fork on the starboard side of the starboard magneto. One branch from the fork terminates outside the starboard magneto housing. The other branch extends aft and then crosses the accessory section to terminate outside the port magneto housing.

(2) REMOVAL.—The blast tube is removed in three sections.

(a) The forward section (25) is removed by unfastening the forward hose clamps (27), bolt (24) at forward bracket which is attached to engine nose by two lower engine studs, and then drawing the tube forward through the engine cylinders.

(b) The welded fork section (28) is removed by disconnecting the aft hose clamps (27) and two tube clamp bolts. On the starboard engine only it is also necessary to disconnect a clip which attaches the oil temperature resistance bulb flexible conduit to the tube on the branch terminating at the starboard magneto, above the welded fork.

(c) The rear blast tube section in the accessory bay is removed by removing screw (30) in Q908-16-8 clip bolted to aft end of starter cover box, and two clips (20) and disconnecting bonding braid at the starboard end, just aft of hose clamp (27).

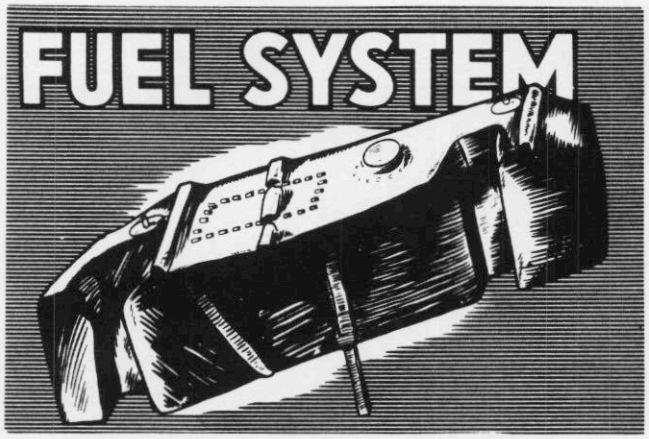
(3) INSTALLATION.—To install the magneto blast tube, perform in reverse order the removal steps outlined in paragraph *c*, (2) above.

d. OIL COOLER AIR DUCT.—Refer to Par. 7, *e*, (2).

e. GENERATOR BLAST TUBE.—Refer to Par. 7, *e*, (2).

★ ★ ★

PARAGRAPH 15.



15. FUEL SYSTEM.

a. GENERAL. *(See figure 131.)*—Fuel is provided for the engines by means of a series feed type system which consists of the main fuel system, the fuel dump system, the vapor dilution system, and the engine primer system. One integral tank and five self-sealing cells in the wing center section are included in the fuel system. Fuel for the engines is taken from the wing tanks near the center line of the airplane.

All units and plumbing in the fuel system are resistant to both ordinary and aromatic fuels.

b. MAIN FUEL SYSTEM.
(See figure 131.)

(1) GENERAL DESCRIPTION.—The main fuel system consists of the fuel storage tanks, the fuel units assembly, and the engine-driven pumps. The fuel units assembly may be divided into two identical assemblies, except for the cross-feed valve (1), each assembly consisting of the following units: a fuel shut-off valve (7), a fuel selector valve (5), an A. E. L. unit (4), a fuel flowmeter (6) and the necessary plumbing and controls.

The fuel tank plan provides for installation of five self-sealing fuel cells in the starboard tank of all odd-numbered airplanes and in the port tank of all even-numbered airplanes as they leave the factory. Cells can be installed, however, in both tanks or may be completely removed as required.

Maximum capacity of the two fuel tanks without cell installation is 1750 U. S. (1457 Imp.) gallons. When cells are installed on one side, the maximum capacity of the cells, plus the remaining integral tank is 1497 U. S. (1245.8 Imp.) gallons. When cells are installed in both tanks the maximum capacity (water borne) is 1244 U. S. (1035.3 Imp.) gallons.

Access to any part of the tanks is provided by manholes in the upper surface of the wing immediately to the right and left of the center line. A filler cap is located at the center of the manhole cover. In addition to the manholes there are access panels in the upper surface of the wing which may be removed for tank inspections and repairs, cell removals or installations. These panels are aft and outboard of the manholes and extend from wing station 2.0 to station 4.5. Gas tight fuel cell manifold access doors are located on the under surface of the wing on each side of the superstructure. Transparent inserts for visual inspection of fuel cell manifolds are installed in the access doors on the side which carries fuel cells. Additional inserts are provided for installation on the other side of the wing also, when cell installations there may require inspection. Control valves, strainers, and emergency hand-operated fuel pumps are located in the superstructure immediately forward of the engineer's station. The fuel system controls and indicators are mounted on the engineer's panel and elsewhere in the engineer's compartment. A tank dumping and carbon dioxide (CO_2) dilution system is included in the fuel system equipment for emergency operation. All fuel lines are identified by ½ inch wide red bands.

(2) FUEL TANKS.

(a) DESCRIPTION.

1. SELF-SEALING FUEL CELLS. *(See figure 132.)*—The self-sealing fuel cells are Goodyear FTL-1ON, Buna Containers, which will seal holes or injuries automatically. The cells are equipped with exterior metal stiffeners and have the following capacities and approximate weights:

Cell No.	Capacity Gallons	Weight (empty) Pounds
1	151 U. S. (126.8 Imp.)	108.0
2	119 U. S. (99.2 Imp.)	88.7
3	120 U. S. (100.0 Imp.)	92.5
4	160 U. S. (133.0 Imp.)	103.7
5	80 U. S. (66.7 Imp.)	77.0
Total	630 U. S. (524.0 Imp.) Gal	469.9 lbs

The total usable capacity of the five cells when installed in the plane is slightly less than the above total, however, and it is as follows:

Cell capacity for each side when plane is water borne is 622 U. S. (517.6 Imp.) gallons.

A removable access cover is installed in the top of each cell. All fittings for the connection of the tank with the fittings of the plumbing lines are vulcanized into the cell and cannot be removed.

The order of placement of the cells in the wing is as follows: No. 1 cell inboard; No. 2 next; then Nos. 3, 4, and 5 next outboard in that order. Each cell is protected against chafing and damage from the wing structure by means of a metal lining installed on the floor of its compartment in the wing, a metal sup-

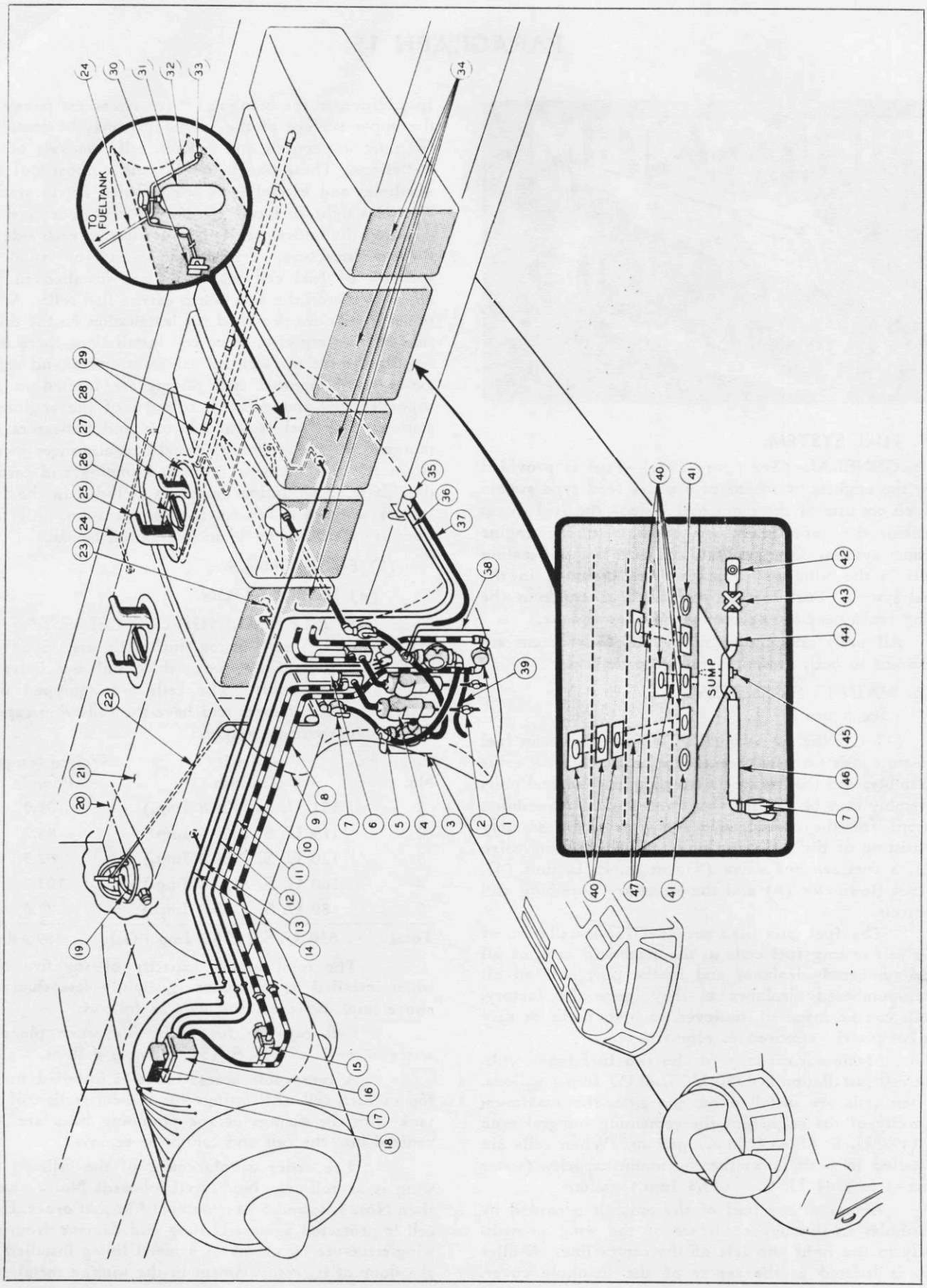


Figure 131—Fuel System Diagram

port plate between the forward end of the cell and the front spar, a wooden support plate at the rear spar, and canvas curtains attached to the bulkheads between the cells and at the inboard and outboard sides.

2. INTEGRAL TANKS.—The two integral tanks are formed by the front and rear wing spars, the center line bulkhead (wing station 1.0) the wing bulkheads at station 5.0, left and right and the upper and lower surface of the wing. Self-sealing fuel cells are installed in either one or the other of the integral tanks and can be installed in both. The integral tanks consist essentially of a part of the regular wing structure which has been properly reinforced and sealed to produce a fuel-tight container. Attached to the structure inside the integral tank, are screen bags filled with potassium dichromate crystals, which act as corrosion inhibitors.

3. SUMP ASSEMBLY. *(See figure 133.)*—There are two sumps; one attached below each fuel tank near the wing center line, fitting into the superstructure between the inner and outer fairing. They are long, narrow, rectangular shaped funnels with tops extending from points immediately aft of the front spar to the rear spar. The sumps are riveted to the wing. At the bottom of each sump is a casting which contains the main fuel line outlet, a tank drain and refuel line outlet, and a corrosive inhibitor capsule which is accessible through the sump drain plug. The lower portion of the sump casting can be removed.

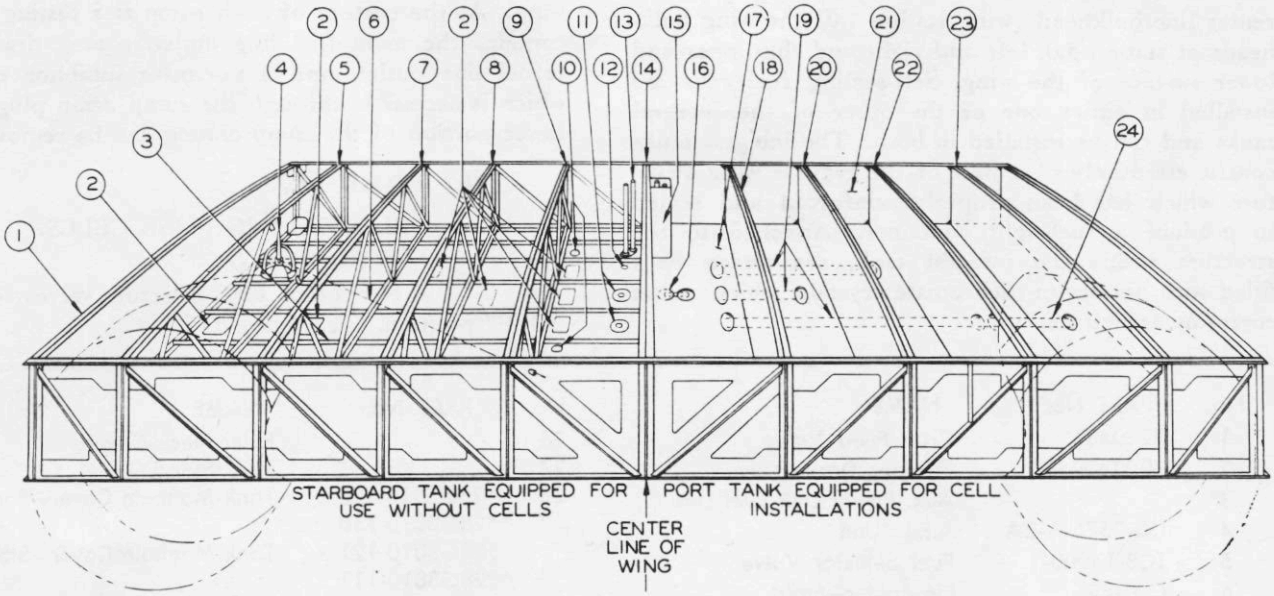
(b) REMOVAL.

1. SELF-SEALING FUEL CELLS. *(See figure 131.)*

a. Set both fuel selector valves (8) in "OFF" position. *(See figure 176.)*

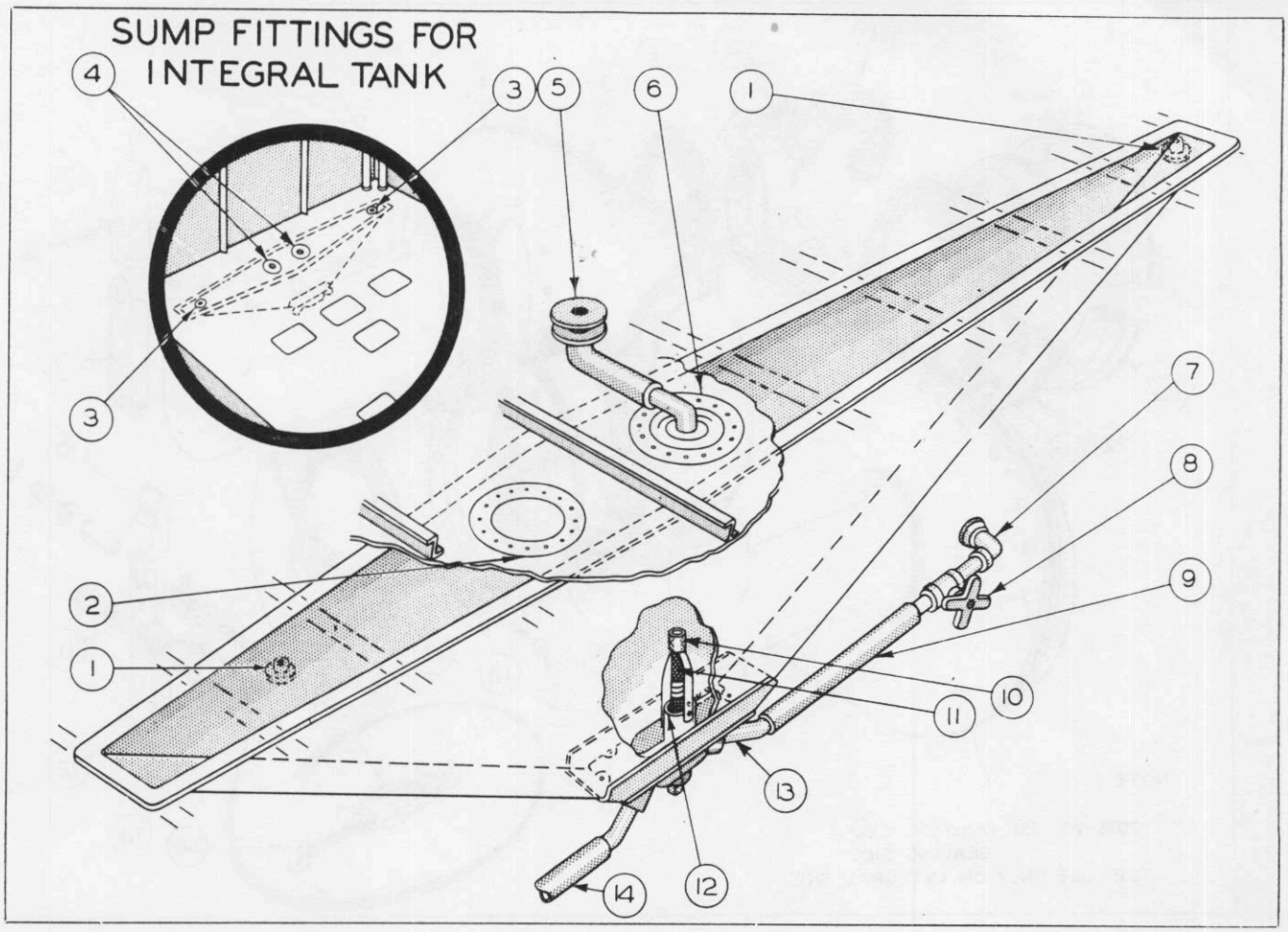
No.	PART No.	NAME
1	124043	Cross-Feed Valve
2	702-GG-6D	Strainer Drain Valve
3		Aux. Power Unit Fuel Line
4	UD-2575-A-CA	A.E.L. Unit
5	TCB-14000-1	Fuel Selector Valve
6	C-1045	Flowmeter—Stb'd.
	C-1043	Flowmeter—Port
7	UB-1460-C1	Fuel Shut-Off Valve—Port
	UB-1460-C2	Fuel Shut-Off Valve—Stb'd.
8		Cross-Feed Fuel Line
9		Center Line of Wing
10		Main Fuel Line to Engine
11		Fuel Pressure Line
12		Vent Line to Pressure Gage
13		Engine Primer Line
14		Vent Line—Tank to Carb.
15	CH4E3-3	Engine Driven Fuel Pump
16	***Type PD-12H-4	Carburetor
	****Type PD-12H-1	
17		Carburetor Elbow Scoop
18		Primer Line Spider
19	28G1011-555	Dump Valve
20	28G5080	Dump Duct
21		Integral Fuel Tank
22		Dump Valve Actuating Cable
23	28G1042	Dump Valve Control Lever
24		Vapor Dilution Line
25		Vent Standpipe
26		Filler Neck Cover
27		Vent Standpipe
28	*28G3010-120	Tank Manhole Cover—Port
	**28G3010-110	
	*28G3010-121	Tank Manhole Cover—Stb'd.
	**28G3010-111	
29		S. S. Cell Vent Tubes
30	17308	Purging System Pull Handle
31	24390	Purging Cylinder
32		Pressure Relief Line
33	22315	Pressure Relief Disk.
34	28G5105 L/R	No. 1 Cell
	28G5106 L/R	No. 2 Cell
	28G5107 L/R	No. 3 Cell
	28G5108 L/R	No. 4 Cell
	28G5109 L/R	No. 5 Cell
35	P4CA-2A Type B2	Primer Pump
36		Engine Primer Line
37		Fuel Line to Primer Pump
38		Central Heater Fuel Line
39		Tail Heater Fuel Line
40	28W5064	Manifold Inspection Window
41	28W5522-7	Sight Gage Insp. Window
42	28G1041-5	Drain & Refuel Outlet
43	1-2040-8	Drain & Refuel Valve
44		Drain & Refuel Line
45		Sump Drain Plug
46		Main Fuel Line
47		S. S. Cell Manifold Lines

Item 1 is an Aero Supply Mfg. Co. part number.
Items 2, 35 and 43 are Parker Appliance Co. part numbers.
Items 4 and 7 are United Aircraft Products, Inc., part numbers.
Item 5 is a Thompson Products, Inc., part number.
Item 6 is a Fischer and Porter Co. part number.
Item 15 is a Chandler Evans Corp. part number.
Item 30, 31 and 33 are Walter Kidde and Co. part numbers.
*PBY-5A only.
**PBY-5 only.
***PBY-5A and PBY-5 (Serial number 08349 and on).
****PBY-5 (up to serial number 08349).



No.	PART No.	NAME
1		Wing Bulkhead 5
2	28W5065-13	Cover—Access Hole
3		Stringer—Lower Surface
4	28G1011-555	Dump Valve
5		Wing Bulkhead 4.5
6		Dump Valve Cable Control
7		Wing Bulkhead 4
8		Wing Bulkhead 3
9		Wing Bulkhead 2
10		Cover—Access Hole
11	28G5039-8	Fuel Outlets to Sump
12		Sump Drain Hole
13		Sight Gage Standpipes
14		Wing Bulkhead 1
15	28G5051	Rear Sight Gage Guard
	28G5052	Front Sight Gage Guard
16		Cell to Sump Connection
17	28G5161 L/R	Floor Liner Bay No. 1—Rear
	28G5167 L/R	Floor Liner Bay No. 1—Front
	28G5162 L/R	Floor Liner Bay No. 2—Rear
	28G5168	Floor Liner Bay No. 2—Front
	28G5163 L/R	Floor Liner Bay No. 3—Rear
	28G5168	Floor Liner Bay No. 3—Front
	28G5164	Floor Liner Bay No. 4—Rear
	28G5170	Floor Liner Bay No. 4—Front
	28G5165 L/R	Floor Liner Bay No. 5—Rear
	28G5171 L/R	Floor Liner Bay No. 5—Front
18	28G5055-0L	Curtain—Blkhd 2—Outboard
	28G5055-0R	Curtain—Blkhd 2—Inboard
19	Q2202-32-38.5	Manifold No. 1 to No. 3 Cell
	Q2202-32-20	Manifold No. 1 to No. 2 Cell
	Q2202-32-55	Manifold No. 1 to No. 4 Cell
20	28G5055-2L	Curtain—Blkhd 3—Outboard
	28G5055-2R	Curtain—Blkhd 3—Inboard
21	28G5172 L/R	Liner Bay No. 1—Rear Spar
	28G5173 L/R	Liner Bay No. 2 & 3—Rear Spar
	28G5174 L/R	Liner Bay No. 4—Rear Spar
	28G5175 L/R	Liner Bay No. 5—Rear Spar
22	28G5055-3L	Curtain—Blkhd 4—Outboard
	28G5055-3R	Curtain—Blkhd 4—Inboard
23	28G5055-4L	Curtain—Blkhd 4.5—Outboard
	28G5055-4R	Curtain—Blkhd 4.5—Inboard
24	Q2202-32-16.5	Manifold No. 4 to No. 5 Cell

Figure 132—Interior Plan of Wing Fuel Tanks



No.	PART No.	NAME
1	AN913-6D	Pipe Plug
2	28G5039-6	Cover Plate—S. S.
	28G5200	Gasket
3		Sump Drain Hole
4	28G5039-8	Plate—Integral
5		Cell Fitting
6	28G5027	Sump Fitting Assem.
	28G5019	Plate—Sump Fitting
	28G5020-6	Flange
	28G5053	Gasket—Flange
	28G5200	Gasket—Plate
	AN842-16D	Elbow Fitting

No.	PART No.	NAME
7	28G1041-5	Drain & Refuel Elbow
8	1-2040-8	Drain & Refuel Valve
	(Parker Appliance Co.)	
	28G5012-6	Mounting Plate—Valve
9	Q2202-16-13.5	Drain & Refuel Line
10		Guard for Capsule
11	28G2010	Strainer & Drain Plug
12	28G2006	Outlet Assembly
13	AN844-16D	Drain & Refuel Fitting
14	Q2202-16-42	Main Fuel Line
	AN844-16	Main Fuel Line Fitting

Figure 133—Fuel Sump

b. Drain fuel cells. (Refer to Section III, Par. 2, *h*, (1), *(d).*)

c. Remove large access door in the upper surface of the wing.

d. Remove manhole cover as follows: *(See figure 134.)*

(1) Remove screws which hold filler neck body (18) to filler neck (23).

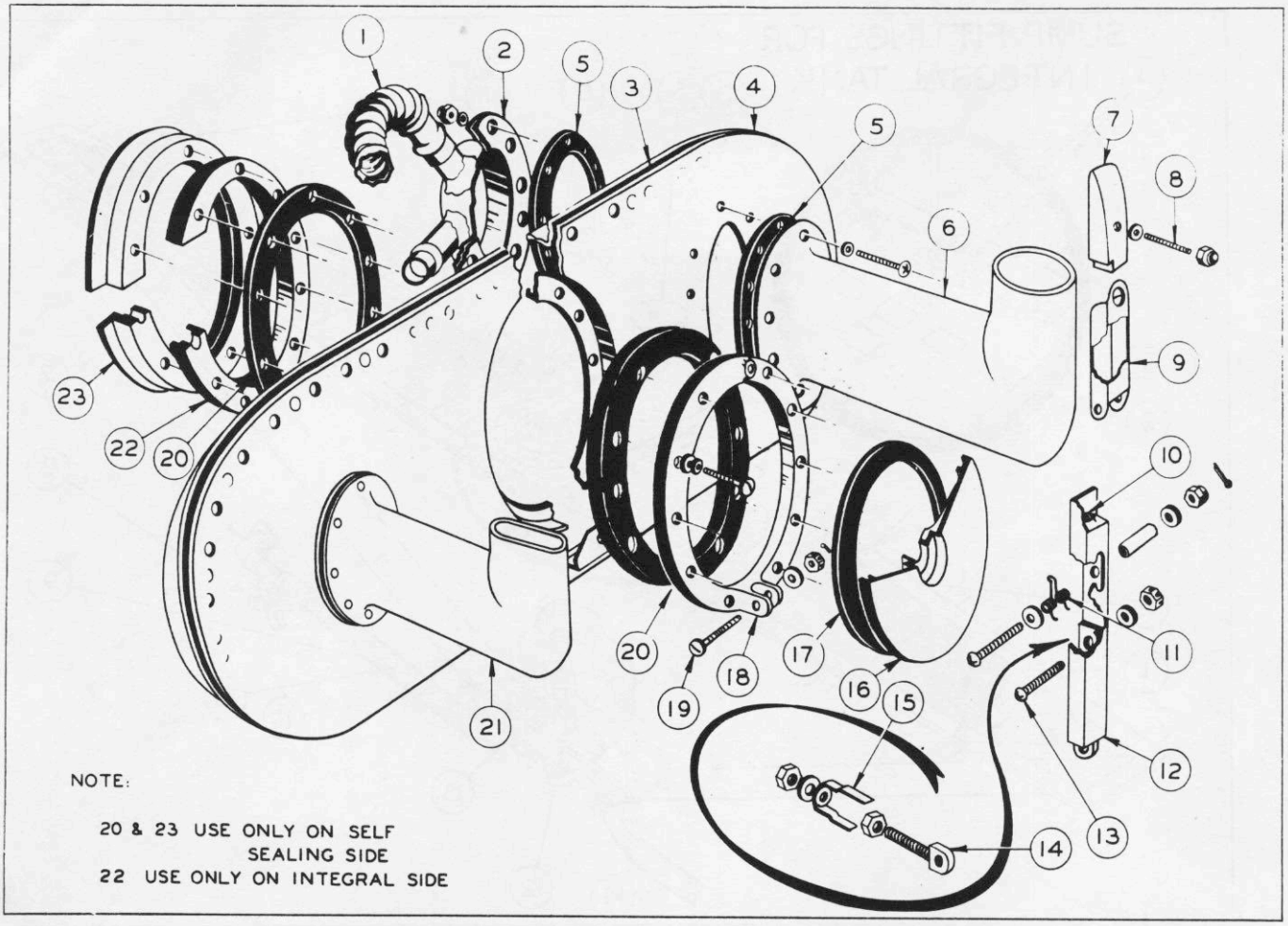
(2) Detach nut from stud (8) and remove latch clamp (7).

(3) Remove stud (8) from filler neck.

(4) Remove screws which fasten manhole cover (4) to wing structure and carefully lift cover until sufficient room has been obtained to disconnect the bellows type vent lines attached to the lower portion of the vent.

e. Remove vent lines (29) from cells two, three and four. *(See figure 131.)*

f. Remove manifold access doors (40) and sight gage access doors (41) from the lower surface of the wing.

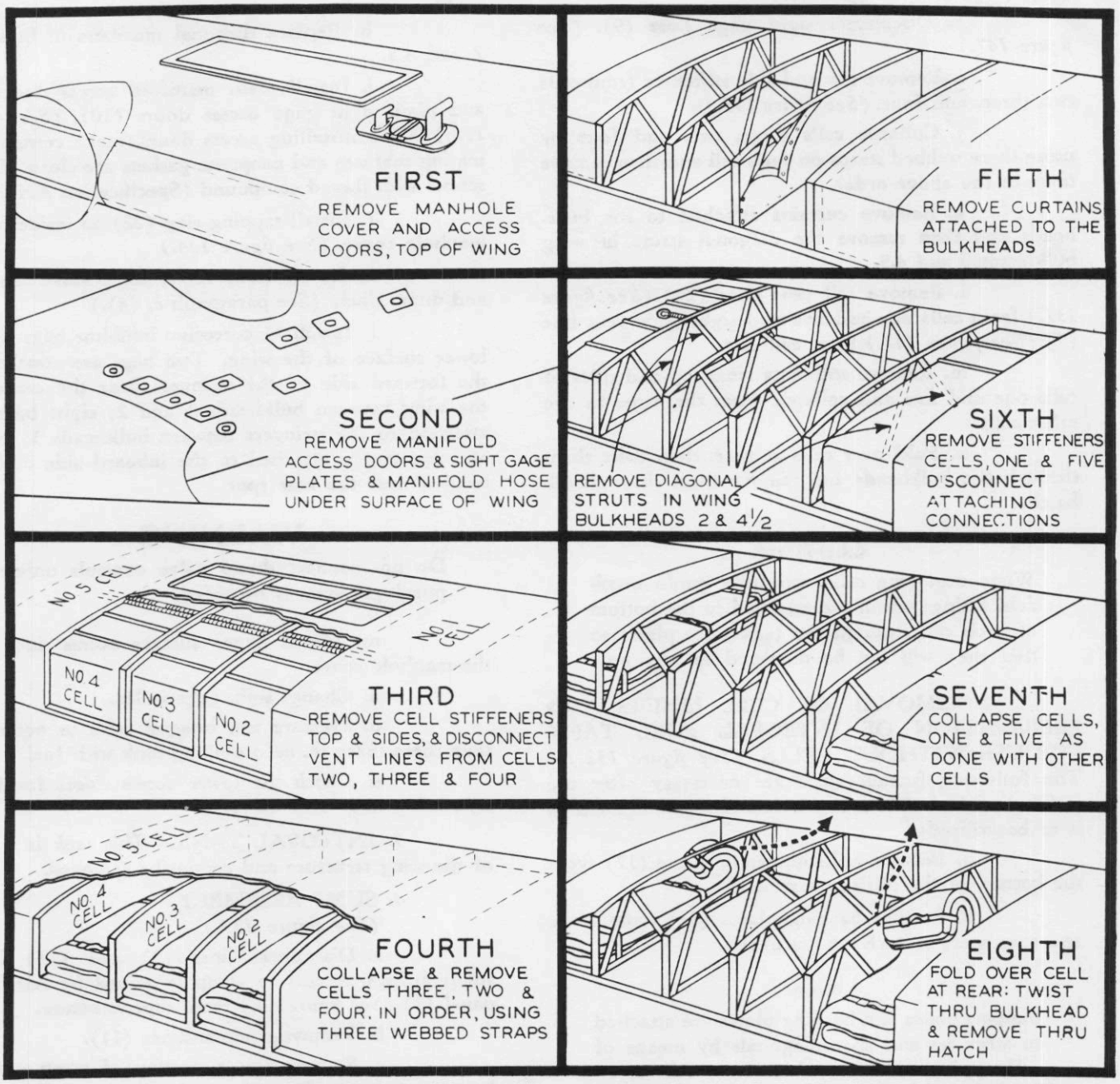


No.	PART No.	NAME
1		Flexible Hose
2	28G5121 L/R	Vent Coupling
3		Gasket—Body
4	*28G3010-120	Manhole Cover Assem.—Port
	**28G3010-110	
	*28G3010-121	Manhole Cover Assem.—Stb'd.
	**28G3010-111	
5	28G5096	Gasket—Vent
6	28G5122	Vent
	AN526-1032-14	Screw
	AN960-A10L	Washer
	AN960-A10	Washer
	AN365-1032	Nut
7	28-0-2024	Clamp—Latch
8	28-0-2017-3	Stud
9	28-0-3002	Locking Clip
10	22Q098-2	Fastener
11	28-0-5049	Spring—Locking Clip
	AN515D6-20	Screw
	AN365-D632	Nut
	Q808D4-26	Spacer
	AN960-AL6	Washer
12	28-0-2023	Latch
13	AN23-17	Clevis Bolt

No.	PART No.	NAME
	AN320-3	Nut
	AN380-2-2	Cotter Pin
	AN960-A10L	Washer
14	28-0-2025	Eyebolt
	AN316-4R	Nut
	AN960-416	Washer
	AN310-4	Nut
	AN380-2-2	Cotter Pin
15	28-0-2042	Clip
16	28-0-2020-2	Cover—Filler Neck
17	28-0-2026	Gasket—Cover
18	28-0-3009	Body—Filler Neck
	NAF1064-1024-10	Screw
	AN935-10	Lockwasher
	AN960-10	Washer
19	AN23-17	Clevis Bolt
	AN320-3	Nut
	AN380-2-2	Cotter Pin
	AN960-A10L	Washer
20	28-0-2022	Gasket—Body
21		Vent
22	28-0-2021	Tapping Ring
23	28G5022	Filler Neck

*PBY-5A only.
**PBY-5 only.

Figure 134—Manhole Cover and Filler Neck



BEFORE PROCEEDING WITH THE REMOVAL OF ANY OR ALL SELF-SEALING FUEL CELLS, BE SURE THAT ALL FUEL IS DRAINED OUT OF THE CELLS AND THAT THEY ARE DRY. TO DRAIN CELLS, OPEN THE DRAIN VALVE IN THE ENGINEER'S COMPARTMENT AFT OF THE ENGINEER'S WINDOW IN THE SUPERSTRUCTURE.

CAUTION

1. BE SURE ALL FITTINGS AND LINES ARE DISCONNECTED AND ALL METAL STIFFENERS TAKEN OUT BEFORE ATTEMPTING REMOVAL OF CELLS.
2. DO NOT PRY ON RUBBER FITTINGS OR CELLS WITH SHARP INSTRUMENTS.
3. WHEREVER POSSIBLE, TEMPERATURE SHOULD BE KEPT AT FROM 65° TO 100° F WHEN CELLS ARE TO BE COLLAPSED.
4. DO NOT ALLOW ANY CELL TO REMAIN COLLAPSED FOR MORE THAN 30 MINUTES.
5. DO NOT BEND CELLS AT FITTINGS OR AT INSPECTION DOORS. DO NOT DRAG CELLS. BE SURE ALL OPENINGS ARE COVERED WHEN CELLS ARE OUT OF TANK.
6. DO NOT LIFT CELLS BY THEIR FITTINGS OR ALLOW THEM TO SCRAPE AGAINST SHARP METAL EDGES OR POINTS. DO NOT DROP CELLS FROM WING TO THE FLOOR. ALWAYS HANDLE CELLS WITH CARE.

Figure 135—Procedure for Removal of Fuel Cells

g. Remove manifold hose and couplings (47). *(See item 18, figure 40.)*

h. Disconnect sight gage hose (9). *(See figure 147.)*

i. Remove top and side stiffeners from cells two, three, and four. *(See figure 135.)*

j. Collapse cells three, two, and four by using three webbed straps on each cell and then remove them in the above order.

k. Remove curtains attached to the bulkheads and then remove the diagonal struts in wing bulkheads 2 and 4.5.

l. Remove cell vent lines (29) *(See figure 131.)* from cells one and five and sight gage vent line (7) *(See figure 147.)* from cell one.

m. Remove stiffeners from top and sides of cells one and five and collapse them the same as the other cells.

n. Fold over cells at rear, then twist them through the bulkheads and remove them through the hatch.

CAUTION

When removing cells, carefully guide manifold fittings which are attached to the bottom of each cell through the tank liner plates so that they will not be damaged in any way.

2. REMOVAL OF CELL LINERS AND PREPARATION OF INTEGRAL FUEL TANK FOR USE WITHOUT CELLS. *(See figure 132.)*—The following further steps are necessary after the self-sealing fuel cells are removed if the integral tank is to be utilized:

a. Remove cell supporting plates (17) from the bottom of the cell compartments.

b. Remove backing plates (21) from front and rear spars in each compartment.

