖Line—Oil Eng. to Drain Valve	88-47802	Al Alloy Tube	52SO	1	.049	11 5/8		
‖Line—Oil Tank to Drain Valve	88-47801	Al Alloy Tube	52SO	1	.049	12 1/8		
‖Line—Oil Cooler to Tank	88-47805	Al Alloy Tube	52SO	1	.049	39 7/8		
‖Line—Oil Tank in "Y"	88-47806-2	Al Alloy Tube	52SO	1	.049	7-1/16		
‖Line—Oil Tank in "Y"	88-47806-3	Al Alloy Tube	52SO	1	.049	12-3/14		
‖Line—Surge Vlv. to Cooler Oil	88-47807	Al Alloy Tube	52SO	1	.049	36		
‖Line—Eng. to Surge Vlv. Oil	88-47808	Al Alloy Tube	52SO	1	.049	13-11/16		
‖Line—Oil Drain	88-47809	Al Alloy Tube	52SO	1	.049	7-9/16		
†Line—Oil Eng. to Oil Tank L. Vent	88-47810	Al Alloy Tube	52SO	1/2	.042	29		
†Line—Oil Eng. to Oil Tank R. Vent	88-47811	Al Alloy Tube	52SO	1/2	.042	25		
¶Line — Eng. Crankcase Tee Breather	88-42801	Al Alloy Tube	52SO	3/4	.049	35 1/2		

* Used on Airplanes AC43-24902 to British EX-386.
† Used on Airplanes Serial No. AC42-84202 and Subsequent.
‡ Used on Airplane British Serial Nos. EX-847 to AC42-84201.
‖ Used on British Serial No. EX-847 and Subsequent.
¶ Used on Airplanes Serial No. AC88-10583 and Subsequent.

LINE COLOR CODING.

a. Width of each color in the marking band shall be approximately ½-inch.

b. Cellulose tape in the appropriate colors shall be used for the marking band.

c. The following colors shall be used as the means of identification for lines:

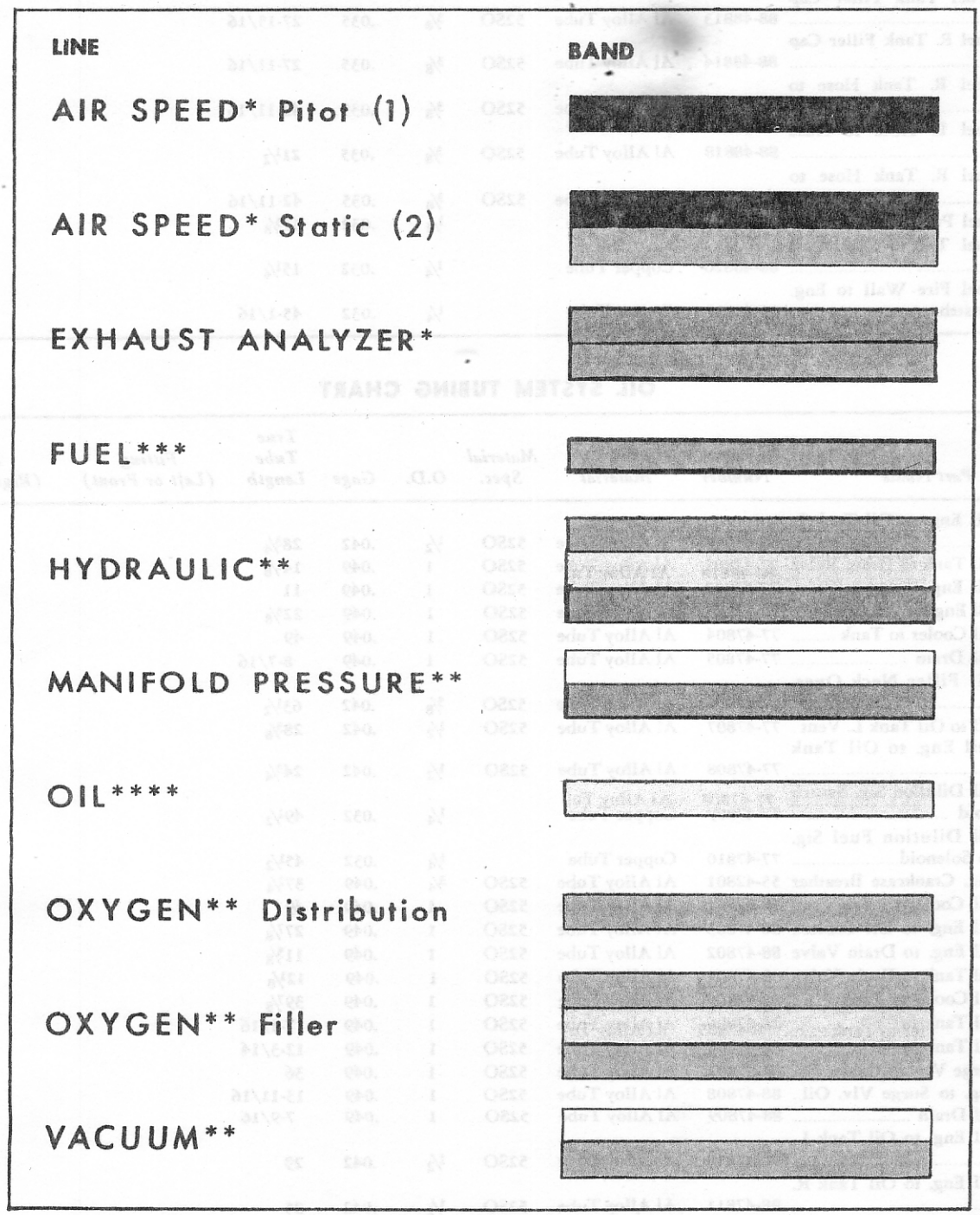

Figure 360 — Line Color Coding

*Each side of all union connections.
**Near each union.
***Near each union and on each side of every flexible connection.
****Near each end.
(1) "P" to be stamped on all B-Nuts on Pitot line.
(2) "S" to be stamped on all B-Nuts on Static line.

SECTION IX
CHARTS AND TABLES

TABLE 1

WRENCH LOADS ON BOLTS

Excessive tightening of a nut produces a stretching or distortion of the threaded portion, which may lead eventually to the failure of the bolt. To eliminate the possibility of such damage, it is necessary that the twist or torque moment be accurately controlled and held below certain maximum limits, but above minimum limits necessary to secure fastening of parts.

In applying the specified torque loads, effort should be made to stop just inside the prescribed low limit, thus leaving sufficient reserve to enable further tightening to secure alignment of cotter holes without exceeding the specified upper limit. A nut should not be backed off to secure cotter alignment.

Torque moments to be applied to fine thread standard aircraft steel bolts are as follows:

	(Inch-Pounds)	
Bolt Size	*Tension Type Nuts 365 and AN310 (40,000 p.s.i in Bolt)*	*Sheer Type Nuts 364 and AN320 (60% of column 2)*
10-32 inch	20-25	12-15
1/4-28 inch	50-70	30-40
5/16-24 inch	100-140	60-85
3/8-24 inch	160-190	95-110
7/16-20 inch	450-500	270-300
1/2-20 inch	480-690	290-410
9/16-18 inch	800-1000	480-600
5/8-18 inch	1100-1300	660-780
3/4-16 inch	2300-2500	1300-1500

Torque moments to be applied to 24ST aluminum-alloy aircraft bolts are as follows:

Bolt Size	*Pound-Inches*	*Pound-Feet*
3/16 inch No. 10	10 to 14	
1/4 inch	20 to 35	2 to 3
5/16 inch	50 to 75	4 to 6
3/8 inch	80 to 110	7 to 9
7/16 inch	100 to 140	9 to 11
5/8 inch	300 to 460	24 to 38

The above torques are to apply when used with AN-365 nuts and antisieze paste (zinc dust and petroleum jelly).

TABLE 2

METRIC UNITS

AMERICAN		BRITISH
Multiply	*by*	*to Obtain*
U.S. Gallons (gal)	× 0.833	= Imperial gallons (Imp. gal.)
U.S. Gallons	× 3.785	= Liters
Miles per hour (mph)	× 1.609	= Kilometers per hour (km ph)
Miles per hour	× 0.8684	= Knots
Miles	× 1.609	= Kilometers (km)
Miles	× 0.8684	= Nautical miles
Feet (ft.)	× 0.3048	= Meters (m)
Inches (in.)	× 2.54	= Centimeters (cm)
Pounds (lb.)	× 0.4536	= Kilograms (kg)
Pounds per sq. in. (lb./sq. in.)	× 0.0703	= Kilograms per square centimeter (kg/sq.cm.)
Inches of mercury (in. Hg)	× 2.54	= Centimeters of mercury (cm Hg)
Horsepower (hp)	× 1.014	= Metric horsepower (mhp)
Degrees Centigrade (°C)	+ 17.8 × 1.8	= Degrees Fahrenheit (°F)

TABLE 3

AIRPLANE BLOCK NUMBERS

NOTE

Effective on AT-6D airplane AC 41-54591, production block numbers are eliminated from the fuselage side panel, acceptance plate, and all drawings and parts lists affected. Block numbers on previous ships have been canceled.