Note

Support plates and backing plates are attached to stringers and spar diagonals by means of self-tapping sheet metal screws. All screw heads are covered by adhesive tape.

c. Remove the two pipe plugs from front and rear sump drain holes (12) in No. 1 cell compartment.

d. Remove plate assembly (6) and cover plate (2) from the top of the sump and install the plates (4) having the plain sump opening. *(See figure 133.)*

e. Remove all bellows tubing from vent system.

f. Remove guard from in front of sight gage standpipes. *(See figure 147.)*

g. Remove the synthetic rubber nipple fitting (6) from the top of the fuel sight gage standpipes.

h. Replace diagonal members in bulkhead 2 and 4.5.

i. Install plain manifold access doors (2) and plain sight gage access doors (10). *(See figure 132.)* When installing access doors, make certain that mating surfaces and neoprene gaskets are clean. Insert screws with thread compound (Specification AN-P-51).

j. Install tapping ring (22) on inside of the manhole cover. *(See figure 134.)*

k. Install dump valve, dump valve controls, and dump duct. (See paragraph *c*, (4).)

l. Install 11 corrosion inhibitor bags on the lower surface of the wing. Two bags are attached to the forward side of the stringers near the center of the wing between bulkheads 1 and 2; eight bags are attached to the stringers between bulkheads 3 and 4; and one bag is attached to the inboard side of bulkhead 4 near the rear spar.

WARNING

Do not connect dump valve controls unless purging system is provided.

m. Install upper surface access door and the manhole cover.

n. Change sight gage scales.

o. Pressure test integral tank to not more than three lb/sq in. before filling tank with fuel.

p. Check the lower access doors for leakage, using soap and water.

3. INTEGRAL TANK.—This tank is a part of the wing structure and cannot be removed.

4. SUMP ASSEMBLY.
(See figure 133.)

a. Disconnect lines (9) and (14) from sump fittings. Access to sump is gained by removing panel (3) *(See figure 64.)* from superstructure.

b. Remove sump strainer (11).

c. Remove lower portion of sump casting by removing nuts from the studs.

(c) MAINTENANCE.

1. SELF-SEALING FUEL CELLS.

a. If leak has developed at manifold fittings or at sight gage connection, tighten hose clamps.

b. For repairs to cells, see Structural Repair Manual, AN 01-5MA-3.

2. INTEGRAL TANK.

a. For repairs to integral tank, see Structural Repair Manual (AN 01-5MA-3).

b. At each 240 hour inspection, drain tank and remove the corrosion inhibitor bags. There are 11 bags in each tank. Replace with new bags.

3. SUMP ASSEMBLY.

a. If leak develops between sump and lower surface of wing, tighten rivets with a rivet gun and bucking bar. If this does not stop leak, remove sump from wing and replace neoprene gasket between sump and wing. To remove sump from wing, it is necessary to remove wing from airplane.

An alternate method for removing sump is outlined in Bureau Change Number 153 for PBY-5 and Change Number 143 for PBY-5A.

b. If leak develops at bottom of sump, tighten nuts on studs or if necessary remove bottom and replace gasket.

c. Tighten hose clamps on sump fittings.

(d) INSTALLATION.

1. PREPARATION OF INTEGRAL TANK FOR SELF-SEALING CELLS.

a. Remove the manifold access doors and the two sight gage access doors on the lower surface of the wing.

b. Remove the large access door on the upper surface of the wing between bulkheads 2 and 4.5.

c. Remove manhole cover (4) from top surface of the wing and the tapping ring (22) at the bottom of the filler cap by removing the rivets. *(See figure 134.)*

d. Remove the detachable truss member in the center of bulkheads 2 and 4.5 inside the tank.

e. Remove the dump valve, dump valve actuating cable, and dump duct. The dump valve actuating gland is to be plugged with a neoprene washer and a metal washer, and the gland cap then replaced and made secure. (Refer to paragraph *c*, (2).)

f. Remove the 11 corrosion inhibitor bags from the stringers on the lower surface.

g. The carburetor vent tubing is connected to the carburetor vent flange on the front spar and to the cell vent line at No. 1 cell. This line is to be taped to the top stringer until No. 1 cell is installed.

h. Place the plugs in the fore-and-aft drain holes from the tank into the sump. Bolt cover plates to the large outlet holes to the sump, using the plate with elbow on the aft one of the two holes. The elbow is to face outboard. Paint all connections with a mixture of soap and water and pressure test for leaks, using up to three lb/sq in. pressure.

i. Install elbow and tube at the bottom of the forward and aft sight gage standpipes.

j. Attach fuel sight gage guards to the bulkhead wall.

k. Attach vent cap and line to top of sight gage standpipes. Tape vent line to wing structure until No. 1 cell is installed.

l. Install cell liner on floor of each compartment, the metal support plate on the front spar, and the wooden backing plate against the rear spar. All plates are attached to the wing structure by means of self-tapping screws. All exposed screws, rough edges, and corners are to be covered with tape and then covered with a coat of shellac to prevent chafing or damaging of the cells.

m. Install each of the four manifold hoses in its proper location between the lower skin surface and the cell lining so that the ends of the hoses are near the access holes in the bottom of the wing. *(See figure 132.)*

2. SELF-SEALING FUEL CELLS. — Fuel cells are to be installed in the following order: No. 1, No. 5, No. 4, No. 2, and No. 3.

a. Remove stiffeners from No. 1 cell and collapse cell. Hold in collapsed position with three webbed straps. Place sight gage guards, 28U5097, *(See figure 40.)* in position.

CAUTION

Do not collapse cells until ready to install them, as they are not to remain collapsed longer than 30 minutes.

b. Lift the cell to the top of the wing and insert the front end downward through the access door into No. 2 cell compartment. Turning inboard side downward one quarter turn. Fold the front end 90°, passing it through the opening in the bulkhead made by the removal of the diagonal truss members; continue pushing cell forward until rear end passes the diagonal members into No. 1 compartment; and then turn the cell so that top surface is upward.

c. While the cell is still collapsed, attach the canvas curtain to the inboard side of the top chord member of bulkhead 2 and roll it up out of the way.

d. Remove the straps from around the cell and allow it to expand into place.

e. After the cell has returned to its original shape, press the outboard side down and turn it over to allow sufficient clearance for installation of inboard stiffeners.

f. It is important that the interconnecting manifold outlet in the bottom of the cell be centered on the manifold access hole cut in the floor liner.

g. Connect the manifold outlet on the bottom of the cell to the interconnecting manifold hose. If hose does not readily slip on the male fittings, apply talcum powder or a soap and water mixture to the male fitting in order to lubricate it.

h. Raise No. 1 cell slightly and attach the outlet for the fuel sump to the elbow on the top of the sump. Also connect the nipples on the bottom of the cell to the sight gage tubing at the fore-and-aft inboard corners of the tank.

i. Press down the top of the cell enough to connect the aft fuel sight gage and the nipple on the cell. The interconnecting tubing for the forward sight

gage is connected with the forward vent nipple tee. The tube which leads to the carburetor vent flange on the front spar is connected to the outboard side of the top vent.

j. Install No. 5 cell in its compartment in the same manner as described for the installation of No. 1 cell.

k. Connect vent hose to vent opening in top of No. 5 cell, using wooden wedges if necessary to gain sufficient clearance.

l. After connections have been made, install stiffeners in the remaining slots at the top and sides of the cells.

m. Roll curtains down and attach them to the bottom of the bulkheads.

n. Attach the removable diagonal members to bulkheads 2 and 4.5.

o. Hold the filler neck on No. 1 cell against the filler plate and attach it with screws.

p. Attach curtains to bottom studs on inboard side of bulkhead 4.5. The outboard side of bulkhead 2, the outboard side of bulkhead 4, and the inboard side of bulkhead 3.

q. Remove side stiffeners from No. 4 cell, collapse and strap it down. Insert in No. 4 cell compartment, placing the forward end in the compartment first. Complete the installation as in previous instructions.

r. Center cell over the manifold opening in the floor liners and attach interconnecting manifold hose. Attach interconnecting vent hose.

s. Install No. 2 cell in the same manner as No. 4 cell.

t. Attach curtains to button studs on outboard side of bulkhead 3 and inboard side of bulkhead 4.

u. Install No. 3 cell in the same manner as cells No. 4 and 2.

v. Place "T" connection in the vent tubing leading from No. 5 cell to No. 4 cell and connect the forward vent line which extends to the inboard vent in the tank manhole cover.

3. SUMP ASSEMBLY.

a. Replace fittings in lower portion of sump casting.

b. Attach casting to bottom of sump. Make certain that mating surfaces and gasket are clean before installing castings.

c. Install drain plug and strainer assembly.

d. Safety-wire the nuts and drain plug. Attach hose to fittings.

(e) OPERATIONAL CHECK.

1. Check to see that fuel selector valves are in "OFF" position.

2. Pump 100 gallons of fuel into the cells in 20 gallon increments, checking the sight gage readings after each 20 gallons is inducted. Note angle of plane by reading the inclinometer and, using tilt chart, interpolate the gage readings to see whether fuel gallonage thus arrived at is the same as the known amount pumped into cells.

3. Check all bottom connections for possible leaks.

4. After the first 100 gallons is inducted, the cells are to be filled, with stops being made as each additional 50 gallons is pumped in. Sight gage reading checks are made at each interval between fillings, and cell connections are to be re-checked for evidence of leakage.

5. If, when cells are full, there are no leaks, the manifold access doors and the sight gage inspection doors (all above access doors have Plexiglas inspection windows) are to be attached in their proper places on the under surface of the wing. The upper access door and filler neck cover are to be installed to complete the fuel cell installation.

(3) FUEL LINES, VENT LINES AND FITTINGS.

(a) DESCRIPTION. *(See figure 46.)* — The lines of the main fuel system are of two kinds, self-sealing and non-self-sealing. The non-self-sealing lines are of 52S aluminum alloy or synthetic rubber. All fuel lines of this type are marked for quick visible identification, with a red band at each end. The self-sealing hoses also have a red stripe running lengthwise of the tube.

All lines originate in the superstructure and terminate in the nacelle. They may be disconnected at the leading edge lower surface in the superstructure, at the leading edge ribs inboard of the nacelles, and at the nacelle firewalls.

The lines are clipped to the airplane structure at approximately 18 inch intervals throughout their run.

Lines are interconnected or attached to the various units of the fuel system by means of standard hose or flared tube fittings and by short pieces of beaded metal tubing.

For the arrangement of fuel lines in the nacelle forward of the firewall, see figure 137.

(b) REMOVAL

(See figure 131.)

1. Drain fuel lines by the following method:

a. Place shut-off valves (7) in "OFF" position. Access to shut-off valves is gained by removing access panels from both sides of the forward portion of the superstructure.

b. Open strainer drain valves (2). Control handles for these valves are on the flight engineer's instrument panel.

c. In engineer's compartment, disconnect tail heater fuel valve from the strainer.

d. Open cross-feed valve (1) and tail heater valve. Drain fuel into a container.

e. Disconnect fuel lines from the fuel pump on both engines in order to let air into the lines.

2. Each line to be removed is disconnected at its ends, also at the junction of the leading edge lower surface and the superstructure, as well as at the leading edge rib inboard of the nacelle, and at the firewall. *(See figure 46.)*

3. Remove clips which fasten the line to the airplane structure.

4. The exposed openings of fittings or units should be covered by taping to preclude entry of dirt and other foreign matter into the fuel system.

5. Remove the lines.

Note

Carefully avoid bending or denting metal lines, and damage to adjacent installations or equipment.

(c) MAINTENANCE.

1. NON-SELF-SEALING FUEL LINES.

a. If metal lines have deep dents or abrasions, replace them.

b. If leakage occurs at connectors, tighten the clamping screws. If it continues, replace the defective parts.

c. If rubber hose connectors are cracked, hard, frayed, swollen, or worn, replace them.

d. If hose clamps are corroded or their screws are loose in the threads, replace them.

e. If the bonding is loose, broken, or corroded, replace it.

f. Disconnect at both ends any clogged sections or connections of the fuel lines. Blow them out with compressed air and flush them with clean gasoline to cleanse them of obstructing matter.

2. SELF-SEALING FUEL LINES.

a. Replace all sections of the line in which any of the following defects are found: punctures, blisters, cracks, pits, seepage, leakage, or collapsed side walls.

b. A steel ball whose diameter is 5/32 inch smaller than the nominal diameter of the tube must pass freely through the tube. If it does not, replace the tube.

(d) INSTALLATION.

(See figure 46.)

1. To install lines, reverse the removal procedure as outlined in paragraph *b*, (3), *(b)*.

2. When clamping hose to fittings or interconnectors, make certain that hose and clamp are correctly installed on the fitting. For typical installation, see figure 136.

3. Clip lines to airplane structure at approximately 18 inch intervals.

4. Hose must not be twisted during installation. The longitudinal red stripe on the self-sealing hose will indicate whether or not the hose is twisted.

(e) OPERATIONAL CHECK.

1. Flushing procedure is to be in accordance with "PROCEDURE CHART." *(See figure 138.)*

2. After flushing the fuel lines and units as outlined above, the carburetor is to be flushed as follows:

a. Set fuel selector valves on the tank containing fuel cells.

b. Remove the 1/8 inch pipe plug in the large nut over the mixture control lever, to facilitate filling and flushing the carburetor.

c. With the mixture control lever in "AUTOMATIC RICH," operate left and right wobble pumps respectively with a fuel pressure not over two or three lb/sq in. until gasoline appears in a clear stream at 1/8 inch pipe plug opening.

d. Immediately shift mixture control back to "IDLE CUT-OFF."

e. Replace and rewire pipe plug.

3. In completing the flushing operation, these further steps are to be followed:

a. Connect all lines and put starboard and port fuel selector valves on tank containing self-sealing cells. See that the mixture control lever is in "IDLE CUT-OFF," then pump up pressure to 14 to 16 pounds, and check for leaks (right side with right wobble pump and left side with left wobble pump).

b. Place port fuel selector valve in "OFF" position; open cross feed valve; and set starboard

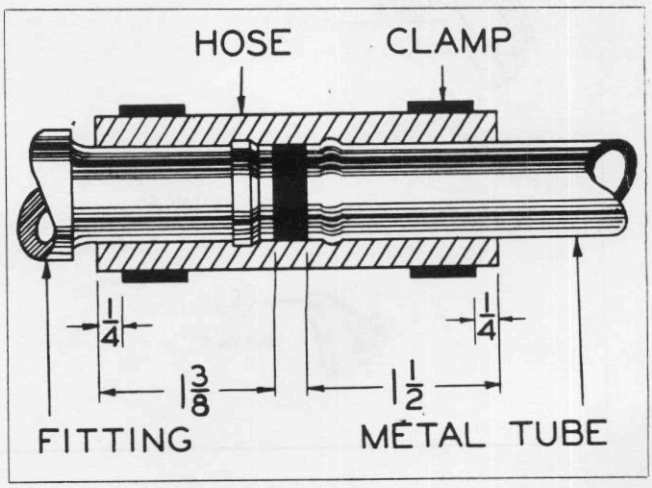


Figure 136—Hose Clamp Installation

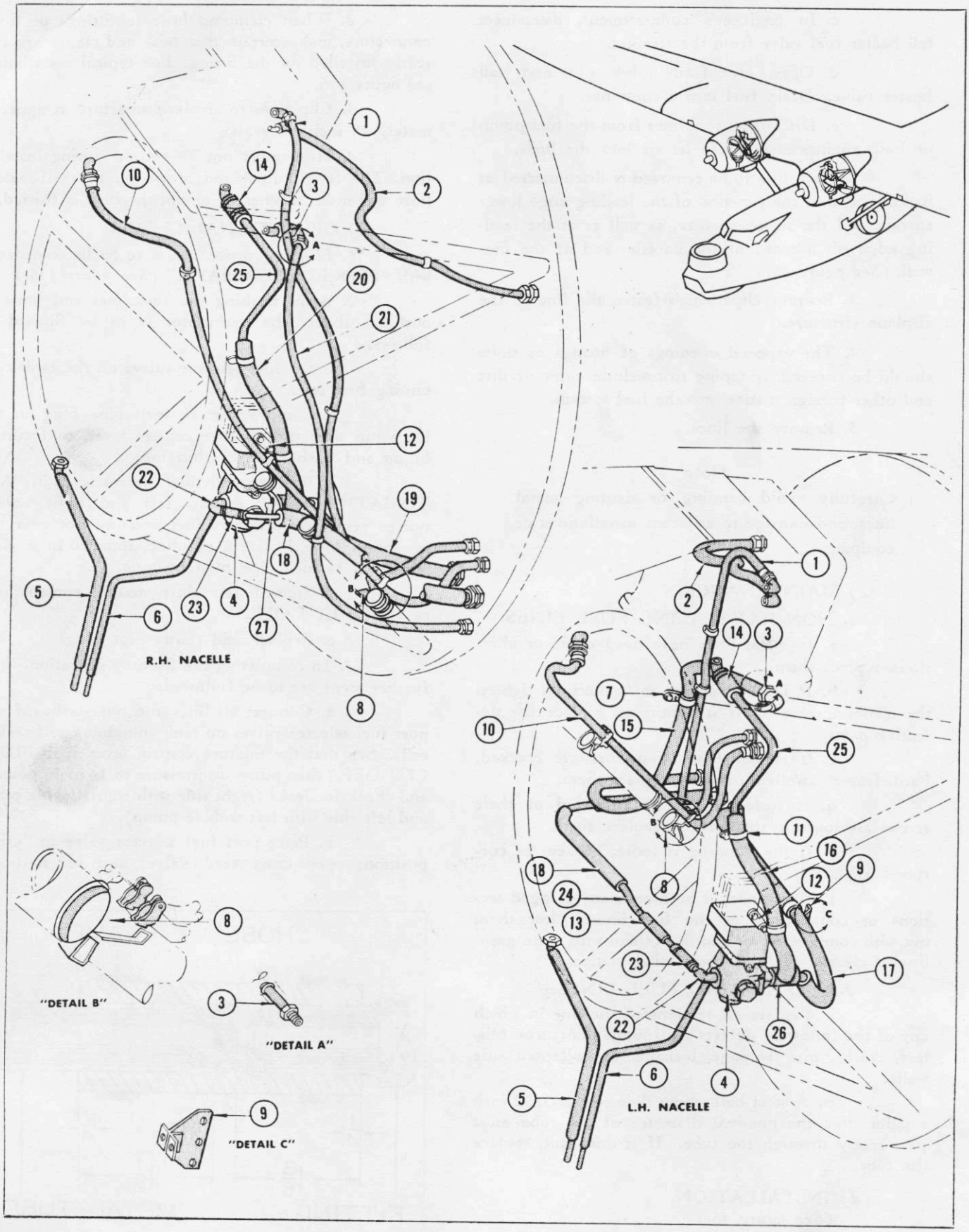


Figure 137—Fuel System Forward of Firewall

No.	PART No.	NAME
1	29G1087-7	Hose—Engine Gage Vent
	AN914-1D	Fitting—Air Scoop
	AN832-4D	Bulkhead Fitting—Firewall
	AN924-4D	Nut—Bulkhead Fitting
2	*32P079-9	Hose—Carburetor Vapor Vent
	**32P079-8	
	AN914-1D	Fitting—Carburetor
	AN832-4D	Bulkhead Fitting—Firewall
	AN924-4D	Nut—Bulkhead Fitting
3	28G5186-6	Fitting—Hose
4	CH4E3-3	Fuel Pump
	(Chandler Evans Corp.)	
5	28G5142-83	Hose—Blower Case Drain
6	28G5050	Hose—Fuel Pump Drain
7	28E5137	Clip Adapter—Pressure Line
8	28G3016-2	Clip Assembly
	28G3016-3	Clip Assembly
9	28G5192	Bracket—Cross-Feed Line
10	28G3014-6	Hose—Engine Primer
	AN822-4D	Fitting—Primer Spider
	AN832-4D	Bulkhead Fitting—Firewall
	AN924-4D	Nut—Bulkhead Fitting
11	*28G5540-8	Clip—Adapter—Carburetor Line
	**28G5540-6	
12	28G5540-7	Clip—Adapter—Carburetor Line
13	22Q180-6-3	Chafing Hose
14	Q2202-12-3.5	Hose—Carburetor Fuel
	AN842-12D	Fitting—Carburetor Hose
15	AN878-6-156	Hose—Fuel Pressure
	28P5166-4D	Bulkhead Fitting—Firewall
	AN840-6D	Hose Fitting—Fuel Pressure
16	Q2202-12-21.75	Hose—Carburetor Fuel
	AN844-12D	45° Fitting—Fuel Pump
17	Q2202-12-29	Hose—Cross-Feed
	AN844-12D	45° Fitting—Fuel Pump
	28G2030-2	Bulkhead Fitting—Firewall
	NAF213830-12D	Nut—Bulkhead Fitting
	AN842-12D	90° Fitting—Firewall
18	Q2202-12-19	Hose—Fuel to Pump
	28G2030-2	Bulkhead Fitting—Firewall
	NAF213830-12D	Nut—Bulkhead Fitting
	AN844-12D	45° Fitting—Firewall
19	Q2202-12-14.25	Hose—Cross-Feed
	AN844-12D	45° Fitting—Fuel Pump
	28G2030-2	Bulkhead Fitting—Firewall
	NAF213830-12D	Nut—Bulkhead Fitting
	AN844-12D	45° Fitting—Firewall
20	Q2202-12-22	Hose—Carburetor Fuel
	AN844-12D	45° Fitting—Fuel Pump
21	AN878-6-171	Hose—Fuel Pressure
	28P5166-4D	Bulkhead Fitting—Firewall
	AN840-6D	Hose Fitting—Fuel Pressure
22	AN842-12D	90° Fitting
23	AN878-12-13	Hose—Fuel to Pump
24	28G5142-54	Tube—Fuel to Pump
25	28G5142-58	Tube—Carburetor Fuel
26	NAF213760-5D	Fitting—Fuel Pump Tee
27	28G5142-13	Tube—Fuel to Pump

*PBY-5A and PBY-5 (Serial number 08349 and on).
**PBY-5 (up to serial number 08349).

selector valve on tank containing fuel cells. Pump up pressure to 14 to 16 pounds with wobble pump.

c. Drain each A. E. L. strainer with its strainer valve in all positions.

(4) FUEL SELECTOR VALVE.
(See figure 139.)

(a) DESCRIPTION.—The fuel selector valve is mounted in the fuel unit compartment of the superstructure and is controlled manually from the engineer's instrument panel by means of a dial handle. There are two of these valves, one for the left-hand tank and one for the right-hand tank. They are interconnected by hose lines to permit fuel to flow from either or both tanks to either or both engines.

The body assembly of the valve is composed of the body casting and synthetic rubber seals vulcanized into the grooves around the ports in the casting. The ports are threaded with standard ¾ inch National Pipe Thread. The gasket for sealing between the body and cover is positioned by a raised pilot on the body flange.

The cone assembly consists of the seal member and the torque member. The torque member is brazed permanently into the seal member. When installed in the selector valve, the cone assembly rests on the seals in the body cavity.

The cover assembly contains the remaining parts of the selector cock. The thrust bearing (23) rests on the tang of the shaft (25). The upper race (22) rests on this bearing. The cone pressure spring (21) presses against the upper race, and is restrained at its upper end by the spring retaining washer (20). The washer fits on a shoulder in the cover (19). The packing (4), auxiliary seal (14), and seal retaining washer (15) are held in the stuffing box in this order by the packing gland seal spring (13). The seal spring is restrained by the retaining washer (12). This washer is held in place in three segments of the washer restraining ring (11). The drive end bearing (10) seats on the spring retaining washer, and the shims (9), if used, rest on the bearing. The yoke (8) seats on the shims, and around the shaft. The lifting pin (24) fits in the hole in the end of the shaft, holding the yoke (8) in place. A cotter pin (7) retains the lifting pin in the hole in the shaft. Cotter pins are also used to hold the finder spring retaining washers (16), the position finder spring (17), and the position finders (18) in two lugs on the cover. The universal joint (5) is held in the yoke by the universal joint positioning pin (6) and two cotter pins. The cover assembly is fastened to the body assembly by five screws

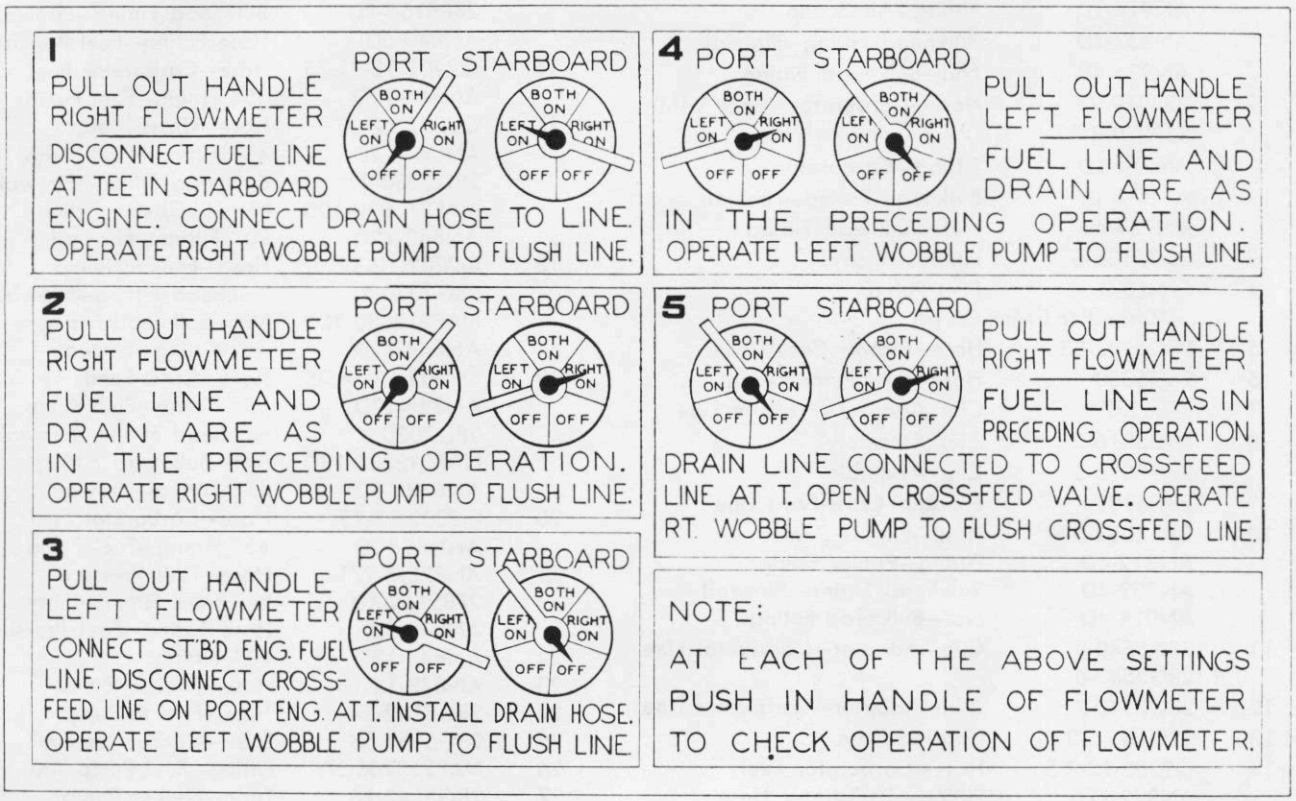


Figure 138—Flushing Procedure

so that the tang of the shaft engages in the torque member of the cone assembly.

(b) REMOVAL.—The fuel selector valve and the A. E. L. unit are joined together by a fitting and, therefore, must be removed from the airplane together.

1. Place fuel shut-off valve (7) in "OFF" position. *(See figure 131.)*

2. Drain fuel lines. (Refer to paragraph *b*, (3), *(b)*, *1.*)

3. Disconnect all lines from fuel selector valves and A. E. L. units. Access to valves and A. E. L. units is gained by removing panels from the forward end of the superstructure.

4. Disconnect control rods attached to the levers of the wobble pumps and to the aft side of the selector valves.

5. Remove the fuel selector valve and A. E. L. unit by detaching three bolts from the A. E. L. unit and four bolts from the valve.

6. Separate fuel selector valve and A. E. L. unit at fitting.

7. The procedure for disassembly of the fuel selector valve is as follows: *(See figure 139.)*

a. Remove the screws (3) and washers (2) which hold the cover (19) to the body.

b. Remove the cover and gasket (1) leaving the cone (26) free in the body cavity.

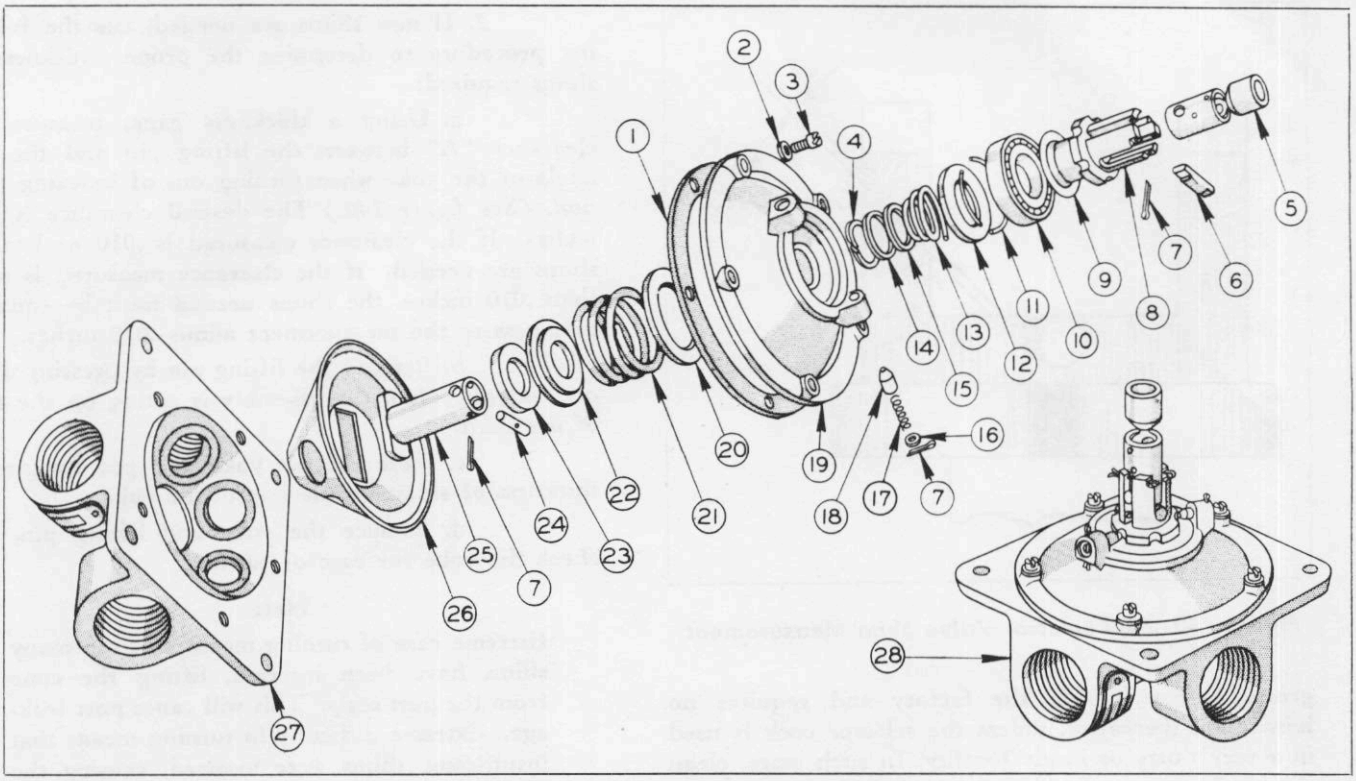
c. Remove the cotter pins (7) that hold the universal joint positioning pin (6) in the yoke (8), and remove the universal joint (5) and the positioning pin from the yoke.

d. Remove the cotter pins from the lugs in the cover.

Note

Be careful not to lose the position finder springs (17), and washers (16) which will be pushed out of the lugs when the restraining cotter pins are removed.

e. Remove the cotter pin which retains the lifting pin (24). Stand the cover assembly upon the tang of the shaft and press down on the cover until the lifting pin (24) can be pushed out of the hole in the shaft.



No.	PART No.	NAME	No.	PART No.	NAME
1	TCA-14061	Gasket—Cover	15	TCA-14024	Washer—Seal Retaining
2	TFA-167	Washer—Plain	16	TCA-14036	Washer—Spring Retaining
3	TVA-4133	Screw	17	TCA-14035	Spring—Position Finder
4	TCA-14022	Packing—Stuffing Box	18	TCA-14034	Position Finder
5	TCA-14020	Universal Joint	19	TCD-14032	Cover
6	TCA-14351	Pin—Positioning	20	TCA-14018	Washer—Spring Retaining
7	TCA-14037	Cotter Pin	21	TCA-14016	Spring—Cone Pressure
8	TCB-14048-1	Yoke	22	TCA-14015	Upper Race—Thrust Bearing
9	TCA-14047	Shim	23	TCA-14069	Bearing—Thrust
10	TCA-14012	Bearing—Drive End	24	TCA-14049-1	Pin—Lifting
11	TCA-14027	Ring—Washer Retaining	25	TCA-14107	Shaft
12	TCA-14026	Washer—Spring Retaining	26	TCA-14002	Cone Assembly
13	TCA-14025	Spring—Packing Gland Seal	27	TCA-14033	Body Assembly
14	TCA-14023	Auxiliary Seal	28	TCB-14000-1	Valve Assembly

All numbers listed above are Thompson Products, Inc. part numbers.

Figure 139—Fuel Selector Valve

f. Pull the shaft (25) down through the opening in the cover. The spring retaining washer (20), the cone pressure spring (21), the end thrust bearing race (22), and the thrust bearing (23) will come off with the shaft.

g. Lift the yoke (8) out of the bearing, and remove shims (9), if used.

h. Lift out the drive end bearing (10).

i. Press down on seal-spring retaining washer (12), pry out the segments of the washer retaining ring (11), and then remove seal-spring retaining washer, packing gland seal spring (13), seal retaining washer (15), auxiliary seal (14), and the packing (4) from the stuffing box.

(c) MAINTENANCE.

(See figure 139.)

1. Take out the cover assembly and wash the inside of selector valve with clear gasoline at every regular overhaul period to prevent foreign substance from collecting between seals and cone. Do not wash out the lubricant from the drive end bearing (10). If the airplane has been operating under conditions where it would be likely that foreign matter would get into the gas tanks, the selector cock should be washed out more frequently.

The drive end bearing is packed with

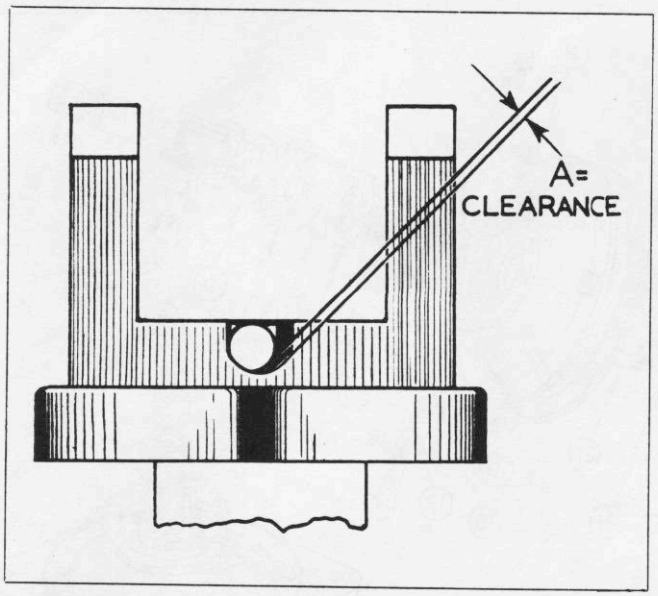


Figure 140—Fuel Selector Valve Shim Measurement

grease before leaving the factory and requires no lubrication thereafter, unless the selector cock is used in a very dusty or sandy locality. In such cases, clean the bearing in a solvent and repack with grease, Fresoleum 250 (Beacon Lubricant No. 285).

2. If new shims are needed, use the following procedure to determine the proper thickness of shims required:

a. Using a thickness gage, measure the clearance "A" between the lifting pin and the 45° angle of the yoke when turning out of indexing position. *(See figure 140.)* The desired clearance is .010 inches. If the clearance measured is .010 or less, no shims are needed. If the clearance measured is more than .010 inches, the shims needed must be equal in thickness to the measurement minus .010 inches.

b. Remove the lifting pin by pressing down on the yoke when the assembly is sitting on the tang of the shaft.

c. Take off the yoke and put the proper thickness of shims on the hub of the yoke.

d. Replace the yoke and lifting pin, and check the yoke for ease of turning.

Note

Extreme ease of turning means that too many shims have been inserted, lifting the cone from the port seals. This will cause port leakage. Extreme difficulty in turning means that insufficient shims were inserted, causing the cone spring to push the cone too hard against the port seals. Readjust shims if necessary.

3. In the following table, each service trouble which may occur is listed, along with the probable cause and remedy. *(See figure 139.)*

TROUBLE	POSSIBLE CAUSE	REMEDY
Shaft leak.	Damaged packing.	Replace.
	Damaged auxiliary seal.	Replace.
	Packing not packed correctly.	Repack.
Port seal break.	Foreign substance between cone assembly and synthetic rubber seal.	Clean body and cone assemblies thoroughly with gasoline.
	Shim not of proper thickness.	See paragraph *b*, (4), *(c)*, 2.
	Cone assembly cracked, scored, or scratched.	Remove the cover assembly and replace the cone.
	Distorted or cracked body casting.	Replace entire valve.
	Synthetic rubber seals, gouged, scored, or torn.	Replace entire valve.
	Broken thrust bearing, causing the cone assembly to tilt on the synthetic rubber seals.	Replace the bearing.
Turning mechanism will not work properly	Broken prongs on yoke.	Replace yoke.
	Broken universal joint.	Replace universal joint.
	Broken connection to the yoke or universal joint.	Repair the connection.
	Not shimmed high enough to keep the proper turning torque.	See paragraph *b*, (4), *(c)*, 2.
	Position finding lugs on cover or finder plate broken or bent.	Replace cover.

(d) TEST BEFORE INSTALLATION.

1. After valve is reassembled, see that it operates freely.

2. Connect the valve inlet port to a source of fuel supply having a pressure of approximately five lb/sq in. and allow it to stand for about twenty minutes. Then inspect the ports to see if there is any leakage.

(e) INSTALLATION.

(See figure 139.)

1. The procedure for reassembling the fuel selector valve is as follows:

a. Place the cone assembly (26) in the cavity of the body assembly in such a position that all ports are open.

b. Place the thrust bearing (23) over the shaft (25) so that it rests on the tang with the chamfered side of the inside diameter down.

c. Then place the end thrust bearing upper-race (22) over the shaft with the large diameter down.

d. Drop the cone pressure spring (21) over the shaft, being sure to engage the shoulder on the bearing race with the bottom of the spring.

e. Put the spring retaining washer over the shaft so that it rests on the top of the spring. Then place the cover (19) over the shaft. The washer should seat firmly on shoulder of cover.

f. Wrap new packing (4) around the shaft and then press down tightly into chamber in the bottom of the stuffing box of the cover.

g. Push the auxiliary seal (14) down around the shaft and follow with the seal retaining washer (15).

h. Put the packing gland seal spring (13), with the small end down, over the shaft.

i. Seat the seal spring retaining washer (12), flat side down, on the spring. Press down on the washer until it bottoms on the cover casting below the groove in the cover and push the segments of the washer retaining ring (11) into this groove in the cover.

j. Insert the drive end bearing (10) with the notched side down over the shaft so that it seats firmly on the washer.

k. Place the original shims, if used, on the hub of the yoke if they are not damaged or lost. If new shims are needed, follow the procedure outlined under paragraph *b,* (4), *(c), 2.*

l. Place the yoke over the shaft and press down so the pilot diameter enters the drive end bearing (10) and the yoke (8) seats on the bearing.

m. Place the assembly up on the tang of the shaft and press down on the yoke, being careful not to tip the assembly over and damage it. The shaft will be raised in the yoke by the pressure so that the lifting pin (24) can be inserted in the hole of the shaft.

n. Fasten the cover assembly and gasket to the body assembly with five screws (3).

o. Put the universal joint positioning pin (6) in the universal joint (5). Then place the universal joint in the yoke with the narrow end of the positioning pin in the narrow slot of the yoke.

p. Put cotter pins in the holes in the yoke prongs and through the shaft and lifting pin.

q. Put the position finders (18), position finder springs (17), and washers (16) in the lugs on the cover. Hold them in place and put in the cotter pins.

2. Join fuel selector valve and A. E. L. unit together by means of the nipple fitting.

3. Install assembly by means of the three bolts through the A. E. L. unit and the four bolts through the valve. Attach interconnecting bracket to forward side of the A. E. L. units at the same time.

4. Connect fuel lines to the fuel selector valve and to the A. E. L. unit.

5. Connect control rods to wobble pump and to fuel selector valve. When red line on valve cover and yoke are aligned, the valve is in the "BOTH ON" position. Check this position when installing control rod.

6. Turn fuel shut-off valve to "ON" position and replace superstructure access panels.

(f) OPERATIONAL CHECK.

1. Set port fuel selector valve in "LEFT ON" position and starboard valve in "RIGHT ON" position and operate engine.

2. While operating engine, set fuel selector valves in positions indicated on "Fuel Selector Valve Position Chart." *(See figure 142.)*

3. Set port valve in "LEFT ON" position and starboard valve in "RIGHT ON" position and then turn valves to "OFF" position individually. The engines should stop in a few seconds.

(5) FUEL TANK SHUT-OFF VALVE.

(a) DESCRIPTION. — Two tank shut-off valves, one for each tank, are mounted in the fuel units compartment of the superstructure forward of the engineer's compartment.

The main fuel lines are routed from the sumps through the space between the superstructure fairing and the walls of the engineer's compartment to the shut-off valves. The valves are manually operated and can be reached by removing the superstructure fairing section stençilled "MAIN FUEL TANK STRAINER" and secured by Dzus fasteners.

(b) REMOVAL.

1. Drain fuel from tanks. (Refer to Section III, Par. 2, *h,* (1), *(d).*)

2. Disconnect hose from fittings in valve.

3. Remove valve by detaching the three bolts that fasten it to the structure.

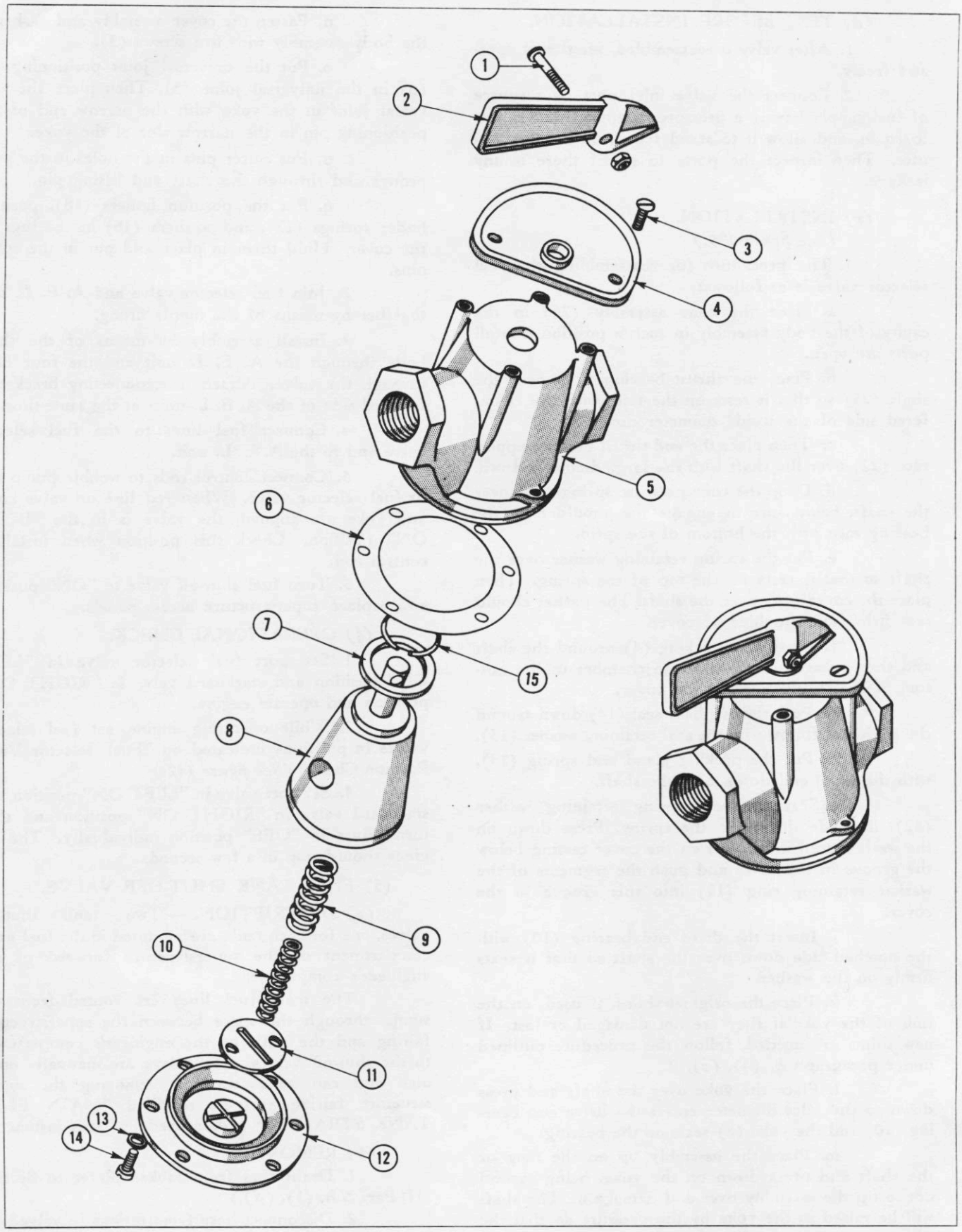


Figure 141—Fuel Shut-off Valve

No.	PART No.	NAME	No.	PART No.	NAME
1	UA-400933	Clevis Bolt	7	UA-1459	Washer
	AN365-632	Nut	8	UA-1463-C	Stem Assembly
2	UB-1613	Handle	9	UA-400256	Outer Spring
3	AN505-8-6	Screw	10	UA-400257	Inner Spring
4	UA-4278-2	Dial—Port	11	UB-682	Indexing Plate
	UA-4271-2	Dial—Starboard	12	UB-1462	Cover
5	UB-1461-Y	Body	13	AN935-10	Washer
6	UA-864	Gasket	14	AN500-10-8	Screw
			15		Ring—Washer Retaining

Complete valve assembly part number is UB-1460-C1 for port valve and UB-1460-C2 for starboard valve. All items listed above except 3, 13 and 14 are United Aircraft Products, Inc., part numbers.

4. Remove fittings from valve.

5. The procedure for disassembly of the valve is as follows: *(See figure 141.)*

a. Remove handle (2) and dial (4) by detaching screws (1) and (3).

b. Detach cover (12) by removing screws (14). Remove cover carefully so as not to lose springs (9) and (10).

c. Remove indexing plate (11) and springs (9) and (10).

d. Stem assembly (8), washer (7), and washer retaining ring (15) may now be removed.

(c) MAINTENANCE.

1. Wash inside of valve with clear gasoline at every overhaul period to prevent foreign substance from collecting.

2. If body casting or stem assembly is damaged, replace valve.

(d) TEST BEFORE INSTALLATION.

1. Check freedom of operation of valve.

2. Connect the valve to a source of fuel supply having a pressure of approximately five lb/sq in. and allow it to stand twenty minutes. Then inspect the port to see if there is any leakage.

(e) INSTALLATION.
(See figure 141.)

1. The procedure for reassembling the valve is as follows:

a. Place the washer (7) on stem assembly (8) and lock in place with retaining ring (15).

b. Insert stem assembly in body (5) aligning stem so that ports are open.

c. Place gasket (6) in position on body.

d. Insert springs (9) and (10) in stem and place indexing plate in correct position above the pins in the stem.

e. Place cover (12) in position and compress springs by pushing down on cover. Holes in indexing plate must engage pins in stem assembly and the head in the indexing plate must engage notch on inside of cover. When the cover is in place, insert and tighten the six screws (14).

2. Install fittings in valve ports and mount valve to structure by means of the three bolts.

3. Attach hose to fittings and replace superstructure access panels.

(6) A.E.L. UNITS.

(a) DESCRIPTION.—The two A.E.L. units are joined to the inboard side of the fuel selector valves in the fuel units compartment of the superstructure. Each unit combines a fuel strainer, hand pump, relief valve, and by-pass valve within its housing. The strainers can be drained during flight by means of the strainer drain control handles on the engineer's panel without disturbing flow of fuel to the engines. The pumps are connected by push-pull rods to the handles on the engineer's panel. The handles overlap so that both pumps can be operated together with one hand, or either can be operated singly.

All working parts are housed in an aluminum alloy housing. Fuel line connection bosses are tapped with ¾ inch National Pipe Thread.

The strainer consists of a cylindrical 60 mesh wire screen of monel metal and is readily removable. The strainer cover is secured to the bottom of the unit by means of a hinged swivel bar, wing nut, and bolt. The gasket is of a synthetic rubber material resistant to aromatic fuel and fits into a recess provided in the unit housing. The pump stroke of the handle is 100 degrees.

(b) REMOVAL AND DISASSEMBLY.

1. A. E. L. UNIT.

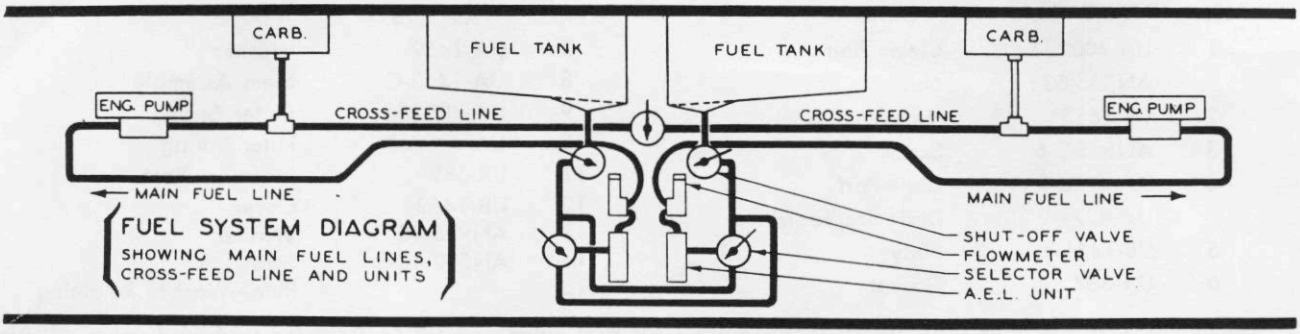
a. For removal of unit from the airplane, refer to paragraph *b*, (4), *(b)*.

b. The procedure for disassembly of the unit is as follows: *(See figure 143.)*

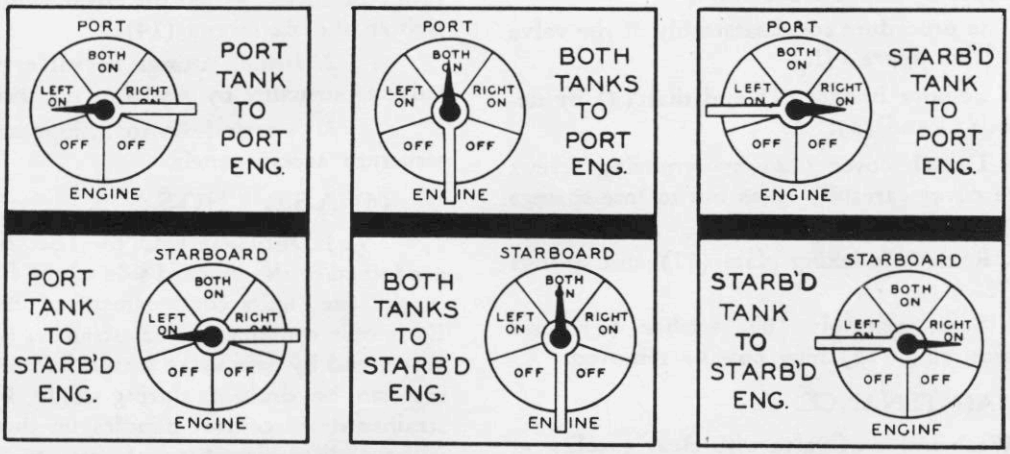
(1) Loosen wing nut (20) and remove cover (24), gasket (28), and strainer (29).

(2) Detach lever (13) from shaft and remove packing nut (14).

(3) Remove cover (19), and by pushing from the inside of the cover, remove gland (15) and packing (16).



FUEL CONTROL POSITIONS WITH CROSS-FEED VALVE "OFF"



FUEL CONTROL POSITIONS WITH CROSS-FEED VALVE "ON"

(NOTE: CROSS-FEED VALVE TO BE "ON" ONLY IF PUMP FAILS)

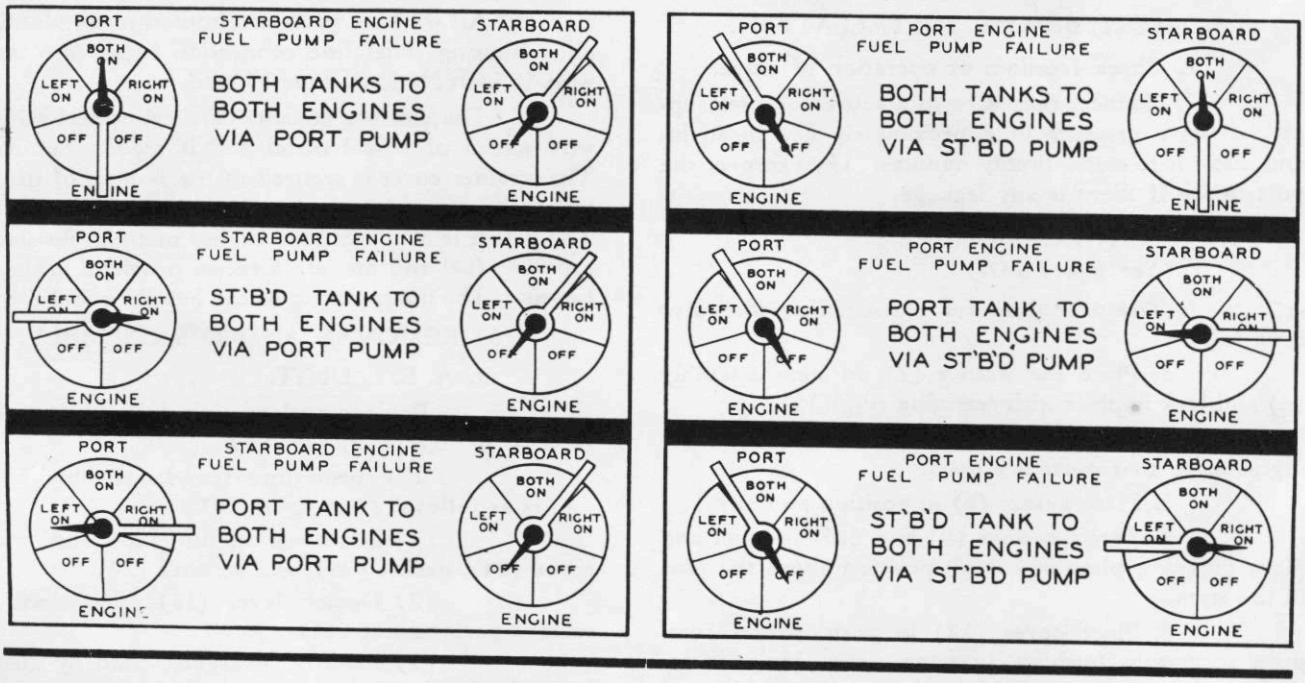


Figure 142—Fuel Selector Valve Position Chart

(4) Gasket (11), top rotor plate (10), rotor assembly (9), and cage assemblies (8) and (22) may now be removed.

2. STRAINER. *(See figure 143.)*—The following procedure is used for the removal of the strainers. When the A.E.L. units are mounted in the airplane:

a. Disconnect drain lines from strainer cover.

b. Cut safety wire and loosen wing nut (20).

c. Remove cover (24) and pull strainer (29) straight down until it clears the unit.

CAUTION

Use care in removing the strainer from the fuel units compartment so as not to damage the strainer on adjacent structure or lines.

(c) MAINTENANCE.

1. Keep mounting bolts and hose clamps tight.

2. If cover leaks, tighten the cover screws, or, if this does not stop the leak, replace the gasket and tighten screws uniformly.

3. If packing around the rotor shaft leaks, tighten the packing nut by hand or replace the packing.

4. Leaks through the inlet and outlet pipe connections are corrected by tightening the fittings with a wrench.

5. The strainer screen should be removed and cleaned with gasoline or solvent at each 120 hour inspection. Small holes in the strainer screen may be repaired by ordinary soft solder.

(d) TEST BEFORE INSTALLATION.

1. To check for leaks, attach air hose to inlet port and plug outlet ports. Submerge unit in water and subject it to air pressure of 5 lb/sq in.

2. Check pressure relief valve by attaching an air hose to the outlet port and applying a pressure of 15 lb/sq in. Valve should open at this pressure.

3. Connect inlet port of unit to a source of fuel supply and outlet port to a calibrated flowmeter. Operate pump handles at approximately 120 single strokes per minute and check rate of flow. It should be approximately 135 gal/hr.

(e) INSTALLATION.

1. A.E.L. UNIT.
(See figure 143.)

a. The procedure for the assembly of the unit is as follows:

(1) Insert cage assemblies (8) and (22), rotor assembly (9), and top rotor plate (10) in housing (30).

(2) Replace cover gasket, cover, packing gland assembly, and control lever.

(3) Install strainer in housing.

b. To install unit in airplane, refer to paragraph *b*, (4), *(e)*, 2.

2. STRAINER.—Install strainer by reversing removal procedure outlined in paragraph *b*, (6), *(b)*, 2.

CAUTION

Seat strainer properly before installing the cover. The strainer is apt to be damaged if it is seated by means of the cover.

(f) OPERATIONAL CHECK.—Set mixture control in "IDLE CUT-OFF" position and pump up pressure to 14 to 16 pounds (preferably 16 pounds) with wobble pumps. Check A.E.L. unit and all connections for leaks.

(7) CROSS-FEED FUEL VALVE.

(a) DESCRIPTION.—A cross-feed fuel valve is mounted in the fuel units compartment of the superstructure and is manually controlled by means of a handle mounted at the lower left side of the engineer's instrument panel. The valve is a two-port valve made by the Aero Supply Manufacturing Company, Corry, Pa., and consists primarily of a cast body and two spring-loaded poppet valves. The poppet valves are operated by a cam mounted on the crank pin of the operating shaft. The function of the valve is to enable the engineer to direct fuel from one engine-driven pump to the other engine in the event an engine-driven pump fails.

(b) REMOVAL.

1. Detach control rod from valve by removing the two cotter pins at the connection on the aft side of the valve. Access to valve is gained by removing the port panel on the forward portion of the superstructure.

2. Disconnect hose from valve.

3. Remove valve by detaching the four bolts which hold the valve retaining straps in place.

4. The procedure for disassembly of the valve is as follows: *(See figure 144.)*

a. Remove yoke (21), lock ring (20) and washer (19).

b. Remove cover (1) and gasket (2) by removing the four screws. Use caution in removing cover as spring (16) is compressed by cover.

c. Shaft assembly (14), index plate (15), spring (16), retainer (17), and seal ring (18) may now be removed from housing (3).

d. Detach fitting (5) and gasket (4) by removing the six screws which fasten it to the body.

e. Remove lock ring (6) by squeezing the two ends together with pliers. Care must be used in removing lock ring as spring (8) is held in a compressed position by this ring.

f. Remove the remaining part of the poppet valve from the housing.

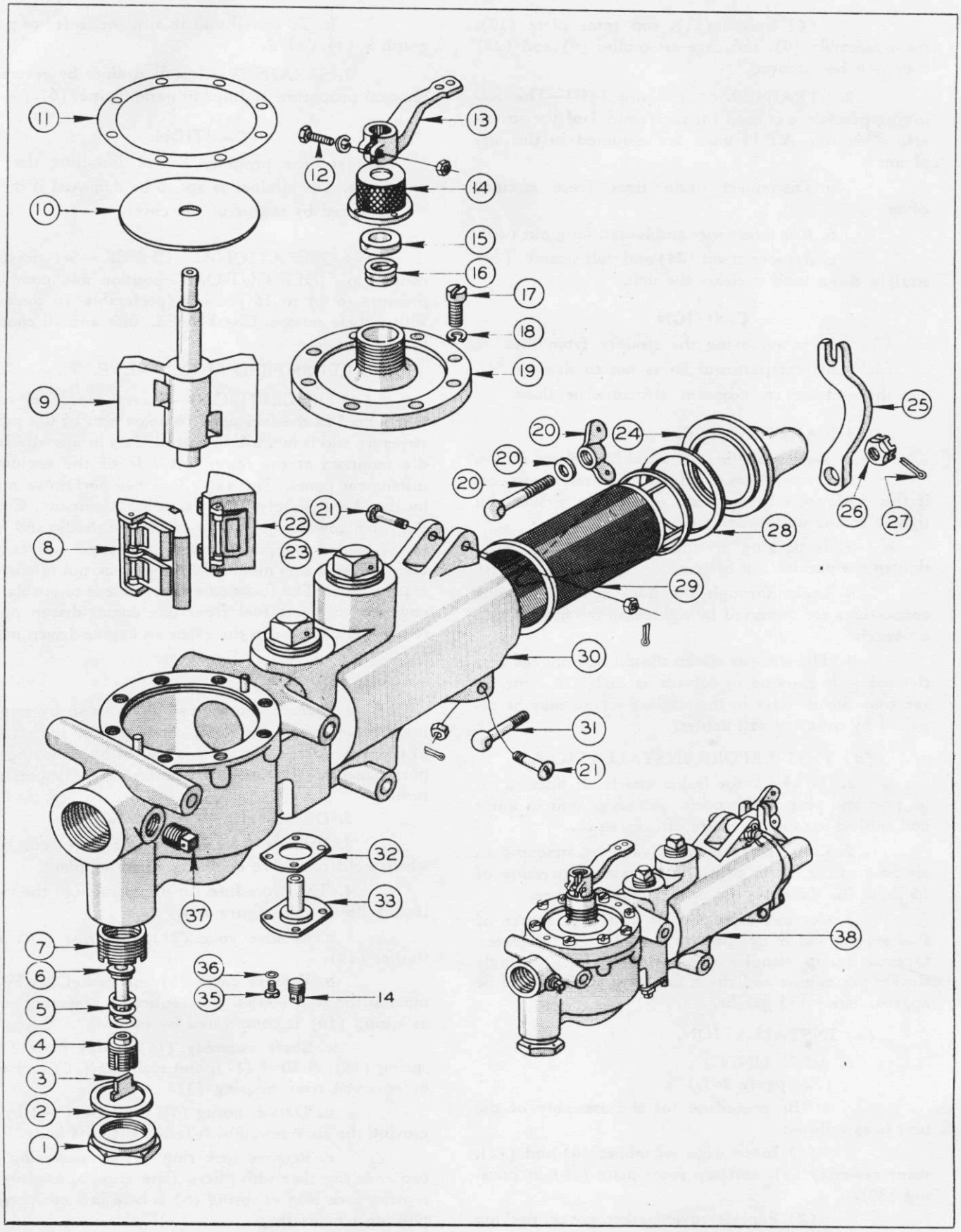


Figure 143—A. E. L. Fuel Unit

No.	PART No.	NAME
1	UA-2574	Cap
2	UA-2584	Gasket
3	UA-2588	Lock Plate
4	UA-2585	Adjusting Screw
5	UA-2590-1	Spring
6	UA-2589	Valve
7	UA-2586	Bushing
8	UA212	Cage Assembly
	UA-401822	Packing
	UA-401821	Support Strip
	UA-401820	Seal Spring
9	UA-2591	Rotor Assembly
10	UA-215	Plate—Rotor Top
11	UA-216	Gasket
12	AN3-10	Bolt
	AN310-3	Nut
	AN380-C2-3	Cotter Pin
13	UA-400394-2	Handle
14	UA-217-1	Packing Nut
15	UA-218-1	Packing Gland
16	UA-225	Packing
17	AN500A-10-10	Screw
18	AN935-10	Washer
19	UA-2572	Cover Assembly
20	UA-629	Wing Nut
	AN960-416	Washer
	VA-400292	Screw
21	AN23-20	Clevis Bolt
	AN960-10	Washer
	AN320-3	Nut
	AN960-10L	Washer
22	UA-209	Cage Assembly
	UA-401822	Packing
	UA-401821	Support Strip
	UA-401820	Seal Spring
23	UA-400314-5D	Plug
24	UB-2565	Cover
25	UA-637	Clamp
26	AN320-3	Nut
27	AN380-C2-2	Cotter Pin
28	UA-2573	Gasket
29	UA-2566	Strainer Assembly
	UB-2597	Strainer Assembly
30	UD-2578	Body
31	UA-400335	Screw
32	UA-2567	Gasket
33	UA-2570	Guide
34	UA-400314-1D	Plug
35	AN500A-6-6	Screw
36	AN935-6	Washer
37	UA-400314-1D	Plug
38	UA-2575-A-CA	A. E. L. Unit

All numbers listed above are United Aircraft Products, Inc., part numbers excepting standard parts.

(c) MAINTENANCE.

1. If the unit is loose in its mounting, tighten the mounting bolts.

2. If the bolts do not tighten firmly, renew both the bolts and the nuts.

3. If cover plate gasket leaks, replace it.

4. If fuel line connections leak, tighten them. If leakage continues, replace gaskets.

5. If the body casting is cracked, replace the entire unit.

6. If the yoke is loose, tighten the taper pin.

7. If the yoke on the bracket is cracked, replace it.

(d) TEST BEFORE INSTALLATION.

1. See that the valve operates freely by grasping the yoke attached to the stem and turning it carefully.

2. Connect one port to a source of fuel supply having a pressure of approximately 20 lbs/sq in. and allow it to stand for about 20 minutes, then inspect the ports to see if there is any leakage at the poppet valves.

3. Turn the operating yoke several times to see that the poppet valves open and close properly.

4. Clean the valve thoroughly with clear gasoline in order to wash out grit and dirt.

(e) ASSEMBLY AND INSTALLATION.

1. The procedure for assembly of the valve is as follows: *(See figure 144.)*

a. Assemble stem and cam (14), index plate (15), spring (16), retainer (17), and seal ring (18) and insert them into the body of the valve.

b. Compress spring until it is possible to install washer (19), lock ring (20), and yoke (21). Make certain that index engages pins in body of valve.

c. Install gasket (2) and cover (1). Tighten cover screws uniformly.

d. Insert bushing (13) into body and assemble poppet (9), rubber washer (10), and lock ring (12) and then insert assembly into bushing.

e. Place spring (8) and spring seat (7) in position and secure them with lock ring (6).

f. Install gasket (4) and fitting (5).

2. Install valve in airplane by means of the two metal retaining straps and the four bolts.

3. Connect control rod and fuel lines to valve.

4. Replace superstructure access panels.

(f) OPERATIONAL CHECK.

1. Operate the engines with fuel from their respective fuel supplies, that is, left engine from left tank and right engine from right tank.

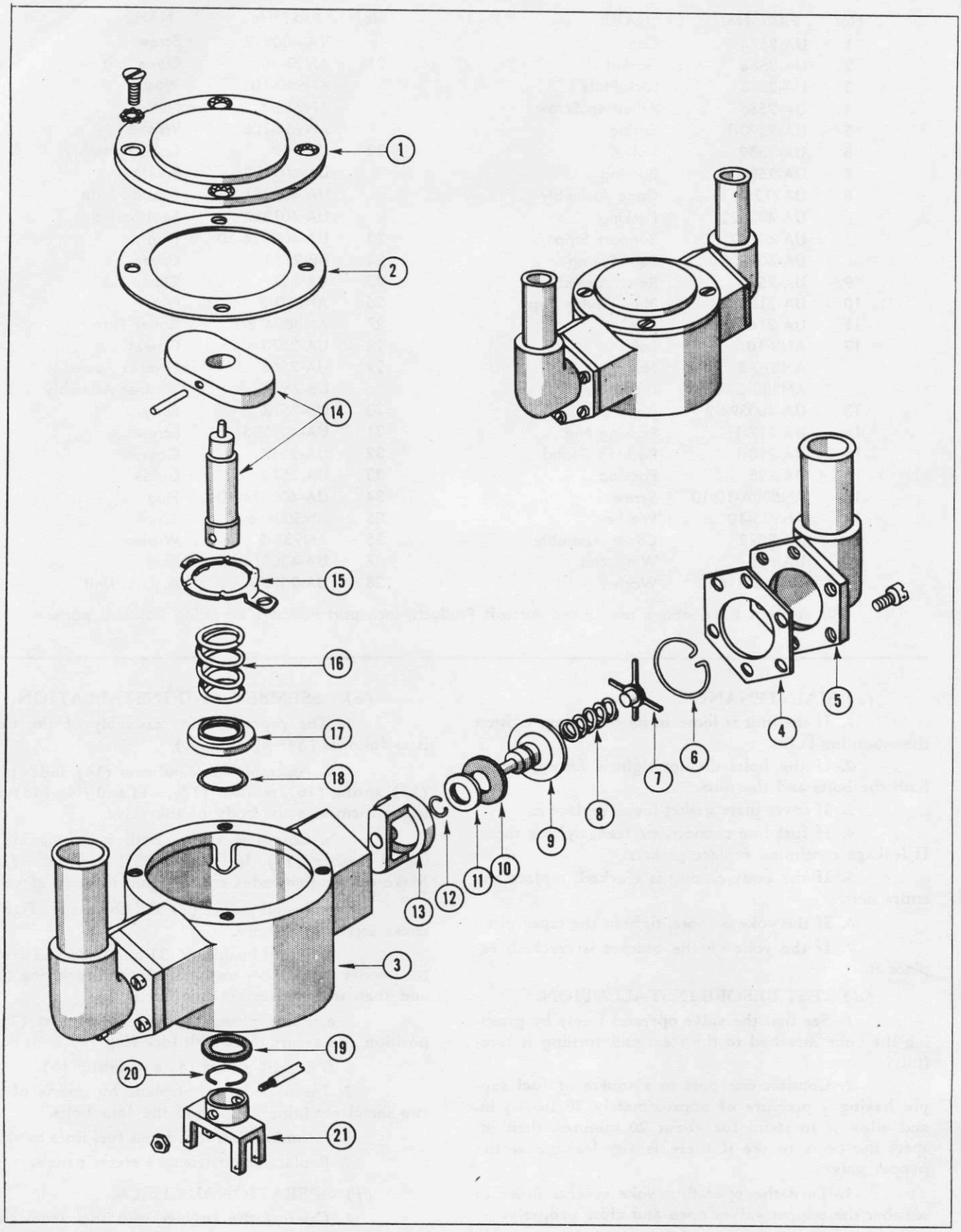


Figure 144—Cross-Feed Valve—Poppet Type

No.	PART No.	NAME	No.	PART No.	NAME
1	1238108	Cover	11	103860	Washer—Cupped
2	838112	Gasket	12	103861	Lock Ring
3	441107	Body	13	43916	Bushing
4	94187	Gasket	14	441108	Shaft Assem.
5	44111	Fitting Hose	15	123893	Index Plate
6	44093	Lock Ring	16	124101	Spring
7	44190	Spring Seat	17	1241117	Retainer—Seal Ring
8	103856	Spring	18	34A3590-8	Seal Ring
9	103862	Poppet Assem.	19	64141	Washer
10	103859	Washer—Rubber Seal	20	54136	Lock Ring
			21	067590	Yoke

Complete valve assembly part number is 124043. All numbers listed above are Aero Supply Mfg. Co. part numbers.

2. Open cross-feed valve and turn left-hand fuel selector valve to "OFF." Then turn left selector valve to "LEFT ON" and right selector valve to "OFF." If cross-feed valve is operating correctly, both engines should continue to run under both the above conditions.

CAUTION

Do not operate either engine for too long a period of time by means of the cross-feed valve. This procedure tends to overheat the by-passed fuel pump.

(8) ENGINE-DRIVEN FUEL PUMP.

(a) DESCRIPTION.—The engine-driven pump is mounted below the oil inlet and outlet flanges on the lower left-hand face of the engine crankcase rear section. It is driven from the oil pump drive. The fuel pump gear ratio with respect to the engine crank shaft is 0.875 to 1.0 and its direction of rotation is counter-clockwise. (Observer facing mounting pad on engine.)

The fuel pump is a Chandler-Evans Model No. CH4E3-3, Navy Type H4E3. The quantity of fuel delivered by this pump is approximately 400 gallons per hour.

This pump is a rotary, four-vane positive displacement type, with a relief valve which carries excess fuel from the discharge port back to the intake port when the discharge pressure would otherwise exceed the valve setting.

The relief valve is contained in a separate housing mounted on the fuel pump. It is of the balanced type with two guides to insure positive alignment. The valve is controlled by a spring, the tension of which may be altered by means of an adjusting screw assembled in the valve cover. This maintains a uniform discharge pressure throughout a wide variation in intake suction or pressure, discharge rate, and pump speed. The top of the diaphragm is vented to the atmosphere through a screened ⅛ inch pipe plug.

A by-pass valve relieves pressure on the suction side of the relief valve when the hand pump is being used and fuel is being pumped into the suction side of the valve chamber. Relieving the pressure thus facilitates the action of the diaphragm in opening the relief valve to permit the flow of fuel around the pump proper.