TABLE 4

CONVERSION LIST NORTH AMERICAN-STANDARD PARTS.—Following is a Conversion List noting the old and new North American standard part numbers.

Old No.	*New No.*	*Old No.*	*New No.*	*Old No.*	*New No.*
B251	—1H1	B985	—2W1	B1054	—4B2
B310	—1N1	B1000	—2H6	B1055	—4B3
B981	—2W6	B1009	—4B14	B1056	—4B4
B983	—2W2	B1017	—2L5	B1057	—4B5

Old No.	New No.
B1058	4B6
B1059	4B7
B1060	4B8
B1061	4B9
B1062	4B10
B1063	4B11
B1064	4B13
B1068	5P2
B1070	4S3
B1071	4S4
B1074	5B11
B1078	3C1
B1079	5C1
B1082	2C1
B1084	5B6
B1086	5B7
B1089	2L4
B1094	2F1
B1097	5P3
B1100	2W8
B1102	2W3
B1103	4S1
B1104	4C1
B1105	6C17
B1111	6C15
B1113	6C14
B1116	6C13
B1117	6C12
B1118	6C11
B1121	6C10
B1123	6C9
B1132	2L2
B1133	2L1
B1134	3S6
B1135	5R8
B1136	5R7
B1140	3P1
B1141	7B1
B1142	7B2
B1144	4C2
B1148	2H3
B1149	8B2
B1153	4R3
B1154	4R2
B1155	1C24
B1158	2H2
B1160	3C3
B1161	3C2
B1167	6C6
B1169	2H1
B1170	2B1
B1171	7B3
B1172	6S1
B1173	5B8
B1174	5B2
B1175	5B3
B1176	3B2
B1178	3C4
B1180	5C2
B1181	2C15
B1184	1R6
B1185	5B5
B1188	6C5
B1190	5R9
B1192	8E1
B1194	2P1
B1195	1R4
B1196	5C3
B1201	2C16
B1204	4B1
B1205	2L3
B1206	6C16
B1207	5S2
B1209	5S3
B1210	1W4
B1211	2C17
B1212	1R5
B1213	1W2
B1214	1W3
B1217	5R5
B1221	5P1
B1222	1F2
B1223	1P2
B1226	5B10
B1227	2B1
B1228	2H4
B1230	1W1
B1231	2W5
B1232	6C8
B1233	6B1
B1234	2S5
B1235	1G3
B1236	1G2
B1238	1B1
B1240	2C2
B1243	6B2
B1244	5B9
B1245	6C7
B1246	1A1
B1247	5R4
B1248	7S6
B1249	5C4
B1251	7S2
B1252	3F2
B1253	1B3
B1254	1B2
B1256	4S2
B1257	1C1
B1258	2C8
B1259	6C4
B1260	4B12
B1261	2C3
B1262	2C4
B1263	2C5
B1264	2C6
B1265	2C7
B1268	5S1
B1269	5B4
B1272	2C9
B1276	1T3
B1277	1T1
B1278	3G1
B1281	3F1
B1282	5R6
B1284	1T2
B1285	2P2
B1286	7S1
B1287	7S4
B1289	7S5
B1295	1P3
B1297	1N2
B1298	5R3
B1299	6C3
B1304	6B3
B1305	2C10
B1306	2C11
B1309	5P5
B1310	2W4
B1311	2L6
B1312	6C2
B1314	7S8
B1315	3R3
B1316	2C13
B1319	2C12
B1320	5P8
B1321	3C5
B1322	5P7
B1323	5P6
B1325	1G1
B1326	5R2
B1327	1F1
B1328	2C14
B1331	2S1
B1332	3B1
B1333	3R1
B1334	5R1
B1335	2S2
B1336	2S4
B1337	2S3
B1338	7S7
B1339	7S3
B1340	3R2
B1341	5P4
B1343	9B1
B1344	2P3
B1346	1R7
B1348	3W1
B1349	2G3
B1350	2G2
B1351	2G1
B1352	5P9
B1355	5B12
B1356	4R1
B1357	1G4
B1358	1C20
B1359	1C21
B1360	1C22
B1361	1C23
B1362	8B1
B1363	2H7
B1364	2H8
B1365	3R4
B1366	4P1
B1367	7S9
B1368	7S10
B1369	5B1
B1370	2R2
B1371	2R3
B1372	2R4
B1373	6R1
B1374	3G2
B1375	2F2
B1376	5C5
B1377	3S5
B1378	3S4
B1379	3S2
B1380	3S3
B1381	3F3
B1382	2L7
B1383	2C18
B1384	7S11
B1385	6R2
B1386	3H1
B1387	1R1
B1388	1R2
B1389	1R3
B1390	1G5
B1442	6C1
B5000	1D1
B5001	1D2
B5002	1D3
B5003	1D4
B5004	1D5
B5005	1D6
B5006	1D7
B5007	1D8
B5008	1D9
B5009	1D10
B5010	1D11
B5011	1D12
B5012	1D13
B5013	1D14
B5014	1D15
B5015	1D16
B5016	1D17
B5017	1D18
B5018	1D19
B5019	1D20
B5020	1D21
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B5100	1D101
B5101	1D102
B5102	1D103
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B5104	1D105
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B5106	1D107
B5107	1D108
B5108	1D109
B5109	1D110
B5110	1D111
B5111	1D112
B5112	1D113
B5113	1D114
B5114	1D115
B5115	1D116
B5116	1D117
B5117	1D118
B5118	1D119
B5120	1D121
B5121	1D122
C106	1C19
C107	1S14
C108	1E116
C109	6E39
C110	6E19
C111	1S83
C112	3E1
C113	6E20
C114	1E115
C115	2E10
C116	1E114
C117	3E2
C119	1S41
C120	1E113
C121	6E70
C122	2E11
C123	1S40
C124	1S39
C125	1S38
C126	1S37