A drain hole immediately below the mounting flange and a drain line attached to it provide facilities for carrying off slight amounts of fuel that may have worked past the shaft seal. The line is attached at its lower end to the drain gang bracket at the bottom of the nacelle.

Two other engine-driven fuel pumps are interchangeable with the Chandler-Evans pumps. They are the Pesco pump, Model No. 2P-R600-CWT and the Thompson pump, Model No. TFD-100.

(b) REMOVAL AND DISASSEMBLY. *(See figure 131.)*

1. To remove the fuel pump proceed as follows:

a. Remove accessory cowl panel. (See Par. 7, *e*, (1), *(b)*.)

b. Disconnect the four fuel lines attached to the fuel pump.

c. Take off four nuts at fuel pump flange and remove pump.

2. To disassemble the fuel pump, proceed as follows: *(See figure 145.)*

a. Remove the four screws holding the rear plate assembly (2) to the fuel pump. This will allow the removal of the rear plate assembly, drive shaft (6), rear seal (5), and seal spring (7).

b. The relief valve assembly may be removed intact by loosening the four screws (22) in the relief valve cover (21). By removing the four screws, the assembly separates into cover (21), housing (18), diaphragm (20), relief valve (19), and spring (23).

(c) MAINTENANCE. — Upon completion of disassembly, the parts should be carefully cleaned in clear gasoline and inspected for damage and wear. All

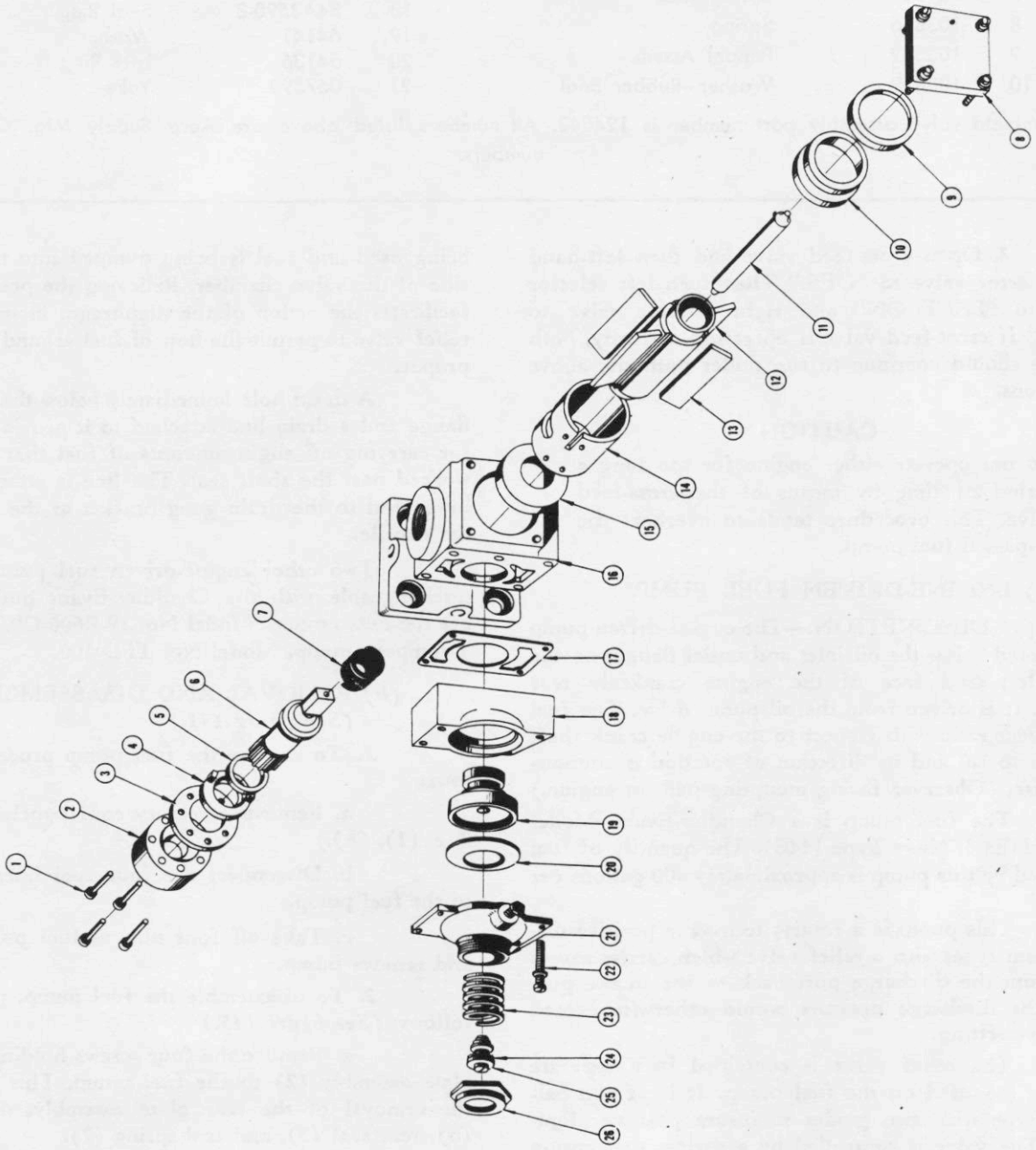


Figure 145—Engine-Driven Fuel Pump

No.	PART No.	NAME	No.	PART No.	NAME
1	35	Screw	14	3803	Liner
2	8054	Rear Seal Plate	15	3804	Drive End Bearing
3	2052	Seal Plate Gasket	16	5672	Main Housing
4	3833	Seal Collar	17	2068	Valve Housing Gasket
5	3782	Seal Ring	18	307	Valve Housing
6	502	Drive Shaft	19	46	Relief Valve
7	3117	Shaft Seal Spring	20	3825	Diaphragm
8	5482	Front Cover	21	510	Valve Housing Cover
	9	Screw	22	33	Valve Housing Screw
	10	Washer		10	Washer
9	3831	Cover Gasket	23	507	Relief Valve Spring
10	3805	Anti-Drive End Bearing	24	2070	Gasket
11	503	Vane Spacer Pin	25	505	Adjusting Screw
12	5246	Rotor		3811	Spring Follower
13	5347	Vane	26	508	Locknut

All numbers listed above are Chandler Evans Corp. part numbers.

damaged parts should be replaced. Particular attention should be paid to the following parts:

1. BEARINGS.—Inspect the bearings carefully for signs of fatigue. If they are in good condition, except for scoring on the sides, they may be lapped smooth by using a fine grit lapping compound.

2. VALVE HOUSING.—See that the valve seat is square and is not worn or damaged.

3. VALVE.—Inspect the valve and guide to see that there is no evidence of wear or damage. Slight imperfections may be removed with fine emery cloth.

4. DRIVE SHAFT.—Examine the spline for wear and scoring. The teeth of the spline may be smoothed with a fine grain stone. If wear is very noticeable, the shaft should be replaced.

5. DIAPHRAGM.—Inspect the diaphragm for signs of cracks, fatigue, or failure. If any of the above conditions are noticeable, it should be replaced.

Note

It is good practice to renew all gaskets and packing wherever the joints have been opened. It is also recommended that an approved thread lubricant be used on all threads.

(d) INSTALLATION.—To install the fuel pump, reverse the procedure as outlined in paragraph *b*, (8), *(b)*.

(e) OPERATIONAL CHECK.

1. Inspect all fuel line connections to the pump for leakage.

2. Start the engine and run at speeds varying from 500 rpm to 1700 rpm. Check the fuel flow and fuel pressure at these speeds.

3. Inspect the pump for excessive heat after it has been running about ten minutes. If excessive heat is indicated, check the alignment of the mounting.

(9) FUEL FLOWMETER.

(a) DESCRIPTION. — Two direct indicating fuel flowmeters with by-pass controls are installed at the left and right sides of the mixture control quadrant at the top of the engineer's instrument panel. Each is mounted so that the axes of the Pyrex measuring tube is in a vertical position when the airplane is in normal level flight attitude.

Fuel flow rate is indicated by the calibrated scales on each side of the tube. The calibrations on the scale at the left side of the tube indicate gallons per hour based on the use of aviation grade gasoline, specific gravity 0.71, at a temperature of 21°C (70°F). The right-hand scale is calibrated to indicate pounds per hour. The bottom line of each scale is a zero reference line and should match the elevation of the red line fused on the metering tube. The float, or flow indicator, within the tube rises as rate of flow increases or drops as flow decreases to give the rate readings.

A by-pass valve and handle are included in the flowmeter assembly to permit complete isolation of the meter from the fuel system. When the by-pass valve handle is out, fuel by-passes directly from inlet port to outlet port. When the handle is pushed in, the flow is directed through the flowmeter and flow rate is indicated by the float.

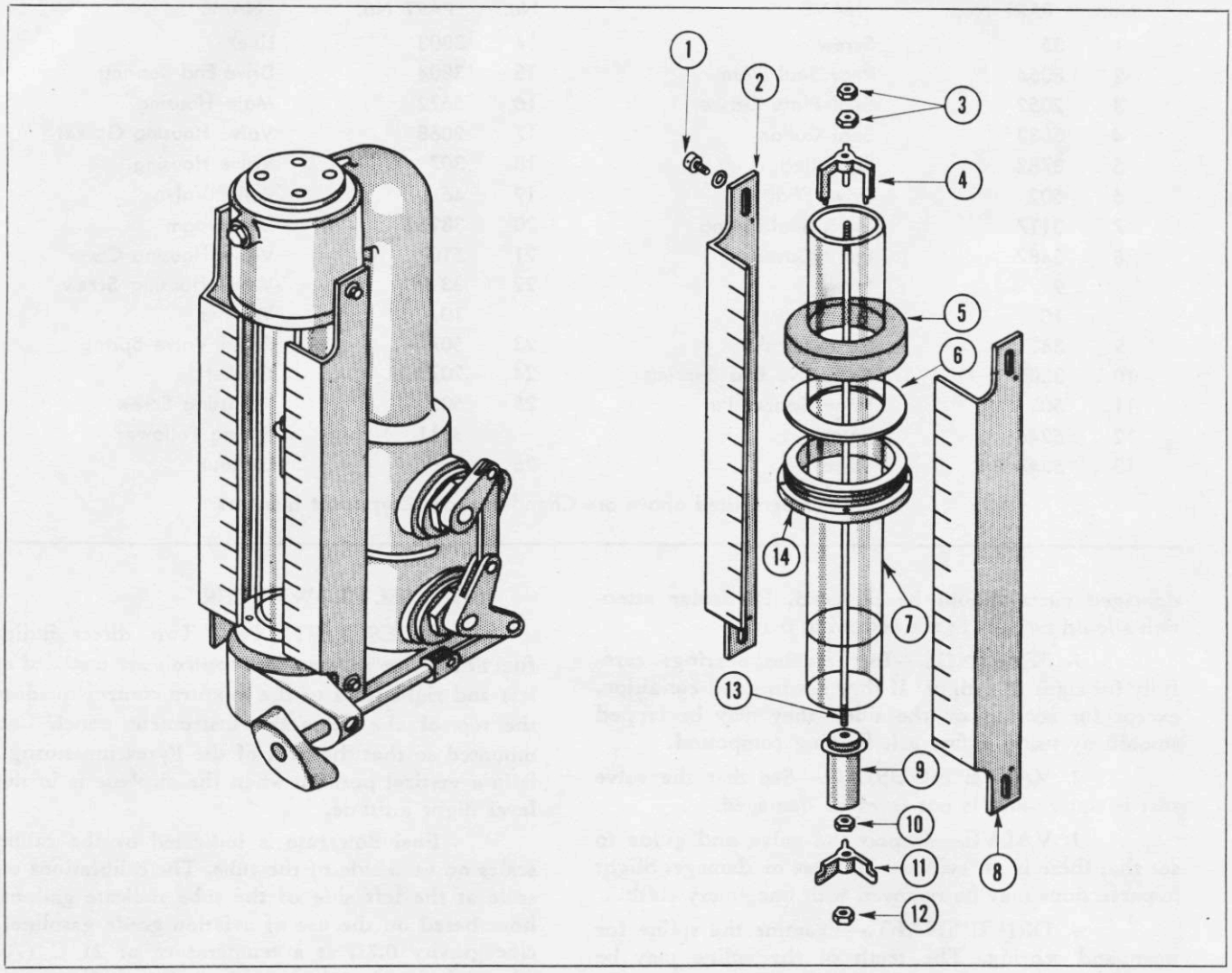
A vent is located at the top of the flowmeter to bleed off any air which may be trapped in the measuring tube. The vent is closed by a ⅛ inch pipe plug.

(b) REMOVAL.

(See figure 131.)

1. Remove access panels on forward portion of superstructure.

2. Place fuel tank shut-off valve in "OFF" position.



No.	PART No.	NAME	No.	PART No.	NAME
1	S-5914	Screw	7	G-12409	Metering Tube
	S-6185	Washer	8	S-5815	Scales
2	S-5815	Scale	9	S-6110	Float
3	S-5807	Nut—Guide Rod	10	S-5807	Nut
4	S-5710	Outlet Spider	11	S-5709	Inlet Spider
5	2 1/16 O.D.	Packing—Ameripol	12	S-5807	Nut—Guide Rod
6	S-5803	Ring—Stuffing Box	13	S-5807	Guide Rod
			14	S-5708	Nut—Stuffing Box

Complete flowmeter assembly part number is C1006L for port side and C1006R for starboard side.
All numbers listed above are Fischer and Porter Co. part numbers.

Figure 146—Fuel Flowmeter

3. Disconnect hose from fittings.

4. Remove flowmeter from airplane by detaching the three bolts which fasten it to bulkhead 4.

5. Complete disassembly of the flowmeter is not to be attempted since any major repairs will require return of the instruments to the factory.

(c) MAINTENANCE. *(See figure 146.)* — A Fisher and Porter No. 482 adjustable spanner wrench *(See figure 40.)* is provided for turning the screw type stuffing box followers (14) and the top and bottom cleanout plugs. Remove one or both scales (2) from the meter body before using the spanner. After tightening the stuffing boxes, replace scales, making sure that zero reference lines match the line etched on the tube.

Should the metering tube (7) become fouled, the center rod (13) and float assembly (9) can be removed by unscrewing the upper and lower caps with the

spanner wrench, removing hex nuts (3) at top of outer rod and removing guide wire assembly through the bottom of the meter. The tube can then be cleaned with a soft cloth and wooden stick. Do not use metal. Replace float and center rod assembly in reverse order of method outlined above. Be sure that hex nuts on the center guide rod are pulled up snugly so that the guide rod is centered and rigid.

CAUTION

The scales are made of laminated bakelite and should be handled with care to prevent breakage.

Note

The stuffing boxes are packed with synthetic compound molded rings that are resistant to aromatic fuels.

(d) INSTALLATION.—Reverse removal procedure outlined in paragraph *b*, (9), *(b)*.

(e) OPERATIONAL CHECK.

(Refer to paragraph *b*, (3), *(e)*, *1.*)

(10) FUEL SIGHT GAGES.

(a) DESCRIPTION. *(See figure 147.)*—The fuel sight gages are attached to the inboard bottom corners of the fuel tanks at both the front and rear spars. A scale for integral tanks, calibrated in U. S. gallons, is attached to both the front and rear sight gages. When self-sealing cells are installed, scales calibrated for self-sealing cells are attached over the integral scales on the side or sides in which the cells are installed.

Each sight gage is composed of two standpipes, two float assemblies, two transparent tubes, a casting, sealing washers, and retaining nuts. The standpipes are beaded at their approximate center so that the float assemblies will not pass this point. The float in the inboard standpipe is above the bead and the float in the outboard standpipe is below the bead. Threaded into the bottom of each transparent tube is a drain valve. Incorporated into the bottom of the casting is a shut-off valve which restricts the flow of fuel into the standpipe.

The casting on the self-sealing fuel cell side of the wing is connected to No. 1 cell by means of a tube assembly and the standpipes are vented to the top of No. 1 cell.

Note

Figure 146 shows the fuel sight gage installation for the PBY-5A airplanes. The fuel sight gage installation for the PBY-5 airplanes is similar to figure 146 except for the type of material used in the transparent tubes and the method of attaching the transparent tubes. However, the sight gage installations are interchangeable.

(b) REMOVAL.

(See figure 147.)

1. Close fuel sight gage valves (2).

2. Break safety wire and open drain valves (11) in bottom of tubes to drain gasoline from tubes.

3. Remove tube drain valve assembly by loosening the upper hose clamp (29) and slipping the valve assembly from the tube.

4. Remove scales by detaching screws which fasten them to the inner fairing of the superstructure. Upper screws are engaged by a tapping strip which is riveted to the bulb angle of the superstructure.

5. Using special wrenches 28U3000 and 28U032 *(See figure 40)*, remove retainer nut (26).

6. Remove metal washers (25) and (23), split washer (24), rubber packing (22), and tube (28).

WARNING

Further removal of sight gage is not to be attempted unless the integral cells and the fuel cells are drained.

Note

Standpipes and castings cannot be removed from the self-sealing cell side of the wing unless fuel cells 1, 2, and 3 are removed.

7. After all fuel has been drained from the airplane, remove retainer nut (20) by using the special wrenches 28U3000 and 28U032. *(See figure 40.)*

8. Remove washer (19), standpipe (15), and packing (18).

9. Remove float from outboard standpipes (floats cannot be removed from the inboard standpipes).

10. Remove shut-off valve assembly by loosening valve body.

11. The following steps are necessary to disassemble valve:

a. Loosen nut (35) and remove knurled knob (36) from valve stem (31).

b. Remove packing nut (34) and packing (33).

c. Remove valve stem (31) from valve body (32).

12. Remove casting (17) by loosening screws which are engaged by tapping ring (16). Tapping ring is riveted to inside of wing.

13. Remove fuel cells as outlined in paragraph *b*, (2), *(b)*, *1.*

14. Remove vent fitting (6) from standpipes.

15. Remove standpipe guards (8) by loosening self-tapping screws which hold them in place.

16. Disconnect fuel line (9) from the casting and then proceed with the removal of standpipes and castings as outlined above.

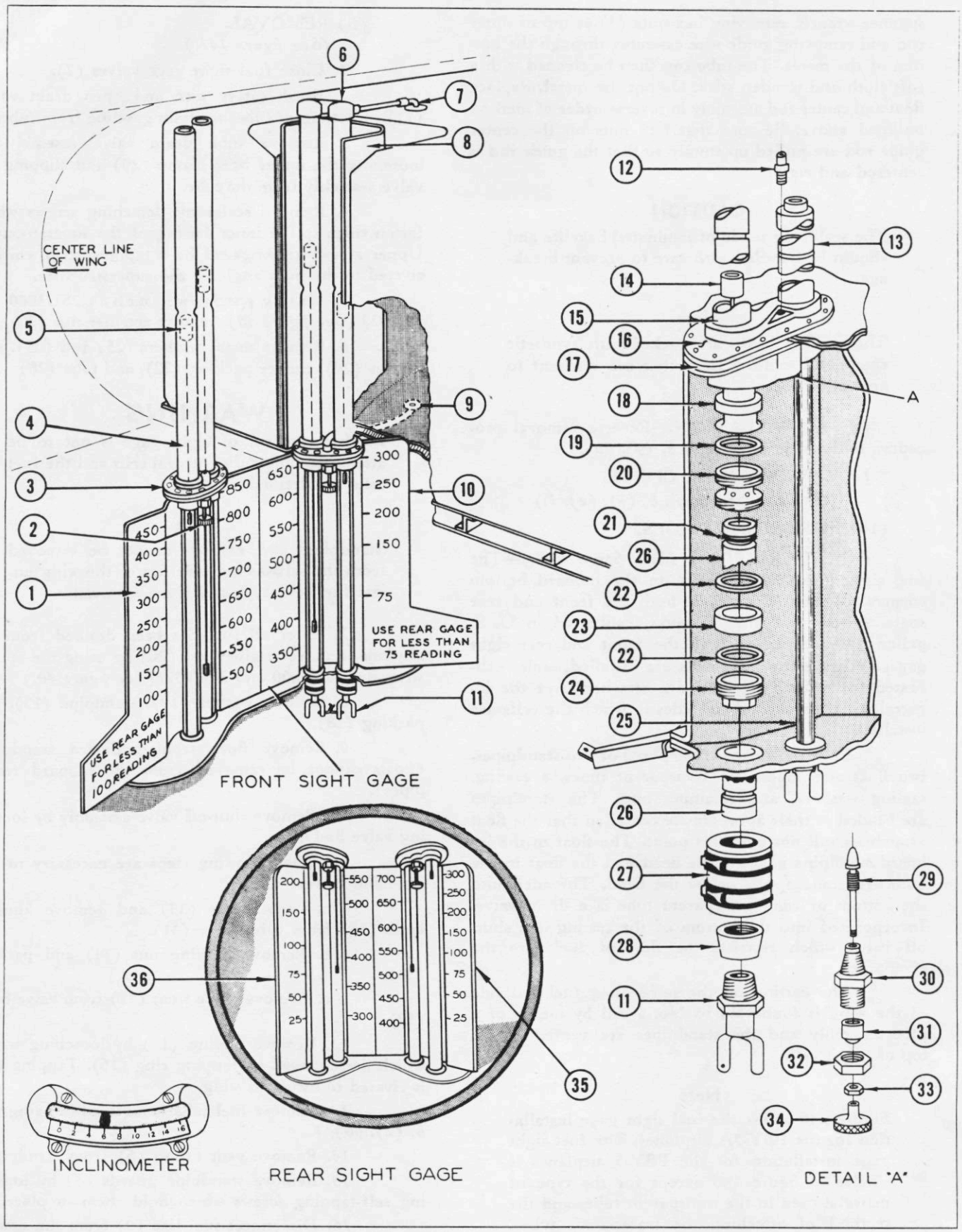


Figure 147—Fuel Sight Gages (PBY-5A)

No.	PART No.	NAME
1	28G037-0	Scale—Integral Tank
2	28G3004	Valve Assembly
3	28G027 L/R	Tapping Ring
4	28G3024-2	Standpipe—Inboard Front
	28G3024-3	Standpipe—Inboard Rear
	28G3025-2	Standpipe—Outboard Front
	28G3025-3	Standpipe—Outboard Rear
5	28G033-4	Float Assem.—Outboard Front
	28G033-5	Float Assem.—Outboard Rear
6	28G5034	Vent Fitting—Standpipe
	AN748-46	Clamp
7	28G5040-18	Standpipe to Hose Fitting
	28G5040-40	Hose—Vent
	28G5040-13	Vent Fitting—Cell
8	28G5052	Guard—Front Sight Gage
	28G5051	Guard—Rear Sight Gage
9	28G5040-25 L/R	Fuel Line—Front Sight Gage
	28G5040-30 L/R	Fuel Line—Rear Sight Gage
	28G5040-44	Hose—Sight Gage Fuel line
	28G5040-43	Cell Fitting—Fuel Line
10	28G5126-6	Scale—Port S. S. Cells
	28G5126-7	Scale—Stb'd. S. S. Cells
11	28G10105-6	Drain Valve
12	28G3026	Fitting—Fuel Line
13		Standpipe
14		Float Assembly
15		Standpipe
16	28G027 L/R	Tapping Ring
17	28G3003-2	Casting
18	28G3021	Packing
19	28G1075-2	Gasket
20	28G3020	Packing Nut
21	NAS 51-62	Snap Ring
22	28G10098	Washer
23	28G10101	Rubber Washer
24	28G031	Nut—Retaining
25	28G10104-6	Tube—Inb'd. Front & Rear
26	28G10104-7	Tube—Outb'd. Rear
	28G10104-8	Tube—Outb'd. Front
27	AN878-10-6	Hose
		Hose Clamps
28	28G10103	Valve Fitting
29	28G3005	Valve Stem
30	28G3006	Valve Body
31	28G3008	Packing
	Q7007-N10-064	Washer
32	28G3007	Packing Nut
33	AN315-3R	Nut
34	28G3018	Knob
35	28G038-0	Scale Integral Tank
36	28G5124-7	Scale Port S.S. Cells
	-6	Scale Stb'd. S.S. Cells

(c) MAINTENANCE.

1. If leakage occurs at the casting flange, tighten screws. If this does not stop leak, replace gasket.

2. If leakage occurs at top of the transparent tube, tighten packing nut. If leak does not stop, replace the packing.

3. If leak develops at valve stem, tighten packing nut. Replace packing if leak does not stop.

4. Clean transparent tubes with a soft cloth and a wooden stick. Do not use metal.

(d) INSTALLATION.

(See figure 147.)

1. Install castings (17) by inserting screws which engage tapping ring (16).

2. Insert float in outboard standpipe and install standpipes (15), gasket (19), and packing nut (20). Packing (18) must be slipped over standpipe before insertion of standpipe in castings.

Note

Place a strip of tape over openings in castings to hold indicators on bottom of floats out of the way so that they will not be damaged while installing shut-off valve.

3. Connect fuel line (9) to sump casting and vent fitting (6) to standpipes on the self-sealing side.

4. Install standpipe guard by means of the self-tapping screws.

5. Install fuel cells. (Refer to paragraph *b*, (2), *(d)*, *2.*)

6. Assemble valve by reversing removal procedure outlined in paragraph *b*, (10), *(b)*, *11*, and install it in the casting.

7. Place retainer nut (26) on tube (28) and lay washer (25) on top of the packing nut.

8. Insert the two halves of the split washer (24) into the groove at the top of the tube and allow the full weight of the tube to be supported by the split washer resting on the retainer nut.

9. Place retaining washer (23) around the split washer and then slip rubber packing (22) and washer (21) over the end of the tube.

10. Insert assembly very carefully into the casting and secure it in place with the retainer nut.

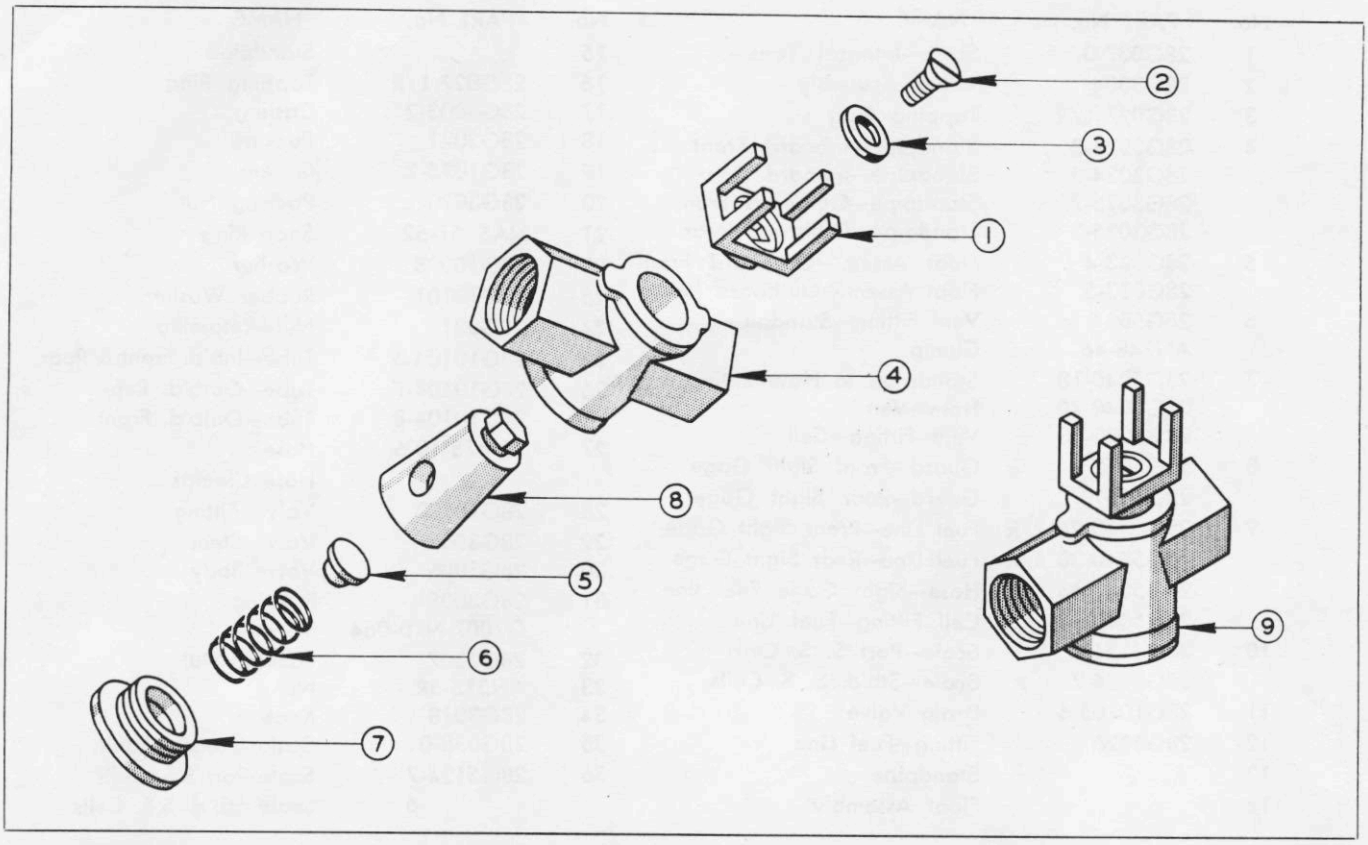
11. Place scales in position and secure them with screws.

12. Slip valve assembly over the lower end of the tube and tighten the upper hose clamp.

(e) OPERATIONAL CHECK.—Refer to paragraph *b*, (2), *(e)*, *1* through paragraph *b*, (2), *(e)*, *4.*

(11) STRAINER DRAIN VALVE.

(a) DESCRIPTION. *(See figure 131.)*—Two Parker Appliance Co. Type 702GG plug valves are mounted in the fuel units compartment of the superstructure. Their control handles are mounted on the engineer's instrument panel. Each valve consists of an



No.	PART No.	NAME
1	701-P10-6S	Yoke
2	A3-2741-16-10-6	Screw
3	A12-1836-1-3	Washer
4	A2-1941-3	Body
5	A12-1836-2-6	Spring Button
6	A3-639-4	Spring
7	A8-343-4	Cap
8	B3-641-7-6	Plug
9	702-GG-6D	Valve Assembly

All numbers listed above are Parker Appliance Co. part numbers.

Figure 148—Strainer Drain Valve

aluminum alloy plug, a forged aluminum alloy body, and a four pronged yoke attached to the plug for operation of the valve.

(b) REMOVAL AND DISASSEMBLY.

1. Remove access panels from forward portion in superstructure.

2. Place fuel selector vavles in "OFF" position.

3. Drain the fuel strainers by opening strainer drain valve.

4. Disconnect metal and rubber lines from the valve fittings.

5. Detach control rod from the aft side of the valve.

6. Remove valve by detaching the two clips which hold it to the airplane structure.

7. Remove fittings from valves.

8. To disassemble the valve, proceed as follows: *(See figure 148.)*

Note

Before disassembly, mark the plug stem and yoke so the valve may be reassembled in its proper position. Also tag the valve indicating that it is used in the fuel system, so that the proper lubricant will be used on the plug. Different types of lubricants are used for different systems.

a. Remove cap (7), spring (6), and spring button (5).

b. Detach yoke (1) by removing screw (2).

c. Remove plug (8).

Note

When disassembling plug valves, keep body and plug together, as these are matched and parts are not interchangeable with other valves.

(c) MAINTENANCE.

1. Check valve for external leakage, and if leakage exists, replace the valve.

2. If the yoke on the valve is unreasonably hard to turn, remove valve and disassemble it. Lubricate valve as directed in the following steps:

a. Wash all parts thoroughly in a clean, approved solvent (Stoddart or Savosal No. 5).

b. Apply a thin coating of "Valvlube" (Parker Appliance Co.) over the entire contacting surface of the plug. It should be applied sparingly, as excess quantities are apt to wash into the lines and plug small port openings or obstruct movable parts.

c. After lubricating and reassembling the valve, move the yoke back and forth several times. This will cause lubricant to work out into the flow passages of the valve. Remove this excess lubricant by turning the plug to an open port and scraping out with the flat side of a wooden stick the excess lubricant which has worked into the passageway. Repeat at each port.

Note

Do not use a screw driver or other metallic object, as these are likely to scratch or nick plug or body.

d. Tag or mark the valve indicating that it has been lubricated for use in the fuel system. This is very important as the lubricant used for valves in the fuel system is not used for valves in other systems.

3. If valve plug or valve body are scored to such an extent that lapping will not remove the scored places, both the plug and body should be renewed, as these parts cannot be successfully mated with spare parts.

(d) ASSEMBLY AND INSTALLATION.

1. To assemble valve, reverse disassembly procedure as outlined in paragraph *b*, (11), *(b)*, *8*.

Note

Before assembling valve, see maintenance instructions in paragraph *b*, (11), *(c)*.

2. To install valves, reverse removal procedure as outlined in paragraph *b*, (11), *(b)*.

(12) DRAIN AND REFUEL VALVE.

(a) DESCRIPTION.—A Parker Appliance Co. No. 1-2040-8 globe valve is provided on each side of the superstructure behind the flight engineer's seat for draining or pressure refueling of the fuel tanks. Pressure refueling is to be done on the integral side only.

The principle of the globe valve is simple in that the turning of a non-rising stem raises or lowers a slide to and from a seat, permitting the close regulation of flow through the seat passageway.

(b) REMOVAL.

1. Drain fuel tanks. (Refer to Section III, Par. 2, *h*, (1), *(d)*.)

2. Remove the four screws which fasten the elbow fitting to the outer fairing of the superstructure.

3. Disconnect hose from the valve. Access to hose is gained by opening access panel on the side of the superstructure above and aft of the flight engineer's window.

4. Remove the six screws which fasten the valve to the inner fairing of the superstructure. The screws are engaged by nutplates.

(c) MAINTENANCE.

1. External leakage between cap and stem may sometimes be remedied by tightening down the packing cap. If cap-stem leakage cannot be stopped by tightening the cap, it will be necessary to replace the packing.

2. Valves may be repacked without removing them from the line by using the following procedure:

a. Place one-inch pipe plug in drain and refuel fitting outside the superstructure aft the flight engineer's window.

b. Turn the handle to the extreme closed position.

c. Hold the handle to prevent turning while loosening the jam nut and packing cap.

d. Remove jam nut, handle, packing cap, and packing follower.

e. Extract the packing with a wire hook.

f. Clean off any packing material adhering to stem, packing recess, or follower.

g. Re-pack using a graphite impregnated asbestos packing, winding it around the stem.

h. Compress the string packing into the recess, place the packing follower on top of the packing, and replace cap, screwing down to finger tightness.

i. Replace handle and handle nut.

j. Turn the valve handle so that the valve will not be in an extreme open or closed position, then tighten down the packing cap until leakage stops.

3. No lubrication is required for globe valve.

4. If leaks develop at the bonnet gasket, tighten the bonnet.

(d) INSTALLATION.—Reverse removal procedure as outlined in paragraph *b*, (12), *(b)*.

c. FUEL DUMP SYSTEM.

(1) DESCRIPTION.—Each airplane is equipped with a dump valve and duct by means of which fuel in the integral tank may be dumped from the airplane. The valve and duct are installed on the starboard side of all even-numbered airplanes, and on the port side of all odd-numbered planes as they leave the factory.

The valve is located in the aft outboard corner of the tank floor, and the duct is attached to the under surface of the wing aft of the nacelle. It is an aluminum tube 3½ inches in diameter and is installed on the wing, parallel with the air stream. Its outlet is aft of the wing trailing edge, so that fuel will clear the airplane during the dumping operation.

The valve is operated by a lever and cable. The

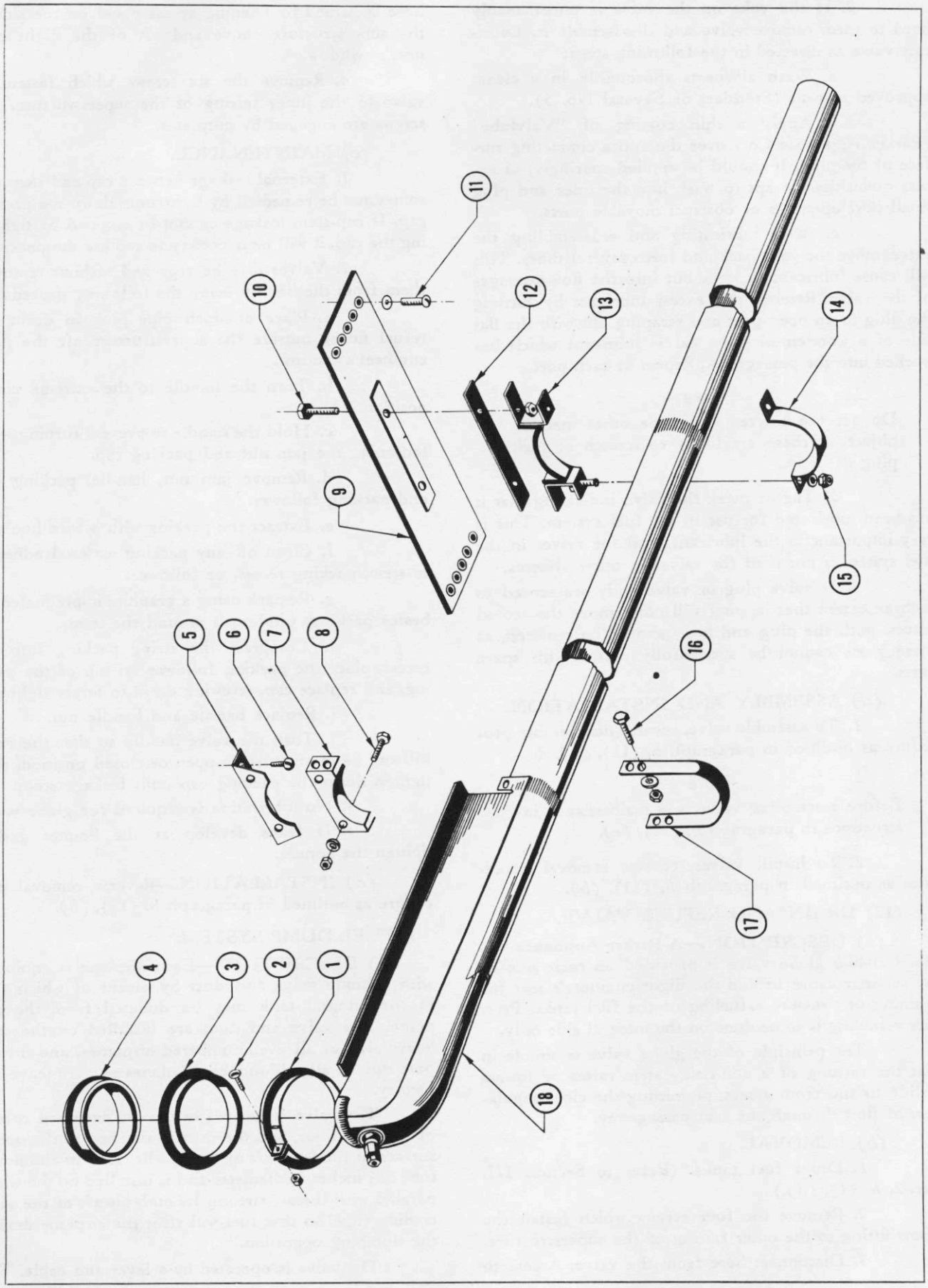


Figure 149—Fuel Dump Duct Installation

No.	PART No.	NAME
1	28G5110	Clamp
2	AN526-DD1032-10	Screw
	AN365-D1032	Nut
3	28G5111	Gasket
4	28G5112	Collar
5	28G5113-8	Angle Bracket
6	AN526-DD1032-10	Screw
7	28G5113-6	Adapter
8	AN3-4A	Bolt
	AN365-1032	Nut
	AN960-10	Washer
9	28G5114-6	Support Plate
10	AN4-6A	Bolt
	AN365-428	Nut
11	AN526-DD632-6	Screw
	AN960-D6	Washer
12	28G5114-8	Plate
13	28G5114-7	Adapter
14	28G5114-11	Clamp
15	AN365-428	Nut
	AN4-4A	Bolt
	AN960-416	Washer
16	AN3-4A	Bolt
	AN365-1032	Nut
	AN960-10	Washer
17	28G5113-7	Clamp
18	28G5080	Duct Assembly

lever is located above and aft the window in the flight engineer's compartment. Partial or complete elimination of fuel from the tank can be accomplished by releasing the lever in accordance with the degree of elimination desired. A spring in the valve assembly closes the trap instantly when the control lever is released.

(2) REMOVAL AND DISASSEMBLY.

(a) FUEL DUMP DUCT.

(See figure 149.)

1. Drain fuel tank. (Refer to Section III, Par. 2, *h*, (1), *(d)*.)

2. Remove clamp (1) from duct.

3. Detach front support by removing the two bolts (16) from both sides of the support (17).

4. Detach rear support by removing nuts (15).

5. Remove duct.

6. To remove remaining parts of front support, detach screws which fasten it to the lower surface of the wing. The screws are engaged by a tapping strip inside the wing.

7. To remove the remaining parts of rear support, detach the screws which fasten the large plate to the trailing edge ribs. Screws are engaged by rivnuts.

(b) FUEL DUMP VALVE.

(See figure 151.)

1. Drain fuel tank. (Refer to Section III, Par. 2, *h*, (1), *(d)*.)

2. Remove access panel on upper surface of wing.

3. Detach cables (9) and (12) from valve by removing clevis bolt.

4. Remove valve assembly by detaching screws which fasten it to the wing skin.

5. The procedure for disassembly of the dump valve is as follows: *(See figure 150.)*

a. Remove shackle (13) by detaching bolt (15).

b. Detach lever (17) by removing bolt (18).

c. Detach cover assembly by removing bolt (8).

d. Break safety wire between cover and yoke.

e. Remove clevis bolt (7).

f. Turn fork (10) to remove it from stud (11).

g. Remove cover plate (6) and withdraw adjusting pin (5) from cover (4).

h. Packing nut (3) is staked in cover but may be removed by forcing it past the staking points.

6. Remove cable (12) and spring (11) from clip. *(See figure 151.)*

7. Disconnect cable at turnbuckle (7) and remove cable (9).

8. Remove pulley (2) by removing axle bolt. Access to pulley in the leading edge is gained by opening panels (14) and (14B). *(See figure 20.)*

9. Disconnect cable at turnbuckle (5) which is in the leading edge, and remove cable (6). *(See figure 151.)*

10. Remove fair-lead from lower surface of the leading edge.

11. Remove pulley (17) from superstructure by removing axle bolt. Access to pulley is gained by removing panels from forward portion of superstructure.

12. Detach cable (3) from control handle (21).

13. Remove cable guide (36).

14. Attach a guide wire to end of cable (3) in superstructure forward of bulkhead 4, and then withdraw cable by pulling forked end aft. Guide wire is used to facilitate installation and should be longer than cable to be removed.

15. Detach nut from stud (14) and remove control handle (21).

(3) MAINTENANCE.

(a) FUEL DUMP DUCT.

1. Keep all bolts, screws, and clamps tightened.

2. For structural repair, refer to Structural Repair Manual, AN 01-5MA-3.

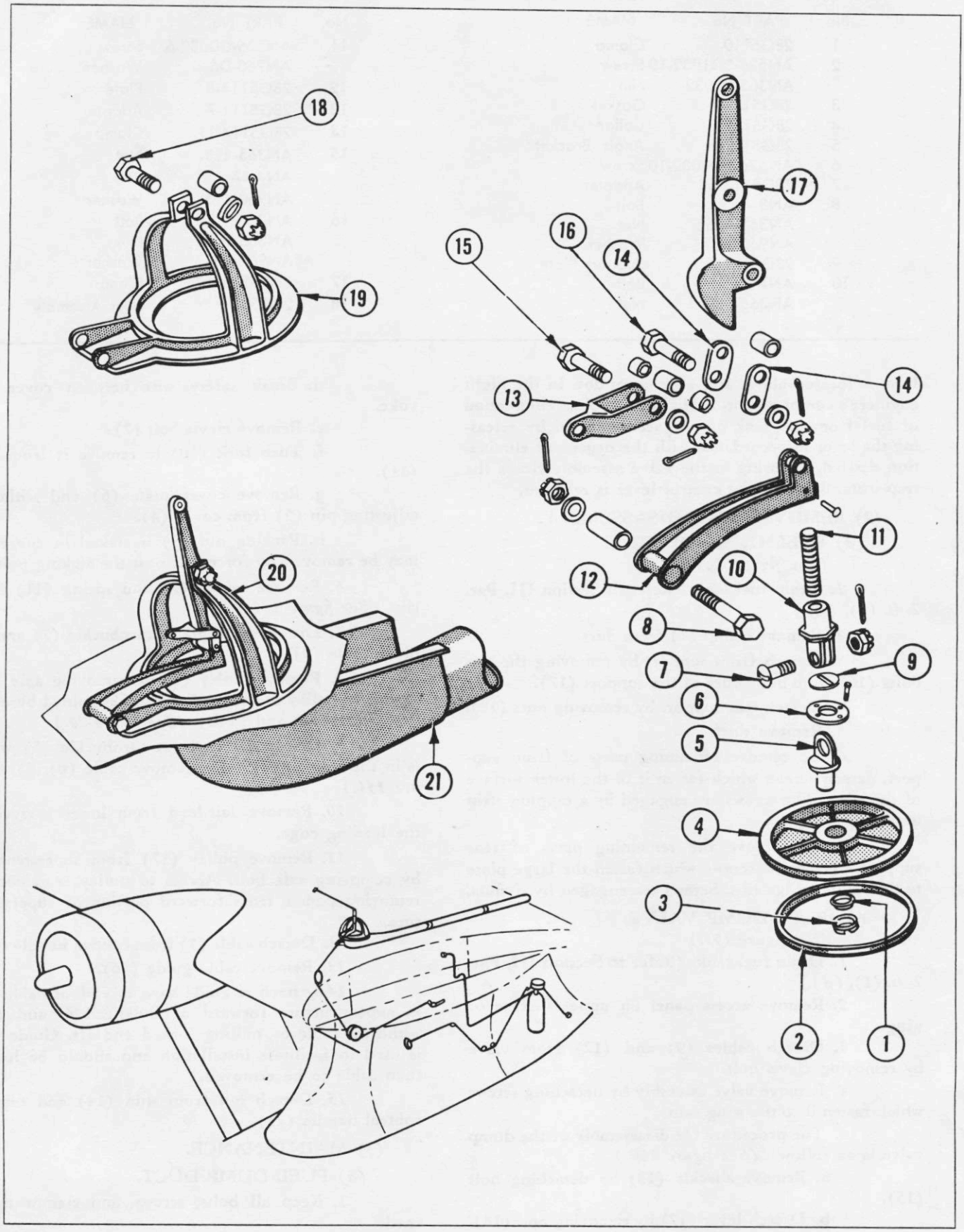


Figure 150—Fuel Dump Valve Details

No.	PART No.	NAME
1	28G1016	Packing
2	28G1013	Gasket
3	28G1015	Nut—Packing
4	28G1012	Cover
5	28G1017	Adjusting Pin
6	28G1014	Plate
	AC500A10-6	Screw
7	AN24-12	Clevis Bolt
	AN320-4	Nut
	AN380-B2-2	Cotter Pin
8	AN3-24	Bolt
	Q610-6-56	Spacer
	AN310-3	Nut
	AN380-B2-2	Cotter Pin
	AN960-10	Washer
9	28G1080	Washer
10	28G1018	Fork
11	28G1020	Stud
12	28G1019	Yoke
13	28G1027	Shackle
14	28G1021	Link
15	AN3-14	Bolt
	Q610-6-16.5	Spacer
	Q610-6-5	Spacer
	AN310-3	Nut
	AN380-B2-2	Cotter Pin
	AN960-10	Washer
16	AN3-11	Bolt
	Q610-6-16.5	Spacer
	AN310-3	Nut
	AN380-B2-2	Cotter Pin
	AN960-10	Washer
17	28G1022	Lever
18	AN3-12	Bolt
	Q614-6-17	Spacer
	AN310-3	Nut
	AN380-B2-2	Cotter Pin
	AN960-10	Washer
19	28G1023	Frame
20	28G1011-555	Dump Valve Assembly
21	28G5080	Duct Assembly

(b) FUEL DUMP VALVE AND CONTROLS.

1. If leak develops around frame attaching screws, tighten screws. If leak does not stop, replace gasket.

2. If leak develops around valve seat, turn adjusting pin counterclockwise until leak stops. If this does not stop the leak, replace the valve cover gasket.

3. If valve does not close after having been opened, check for broken or loose spring on closing cable assembly.

4. For maintenance of cable and pulleys, refer to Par. 18, *b*, (3).

(4) ASSEMBLY AND INSTALLATION.

(a) FUEL DUMP VALVE AND CONTROLS.

1. Assemble dump valve as follows: *(See figure 150.)*

a. Attach yoke (12) to frame (19) by means of bolt (8).

b. Screw fork (10) on stud (11).

c. Assemble cover (4), adjusting pin (5), plate (6), and washer (9).

d. Attach cover assembly to yoke assembly by means of clevis bolt (7).

e. Attach lever (17) to frame (19) by means of bolt (18).

f. Complete assembly by installing shackle (13) and links (14).

g. Adjust cover so that it locks in place when a small force is exerted on the end of lever (17).

h. After adjusting cover, insert packing (1) and packing nut (3) and stake packing nut in place.

2. Install control level (21). *(See figure 151.)*

3. Attach threaded end of cable (3) to aft end of guide wire and draw guide wire forward until cable is in its proper position.

4. Attach forked end of cable to control lever and install cable guide (36).

5. Install pulley (17) and cable guard (20).

6. Insert end of cable (3) through hole in leading edge of wing and install fair-lead (4).

7. Place nut (42) and bushing (41) on the long fitting end of cable (6). Wrap a nine inch piece of packing (40) around fitting and then insert fitting into flange (8).

8. Insert packing (40) and bushing (41) into flange and tighten packing nut (42).

9. Connect cable (6) and cable (3) at turnbuckle (5).

10. Connect cable (9) to dump valve and at turnbuckle (7).

11. Install cable (12) and spring (11). Spring should be elongated approximately two inches after installation with dump valve seated.

12. Tighten turnbuckles (5) and (7) sufficiently to take up the slack in the cable. Be careful not to tighten the cable so much that the valve is unseated.

13. Attach clip (43) to cable ⅛ inch forward of packing gland nut (42).

14. For safetying of turnbuckle, see Par. 18, *d*, (4), *(b)*, *6*.

(b) FUEL DUMP DUCT. *(See figure 149.)*

1. Assemble support plate (9), fill-in plate (12), and adapter (13) by means of bolts (10).

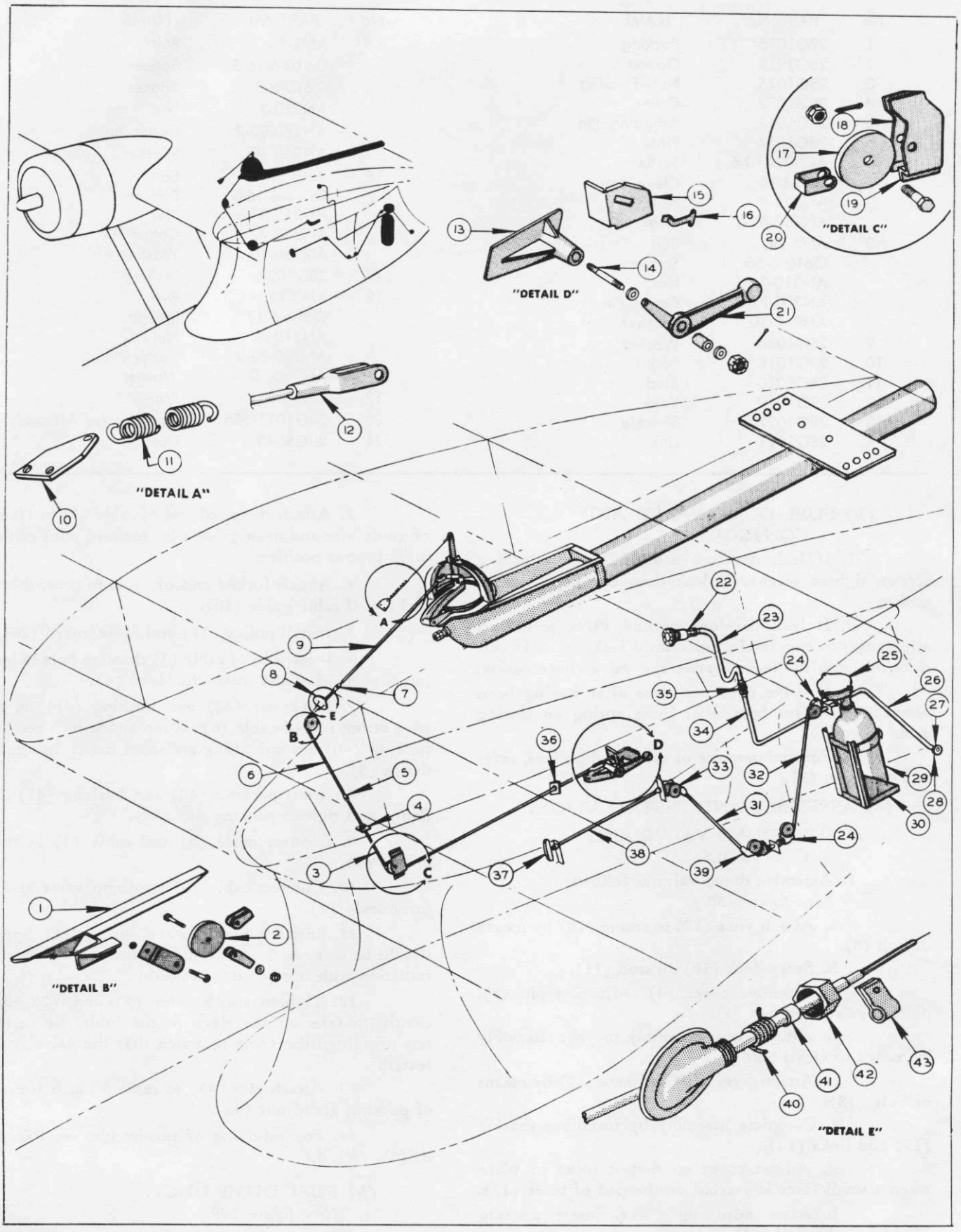


Figure 151—Fuel Dump and Vapor Dilution System

No.	PART No.	NAME
1	28P5160 L/R	Mounting Bracket
2	AN210-2A	Pulley
	Q4002-2-1	Bracket—Pulley
3	28G1031-12	Cable
4	28G1076	Fairlead
5	AN155-8S	Turnbuckle
6	28G1031-2	Cable
7	AN155-8S	Turnbuckle
8		Flange—Packing Gland
9	28G1031-4	Cable
10	28G2013	Lug
11	28G1065	Spring
12	28G1031-10	Cable
13		Bracket—Dump Lever
14	28G1068	Stud
	AN960-516	Washer
	Q614-10-18	Spacer
	AN380-B2-2	Cotter Pin
15	28G1073 L/R	Bracket
	AN526-DD632-7	Screw
	AN526-DD632-8	Screw
	AN372-D632	Nut
16	28G1069	Spring
17	28G069-6	Pulley
	AN3-7	Bolt
	AN310-3	Nut
	AN380-2-2	Cotter Pin
18	28G069-5	Bracket—Inner Stb'd.
	28G069-4	Bracket—Inner Port
19	28G069-3	Bracket—Outer Stb'd.
	28G069-2	Bracket—Outer Port
20	22P557	Cable Guard
21	28G1042	Lever
22	12700 (Schwien Eng. Co.)	Check Valve
23	28G5054-7	Line—Starboard
	28G5054-20	Line—Port
24	*19042	Pulley
25		Cover—Operating Head
26	28G5054-6	Line—Discharge
27	*17807	Fitting
28	*22315	Outb'd. Discharge Fitting
29	*24390	Cylinder Assembly
30	28G5091	Mounting Bracket
31	28G5054-8	Cable Guard
32	28G5054-12	Cable
33	*17386	Pulley
34	28G5054-18	Line
35	AC811 HT-8D	Union
36	28G079	Cable Guide
37	*17308	Handle Assembly
38	28G5054-9	Cable Guard
39	*18175	Pulley
40	28G1010-2	Packing
41	28G1029	Bushing—Packing Gland
42	28G1030	Nut—Packing Gland
43	Q907A3-8	Clip
	AN515-D6-6	Screw
	AN365-D632	Nut

*Items 24, 27, 28, 29, 33, 37 and 39 are Walter Kidde and Company part numbers.

2. Install the above assembly on the trailing edge of the wing by means of screws (11).

3. Attach angle (5) to lower surface of the wing at the rear spar by means of screws (6).

4. Attach adapter (7) to angle (5) by means of bolts (8).

5. Insert collar (4) in valve outlet with zinc chromate paste.

6. Place clamp (1) and gasket (3) around top of duct and install duct on airplane.

7. Tighten clamp (1), making certain that the gasket seals at the lower surface of the wing.

(5) OPERATIONAL CHECKS.—Operate dump valve controls several times before putting any fuel in the tank to see that the valve opens and closes properly.

d. VAPOR DILUTION SYSTEM.

(1) DESCRIPTION. *(See figure 151.)*—The vapor dilution system provides an inert atmosphere within the space surrounding the fuel tanks. In general, it consists of a supply of carbon dioxide gas stored in a light-weight steel cylinder which is fitted with a seat type quick-release valve, tubing to conduct the gas to the integral tank, and a control handle for the operation of the system. The cylinder is mounted vertically in the aft end of the superstructure. A pressure relief line extends from the cylinder to the lower left side of the superstructure, where a red CEL-O-SEAL cap is fitted over the discharge outlet. This pressure relief line is provided with a safety disc to release the gas at a pressure attained when a temperature of approximately 130°F (54.4°C) is reached. Care must therefore be taken to keep the temperature below 130°F to avoid loss of gas through a premature discharge. The red CEL-O-SEAL cap is fitted in the discharge outlet to indicate when the cylinder has been discharged prematurely.

Operation of the valve is effected by pulling the cable attached to the long lever in the operating head of the cylinder. The pull handle is mounted immediately aft and at the right of the engineer's seat. Pulling the cable rotates the release cam which permits the torque arm to turn and allows the stem washer to lift from the seat due to gas pressure. The short lever moves with the long lever and indicates when the valve has been operated. The end of the short lever contains a cross mark which is visible through an inspection window after valve has operated.

(2) REMOVAL.

(See figure 151.)

(a) Access to CO_2 cylinder is gained by remov-

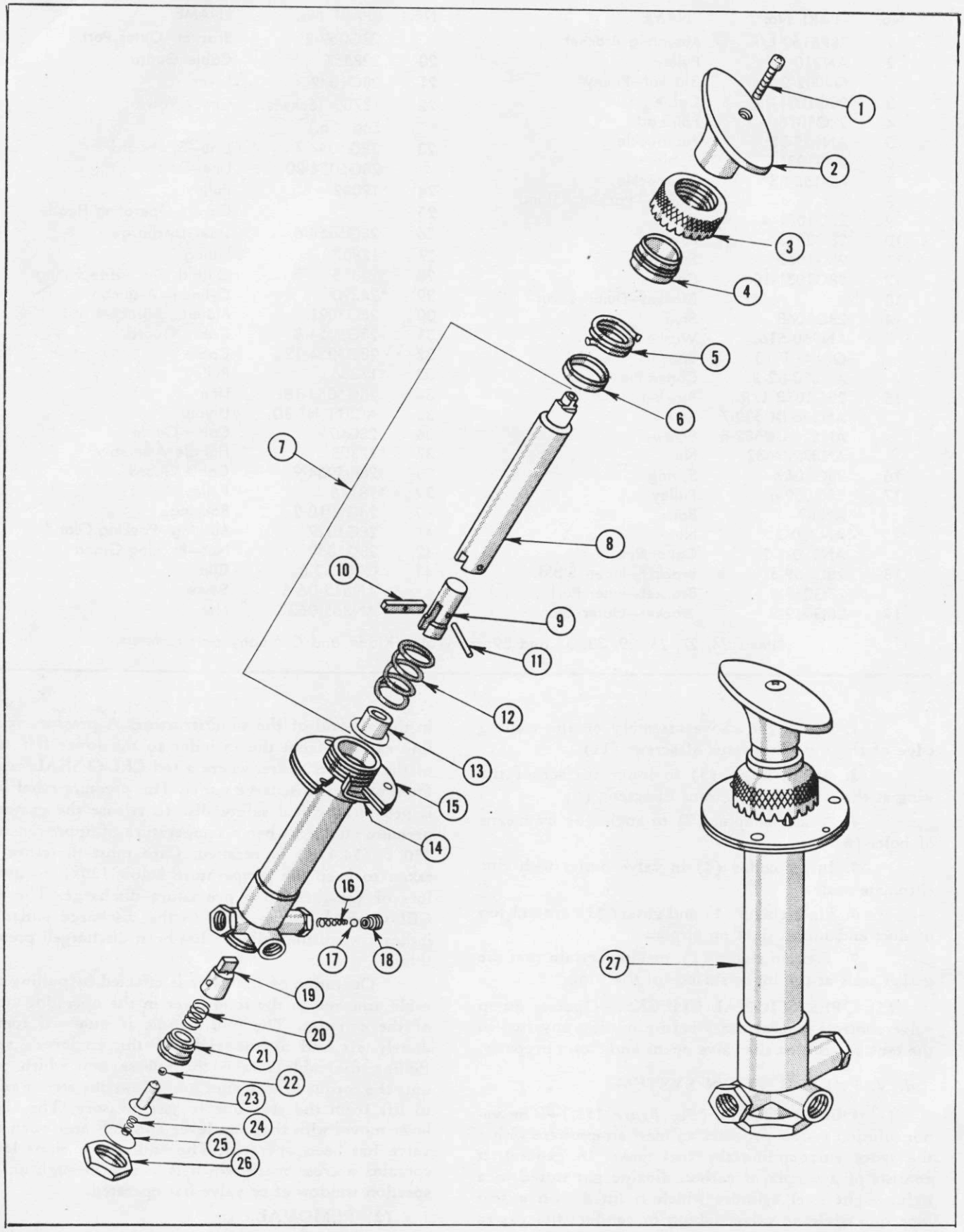


Figure 152—Two-way Engine Primer

No.	PART No.	NAME	No.	PART No.	NAME
1	3-2841-16-10-10S	Screw	15	5-1741-15-1	Body Assembly
2	7-833-1	Handle	16	5-333-1-1	Spring—Inlet Check
3	8-538-19	Packing Cap	17	12-1241-13-5	Ball—Inlet Check
4	8-538-3	Packing Follower	18	3-2834-7	Insert—Inlet Check
5	8-1538-2	Packing	19	9-2838-5	Plug—Selector
6	8-538-2	Packing Retainer	20	5-333-1-3	Spring—Plug
7	5-141-3	Piston Assembly	21	8-134-1	Insert—Plug
8	6-237-3D1	Piston	22	12-1241-13-5	Ball
9	9-2838-6	Key	23	3-2834-2	Piston—Check
10	2-938-1	Guide	24	5-333-1-2	Spring—Piston
11	10-2538-6	Pin	25	11-2541-25	Diaphragm
12	3-2742-3	Spring	26	8-134-2	Cap
13	2-938-2	Cup	27	P4CA-2A	Engine Primer
14		Lock Spring			

All numbers listed above are Parker Appliance Co. part numbers.

ing panel (9) *(See figure 64.)* on the rear of the superstructure.

(b) Remove the CO_2 bottle as follows:

1. Detach vapor pressure line (34) from the operating head.

CAUTION

Disconnect the vapor pressure line (34) from the side of the operating head before working on any of the mechanism attached to the bottle. Do not place the hand or any other part of the body in a position where a blast of escaping CO_2 can come in contact.

2. Remove cover (25) from the operating head of the CO_2 bottle by removing the four screws which hold it in place.

3. Detach cable from the actuating arm in the operating head by removing the cotter pin which locks it in place.

4. Detach pulley (24) from the operating head.

5. Disconnect relief discharge line from the operating head.

6. Loosen strap around bottle and remove bottle from the airplane.

WARNING

Do not drop charged cylinders or handle them roughly, and do not expose them to the direct rays of the sun or to temperatures higher than 54°C (130°F).

(c) Remove the lines as follows:

1. Detach tube (34) at fitting below lower surface of wing and remove the tube.

2. Disconnect line (23) from valve (22) and remove it. Access to valve is gained by opening access hole in the upper surface of the trailing edge just outboard of the walkway.

3. Disconnect line (26) from discharge fitting.

(d) Control cable cannot be removed except by melting solder and unwrapping wire from loop on aft end of the cable, then withdrawing cable by pulling handle end.

(3) MAINTENANCE.

(a) If the cylinder is discharged, install one that is in good condition. If cross mark is visible through the inspection window in the operating head of the cylinder, or, if the red CEL-O-SEAL cap in the side of the superstructure is ruptured, the cylinder is discharged.

(b) If the cylinder is fully charged, but is rusted, take it from the airplane, remove the rust, and paint it.

(c) Remove and weigh cylinder every six months. The fully charged weight of the cylinder is painted on the side of every cylinder. If, when weighing the cylinder, it is found that the weight is four ozs or more less than that painted on the side of the cylinder, replace it with a fully charged cylinder.

(d) Replace any section of the CO_2 lines that is bent, broken, crushed, or loose after tightening the fitting.

(e) If the tube through which the control cable runs is bent or crushed, replace it.

(f) If fuel leakage is found at the junction of the check valve and CO_2 line, tighten the nut on the CO_2 line. If it leaks at the junction of the check valve and flange, tighten the check valve. If it leaks at the joint between the fuel tank and the flange, tighten the rivets.

(g) If cable was removed, put graphite on it at installation.

(4) INSTALLATION.

(See figure 151.)

(a) Install cable in tube and make loop at its end. Bind loop with eight turns of B and S No. 18

(.040) gage copper wire and then solder it solid. Total length of loop, including binding, is not to exceed one inch.

(b) To install CO_2 lines, reverse removal procedure as outlined in paragraph *d*, (2), *(c)*.

(c) To install bottle, reverse removal procedure as outlined in paragraph *d*, (2), *(b)*.

(d) Replace superstructure access panels.

e. ENGINE PRIMER SYSTEM.

(1) DESCRIPTION. *(See figure 131.)*—The fuel line for the primer pump is connected at the "T" on the port selector valve. It runs aft to the Parker P4CA-2A primer pump at the port side of the engineer's station. This fuel line is a non-self-sealing synthetic rubber hose. A separate primer line goes to each engine from the pump, feeding a priming spider attached to the intake pipe for No. 1 cylinder. Eight lines extend to the cylinders from the spider.

The Parker P4CA-2A pump is a displacement plunger type primer in which distribution and shut-off are effected by a single pump handle. A special vacuum check prevents suction of fuel into the engine when the primer is accidentally left in the "ON" position. Plunger displacement is in excess of 0.5 ounces of gasoline per stroke.

To unlock the plunger, push the handle all the way down and turn to "ON" position (for port engine, turn to "L-ON" and starboard engine, to "R-ON"). Plunger may then be pulled back for the stroke. To shut off, push handle all the way in and turn to "OFF." Handle must be pushed all the way in before turning in either direction.

(2) REMOVAL.

(a) Turn port fuel selector valve and port fuel shut-off valve to their "OFF" positions.

(b) Remove primer pump as follows: *(See figure 131.)*

1. Disconnect lines from primer pump. There are two metal lines and one rubber hose. A small amount of residual gasoline will drain from these lines when they are disconnected.

2. Loosen the four bolts which fasten the primer pump bracket to the structure and remove bracket and pump. Pump is attached to the bracket by means of three screws.

(c) Remove primer lines as follows:

(Lines are identified by a red band placed at intervals along the lines.)

1. Remove panel (25) from the flight engineer's instrument panel. It may also be necessary to remove panel (12) in order to gain access to the hose connection of the primer fuel line. *(See figure 175.)*

2. Access to lines in the fuel units compartment of the superstructure is gained by removing the panels on the side of the forward part of the superstructure.

Access to lines in the leading edge is gained by opening panels on upper surface of leading edge.

Access to lines in the nacelle is gained by opening the accessory panels and the panels over the leading edge.

3. Disconnect lines at their terminals, at bulkhead fittings, or at any other of their connections where it may be necessary in order to remove the lines. Lines are clipped to adjacent structure at approximately 15 inch intervals.

Note

Avoid bending or denting metal lines. Do not damage adjacent installations or equipment.

(d) Disassemble primer pump as follows: *(See figure 152.)*

1. Depress packing nut spring lock (14) with thumb nail, unscrew packing nut (3), and remove piston assembly.

2. Remove handle (2) and slide off the packing follower (4), packing (5), and packing retainer (6).

3. Break safety wire, unscrew cap (26), and remove diaphragm (25), vacuum check spring (24), piston (23), ball (22), insert (21), spring (20), and outlet cone (19).

4. Remove insert (18), ball (17), and spring (16).

(3) MAINTENANCE.

(a) PRIMER PUMP.

1. If pump leaks around piston, tighten packing cap. If this does not stop leak, replace the packing.

2. Tighten line fittings if leaks develop at connections. Replace lines if necessary.

3. Clean pump thoroughly with clear gasoline.

(b) PRIMER LINES.

(Refer to paragraph *b*, (3), *(c)*, *1.*)

(4) TEST BEFORE INSTALLATION.—Connect pump to a source of fuel supply and operate pump. Check for full capacity discharge and leaks around the piston. Pump should deliver approximately 0.5 ounces per stroke.

(5) INSTALLATION.

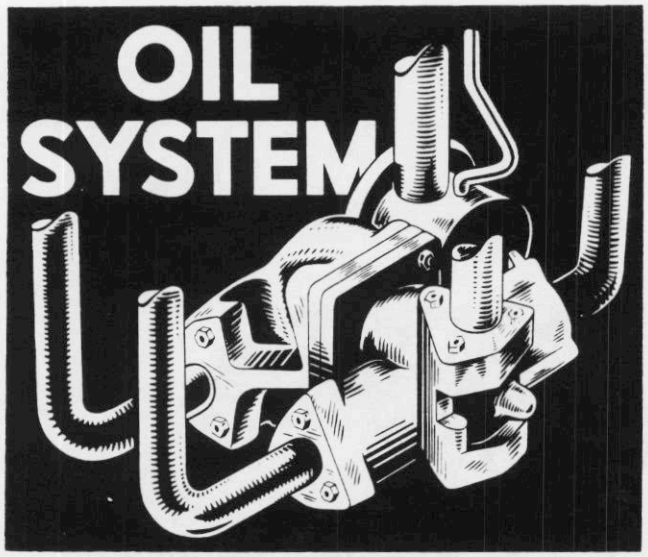
(a) To assemble pump, reverse the procedure for disassembly as outlined in paragraph *e*, (2), *(d)*. *(See figure 152.)*

(b) To install primer lines, reverse the procedure for removal as outlined in paragraph *e*, (2), *(c)*.

(c) Install primer pump by reversing removal procedure as outlined in paragraph *e*, (2), *(b)*.

(6) OPERATIONAL CHECK.—Before connecting line to spider, operate pump and check for fuel flow to spider and for leaks in the lines.

PARAGRAPH 16.



16. OIL SYSTEM.

a. GENERAL.
(See figure 154.)

Each engine has a separate and completely independent oil system. The oil supply for each engine is carried in a tank in the nacelle. This tank forms a part of the nacelle structure and the power plant assembly mounts to its forward face. Oil returning from the engine enters an oil temperature regulator located under the engine mount; and flows from the regulator through a "cold" oil return line to a hopper type warming compartment in the tank; or through a "hot" oil return line to the oil cooler and then through the oil cooler to the top of the oil tank.

The oil flow through the oil temperature regulator is automatically controlled by a thermostatic element in the regulator. Air flows through the oil cooler at all times, and is not controlled.

The oil dilution system consists of a solenoid operated oil dilution valve, which transfers gasoline from the carburetor inlet chamber to the oil supply line at the top of the drain valve. A switch on the flight engineer's instrument panel operates this valve.

A line connected to a box on the bottom of the oil tank outlet casting furnishes the propeller fast feathering pump with a supply of oil.

b. OIL TANK ASSEMBLY.

(1) GENERAL.—Each oil tank is mounted to the wing nacelle support structure forward of the front spar and forms an integral part of the nacelle.

A cylindrical hopper is provided in the oil tank for accelerating warm-up of the oil, and extends from the top to the bottom of the tank.

A Liquidometer oil quantity gage transmitter is mounted on the left-hand side of each tank. The indicating instrument for these transmitters is on the engineer's instrument panel.

(2) OIL TANK.

(a) DESCRIPTION. *(See figure 153.)*—The oil tank is of 24ST Aluminum Alloy construction in which the parts are riveted together. It is a structural part of the nacelle since it supports the full weight of the power plant assembly. A sump casting, incorporating an inlet and outlet port, and a fitting for the attachment of the oil line to the propeller fast feathering pump is installed on the bottom of the tank.

The oil tank is provided with a fitting, near the top on the forward face, which has two ports. One port is for the connection of an oil return line, and the other is for the connection of a vent line to the engine. A safety-wired drain plug is installed in the bottom of the oil tank at the rear of the sump.

The total capacity of the oil tank is 76 U. S. (63.2 Imp.) gallons, but it should not be filled above 65 U. S. (54.1 Imp.) gallons since a foaming space of 11 gallons is required.

(b) REMOVAL.

1. Open lower accessory panel (21) to gain access to the oil drain valve. *(See figure 101.)*

2. Remove plug from bottom of valve and turn handle to "Tank and Engine Drain" position. Drain oil into a container of at least 70 U. S. (58.3 Imp.) gallons capacity.