Old No.	New No.
C127	1S36
C128	3E3
C130	2E12
C131	1S35
C132	1C18
C133	1C17
C134	1C16
C135	1S34
C136	1S33
C141	1E112
C142	1E111
C143	3E4
C144	1S32
C145	1S31
C146	1H2
C147	2P4
C148	1E110
C150	1E1
C151	7E10
C152	7E9
C153	5E10
C154	5E11
C155	2E13
C156	3E5
C157	3E6
C158	3E7
C159	6E69
C160	4E2
C161	2E14
C162	2E2
C163	2E3
C164	2E4
C165	2E5
C166	2E6
C167	2E7
C170	2E15
C171	1C15
C172	1E109
C173	1E108
C174	1E107
C175	1E106
C176	1E105
C177	1E104
C178	1E103
C179	1E102
C180	1E2
C181	1S30
C182	1C14
C184	1C13
C186	7E32
C192	6E72
C193	4E3
C194	3E8
C196	1S29
C197	1S28
C198	2E16
C199	1S27
C200	1S26
C201	3E9
C202	5E1
C203	1E101
C204	1E100
C205	1E99
C206	1E98
C207	4E4
C209	1C12
C211	2E8
C214	1E97
C216	1E96
C217	1E95
C220	1E94
C224	3P2
C225	5E2
C226	1S25
C227	1E93
C228	1E92
C229	1E91
C230	1E90
C231	1E89
C232	1S24
C233	7E6
C234	1S23
C235	1E88
C236	1E76
C237	2E17
C238	2E18
C239	1E3
C245	1E117
C249	5E3
C250	1E87
C251	7E20
C252	7E19
C253	1S22
C254	2E9
C255	1S21
C259	6E68
C260	1E86
C261	1E85
C262	1E84
C263	1E83
C264	7E16
C265	1S61
C266	1S62
C267	1S20
C268	6E67
C269	6E73
C270	5E15
C273	4E5
C274	4E6
C275	7E14
C276	4E7
C277	2E19
C278	6E66
C279	1E82
C280	4E8
C281	7E36
C282	6E71
C283	4E9
C287	1E81
C288	1E80
C289	3E10
C290	6E1
C291	6E2
C292	6E3
C293	6E4
C294	7E13
C295	1E79
C296	5E4
C297	7E30
C299	1E78
C300	1E77
C301	1E118
C303	5E16
C304	6E65
C305	2E20
C307	6E16
C308	6E17
C309	6E5
C310	6E6
C312	6E64
C313	3E11
C314	6E74
C317	7E24
C318	1E75
C319	4E10
C320	4E11
C321	2E21
C322	3E12
C324	6E63
C325	1E74
C326	1E73
C327	1E72
C328	7E29
C329	7E5
C330	1C11
C331	7E15
C332	5E17
C33	5E18
C335	6E62
C336	5E12
C337	2E22
C338	1S19
C339	5E5
C340	1E71
C341	1E70
C342	1E69
C343	4E12
C344	6E61
C345	1S18
C346	1E68
C347	1E67
C348	1E66
C349	1E65
C350	1E64
C351	6E60
C352	4E13
C353	1S17
C354	4E14
C355	1S16
C356	1E63
C357	1S15
C359	7E26
C361	1E62
C362	1E61
C363	6E59
C364	1S13
C365	2E23
C366	1E4
C367	1C10
C369	5E19
C370	6E58
C371	1S12
C372	4E15
C373	1S3
C374	1S11
C375	1S10
C376	6E57
C377	7E21
C378	2E24
C379	3E13
C381	7E4
C382	7E3
C383	7E33
C384	7E8
C385	7E34
C386	7E2
C387	1S9
C388	1S8
C389	7E1
C390	2E25
C401	2E26
C402	2E27
C404	1E60
C405	4E16
C407	1E59
C408	1C9
C409	1C8
C410	2E28
C411	6E56
C412	2E29
C413	6E7
C414	6E55
C415	6E8
C416	6E54
C417	1S7
C418	1E58
C419	5E20
C420	6E53
C421	5E21
C422	4E17
C423	1E57
C424	1E56
C425	1E55
C426	1E54
C427	7E35
C429	5E22
C431	1E53
C432	6E52
C435	1E52
C436	1C7
C437	1C6
C438	5E23
C439	2E30
C441	5E24
C442	5E25
C443	5E6
C444	5E7
C445	5E8
C446	1C5
C447	1E51
C448	3E14
C449	2E31
C450	1E50
C451	1C4
C452	6E24
C453	6E48
C454	6E47
C455	6E46
C456	6E22
C457	6E23
C458	6E45
C459	6E21
C460	2E1
C464	6E49
C465	6E50
C466	6E51
C467	5E26
C469	6E25
C470	6E26
C471	6E27
C472	6E44
C473	3E15
C474	3E16
C475	1C3
C477	5E9
C478	1E49
C479	1E48
C480	6E43
C481	4E18
C482	4E19
C483	4E20
C484	2E32
C486	4E21
C487	4E22
C488	1E47
C489	5E14
C490	5E13
C491	1S6
C492	6E9
C493	6E10
C494	6E11
C495	6E12
C496	1S5
C497	1S4
C498	1E46
C499	4E23
C502	6E42
C503	6E41
C504	7E11
C505	1E45
C506	1E44
C507	1E43
C508	6E28
C513	3E17
C514	4E24
C515	2E33
C517	4E25
C518	1E42
C519	1E41
C521	7E27
C524	6E13
C525	6E14
C526	6E33
C527	6E15
C528	1E40
C529	1E39
C530	1E38
C531	1E37
C532	6E38
C533	2E34
C534	6E37
C535	4E1
C536	2E35
C537	1E36
C538	1E35
C539	4E26
C540	6E36
C541	4E27
C542	4E28
C543	4E29
C544	1E34
C545	1E33
C546	4E30
C547	1E32
C548	1E31
C549	1E30
C550	1E29
C551	1C2
C555	7E37
C556	1E28
C557	1E5
C558	1E27
C559	1E26
C560	1E25
C561	1E24
C562	1E23
C563	4E31
C564	1E22