3. Remove engine and mount assembly. (Refer to Par. 8, *b*, (3), *(b)*.)

4. Remove firewalls from sides of the oil tank. (Refer to Par. 8, *e*, (2).)

5. Remove heat exchangers. (Refer to Par. 25, *b*, (2), *(b)*.)

6. Remove rear access doors. (Refer to Par. 7, *e*, (3), *(b)*.)

7. Disconnect bonding braid on the sides of the tank.

8. Remove cover from Liquidometer (34) and disconnect the three wires from the terminals inside the liquidometer. *(See figure 153.)*

9. Loosen knurled conduit nut on top of Liquidometer and pull conduit and wires from the Liquidometer.

10. Remove screws which fasten the oil tank to the wing nacelle fairing. *(See figure 155.)* Access to nuts which engage screws is gained by opening the circular access doors at the top and bottom of the nacelle just aft of the oil tank.

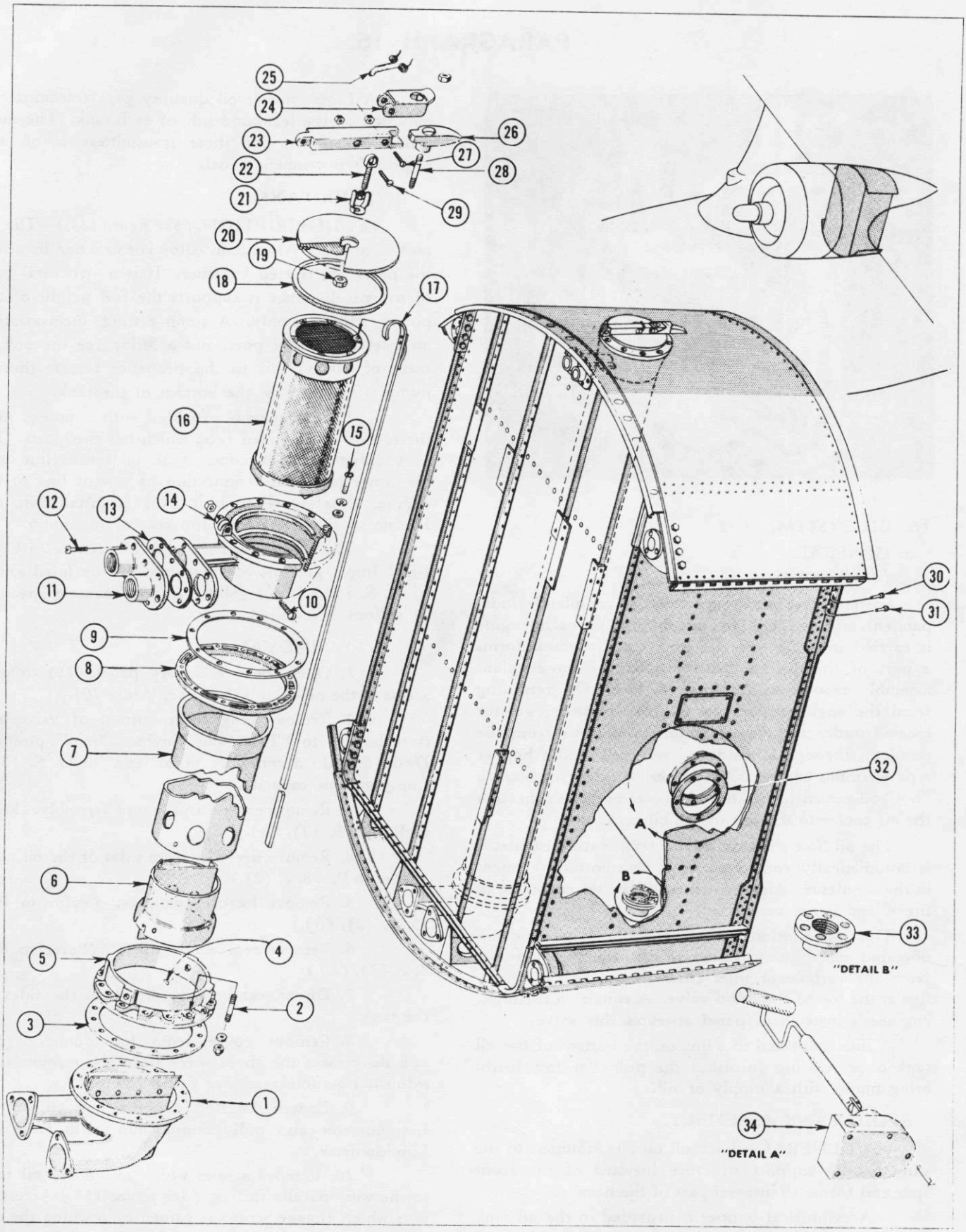


Figure 153—Oil Tank Assembly

No.	PART No.	NAME
1	28-0-3003-5	Outlet Casting
2	28-0-2017-2	Stud
	AN310-3	Nut
	Q7102-10	Washer
	AN380-2-2	Cotter Pin
3	28-0-2016	Gasket
4	NAF1164-1024-6	Screw
	Q7102-10	Washer
5	28-0-2013	Flange—Outlet Tapping
6	28-0-5510-2	Baffle Assembly
7	28-0-5511	Well
8	28-0-2021	Filler Neck Tapping Ring
9	28-0-2022	Gasket
10	AN23-17	Clevis Bolt
	AN320-3	Nut
	AN380-2-2	Cotter Pin
11	28-0-2031	Flange
12	NAF1164-1024-10	Screw
13	28-0-2032	Gasket
14	28-0-2019-6	Body—Filler Neck
15	NAF1164-1024-10	Screw
	AN935-10	Lock Washer
	AN960-10	Washer
16	28-0-2028	Strainer
17	28-0-2027	Sounding Rod
18	28-0-2026	Gasket
19	AN310-4	Nut
	AN380-2-2	Cotter Pin
20	28-0-2020-0	Cover—Filler Neck
21	28-0-2042	Clip
22	28-0-2025	Eye Bolt
	AN316-4R	Nut
23	20-0-2023	Latch
24	28-0-3002	Locking Clip
25	28-0-5049	Spring
26	28-0-2024	Clamp
27	AN515-D6-20	Screw
	Q808-D4-28	Spacer
	AN960-AL6	Washer
	AN365-D632	Nut
28	28-0-2017-3	Stud
	AN960-10	Washer
	AN320-3	Nut
	AN380-2-2	Cotter Pin
	Q610-6-28	Spacer
29	AN23-17	Clevis Bolt
	AN320-3	Nut
	AN380-2-2	Cotter Pin
30	AN4-5A	Bolt
	AN365-428	Nut
	Q7102-A416	Washer
31	AN3-5A	Bolt
	AN365-1032	Nut
	Q7102-A10	Washer
32	28-0-1018	Gasket
33	22Q104	Flange—Tank Drain
34	EA-1611-A	Liquidometer
	(Liquidometer Corp.)	

11. Remove the ten bolts (30) and (31) at each of the four corners of the oil tank.

12. Remove oil tank.

(c) MAINTENANCE.

1. If leaks develop around sump casting or filler neck, tighten the nuts on the sump and the screws on the filler neck. Replace gaskets if leaks do not stop.

2. Check washers under rivet heads in the oil tank. Cracked washers will not require repair unless part or all of the washer is missing, or if there is evidence of a leak around the rivet.

3. For structural repairs to the oil tank refer to the Structural Repair Manual (AN 01-5MA-3).

(d) INSTALLATION.
(See figure 153.)

1. Place oil tank in position and insert the ten bolts (30) and (31) in each of the four corners of the tank.

2. Install screws which fasten the oil tank to the wing nacelle fairing. For location of the correct length screws see figure 155.

3. Insert wires through hole in Liquidometer and tighten knurled nut on conduit.

4. Attach the three wires to each Liquidometer as follows: On the port tank, wire 284 to terminal R—, wire 285 to terminal R+ and wire 894 to terminal C. On the starboard tank wire 364 to terminal R—, wire 365 to terminal R+, and wire 893 to terminal C.

5. Replace cover on Liquidometer.

6. Attach bonding braid to sides of the tank.

7. Install rear access doors. (Refer to Par. 7, *e*, (3), *(d)*.)

8. Install heat exchanger. (Refer to Par. 25, *b*, (2), *(d)*.)

9. Install firewalls. (Refer to Par. 8, *e*, (4).)

10. Install engine and mount assembly. (Refer to Par. 8, *b*, (5), *(a)*.)

11. Place oil drain valve in "Tank to Engine" position and safety wire it.

12. Install plug in bottom of drain valve.

(3) OIL WARM-UP HOPPER AND FILLER NECK.

(a) DESCRIPTION. *(See figure 153.)* — A flange (5) is riveted to the inside bottom of the oil tank. Studs (2) are inserted in the flange and project through the bottom of the oil tank. Sump casting (1)

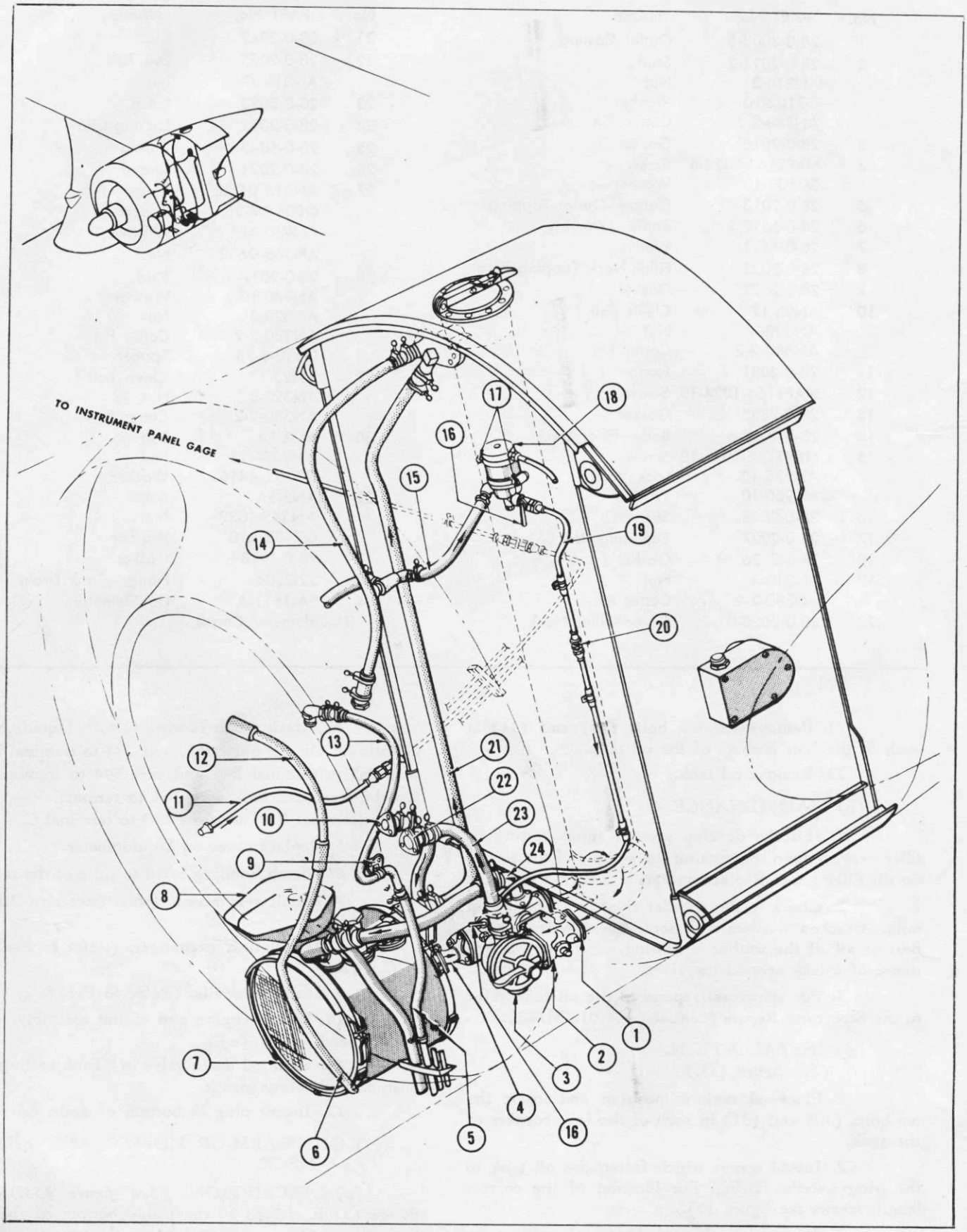


Figure 154—Oil System Diagram

No.	PART No.	NAME
1	24895	Gasket
2	25016	Oil Temperature Control
3	114153	Oil Drain Valve
4	32-0-046	Fitting—Oil Return
	28-0-5000-27	Line—Oil Return
	AN878-16-11	Hose Connectors
	AN748-46	Hose Clamps
5	28-0-5000-18	Hose—Breather Line
	AN748-34	Hose Clamps
6	28-0-5000-19	Breather—Power Section
	*A755-16-2-18	Clip
	AN520-10-10	Screw
	AN960-A10	Washer
	AN365-1032	Nut
7	UD-6012-C	Oil Cooler
8	28P3077-3	Scupper—Oil Screen
9	32-0-055	Lug—Breather Support
	*A755-10-2-8	Clip
	AN520-10-12	Screw
	AN365-1032	Nut
	Q7102-A10	Washer
10	28-0-3009-3	Fitting—Return Line
11	29-0-1028-3	Line—Oil Pressure—Port
	29-0-1028-4	Line—Oil Pressure—Stb'd
12	32-0-001-21	Breather—Power Section
	AN878-16-13	Hose Connectors
	AN748-46	Hose Clamps
	*A755-16-2-8	Clip
	AN365-1032	Nut—Self-Locking
	AN960-A10	Washer—Nut
	Q816-D6-32	Spacer—Long
	AN316-3R	Nut—Plain
	AN960-10	Washer—Plain Nut
	Q816-D6-8	Spacer—Short
	AN520-10-32	Screw
	Q908-36-8	Clamp—Intake Manifold
13	28-0-5000-17	Breather line—Accessory
	AN878-10-13	Hose Connections
	AN748-34	Hose Clamps
14	28-0-5000-30	Vent Line—Engine To Tank
	AN840-12D	Vent Fitting—Oil Tank
	AN878-12-13	Hose Connectors
	AN748-38	Hose Clamps
	AN844-12	Vent Fitting—Engine
15	AN878-6-52	Hose
	AN748-26	Hose Clamps
	AN914-1D	Fitting—Solenoid—Port
	AN915-1D	Fitting—Solenoid—Stbd
	28G5186-6	Hose Fitting
	AN914-1	Fitting—Carburetor
	AN4077-1	Restrictor Fitting
	AN914-1D	Fitting—Restrictor
16	702-GG-4D	Valve—Dilution Line
17	Q901-32	Clamp
	AN3-24A	Bolt
	AN372-1032	Nut
	AN960-A10L	Washer
	28-0-5514	Mounting Bracket—Solenoid
	28-0-5042-6	Valve Support—Outer
	28-0-5042-7	Valve Support—Inner
	AN3-13A	Bolt
	AN3-20A	Bolt
	Q7102-AL10	Washer
	AN372-1032	Nut
18	U-1070-M	Dilution Solenoid
19	28-0-5041-8	Line—Oil Dilution
20	AN815-4D	Union—Dilution Lines
	28-0-5041-10	Line—Oil Dilution—Lower
21	28-0-5000-32	Line—Cooler Tank
	AN842-16D	Return Fitting—Tank
	AN878-16-11	Hose Connectors
	AN748-46	Hose Clamps
22	29-0-3073	Fitting—Oil In
23	28-0-5000-28	Line—Oil to Engine
	AN878-24-13	Hose Connectors
	AN748-66	Hose Clamps
24	28-0-5025	Fitting—"Hot" Oil Line
	28-0-5000-10	Line—"Hot" Oil
	AN878-16-13	Hose Connectors
	AN748-46	Hose Clamps

Items 7 and 18 are United Aircraft Products Co. part numbers.
Item 16 is a Parker Appliance Co. part number.
Item 3 is an Aero Supply Mfg. Co., Inc. part number.
*Items 6, 9 and 12 are Adel Precision Products Co. part numbers.
Items 1 and 2 are Pratt and Whitney Aircraft part numbers.

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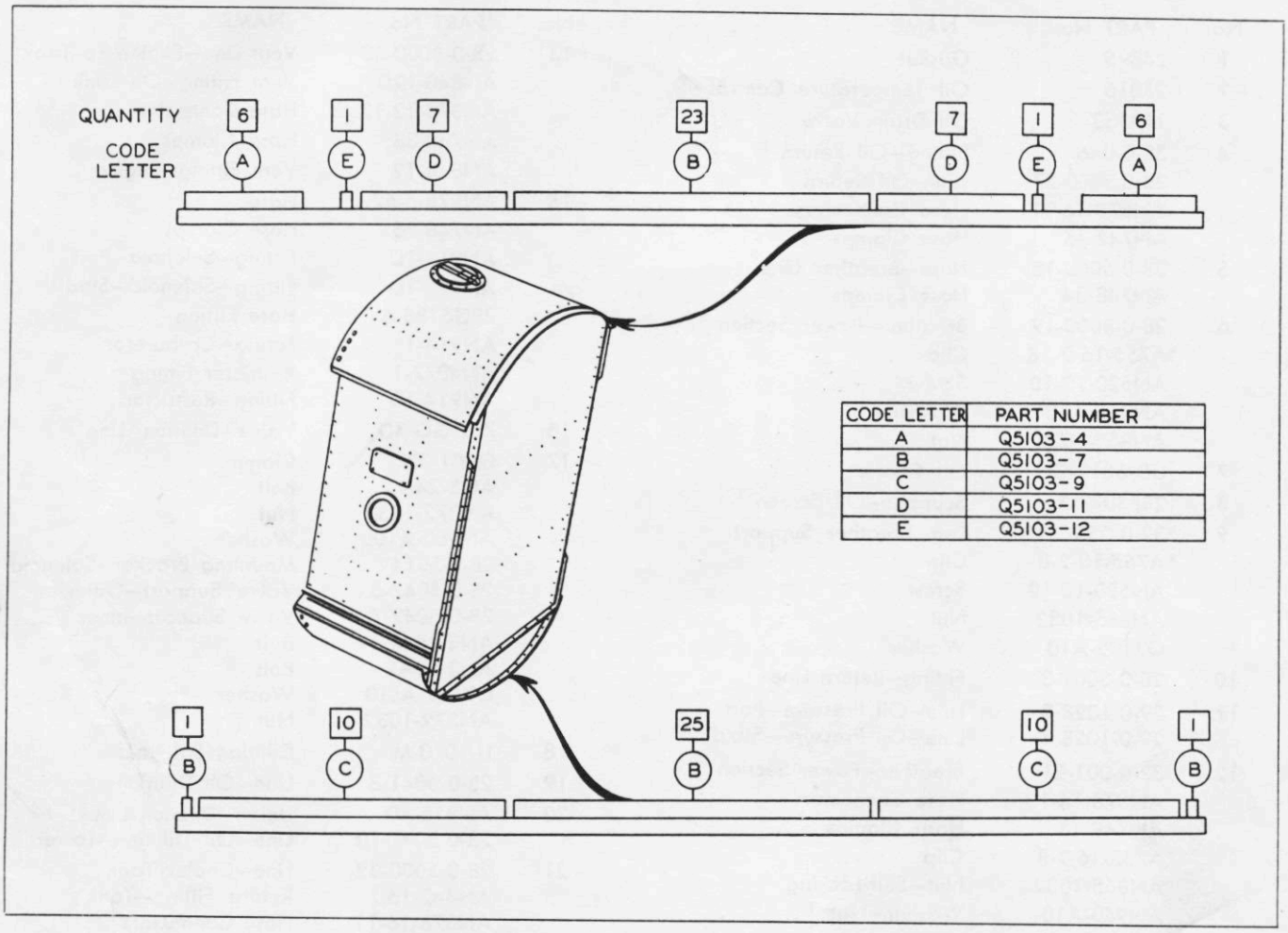


Figure 155—Oil Tank Attaching Screw Diagram

attaches to the bottom of the tank by means of these studs. Baffle assembly (6) and well assembly (7) slip inside the flange (5) and are attached to it by means of screws (4). Filler neck body (14) attaches to the top of the tank and its lower end rests inside the bell shaped end on the well assembly (7). Strainer assembly (16) and sounding rod (17) rest on a ledge around the inside of the filler neck body and are held in place by the cover assembly. Riveted to the filler neck body is a baffle which serves to direct the flow of returning "hot" oil towards the bottom of the tank.

(b) REMOVAL.

(See figure 153.)

1. Remove automatic temperature control unit (2) by removing the three bolts from each flange. *(See figure 154.)*

2. Remove oil supply line to the propeller fast feathering pump. This line originates at the bottom of the sump casting (1).

3. Remove sump casting (1) by loosening nuts on studs (2).

4. Remove filler neck cover assembly by removing clevis bolt (10).

5. To disassemble filler neck, remove nut (19) from eye bolt (22) and detach cover (20).

6. Remove nut from stud (28) and detach clamp (26).

7. Remove stud (28).

8. Lift sounding rod (17) and strainer (16) from the filler neck.

9. Remove flange (11) by detaching screws (12).

10. Remove the four screws (4) from the inside of the hopper. These four screws fasten the baffle (6) and the well assembly (7) to the flange (5). Baffle assembly will drop out of the bottom of the tank when the screws (4) are removed.

11. Allow the well assembly (7) to slip out of the bottom of the tank several inches so that filler neck body can be removed.

12. Remove screws (15) and lift filler neck body (14) from the tank.

13. Withdraw well assembly (7) through the top of the tank.

(c) MAINTENANCE.

(See figure 153.)

1. If tank leaks around filler neck cover, adjust cover by means of the two nuts on the eye bolt (22). If this does not stop leak, replace cover gasket (18).

2. If tank leaks around sump casting (1), tighten nuts. If leaks continue, remove sump and replace gasket (3).

3. Clean strainer screen with clear gasoline at each 240 hour inspection.

(d) INSTALLATION.

(See figure 153.)

1. Insert well assembly (7) through the top of the oil tank and allow it to protrude through the bottom of the tank several inches.

2. Place gasket (9) in position on the tank and insert filler neck body (14) into top of tank.

3. Insert a couple of screws (15) loosely into filler neck body and then place gasket (13) and flange (11) in position on the forward face of the tank.

4. Attach flange (11) by means of the screws (12). Tighten screws to give equal bearing at all points along flange.

5. Insert remaining screws (15) and tighten them uniformly.

6. Push well assembly (7) up making certain that it engages filler neck body properly.

7. Insert baffle assembly (6) through the bottom of the tank and secure it and the well assembly by means of the screws (4).

Note

Baffle must point fore-and-aft and the large holes in the assembly should be on starboard side of the tank.

8. Install gasket (3) and sump casting (1), making certain that the spring clips on the sump casting engage the baffle on the baffle assembly (6).

9. Tighten sump casting nuts to give an equal pressure around flange and secure them with cotter pins.

10. Place nut and clip (21) on eyebolt (22) and then insert eyebolt through cover (20) and install nut (19) on the eyebolt.

11. Assemble spring (25) and clip (24) to latch (23).

12. Install stud (28) in filler neck body and attach clamp (26) to it.

13. Insert strainer (16) and sounding rod (17) in hopper.

14. Attach latch (23) to eyebolt and install assembly on the tank by means of clevis bolt (10).

15. Adjust the two nuts on the eyebolt until cover seats properly.

16. Install oil supply line to propeller fast feathering pump. This line attaches to the fitting on the bottom of the sump casting and to the pump which is located on the forward face of the oil tank.

17. Install automatic temperature control unit (2) to the sump casting by means of six bolts and nuts. *(See figure 154.)*

18. Attach lines to oil tank and to temperature control unit as shown in figure 154.

(4) OIL QUANTITY TRANSMITTER.

(a) DESCRIPTION. — A Liquidometer oil quantity transmitter, type EA-1611-A, is mounted on the port side of each tank. The indicating instrument for these transmitters is on the engineer's instrument panel. The transmitter contains a resistance strip and a movable contact arm. The position of the contact arm is varied by the motion of the float in the tank. This position is transmitted electrically to the indicator which is graduated in gallons. Only one indicator is provided, but this may be used for a quantity reading for either tank. The tank may be selected by means of toggle switches adjacent to the indicating instrument.

For a description of the electrical circuit of the Liquidometer see Par. 22, *y*, (1), *(a)*.

(b) REMOVAL.

(See figure 153.)

1. Remove cover from Liquidometer (34) and disconnect the three wires from the terminals inside the Liquidometer.

2. Loosen the knurled conduit nut on top of the Liquidometer and pull conduit and wires from the Liquidometer.

3. Remove the five screws which fasten the Liquidometer to the tank. Screws are located inside the Liquidometer.

4. Remove Liquidometer by pulling it straight out from the side of the tank being careful not to damage float assembly.

(c) MAINTENANCE.

1. If float leaks, solder hole closed. The float should be thoroughly dried before soldering and care should be taken that additional leaks are not caused by the soldering operation.

Note

Prior to soldering, to remove any oil which might be inside the float, the float should be immersed in boiling water for approximately five minutes after all traces of bubbles have ceased to emerge from the crack.

2. Relieve binding at the float arm bearing by the following method:

a. Remove float arm by taking out the bent pin and withdrawing the bearing pin.

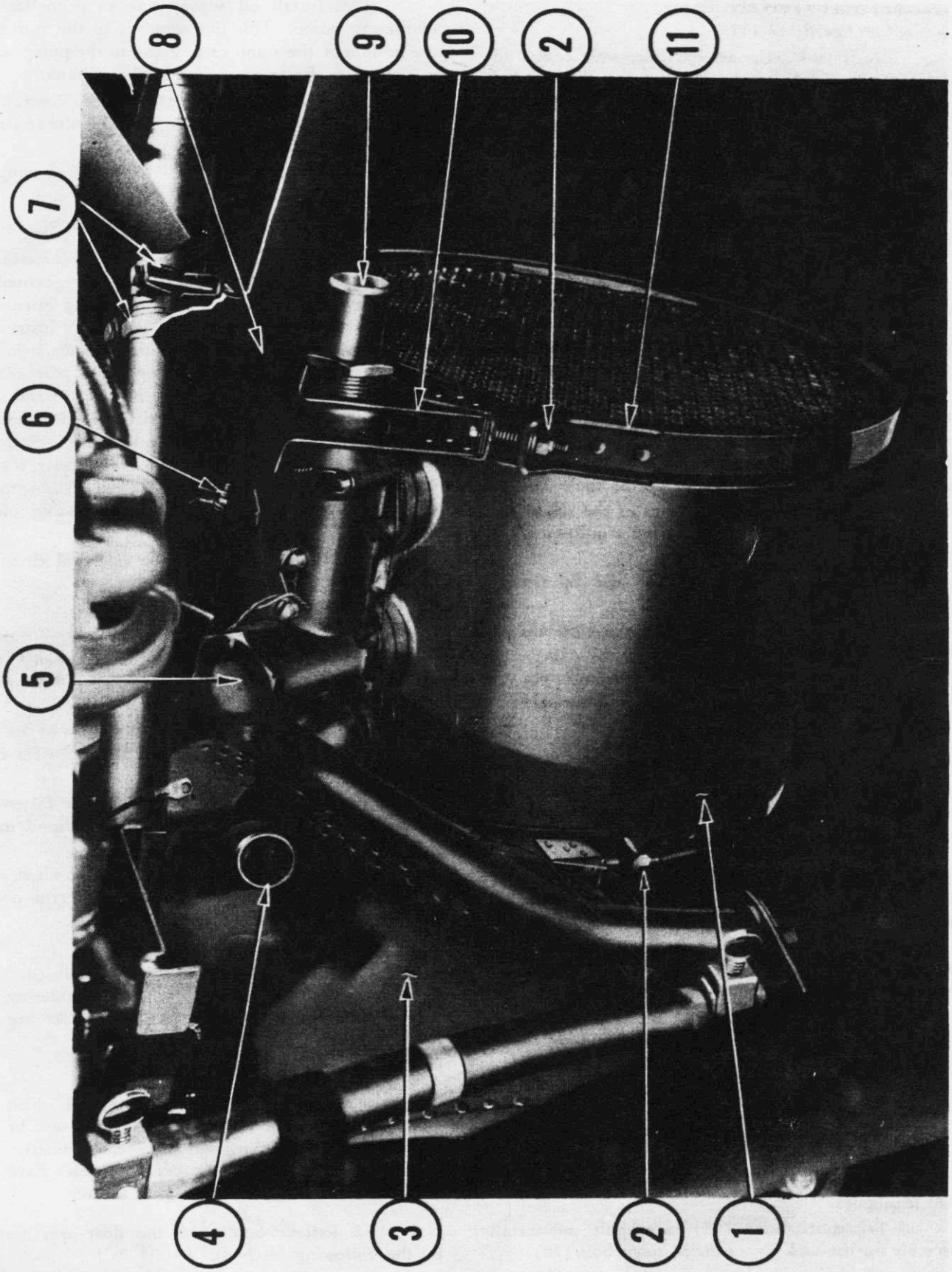


Figure 156—Oil Cooler Installation

No.	PART No.	NAME	No.	PART No.	NAME
1	UD-6012-C	Oil Cooler	7	28P5068	Clip
2	AC501-416-24	Screw		AN3-20A	Bolt
	Q7008-AL17-.064	Washer		AN960-010	Washer
	AN365-428	Nut		AN365-1032	Nut
3	28P5003-3	Cowl Well	8	28-0-5014	Triangular Bracket
4	AN842-17D	"Oil In" Elbow Fitting		AN3-4A	Bolt
5	UB-3250-130	Relief Valve		Q7102-A10	Washer
6	AN526-1032-8	Screw		AN365-1032	Nut
	Q508-A6	Bonding Braid	9	28-0-5028	"Oil Out" Nipple Fitting
	Q7102-A10	Washer	10	28-0-5011	Support Assembly
	AN365-1032	Nut	11	28-0-5013	Strap Assembly

Items 1 and 5 are United Aircraft Products Co. part numbers.

b. Clean bearing and bearing pin and polish them with crocus cloth.

3. For electrical maintenance and adjustment of the Liquidometer, refer to Par. 22, *y*, (1), *(b)*.

(d) INSTALLATION.

(See figure 153.)

1. To install Liquidometer, reverse removal procedure as outlined in paragraph *b*, (4), *(b)*.

2. Connect wires to the terminal of the Liquidometer as outlined in paragraph *b*, (2), *(d)*, 4.

c. OIL COOLER.

(1) DESCRIPTION.—The oil cooler is a cylindrical unit approximately twelve inches in diameter and nine inches in length.

The cooler is suspended from the bottom of the nacelle by two metal straps and protrudes approximately ten inches below the normal nacelle lines.

The oil cooler consists of a core or cooling element enclosed in a shell and surrounded by a warming jacket or muff. A cast flange provides the cooler inlet connection and the mounting face for the valve. Two flow paths are provided; one, the warming path, is connected through the warming jacket, past the relief valve, and out; the other, is around the jacket to the core inlet, through the core for cooling and out.

The core is composed of copper tubes. The tubes are of circular cross-section except at the ends, which are expanded into hexagonal shape for a length of ½ inch. The tubes are bonded together with solder. Baffle plates of brass are incorporated in the core. Openings through the baffles are at alternate ends. The oil, therefore, must traverse the length of the core several times in its cooling path. Oil flow is parallel to the tubes. The inlet to the core is from the warming jacket opposite the flange. The core outlet is through the flange. A sheet brass shell encloses the core.

The warming jacket surrounding the core is formed by the shell and an outer jacket of sheet brass. It serves as a by-pass when the oil requires no cooling. A drain plug is provided.

(2) REMOVAL.

(a) Open the accessory cowl panels (6), (17) and (21) aft of the engine cowl flaps. *(See figure 101.)*

(b) Remove the oil cooler air scoop as follows: *(See figure 130.)*

1. Disconnect the flexible generator blast tube (40), from the air cooler air scoop.

2. Remove the scoop by detaching screws that fasten it to the horizontal angles on both sides of the oil cooler and the three upper attaching bolts inside the forward opening of the scoop.

(c) Drain oil from oil cooler through the drain plug in the bottom of the oil cooler. Use a container of approximately five gallons capacity.

(d) Detach triangular shaped bracket (8) from aft cooler support (10). *(See figure 156.)*

(e) Disconnect the "oil in" line from fitting (4) at the forward end of cooler.

(f) Disconnect the "oil out" line from fitting (9) at the aft end of the pressure valve on top of the cooler.

(g) Mark with pencil the position on the engine mount of the aft sling of the oil cooler. This pencil mark is to be used to locate the aft sling when installing the oil cooler assembly.

(h) Remove the two screws and nuts (7) attaching the aft end of the cooler to the engine mounts.

(i) Remove the screws and nuts (2) attaching both ends of the forward supporting sling (11) to the exhaust collector shroud.

(j) Lower oil cooler carefully to avoid damaging any surrounding equipment.

(3) MAINTENANCE.

(a) Clean cooler by thoroughly flushing with hot running water or steam.

(b) If the cooler is to be installed immediately after washing, it must be first thoroughly dried, either

by immersing with all ports open, in hot, light engine oil of approximately 121°C (250°F) until all bubbling ceases when cooler is agitated or by baking in a hot oven at a temperature from 121° to 135°C (250° to 275°F) for approximately an hour.

(c) Plugged air passages and collapsed core tubes cause oil overheating. Remove all obstructions and replace defective tubes according to instructions in General Manual for Structural Repair (AN 01-1A-1).

(d) Overtightening of mounting clamps may cause leaks in core face between core and shell. Repair according to instructions in General Manual for Structural Repair (AN 01-1A-1).

(e) Replace oil cooler if internal engine failure has been encountered, as this type of failure introduces metal particles into oil system.

(4) INSTALLATION.
(See figure 156.)

(a) Attach the support assembly (10) to oil cooler by means of the aft sling. Tighten nut sufficiently to prevent vibration, but be careful not to crush shell.

(b) Install fittings (4) and (9) in the oil cooler port and valve port.

(c) Raise oil cooler assembly into position and insert bolt on the starboard side through the forward sling and the exhaust collector shroud.

(d) Secure port side of the forward sling by means of the screw and nut (2). Tighten nut sufficiently to prevent vibration, but be careful not to crush shell.

(e) Secure starboard side of forward sling by means of a self-locking nut.

(f) Attach bracket (10) to the engine mount by means of the two clamps (7). Make certain that the bracket lines up with the pencil marks which were placed on the engine mount tube before removal of the oil cooler.

(g) Attach "oil out" hose to fitting (9) and "oil in" hose to fitting (4). Secure hoses to the fittings with hose clamps.

(h) Attach triangular bracket (8) to oil cooler support (10) with bolts and nuts.

(i) Install oil cooler air scoop by reversing removal procedure as outlined in paragraph *c*, (2), *(b)*.

(j) Close and secure accessory cowl panels aft of the cowl flaps.

(k) Check hose connections for leaks after installation.

d. PRESSURE RELIEF VALVE.

(1) DESCRIPTION.—The valve is a spring loaded relief valve in series with the oil cooler warming jacket. The valve is operated in response to oil-pressure drop across the cooler core. The oil from the engine enters the oil cooler at the pipe thread connection on the mounting flange and the oil from the cooler to the tank leaves through the pipe thread connection in the relief valve housing. The oil flows around the jacket to the relief valve port. If the pressure value of the relief valve is less than the pressure drop through the core, the relief valve opens allowing the oil to bypass the core; otherwise, the oil must flow through the oil cooler core.

(2) REMOVAL AND DISASSEMBLY.
(See figure 157.)

(a) Remove oil cooler as outlined in paragraph *c*, (2).

(b) Break the lock wire and remove the eleven screws (4) and (6) attaching the valve to the top of the oil cooler (12).

(c) Remove valve and the two gaskets (8) and (9).

(d) Unscrew cap plug (1) from top of valve.

(e) Remove gasket (2), tension spring (3), and valve plunger (5) from opening in valve.

(3) MAINTENANCE.

(a) Clean all parts thoroughly with white gasoline.

(b) With the relief valve port uppermost, fill the port with oil, (Specification AN-VV-O-446, grade 1120) at room temperature. The valve should retain the oil.

(c) With the relief valve port uppermost, fill the port with gasoline. The valve should retain the gasoline.

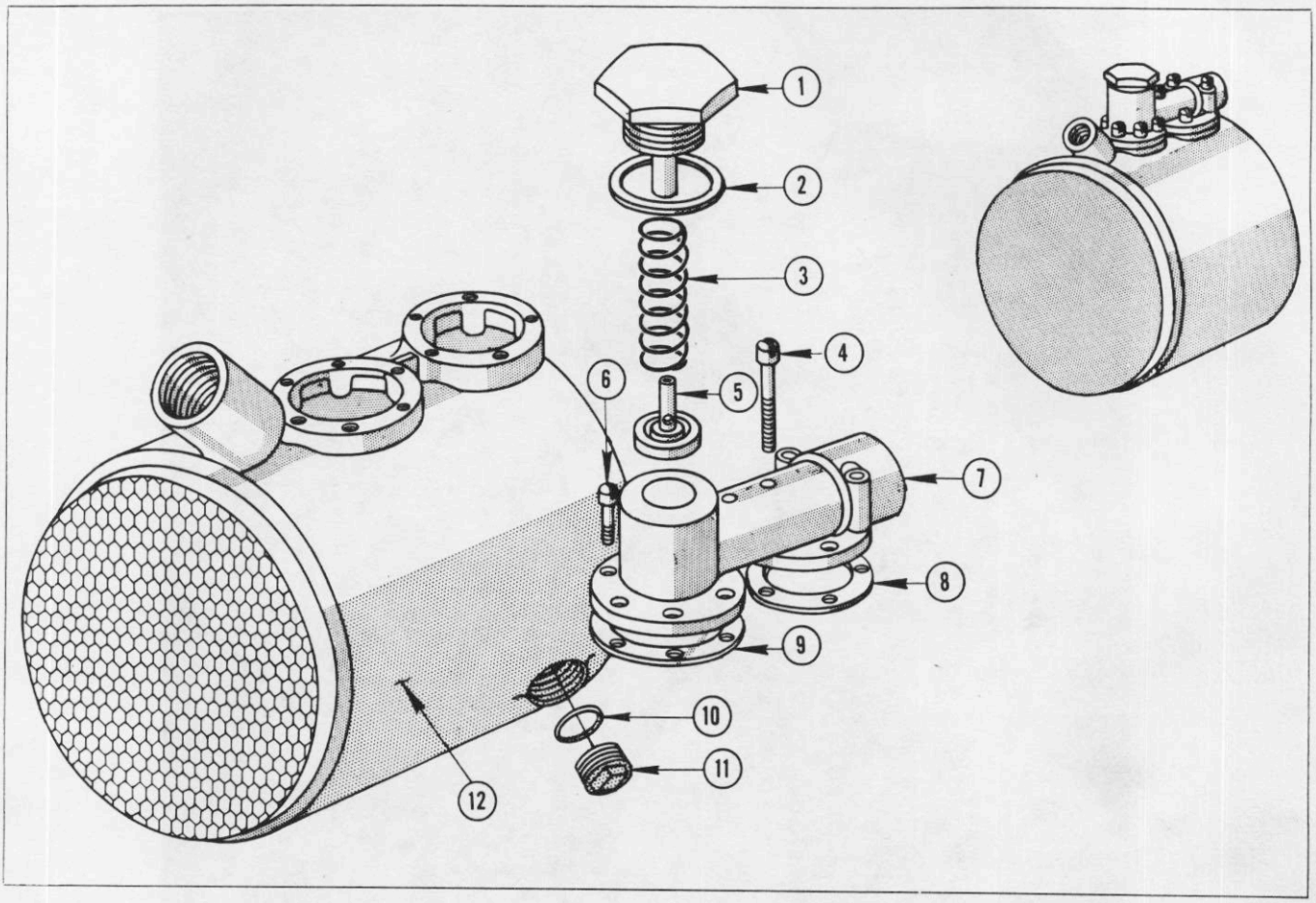
(d) Check alignment of valve to seat; check valve wear, and seat wear. Replace valve if parts are worn.

(4) ASSEMBLY AND INSTALLATION.—To assemble and install, reverse the procedure as outlined in paragraph *d*, (2). Attach bonding wire under head of aft attaching bolt (4).

e. AUTOMATIC TEMPERATURE CONTROL UNIT.

(1) DESCRIPTION. *(See figure 154.)*—A Pratt and Whitney, Type B-1, automatic oil temperature control unit is mounted across the inlet and outlet ports of the oil tank sump. This thermostatic device automatically regulates the temperature of the oil entering the engine to a predetermined setting. The thermostatic valve is set to open at 66°C (150°F) and is fully open at 77° C (170°F).

When the oil is cold (below 66°C (150°F)) the thermostatic valve directs the outlet oil from the engine to the bottom of the hopper through the sump. Consequently, the warm oil coming from the engine will be drawn into the suction line feeding the oil pressure pump. This process continues until the oil entering



No.	PART No.	NAME	No.	PART No.	NAME
1	UA-3255	Cap	7	UA-3256-2	Body Assembly
2	UA-3258	Gasket	8	UA-3156	Gasket
3	UA-400492	Spring	9	UA-3157	Gasket
4	UA-3158	Screw	10	AN900-16	Gasket
5	UA-3253	Valve	11	AC909-16	Plug
6	UA-3159	Screw	12	UD-6012-C	Oil Cooler Assembly

Complete Relief Valve Assembly number is UB-3250-130.
All numbers listed above are United Aircraft Products Co. part numbers.

Figure 157—Oil Cooler and Relief Valve

the engine reaches the desired temperature, at which time the automatic valve directs sufficient oil through the oil cooler, and thence to the top of the oil tank to maintain the desired temperature.

The automatic control unit contains a check valve at the point where the engine return oil line connects to the unit. This check valve prevents oil flowing from the tank into the scavenger system of the engine when the engine is not in operation.

The control unit may be set and locked in position so that all return oil from the engine is directed to the cooler. To accomplish this, loosen the lock nut on the end of the thermostatic control shaft and turn shaft clockwise until it bottoms on the stop provided for this position. Tighten the lock nut and safety with brass wire. This provision is only used, however, on special flights to test cooler capacity. On satisfactory completion of the oil test, the unit should be readjusted to operate automatically.

(2) REMOVAL AND DISASSEMBLY.
(See figure 154.)

(a) Open accessory cowl panels by loosening the Dzus fasteners.

(b) Drain oil tank by means of the drain valve (3). Container into which oil is drained must have capacity of approximately 70 U. S. (58.3 Imp.) gallons.

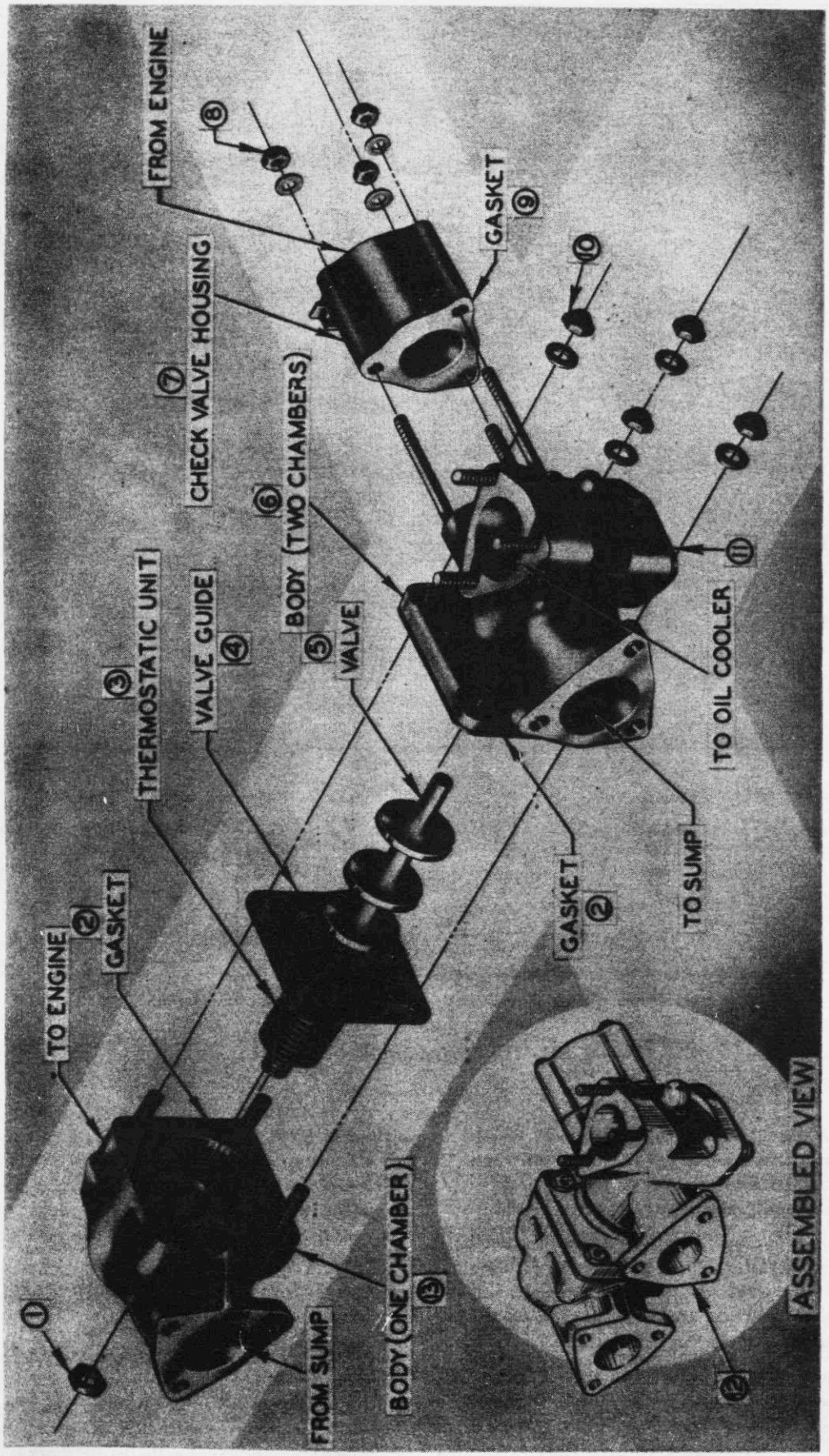


Figure 158—Automatic Oil Temperature Control Unit

No.	PART No.	NAME	No.	PART No.	NAME
1	A-11651	Nut	8	A-33415	Nut
2	A-11650	Gasket		A-172	Washer
3		Thermostatic Unit	9	A-24895	Gasket
4	A-11437	Valve Guide	10	A-33415	Nut
5	A-24908	Valve		A-172	Washer
6	C-24808	Body (Two Chambers)	11	A-24811	Cover
7	B-24989	Check Valve Housing	12	B-25016	Control Unit
			13	C-24807	Body (One Chamber)

All numbers listed above are Pratt & Whitney Aircraft part numbers.

(c) Disconnect the "to engine" line (23) from nipple at top of drain valve, the "from engine" line (4) from the forward end of the automatic temperature control unit, and the oil line (24) to oil cooler from top of temperature control unit (2).

(d) Disconnect oil dilution fuel line (20) from the drain valve.

(e) Remove the six bolts which attach the temperature control unit to the mounting flanges of the sump.

(f) Remove the temperature control unit and the drain valve.

(g) Disassemble automatic temperature control unit as follows:

(See figure 158.)

1. Remove drain valve by detaching the three nuts which fasten it to the control unit.

2. Remove the four nuts (10) holding the thermostatic unit housing (13) and the valve housing (6) together; separate the two housings.

3. Disassemble nut (1) from the end of the thermostatic unit (3) and unscrew unit from body.

4. Remove the three nuts (8) holding the check valve housing (7) from the body (6) which houses the valve and separate.

(3) MAINTENANCE.

(a) Clean all parts with white gasoline.

(b) If the thermostat does not operate within its predetermined limits of 66°C (150°F) to 77°C (170°F), replace the thermostat.

(c) If the valve seats and valves are worn or damaged, replace the necessary part or parts.

(4) TEST BEFORE INSTALLATION.

(a) Circulate oil through the unit at the temperature of the lower setting, 66°C (150°F). With continued operation at this temperature the valve should be just starting to open, although no oil should be allowed to pass through the outlet to which the oil cooler normally connects.

(b) Next, circulate oil at the temperature of the higher setting, 77°C (170°F). The valve should move to and remain in the "open" position which will direct all of the oil through the outlet to the cooler.

(c) The check valve and seat may be tested for leakage at the time of overhaul as follows: Subject the valve to 180 viscosity oil under pressure of 3 lb/sq in. If the valve leaks in excess of one ounce in 24 hours, the faces of both the valve and the valve seat in the casting should be machined to obtain a perfect seat.

(d) The tension of the spring against the valve may also be checked by connecting a head of 180 viscosity oil to "oil from pump" flange of the unit so that with gravity assisting the valve to open, the valve should not open with a five inch oil head nor should remain closed under a 30 inch oil head.

(5) ASSEMBLY AND INSTALLATION.

(See figure 158.)

(a) Assemble gasket on each side of the valve guide and gasket on the threaded end of the thermostatic unit.

Note

Use new gaskets on assembly and installation of unit where possible.

(b) Assemble thermostatic unit (3) in body (13) and fasten with nut (1).

(c) Assemble body (13) and body (6) and fasten them together with washers and nuts (10).

(d) Place check valve housing on the three studs projecting from the valve housing (6).

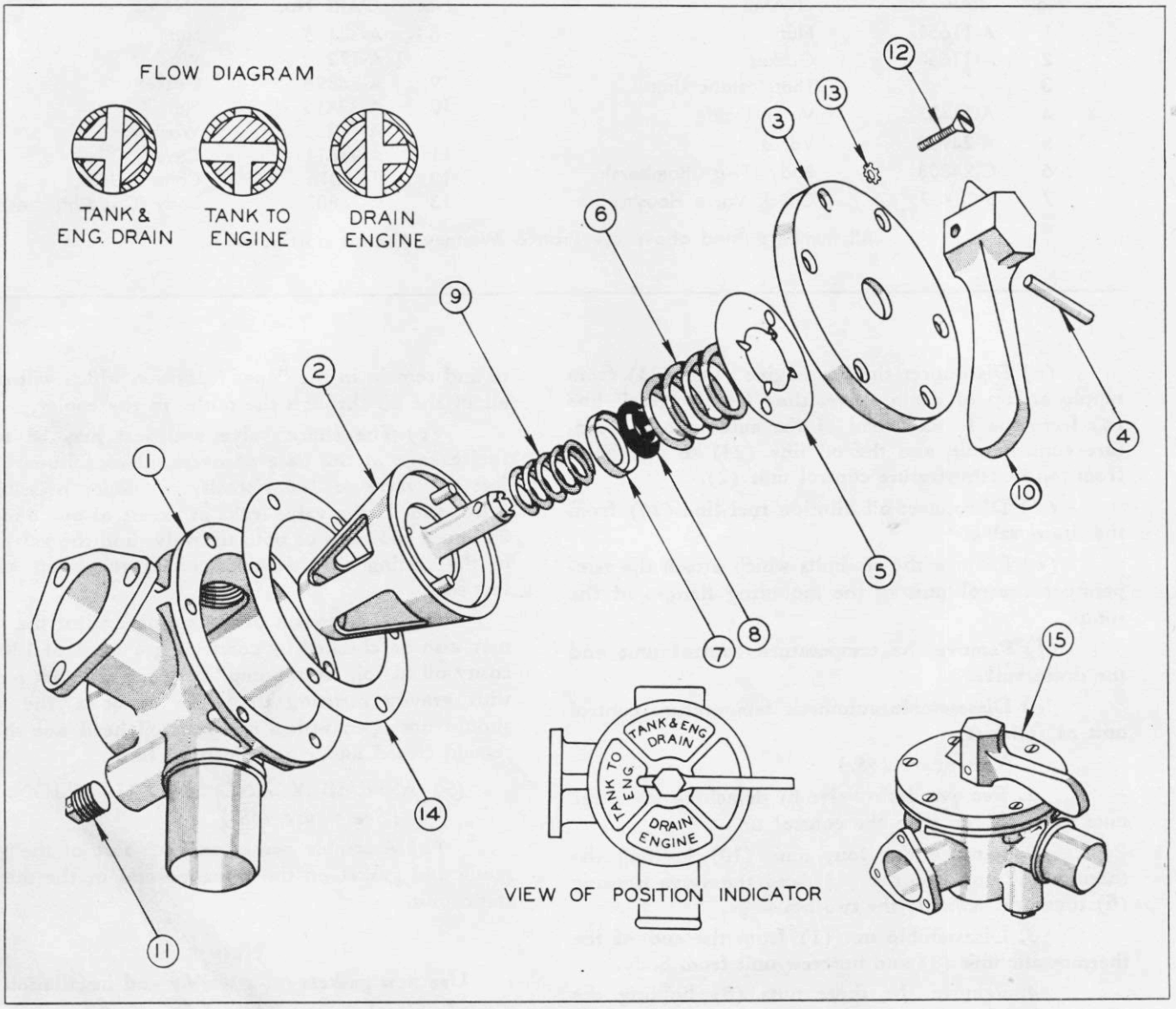
(e) Place fitting (4) on the check valve housing and secure it with three nuts and washers. *(See figure 154.)*

(f) Attach the "to cooler" fitting (24) to the thermostatic unit housing by means of three nuts and washers.

(g) Attach drain valve to the unit.

(h) Install unit on the oil tank by means of six bolts and nuts.

(i) Connect "from engine" line to fitting (4), "to oil cooler" line to fitting (24) and "to engine" line to drain valve (3).



No.	PART No.	NAME	No.	PART No.	NAME
1	1141104	Body	9	74113	Spring
2	34139	Stem Assembly	10	63857	Handle
3	34190	Cover Assembly	11	AC895-71	Plug—Drain
4	AN385-2-8	Pin	12	AN505-10-12	Screw
5	341116	Plate	13	AN936-C10	Washer
6	74114	Spring	14	43770	Gasket
7	34138	Ring—Spring Retaining	15	114153	Valve Assembly
8	34A3590-10	Rubber Ring			

All items except 4, 11, 12 and 13 listed above are Aero Supply Mfg. Co. part numbers.

Figure 159—Oil Drain Valve

(j) Connect oil dilution fuel line to the drain valve.

(k) Place drain valve in "Tank to Engine" position and safety-wire it. Safety-wire plug in drain opening.

(l) Close accessory cowl panels.

(6) OPERATIONAL CHECK.—Ground operation and a flight check will be necessary to verify the correct functioning of the temperature control unit.

f. OIL DRAIN VALVE.

(1) DESCRIPTION.—An Aero Supply Mfg. Co., Inc. drain valve is installed on the left-hand port of the automatic temperature control unit in the line to the engine. This valve has positions of "DRAIN ENGINE," "TANK TO ENGINE ON," and "TANK AND ENGINE DRAIN." The valve is provided with a one-inch National Pipe Thread drain port at the bottom for the attachment of hose or tubing when draining the oil system. The valve is also provided with a ¼-inch National Pipe Thread port for the attachment of a fuel line to introduce fuel into the oil system for oil dilution.

(2) REMOVAL AND DISASSEMBLY.
(See figure 154.)

(a) Open accessory cowl panels for access to the drain valve.

(b) Place valve in "TANK AND ENGINE DRAIN" position in order to drain oil from the engine and the tank. Container into which oil is drained should have a capacity of approximately 70 U. S. (58.3 Imp.) gallons.

(c) Disconnect "oil to engine" line (23) and oil dilution line (20) from the valve.

(d) Remove valve by detaching the three nuts which fasten it to the temperature control unit.

(e) Disassemble valve as follows:
(See figure 159.)

1. Drive out taper pin (4) and remove handle (10).

2. Detach cover (3) by removing the six screws (12).

3. The remaining parts of the valve may now be removed.

(3) MAINTENANCE.

(a) Clean parts thoroughly with clear gasoline.

(b) If the sides of the cone or housing are rough or scratched slightly they may be lapped smooth, using a fine grit lapping compound. If the scratches are too deep to remove by lapping replace the valve or the effected parts.

Note

After lapping, clean parts thoroughly so that all lapping compound is removed from the valve.

(4) ASSEMBLY AND INSTALLATION.

(a) Assemble valve as follows:
(See figure 159.)

1. Insert cone (2) into body (1) so that all ports of the valve are open.

2. Place spring (9), spring retaining ring (7), rubber ring (8), spring (6) and indexing plate (5) on cone stem in that order. Holes in indexing plate (5) must line up with pins in cone.

3. Place gasket (14) on body (1) and install cover (3) so that the dial is in the position indicated in figure 159.

4. Tighten cover screws (12) uniformly.

5. With cone set so that all ports are open, install handle (10) so that it points to "TANK AND ENGINE DRAIN." Secure handle by means of the taper pin (4).

(b) Install valve in the airplane by reversing the removal procedure as outlined in paragraph *f*, (2), *(a)* through *f*, (2), *(d)*.

g. OIL DILUTION SYSTEM.

(1) DESCRIPTION.—*(See figure 154.)*—An oil dilution system is provided for each engine to assist in cold weather starting. This system permits fuel from the carburetor to be admitted into the oil system at the oil drain valve. A solenoid operated valve controls the flow of fuel into the oil system. This solenoid is mounted on the oil tank and shut-off cocks are provided in the fuel line at the solenoid and at the oil drain valve. The solenoids are controlled by toggle switches on the engineer's instrument panel.

(2) REMOVAL AND DISASSEMBLY
(See figure 154.)

(a) Open accessory cowl panels for access to the oil dilution system.

(b) Disconnect line (15) from the solenoid valve by loosening the hose clamp and slipping hose from the fitting.

(c) Disconnect line (19) at valve (16) and line (20) at valve (3).

(d) To remove lines (19) and (20) separate them at connection and detach the clips which fasten them to the oil tank. When removing lines exercise care so that the lines will not be damaged.

(e) Remove the three bolts which fasten the micarta valve support to the oil tank.

(f) Break safety wire and remove wing nut and washer from the top of the solenoid (18).

(g) Lift cap from the solenoid and disconnect wire from terminal under cap.

(h) Loosen knurled conduit nut and pull conduit and wire from the solenoid cap.

(i) Remove solenoid by detaching clamps (17) from the bracket on the oil tank.

(j) Screw valves (16) from fittings on the oil drain valve and the solenoid.

Note

Fittings cannot be removed from the oil drain valve unless the valve is detached from the oil temperature control unit.

(k) Disassemble valve (16) as outlined in Par. 15, *b*, (11), *(b)*, *8*.

(3) MAINTENANCE.

(a) OIL DILUTION SOLENOID.

1. If valve leaks, operate switch on engineer's instrument panel several times. If this does not stop the leak, replace the solenoid.

2. Tighten mounting bolts and check fittings for leaks, tightening them or replacing them if necessary.

(b) OIL DILUTION SHUT-OFF VALVES. (Refer to Par. 15, *b*, (11), *(c)*.)

(4) TEST BEFORE INSTALLATION. — Connect the terminal of the oil dilution valve to a 24-volt circuit and operate the valve. Check to see that valve opens and closes.

(5) ASSEMBLY AND INSTALLATION. *(See figure 154.)*

(a) To assemble oil dilution shut-off valves, refer to Par. 15, *b*, (11), *(d)*, *1*.

(b) Connect valves (16) to the fittings on the oil drain valve and the solenoid.

(c) Attach solenoid (18) to the oil tank by means of the two clamps (17).

(d) Thread wire through hole in cap of the solenoid and attach the wire to the terminal in the top of the solenoid.

(e) Attach conduit to the cap by means of the knurled conduit nut and replace cap on the solenoid. Secure cap by means of the washer and wing nut. Safety-wire wing nut.

(f) Install the split micarta block which supports valve (16) by means of the three bolts.

(g) Attach line (19) to valve (16) and line (20) to valve (3).

(h) Connect lines at fitting (20) and clip lines to oil tank structure.

(i) Attach hose (15) to the solenoid by slipping hose over fitting and tightening hose clamp.

(j) Close accessory cowl panels.

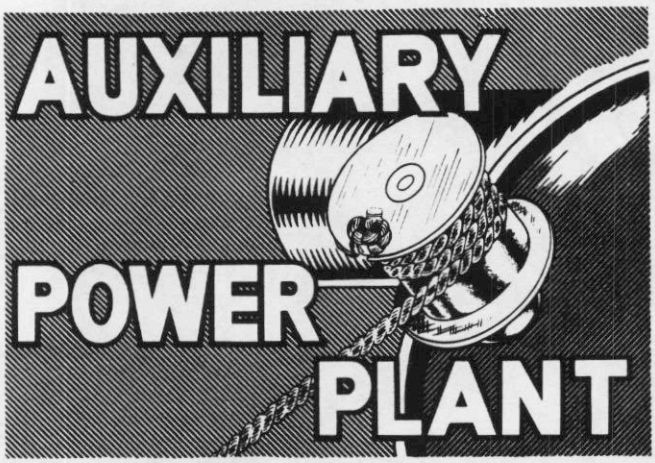
(6) OPERATIONAL CHECK.

(a) Operate engines.

(b) Operate the oil dilution switches momentarily. The fuel pressure gage should show a drop while the oil dilution switch is on; that is, if the oil dilution valve and line are functioning properly.

★ ★ ★

PARAGRAPH 17.



17. AUXILIARY POWER UNIT.

a. GENERAL.—Inasmuch as the auxiliary power unit installations for the PBY-5 and PBY-5A airplanes are different, they will be treated separately in the following paragraphs. Their purpose, however, is the same in that they supply an additional source of electric power for the operation of the various electric units in the airplane.

(1) The auxiliary power unit installation for the PBY-5A airplanes is an Eclipse Aviation No. 699-1-A, Navy Type NEP-2 and is mounted on the port side of the airplane aft of bulkhead 4. It includes the following equipment:

Navy Type NEG-2 power unit (Eclipse 542-2-A).

Navy Type NED-1 bilge pump (Eclipse 543-1-A).

Navy Type NEB-1D generator (Eclipse 638-1-A).

Navy Type NF-1D voltage regulator.

Eclipse number C-57461 auxiliary float chamber.

Oil tank.

Fuel for the A.P.U. is obtained from the main aircraft supply tanks.

(2) The auxiliary power unit installation for the PBY-5 airplanes is mounted on the starboard side of the airplane forward of bulkhead 5 and comprises the following equipment:

Navy Type 1-A, Lawrance Model 30D power unit.

Navy Type NEA-3 generator.

Eclipse Type 1002, Model 1 D. C. voltage regulator.

Eclipse Type 1001, Model 2 A. C. voltage regulator.

Oil tank.

Lux fire extinguishing equipment.

Fuel for the A.P.U. is obtained from the main aircraft supply tanks.

b. ENGINE.

(1) PBY-5A AIRPLANES.

(a) DESCRIPTION.—The Eclipse Aviation, Navy Type NEP-2 Auxiliary Power Unit is a 4-horsepower, single-cylinder air cooled engine. It drives an electric generator (attached to the aft of the engine) at engine crankshaft speed to produce a continuous power output of 0.84 KW alternating current and 1.71 KW direct current. Engine cooling is effected by a fan mounted on the engine drive shaft at the aft end of the engine. A housing around the fan and cylinder directs the cooling air around the cylinder fins and exhausts it against a baffle plate at the front. The starter pulley is a grooved pulley on the drive shaft immediately aft of the fan. A slot on the aft side of the pulley holds the clip end of the starter rope. A small guide pulley is also installed on the inboard side of the engine to prevent chafing of the rope against the housing during starting operations. An asbestos covered flexible exhaust pipe attached to the cylinder head conducts the exhaust gases to the outside through a hole in the port side of the hull, slightly aft of bulkhead 4. The engine is continuously governed by an automatic and remote control system which eliminates the necessity for constant attention from the crew or flight engineer. The auxiliary power unit is shock-mounted to its support stand.

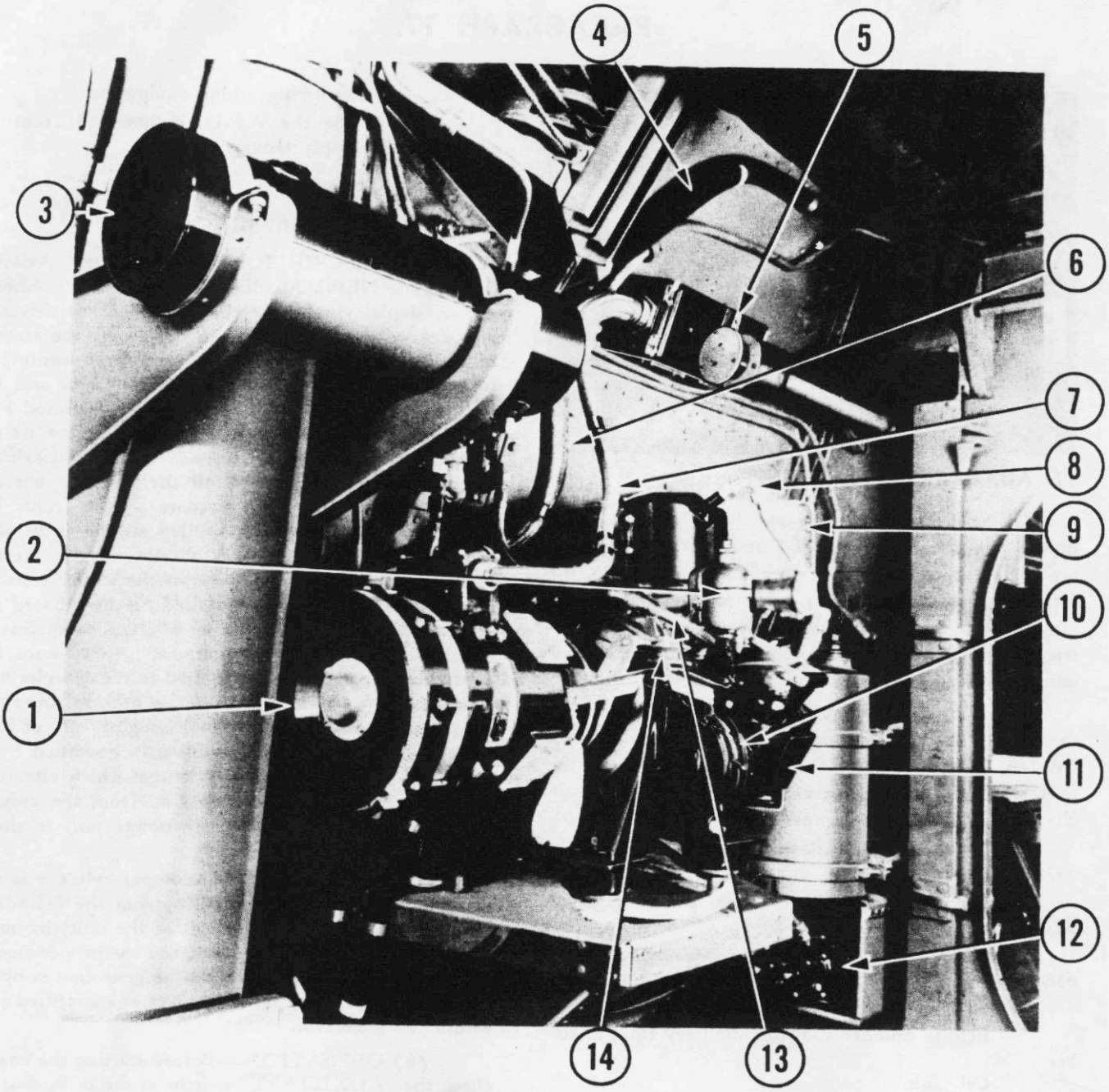
Lubricating oil for the upper cylinder is supplied to the carburetor air horn from the cylindrical oil tank (mounted above and aft of the unit) by means of an integral oil pump which meters the proper amount of oil required. Lubrication of the gear case is by the splash method; oil being maintained at a specified level within the gear case.

(b) OPERATION.—Before starting the engine, check the "AUXILIARY" switch on the main distribution panel and determine that it is in the "OFF" position. Keep this switch "OFF" whenever the engine is not running, and when starting. This procedure will insure against possible discharge of the main battery or a burn out of the generator. Turn the valve on the flight engineer's panel marked "AUXILIARY POWER UNIT," to "MAIN TANK." This allows gasoline from the main tank to flow to the auxiliary float chamber.

1. STARTING THE ENGINE.—To start engine when cold, proceed as follows:

a. Set carburetor choke lever to the position marked "CHOKE."

b. Place starting rope under the guide pulley and insert the clip end into the slot provided on



No.	PART No.	NAME	No.	PART No.	NAME
1	NEB-1D	Generator	8	81808	Spark Plug
2	D-51802	Carburetor	9	28F4094	Cooling Air Deflector
3		Oil Tank	10	NEP-2	Auxiliary Power Unit
4	AN878-6-160	Hose—Fuel Line	11	80761	Scintilla Magneto
5	NF-2D	Voltage Regulator	12		Prop. Anti-Icing Fluid Pump
6		D. C. Cable	13	28F2111-10	Fuel Line
7		A. C. Cable	14	28F4136	Starter Rope Guide Pulley

Items 2, 9 and 11 are Eclipse Aviation part numbers.

Figure 160—Auxiliary Power Unit (PBY-5A)

the starting pulley and turn pulley until the starting rope is completely wound around the pulley. Firmly grasp the handle of the starting rope and with rope bearing against the guide pulley, pull the rope through with a firm snap to start.

c. After the engine starts, turn the choke lever to the position marked "RUN". Should the engine fail to start, move the choke lever to the position marked "RUN", then crank the engine with the starting rope until the engine starts. If the engine fails to start with the choke in "RUN" position, the engine may be flooded.

d. To drain off excess gasoline, open the petcock at the bottom of the compression chamber and with the choke in "RUN" position, turn the engine over several times with starting rope to expel all excess gasoline. Close compression chamber petcock, place choke in "RUN" position, and apply starting rope.

e. If engine fails to start after several attempts, check engine as outlined under paragraph *b*, (1), *(d)*, *5*, b.

f. To start a warm engine, turn choke to "RUN" position and apply starting rope.

g. Although the above starting instructions will under normal conditions provide quick starting, an experienced operator may find that for a given engine slight variations in choke settings may be necessary in order to facilitate starting.

CAUTION

Do not alter the carburetor idling or main jet needle valve setting between major overhaul periods as they are properly adjusted prior to shipment of engines from the factory.

h. Under some cold conditions, when the engine cannot be started by the above procedure, the main battery or engine generator output, if available, may be used to assist the manual starter. Throw both the battery or generator bus selector switch and the auxiliary power unit bus selector switch to bus "A" or "B". Wind the starting rope on the starting pulley as described above. Open the main distribution panel and locate the auxiliary power unit relay which is the second from the right, facing the panel. Station a man to operate the relay and one to pull the starter rope. While one man pulls the rope, the other must manually hold in the relay contacts. If the engine does not start, release the contacts and repeat the procedure. After starting in the above manner, disconnect the auxiliary generator circuit from the power busses until its voltage has reached 28.5 volts.

CAUTION

Never hold the relay contacts in unless the engine is rotating. So doing rapidly discharges the battery, and will probably burn out the generator windings. The above procedure is not recommended except in cases of necessity, because it creates a severe drain on the main battery, if it is used.

2. LOADING THE ENGINE.—After the engine has started, turn the voltmeter selector switch on the main distribution panel to "AUX GEN" and read the voltage on the voltmeter. Do not connect the generator to the power circuit until it shows a reading of 28.5 volts, which it should reach as soon as the engine starts running smoothly.

3. STOPPING THE ENGINE.—The following is the recommended procedure for stopping the engine:

a. Remove all load from the generator.

b. Allow the engine to idle for ½ minute.

c. Shut off the fuel by closing the valve in the fuel supply line and allow the engine to idle to a stop. Valve handle is on the engineer's instrument panel.

d. A grounding button is provided on the rear cover of the magneto for emergency or sudden stopping of the engine. It is recommended, however, that under normal operating conditions, the engine be stopped by the method outlined in paragraphs *3 a* through *3 c* above.

4. RUN-OUT ON UNLEADED FUEL.—Whenever the auxiliary power unit is to remain idle for one week or more, or when it is to be removed from the airplane, it should be run-out for a period of 30 minutes with no load on clear, unleaded fuel to lessen the possibility of internal corrosion. Refer to Specification AN-F-E-568 for instructions on preparing the engine for storage.

(c) REMOVAL.—To remove the auxiliary power unit, the following procedure is outlined: *(See figure 160.)*

1. Check the fuel valve on the engineer's panel for "OFF" position.

2. Disconnect the fuel line (13) at the fuel strainer. If it is desired to disconnect the line from the engine, remove the clamp on the back of the engine before disconnecting at the carburetor.

3. Close the oil valve below the oil tank and disconnect the oil line at the tank end.

4. Disconnect the oil line at the metering pump and drain the line.

5. Remove the cover from the terminal box at the top of the generator (1) and disconnect the wires leading in through D.C. (6) and A.C. (7) cables. Unscrew the knurled nuts and disconnect the cables from the box. Remove the clamps holding the cables to the engine.

6. Remove the air deflector (8), loosen the clamp on the exhaust tube and pull off the exhaust tube.

7. Loosen the clamp screw on the bilge pump tube and pull off the tube.

8. Remove the four ⅜ inch nuts from the mounting bolts. The unit may then be lifted from its support.

9. Because of restricted space and difficult

walking conditions inside the hull, two men should be available to lift and remove the unit from the plane.