Old No.	*New No.*	*Old No.*	*New No.*	*Old No.*	*New No.*
C565	1E21	C607	4E37	C646	1S49
C566	1E20	C609	6E18	C649	1S51
C567	6E29	C610	2T2	C650	1S52
C569	1E19	C611	2T1	C651	1S53
C570	4E32	C612	1S42	C652	1S54
C571	1E18	C613	2E40	C653	1S55
C572	1E17	C614	1S68	C654	6E77
C573	7E28	C615	1S69	C656	1S56
C574	1E16	C616	1S70	C657	6E78
C575	2E36	C617	1S71	C658	1S58
C576	1E15	C618	1S72	C659	6E76
C577	6E30	C619	1S73	C660	1S63
C578	4E33	C620	6E75	C663	1E123
C579	1E14	C621	7E31	C664	1E124
C580	1E13	C623	1E7	C666	1E125
C582	2E37	C624	1E8	C667	4E40
C583	5E27	C625	7E17	C668	1S59
C584	7E18	C626	1E6	C669	1S60
C585	7E23	C627	6E32	C670	4E41
C586	7E22	C628	7E38	C671	1S64
C588	1E12	C629	1E119	C672	1S65
C590	4E34	C631	1E120	C673	1S66
C591	6E31	C632	4E38	C674	1S67
C592	6E35	C633	3E18	C675	1S74
C593	4E35	C634	1S43	C676	1S75
C596	6E34	C635	1S44	C677	1S76
C597	1E11	C636	1S45	C678	1S77
C598	2E38	C637	1S46	C679	1S78
C599	7E12	C638	1S47	C680	1S79
C600	1E10	C640	1E121	C681	1S80
C601	7E25	C641	1S2	C682	1S81
C603	1E9	C642	1S1	C683	1S82
C604	7E7	C643	1E122	C684	1S84
C605	2E39	C644	4E39		
C606	4E36	C645	1S48		

TABLE 5

APPLICABLE TECHNICAL ORDER LIST.—Following is a list of technical orders applicable to the airplane which may be used in conjunction with the handbook text for general information.

GENERAL

00-20A	The Army Air Forces Visual Inspection System for Airplanes.
00-25-4	Aircraft Maintenance Procedure and Overhaul of Engines.
01-1-13	Operation of Airplanes Equipped with Air Filters.
01-1-23	Cleaning of Carburetor Air Filters.
01-1-31	Packing Airplanes and Airplane Parts for Shipment.
01-1-40	Weight and Balance Data (Identifying (Order).
01-1-50	Towing, Mooring and Handling of Airplanes.
01-1-70	Removal of Carburetor Air Screens.
02-1-1	Preparation of Engines for Storage.
02-1-8	Restrictions on Removal of Engines.
02-1-22	Preoiling of Aircraft Engines.
02-1-29	Ground Operation Instructions for Aircraft Engines.
03-1-1	Periodic Inspection of Accessories in Storage.
03-1-12	Repair and Cleaning of Non-Self Sealing Fuel and Oil Tanks.
03-5AA-1	Handbook of Instructions — Aircraft Engine Generators and Control Boxes.
03-10B-1	Handbook of Operation and Service Instructions — Aircraft Carburetors (Float type) (Stromberg).
03-20CA-2	Handbook of Service and Overhaul Instructions with Parts Catalog — Constant Speed and Hydromatic Constant Speed—Propeller Governors and Controls.
03-20CB-2	Handbook of Service and Overhaul Instructions with Parts Catalog — Controllable Propeller — Two Position and Constant Speed (Hamilton).
05-3A-2	Handbook of Service and Overhaul Instructions—Fuel Mixture Indicators.

FUSELAGE

01-1-8	Ventilation of Airplanes in Hot Weather.
22-1-3	Repairs of Wood Constructed Wings, Control Surfaces and Fuselage Members.
23-5-2	Welding of Steel Tubular Structures.
23-5-3	Welding, Machining and Forming Corrosion Resistant Steels and Inconel.
23-15-1	Repair and Manufacturing Practices.
23-20-1	Handbook of Instructions for Installation, Maintenance and Repair of Plastic Sheets.
24-1-2	Brazing and Welding Compounds (Flux).
24-1-3	Desiccant, Corrosion Preventive (Indicating).
S-22	Woods—Class 22.

LANDING GEAR

03-25-1	Handbook of Instructions with Parts Catalog—Master Cylinders and Compensating Pressure Control Air Valve.
03-25-2	Operation of Brake Pedals on Power Operated Brakes.
03-25-6	Care of Pneumatic Shock Struts.

03-25-7	Removal of Wheel and Brake Fairings.
03-25A-4	Handbook of Instructions with Parts Catalog—Smooth Contour Tail Wheels (Variety).
03-25A-6	Tail or Nose Wheels (Hayes).
03-25A-7	Handbook of Instructions with Parts Catalog—Nose and Tail Wheels.
03-25B-1	Handbook of Instructions with Parts Catalog—Landing Wheels (Hayes).
03-25E-1	Air-Oil Shock Absorber Struts.
03-25E-2	Handbook of Instructions with Parts Catalog—Nose, Tail and Landing Gear Struts.

SURFACE CONTROLS

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