(d) MAINTENANCE.

1. PREPARATIONS FOR STARTING.—Before starting the engine for the first time each day, the following checks should be made.

a. Check all electrical connections for security of attachment.

b. Make a final check of all nuts and bolts on both the engine and the engine mount to make sure that they are tight and properly safetied.

c. Make sure that the oil tank is filled with lubricating oil (Specification AN-VV-O-446, grades 1065 to 1100).

d. Check the oil level in the gear case by removing filler plug. If the oil level is below the filler hole, fill with oil (Specification AN-VV-O-446, grades 1065 to 1100). Replace filler plug.

2. 25-30 HOUR MAINTENANCE.—After every 25-30 hours of operation, the engine should be inspected and serviced in accordance with the following procedure:

a. FUEL SYSTEM.—Drain carburetor at sediment bulb located at the base of the carburetor. Remove strainer from the inlet side of the carburetor and clean with compressed air.

b. SPARK PLUG.—Remove and clean spark plug and check gap which should be .025 inch. Be sure copper gasket is in place when installing the spark plug. Replace spark plug if points are badly burned, or if otherwise defective.

c. Remove the magneto breaker housing cover and wipe the interior of the breaker housing with a gasoline moistened cloth to remove any dirt or oil. Clean contacts by inserting a piece of clean paper between them, pressing the contacts together, and pulling out the paper. However, if the contacts are pitted or corroded, they should first be smoothed with an ignition file or crocus cloth and then cleaned with paper. Excessively pitted or burned contacts indicate faulty condenser operation and replacement of the condenser should be made. Reset the contact gap to .018 inch when full open.

d. COMPRESSION CHAMBER.—Open the petcock at the bottom of the compression chamber and drain off any accumulation of oil or gasoline. Be sure to close petcock after draining.

3. 50-60 HOUR MAINTENANCE.—After every 50 to 60 hours of operation, the engine should be inspected and serviced in accordance with the following procedure, in addition to the 20 to 30 hour procedure outlined above.

a. GEAR CASE.—Drain and flush the gear case with flushing oil by removing the drain plugs located at the bottom of the gear housing on each side and in the front directly behind the compression chamber drain cock. Replace drain plugs and refill to proper level with engine oil (Specification AN-VV-O-446, grades 1065 to 1100). Replace filler plug.

b. CARBURETOR AIR SCREEN.—Remove the carburetor air horn assembly and clean thoroughly with gasoline and compressed air.

c. GOVERNOR SETTING.—Run engine and check for variation in speed at no load and full load. Engine speed should be between 3800 and 4200 rpm. Should the speed variation exceed the above limits, the governor should be readjusted by turning the spring adjusting nut on the governor housing in a clockwise direction to increase the speed, or in a counterclockwise direction to decrease the speed. Lock the adjusting nut in place with the locknut after resetting.

d. EXHAUST TUBING.—To assure engine flexibility, the exhaust tubing between engine and muffler should be checked for carbon formation. If the tubing has become rigid, due to carbon formation, replacement should be made.

4. MAJOR OVERHAUL.—After every 150 hours of operation, the engine should be removed from the airplane and forwarded to a recognized service station or overhaul base, or returned to the factory for overhauling. This procedure constitutes a complete disassembly of the engine involving the use of special tools and equipment available only at the above places.

5. ENGINE TROUBLES AND REMEDIES.

a. GENERAL.—The cause of unsatisfactory engine performance is often difficult to determine because of the similarity of symptoms shown by completely unrelated troubles.

Once a symptom is clear, the most effective procedure is to systematically eliminate every possible cause of that symptom starting with the most probable.

b. TROUBLE SHOOTING CHART.—The following is a list of the troubles most frequently encountered in the field together with their possible causes and remedies. If trouble develops, maintenance personnel should check and eliminate each possible cause as indicated in the following paragraphs:

TROUBLE	CAUSE	REMEDY
(1) Engine fails to start.	(a) Lack of fuel.	(a) Check fuel flow from fuel tank through carburetor.
	(b) Dirty, cracked, or incorrectly adjusted spark plug.	(b) Clean or replace spark plug. Gap should be .025 inch.

TROUBLE	CAUSE	REMEDY
	(c) Dirty, pitted, or improperly adjusted magneto breaker points.	(c) Clean, replace, or adjust magneto breaker points. Gap, full open, is .018 inch.
	(d) Carburetor flooded.	(d) Open the petcock at the bottom of the compression chamber and with choke in "RUN" position, turn the engine over several times with starting rope to expel all excess gasoline.
	(e) Water in fuel system.	(e) Remove carburetor and carburetor fuel lines. Drain, clean, and dry. Use compressed air if available.
	(f) Engine and oil excessively cold.	(f) Drain the oil system. Preheat the oil and refill system.
	(g) Ignition wires incorrectly connected or damaged.	(g) Connect correctly or replace.
(2) Failure of engine to develop full power—uneven running.	(a) Dirty or improperly adjusted spark plug.	(a) Remove spark plug, clean, and adjust or replace. Gap should be .025 inch.
	(b) Dirty, pitted, or improperly adjusted magneto breaker points.	(b) Clean or replace and adjust the magneto breaker points. Gap full open is .018 inch.
	(c) Loose or damaged ignition wires.	(c) Tighten all terminal connections. If wires show signs of damage, remove and test for short circuits. Replace if necessary.
	(d) Poor or uneven compression. *1.* Worn or broken rings. *2.* Cylinder worn or scored; cracked piston head, etc. *3.* Leakage at the cork oil-seal retaining plate located on the crankshaft, the cylinder gasket, or the drain petcock. *4.* Assembly of piston in a reversed position.	(d) Correct at major overhaul base.
	(e) Partial or intermittent stoppage of fuel flow.	(e) Disconnect and clean fuel lines. Remove strainer from the inlet side of the carburetor and clean with compressed air.
(3) Overheating — high oil consumption. (This condition may arise from cause *(d)* of paragraph (2) above.)	(a) Improper grade or dilution of oil.	(a) Drain oil from engine and tank and refill with fresh oil of the proper grade (Specification AN-VV-O-446, grades 1065 to 1100).
	(b) Pre-ignition caused by overheated spark plug or carbon deposit in cylinder.	(b) Correct at major overhaul base.
	(c) Broken cylinder fins.	(c) Correct at major overhaul base.

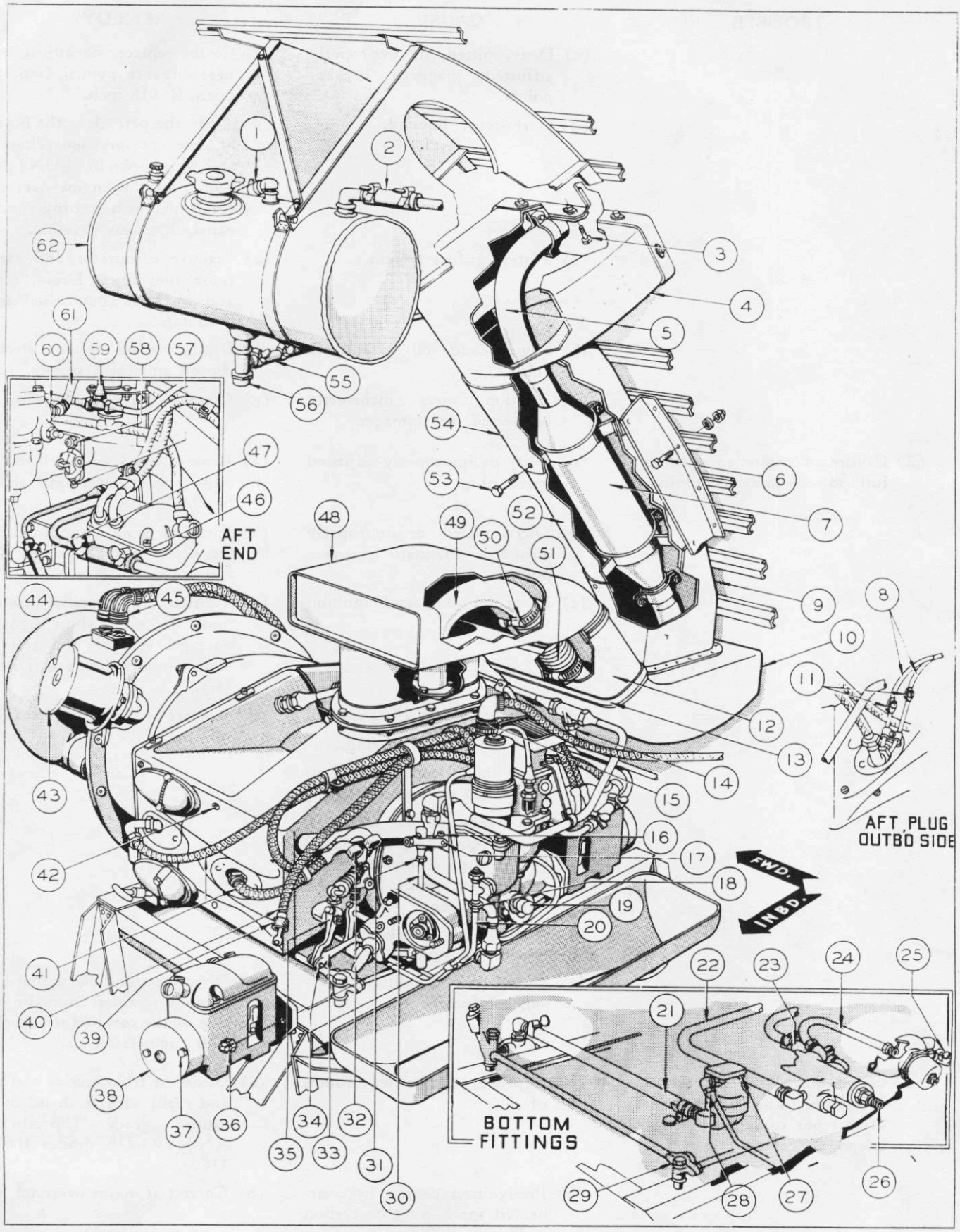


Figure 161—Auxiliary Power Unit (PBY-5)

No.	PART No.	NAME
1	28-O-5036-15	Tube—Oil Vent Line
	AN878-8-15	Hose—Oil Vent Line
	AN748-30	Hose Clamp
2	28-O-5036-16	Tube—Oil Return Line
	AN878-10-15	Hose—Oil Return Line
	AN748-34	Hose Clamp
3	AN3-D5A	Bolt
	Q7102-AL10	Washer
4	28E5263	Outlet Duct—Upper
5	28E5269	Exhaust Tube—Upper
6	AN3-D4A	Bolt
	Q7102-AL10	Washer
	AN365-D1032	Nut
7		Muffler
8	88-L-650 (F.S.C.C.No.)	Thermocouple Lead
9	28E5259	Outlet Duct—Lower Center
10	28E5260-2	Outlet Duct
11		Screws—Thermocouple Lead
12	28E5268-7	Flex Coupling—Outlet Duct
13	CVAC CLA 1-30	Clamp
14		CO_2 Line
15		Ignition Line
16	0510	Screw—Carb. Lever to Carb.
17	11258	Throttle Lever
18		Nut—Fuel Line
19		Tachometer Drive
20	12247	Fuel Line From Pump
21	AN878-6-44	Hose—Fuel Line to Pump
	AN748-26	Hose Clamp
22	28F3100-14	Hose—Oil Pressure Line
23	AN878-10-15	Hose—Oil to Tank Line
	AN748-34	Hose Clamp
24	11630	Oil Line—Heater to Pump
25	AN878-8-15	Hose—Oil to Heater Line
	AN748-30	Hose Clamp
26	88-B-900 (F.S.S.C. No.)	Thermometer Bulb
27	0498	Nut—Fuel Pump Attaching
28		Nut—Fuel to Carb. Line
29	AN6-21A	Bolt—Aft Mounting
	AN6-33A	Bolt—Forward Mounting
	Q818-12-20	Spacer
	AN960-A616	Washer
	AN365-624	Nut
30	12056	Link Rod—Throttle Lever
31	0528	Lock Nut—Link Rod
32		Coupling Nut
33	12236-N2	Link—Governor Control
34	11275	Clevis Pin
35	12249-N2	Lever—Governor Control
36	0499	Nut—Magneto Attaching
37		Bolt—Breaker Cover
38		Magneto Breaker Cover
39		Coupling Nut
40	15920	Magneto Ground Line
41	14356-2	Cable—Rear Plug No. 1 Cylinder
	14356-1	Cable—Front Plug No. 1 Cylinder
	14356-4	Cable—Rear Plug No. 2 Cylinder
	14356-3	Cable—Front Plug No. 2 Cylinder
42		Fastener—Cylinder Cover
43		Manual Starter Drum
44		A. C. Power Cable
45		D. C. Power Cable
46	AN878-8-15	Hose—Oil Vent Line
	AN748-30	Hose Clamp
	28-O-5036-14	Adapter—Oil Vent Line
47	AN878-4-12	Hose—Dribble Drain
	AN748-22	Hose Clamp
	28E5268-12	Adapter—Dribble Drain
48	28E5260-0	Outlet Duct
49	28E5264	Exhaust Tube
50	AN748-66	Clamp
51	28E5437	Flex Tube—Exhaust
52	28E5111-2	Outlet Duct
53	AN3-4A	Bolt
54	28E5261	Outlet Duct
55	28-O-5036-12	Tube—Oil to Heater
	AN878-8-15	Hose—Oil to Heater Line
	AN748-30	Hose Clamp
56	3152-2-½D	Cap—Oil Drain
	3141-5-1OD	Fitting—Oil Tank
57		Stop Screw
58	0498	Nut—Carb. Attaching
59		Luxstat—Diaphragm Line
60		Nut—Choke Meter Line
61	01419-N1	Choke Meter Line
62	28-O-5021	Oil Tank

Item 56 gives Parker Appliance Co. part numbers.

Items 16, 17, 20, 24, 27, 30, 31, 33, 34, 35, 36, 40, 41, 58 and 61 are Lawrance Engineering & Research Corp. part numbers.

(e) **INSTALLATION.**—To install the auxiliary power unit, the following procedure is outlined: *(See figure 160.)*

1. Place unit on its mount with ½ inch long spacers between the mount and the unit. Secure unit to mount with nuts and washers.

2. Slip bilge pump tube over fitting on the pump and secure it with a hose clamp.

3. Connect the exhaust tubing to the engine flange. It will be necessary to enlarge the end of the exhaust tubing by twisting in a direction opposite to the spiral. After attaching the tubing, twist in the opposite direction to tighten on the tubing pilot and clamp in place.

4. Install air deflector (8).

5. Remove the cover from the terminal box at the top of the generator (1) and connect the wires leading in through the D.C. (6) and A.C. (7) cables to the terminals in the box. Tighten knurled nuts attaching cables to the box. Clip cables to the engine.

6. Connect the oil line to the oil metering pump on the forward end of the engine.

7. Connect the oil line to the oil tank (3).

8. Connect the fuel line (13) to the carburetor and to the fuel strainer. Clip line to engine.

9. Open valve on the bottom of the oil tank and bleed all air from the oil line to the pump by removing the air bleeder plug adjacent to the inlet connection at the pump and allowing the oil to flow until a steady stream is obtained. Replace bleeder plug.

10. Fill the gear case to the level of the filler hole with oil (Specification AN-VV-O-446, grades 1065 to 1100). The combination filler and oil level plug is located directly behind the auxiliary drive on the right side of the engine (facing the oil metering pump).

(2) PBY-5 AIRPLANES.

(a) DESCRIPTION.—The U. S. Navy Auxiliary Power Unit, Type 1-A, Lawrance Model 30D, is a 10-horsepower, two-cylinder, horizontally-opposed four-stroke-cycle, air-cool engine. It drives an electric generator attached to the front of the engine at engine crankshaft speed to produce a continuous power output of 1.71 KW direct current and 1.22 KW alternating current. Engine cooling is effected by an axial flow cooling fan which forces air around the cylinders and adjacent crankcase areas. The engine is continuously governed by an automatic and remote control system which eliminates the necessity for constant attention from the crew or flight engineer. The auxiliary power unit is shock-mounted on the starboard side of the airplane forward of bulkhead 5.

Note

The generator end of the engine is referred to as the "front", and the carburetor or magneto end as the "rear". "Rights" and "lefts" are determined by viewing the engine from the rear. The cylinder on the left side and nearest the front of the engine is designated Number 1. The cylinder on the right side is designated as Number 2.

Full pressure, dry sump lubrication is used throughout except for the crankshaft ball bearings, the cylinder walls, and wristpins, which are oiled by spray.

(b) OPERATION.

1. STARTING THE ENGINE.—The engine should be started as follows:

a. Wrap the starting rope around the starter drum in a counterclockwise direction; depress the manual starter rod handle; turn the drum slightly while the handle is being depressed; and then maintain a light tension to keep the starter gear engaged.

b. Turn the ignition switch to "ON" position.

c. Pull the rope through to spin crankshaft.

d. If the engine does not start at the first pull, repeat the process.

e. If, after several attempts, the engine will not start, consult paragraph *b*, (2), *(d)*, 2, b, which gives instructions if engine fails to start.

f. As soon as the engine starts, check the oil pressure gage to see that oil is being circulated under pressure. Normal oil pressure is 55 to 65 lb/sq in.

CAUTION

If the gage does not register normal pressure within 30 seconds after starting, the engine must be stopped immediately and the cause of the trouble determined.

2. ENGINE WARM-UP.—The engine will not attain its rated rpm immediately after starting because a thermostat in the crankcase is connected through a system of linkages to make the governor ineffective until the engine is thoroughly warmed up. The engine speed will gradually increase to 4200 ± 10 rpm with no load, this speed being determined by the governor adjustment at the factory.

During warm-up, the engine oil heater should be turned on. Normal operating temperature should be about 60°C (140°F) and should never be permitted to exceed 88°C (190°F).

Note

After the engine is fully warmed up, the oil heater should be turned off.

3. THERMOSTAT OVER-RIDE CONTROL.—In an emergency, the thermostat over-ride control can be used to immediately advance the engine rpm to operating range. It can also be used in extremely cold weather when the heat developed at idling speed might not be sufficient to actuate the thermostat and allow the engine to attain its normal rpm.

CAUTION

This control should never be used except when absolutely necessary because it does not permit a normal warm-up of the engine and makes the parts liable to excessive wear.

4. LOADING THE ENGINE.—Load may be applied to the generator as soon as engine speed reaches the rated rpm.

5. STOPPING THE ENGINE.—The following is the recommended procedure for stopping the engine:

a. Make sure the heater is turned off.

b. Remove all load from the generator.

c. Allow the engine to idle for ½ minute.

d. Shut off the fuel by closing the valve in the fuel supply line and allow the engine to idle to a stop. Valve handle is on the engineer's instrument panel.

e. Turn the ignition switch to "OFF" position immediately.

Note

This method of stopping the engine is very important as it lessens the possibility of the engine being flooded while not in use.

6. RUN-OUT ON UNLEADED FUEL.—Whenever the auxiliary power unit is to remain idle for one week or more, or when it is to be removed from the airplane, it should be run-out for a period of 30 minutes with no load on clear, unleaded fuel to lessen the possibility of internal corrosion. Refer to Specification AN-F-E-568 for instructions on preparing the engine for storage.

(c) REMOVAL.—To remove the auxiliary power unit, the following procedure is outlined: *(See figure 161.)*

1. Drain oil from tank by removing cap (56) from bottom of oil tank (62).

2. Shut off fuel by closing valve (23) on the engineer's instrument panel. *(See figure 175.)*

3. Disconnect fuel line (21) underneath the engine on the left side by loosening hose clamp. *(See figure 161.)*

4. Disconnect dribble drain line (47) at the rear of the engine by loosening hose clamp.

5. Disconnect the oil pressure line (22) at the bottom of the engine by loosening swivel nut.

6. Disconnect oil-in line (25) on the right side of the engine by loosening hose clamp.

7. Disconnect oil-out line (23) on the right side of the engine by loosening hose clamp.

8. Disconnect oil vent line (46) at the rear of the engine by loosening hose clamp.

9. Disconnect A.C. (44) and D.C. (45) cables from the generator by loosening the knurled nuts and withdrawing the plugs from the receptacles.

10. Disconnect the ignition line (15) at the rear of the engine by unscrewing electrical connector.

11. Disconnect the thermocouple leads (8) attached to the thermocouple on the rear spark plug of No. 2 cylinder by removing tape and loosening screws (11).

12. Remove the oil heater cover by loosening the two nuts on the cover and disconnect wires 1142 and 1143 from the terminals under the cover.

13. Disconnect the oil temperature conduit from the thermometer bulb (26) and located in the aft end of the oil screen chamber by loosening the knurled nut and unplugging the conduit.

14. Loosen clamps (13) and slip flex coupling (12) down until flex exhaust tube (51) is exposed.

15. Loosen clamp (50) attaching flex exhaust tube (51) to the rigid exhaust tube (49) and slide the flex from the rigid tube as far as it will go.

Note

More room may be obtained for loosening of the flex exhaust tube clamp (50) if the bolts which fasten outlet duct to the A.P.U. flange are removed. This will allow the duct to be slid towards the airplane walkway, further exposing the clamp that attaches the rigid and flex exhaust tubes.

16. Disconnect the CO_2 line (14) at the hose connection by loosening hose clamps.

17. Disconnect Luxstat-diaphragm chamber line (59) at the hose connection by loosening hose clamps.

18. Remove the four engine hold-down bolts (29) and nuts.

19. Make an improvised sling for carrying the A.P.U. from the airplane by passing a rope through the engine lifting eye and securing it to a strong pipe or wooden beam of adequate length to permit handling by two men.

20. Lift the A.P.U. from the mounting stand and remove it from the airplane.

21. Detach bolts (3) and (6) and remove cooling air exit duct and exhaust duct assembly from the airplane.

(d) MAINTENANCE.

1. PREPARATIONS FOR STARTING.—Before starting the engine for the first time each day, the following checks should be made:

a. Make sure the magneto ground wires are properly connected and secured to the magnetos and ignition switch. Check all other electrical connections for security of attachment.

b. Make a final check of all nuts and bolts on both the engine and the engine mount to make sure that they are tight and properly safetied.

c. Make sure that the oil tank contains at least three gallons of lubricating oil (Specification AN-VV-O-446, grades 1065 to 1080).

d. Check the fuel supply. This should comply with one of the following specifications: AN-F-25 (87 octane gasoline), AN-VV-F-776 (91 octane gasoline), or AN-F-28 (100 octane gasoline).

e. Turn on fuel valve. Check the fuel flow at the carburetor and check all fuel and oil lines and connections for leaks.

f. Make certain that the gasoline dribble drain line outlet is free and well clear of the airplane.

g. Make sure that the carburetor throttle and control linkage does not bind and that it is adjusted to travel through its full range.

h. Set the ignition switch in the "OFF" position. Engage the manual starter by depressing the starter rod handle and rotating the drum in a counterclockwise direction. Then slowly turn the crankshaft through at least five revolutions by hand. Should it

require undue effort to rotate the shaft, remove a spark plug from each cylinder to determine whether oil or gasoline has collected in the cylinders.

WARNING

Never attempt to start the engine without making the foregoing check. Serious injury to engine, airplane, or operator may otherwise result.

Should any accumulation of oil or gasoline be found in the cylinders, the cause must be determined and eliminated at once.

2. ENGINE TROUBLES AND REMEDIES.

a. GENERAL.—The cause of unsatisfactory engine performance is often difficult to determine because of the similarity of symptoms shown by completely unrelated troubles.

Once a symptom is clear, the most effective procedure is to systematically eliminate every possible cause of that symptom starting with the most probable.

b. TROUBLE SHOOTING CHART.—The following is a list of the troubles most frequently encountered in the field together with their possible causes and remedies. If trouble develops, maintenance personnel should check and eliminate each possible cause as indicated in the following paragraphs:

TROUBLE	CAUSE	REMEDY
(1) Engine fails to start.	(a) Ignition switch not "ON."	(a) Turn ignition switch "ON."
	(b) Lack of fuel.	(b) Check fuel flow from fuel tank through carburetor.
	(c) Dirty, cracked, or incorrectly adjusted spark plugs.	(c) Clean or replace spark plugs.
	(d) Dirty, pitted, or improperly adjusted magneto breaker points.	(d) Clean, replace, or adjust magneto breaker points. Gap, full open, is from .012 to .025 inches.
	(e) Magneto ground wire grounded with switch "ON".	(e) Replace the ground wire.
	(f) Carburetor flooded.	(f) Depress choke release button; hold throttle open; engage manual starter drum; and rotate crankshaft until carburetor and intake manifold are free of excess gasoline. Examine the carburetor check valve and check seat for improper cut-off of fuel. Examine carburetor float for leaks and replace if unserviceable.
	(g) Water in fuel system.	(g) Remove carburetor and carburetor fuel lines. Drain, clean, and dry. Use compressed air if available.
	(h) Carburetor idling adjustment incorrectly set.	(h) Correct the adjustment. Refer to paragraph *c*, (2), *(a)*, *3*.
	(i) Incorrect throttle opening.	(i) Correct the adjustment. Refer to paragraph *c*, (2), *(d)*, *3*, b.
	(j) Engine and oil excessively cold.	(j) Drain the oil system. Pre-heat the oil and refill tank. With ignition switch in "OFF" position, rotate crankshaft a dozen or more times.
	(k) Improper valve or ignition timing.	(k) Correct at major overhaul base.
	(l) Ignition wires incorrectly connected or damaged.	(l) Trace out circuits and re-connect correctly or replace.

TROUBLE	CAUSE	REMEDY
(2) Failure of engine to develop full power—uneven running.	(a) Mixture too rich or lean.	(a) Refer to paragraph c, (2), *(a)*, *3*.
	(b) Leak in the induction system.	(b) Check the intake manifold for cracks and security of attachment to carburetor and cylinder intake ports.
	(c) Dirty or improperly adjusted spark plugs.	(c) Remove spark plugs, clean, and adjust or replace.
	(d) Dirty, pitted, or improperly adjusted magneto breaker points.	(d) Clean or replace and adjust the magneto breaker points.
	(e) Improper valve clearances.	(e) Correct at major overhaul base.
	(f) Improper valve or ignition timing.	(f) Correct at major overhaul base.
	(g) Loose or damaged ignition wires.	(g) Tighten all terminal connections. If wires show signs of damage, remove and test for short circuits. Replace if necessary.
	(h) Improper adjustment of governor-throttle control linkage.	(h) Refer to paragraph c, (2), *(d)*, *3*, b.
	(i) Poor or uneven compression. *1*. Worn or broken rings. *2*. Sticky or improperly seated valves. *3*. Cylinder worn or scored; cracked piston head, etc.	(i) Correct at major overhaul base.
	(j) Partial or intermittent stoppage of fuel flow.	(j) Disconnect and clean fuel lines, Remove and clean inlet strainer elbow on fuel pump. Remove and clean fuel pump, and if necessary replace pump. Refer to paragraph *c*, (2), *(b)*.
(3) Overheating—High oil temperature and consumption. (These conditions may arise from the causes listed in *(a)*, *(b)*, *(e)*, *(f)* and *(l)* of paragraph (2) above.	(a) Improper grade or dilution of oil.	(a) Drain oil from engine and tank and refill tank with fresh oil of the proper grade (Specification AN-VV-O-446, grades 1065 to 1080).
	(b) Improper grade of fuel.	(b) Check to make sure that fuel being used conforms with specifications. (See paragraph *b*, (2), *(d)*, *1*, d.)
	(c) Pre-ignition caused by overheated spark plugs, feathered valves, or carbon deposits in cylinders.	(c) Correct at major overhaul base.
	(d) Bent or improperly installed baffles.	(d) Bent or distorted baffles must be replaced.
	(e) Broken cylinder fins.	(e) Correct at major overhaul base.
	(f) Excessive piston blow-by.	(f) Correct at major overhaul base.

CAUTION

Some variation in oil pressure may be expected as a natural result of changes in engine speed and temperature. However, any abnormal change, either high or low, calls for immediate investigation and correction. Serious damage may result within a few seconds after the stoppage of oil flow to an engine working part. Normal oil pressure is 55 to 65 lb/sq in.

TROUBLE	CAUSE	REMEDY
(4) Oil pressure too high.	(a) Improper grade of oil.	(a) Drain oil from engine and tank and refill with oil of the proper grade (Specification AN-VV-O-446, grades 1065 to 1080).
	(b) Oil pressure relief valve out of adjustment.	(b) Remove cap, loosen locknut, and turn "OUT" oil pressure relief valve adjusting screw until proper pressure is attained. After adjustment is made, make sure locknut is securely tightened and cap replaced.

CAUTION

If abnormally high pressure continues after the foregoing checks have been made, it is an indication of a stoppage within the internal oil system, and the engine must be stopped at once. It must not be started again until the cause of the trouble has been determined and corrected.

TROUBLE	CAUSE	REMEDY
(5) Oil pressure too low.	(a) Improper grade or dilution of oil.	(a) Oil should be drained from engine and tank, and tank refilled with fresh oil of the proper grade (Specification AN-VV-O-446, grades 1065 to 1080).
	(b) Improperly adjusted oil pressure relief valve.	(b) Remove cap; loosen locknut; and turn "IN" oil pressure relief valve adjusting screw until proper pressure is attained. After adjustment is made, make sure locknut is securely tightened and cap replaced.
	(c) Dirt under oil pressure relief valve plunger.	(c) Disassemble oil pressure relief valve and clean all parts thoroughly. Oil all parts well upon re-assembly. (See paragraph *c*, (2), *(e)*, 2.)
	(d) Sticking oil pressure relief valve plunger.	(d) Disassemble oil pressure relief valve and polish plunger lightly with crocus cloth. Clean and oil all parts well upon reassembly. (See paragraph *c*, (2), *(e)*, 2.)
	(e) Loose or leaking plugs in ends of engine oil passages.	(e) Tighten plugs.
	(f) Oil overheated.	(f) Refer to paragraph *b*, (2), *(d)*, 2, *b*, *(3)* of this section.
	(g) Loose or excessively worn main or connecting rod bearings or other pressure oiled parts.	(g) Engine must be removed from the airplane and sent to major overhaul base for repair.
	(h) Loss of pump priming.	(h) Check for air leaks in oil-in line. If connections are found tight, disconnect oil-in line at the oil pump; fill pump with oil; and then reconnect line and rotate crankshaft by hand until the oil pressure gage registers.

(e) INSTALLATION.—To install the auxiliary power unit, the following procedure is outlined: *(See figure 161.)*

1. Install cooling air exit duct and exhaust duct assembly and secure it to the airplane structure by means of bolts (3) and (6).

2. Make an improvised sling for carrying the engine into the airplane by passing a rope through the engine lifting eye and securing it to a strong pipe or wooden beam of adequate length to permit handling by two men.

3. Lower the engine into position on the stand in the airplane and make it fast with the four bolts (29). Make sure the nuts are safetied.

Note

These bolts should be installed head up so that, in case a nut should accidentally work loose, the bolts will not drop out.

4. Connect the oil line (25) from the oil tank to the oil-in elbow on the oil heater.

5. Connect the oil line (23) from the oil tank to the oil-out elbow on the oil pump.

6. Connect the oil tank vent line (46) from the oil tank to the connector on the rear of the engine.

7. Connect the oil pressure line (22) to the oil pump on the bottom of the engine.

8. Connect dribble drain line (47) to the connector on the rear of the engine.

9. Connect fuel line (21) to the elbow on the fuel pump.

10. Attach flex exhaust tube (51) to the rigid exhaust tube (49) on the A.P.U. by means of clamp (50). A ⅛ inch thick piece of neoprene covered asbestos must be wrapped around the rigid exhaust tube before the flex tube is slid over it.

Note

More room may be obtained for tightening of the flex exhaust tube clamp (50) by removing the bolts which fasten outlet duct to the A.P.U. flange. This will allow the duct to be slid towards the airplane walkway, further exposing the clamp attaching the rigid and flex exhaust tubes.

11. Attach outlet duct to the flange on the A.P.U. with bolts and nuts.

12. Position duct sleeve (12) and secure it in place with clamps (13).

13. Connect the CO_2 line (14) at flexible hose connector. Secure with hose clamps.

14. Connect Luxstat-diaphragm line (59) at flexible hose connector. Secure with hose clamps.

15. Connect ignition conduit (15) to the fitting at the rear of the engine. Tighten knurled conduit nut.

16. Connect A.C. (44) and D.C. (45) cables to the fittings on the generator. A.C. cable is the forward one. Tighten knurled conduit nuts.

17. Connect thermocouple leads (8) to thermocouple attached to the rear spark plug on No. 2 cylinder. Wrap each connection with tape.

18. Loosen the two nuts on the oil heater cover and remove cover. Insert wires from heater conduit through the cover and attach them to the terminals of the heater.

Note

Wire 1143 connects to the terminal on the side of the heater, and wire 1142 connects to the terminal on top of the heater.

Replace heater cover and secure conduit to the cover with the knurled conduit nut.

19. Connect oil temperature conduit to the thermometer bulb (26) located in the aft end of the oil screen chamber. Tighten conduit nut.

20. Replace cap (56) on the bottom of the oil tank (62) and pour at least three gallons of oil (Specification AN-VV-O-446, grades 1065 to 1080) into the oil tank.

c. ENGINE ACCESSORIES.

(1) PBY-5A AIRPLANES.

(a) CARBURETOR.

1. DESCRIPTION.—The carburetor located on the side of the engine is an Eclipse Aviation number D-51802, straight tube type. It consists of a float chamber, idling jet, main jet, choke, and throttle valve. Fuel enters the carburetor at the bottom of the float chamber through a screen. From the float chamber the fuel flows through the idling and main jets to the carburetor air horn where it is mixed with air and then enters the cylinder. The open end of the carburetor air horn is covered with a screen.

The carburetor idling and main jet needle valves are properly adjusted prior to shipment of the engines from the factory and their settings should not be altered between major overhaul periods.

2. REMOVAL.

(See figure 160.)

a. Remove oil line from the oil metering pump to the carburetor air horn.

b. Disconnect fuel line (13) from the fitting on the bottom of the carburetor float chamber.

c. Detach the clevis pin connecting the throttle lever to the governor arm.

CAUTION

Do not detach the throttle lever from the carburetor.

d. Separate the carburetor from the engine by removing the two mounting bolts.

3. MAINTENANCE.

a. Remove cover from the top and plug

from the bottom of the carburetor float chamber and clean chamber thoroughly.

b. Remove strainer from the fuel inlet fitting on the bottom of the float chamber and clean with compressed air.

c. Remove the carburetor air horn assembly by loosening the two lock screws and clean thoroughly with gasoline and compressed air.

d. Examine and replace all worn or damaged gaskets.

4. INSTALLATION.—To install carburetor, reverse the removal procedure as outlined in paragraph *c*, (1), *(a)*, *2* above.

(b) AUXILIARY FLOAT CHAMBER.

1. DESCRIPTION.—An Eclipse number C-57461 auxiliary float chamber is mounted on the port side of the airplane above the auxiliary power unit. It is used to regulate the flow of fuel to the carburetor and to strain out any foreign matter which may be in the fuel. It is similar to the float chamber on the carburetor.

2. REMOVAL.

a. Disconnect the fuel lines from the fittings on the float chamber.

b. Detach the two mounting bolts and remove the float chamber from its bracket on the side of the airplane.

3. MAINTENANCE.

a. Remove cover from the top and plug from the bottom of the float chamber and clean the chamber thoroughly.

b. Remove strainer from the fuel inlet fitting on the bottom of the float chamber and clean with compressed air.

c. Examine and replace all worn gaskets.

4. INSTALLATION.—To install auxiliary float chamber, reverse the removal procedure as outlined in paragraph *c*, (1), *(b)*, *2* above.

(c) FUEL STRAINER.

1. DESCRIPTION.—An Aero Supply Mfg. Co. number 35D2265, Type C-1-A fuel strainer is mounted on the port side of the airplane below the auxiliary float chamber. Fuel flows from the float chamber through the strainer to the carburetor. Incorporated into the bottom of the strainer is a drain valve. The bottom of the strainer is removable so that the strainer screen may be cleaned.

2. REMOVAL.

a. Disconnect the fuel lines from the fittings on the strainer.

b. Detach the two mounting bolts and remove the strainer from its bracket on the side of the airplane.

3. MAINTENANCE.

a. Drain the fuel strainer prior to starting the auxiliary power unit each time.

b. Loosen wing nut and remove the strainer screen through the bottom of the strainer. Clean screen thoroughly and replace in strainer.

4. INSTALLATION.—To install the fuel strainer, reverse the removal procedure as outlined in paragraph *c*, (1), *(c)*, *2* above.

(d) MAGNETO.

1. DESCRIPTION.—A Scintilla Magneto, number 80761, is mounted on the forward end of the auxiliary power unit. It is completely radio shielded and is driven at one half engine speed. A grounding button is provided on the rear cover of the magneto for emergency or sudden stopping of the engine.

2. REMOVAL.

(See figure 160.)

a. Disconnect the ignition cable from the spark plug (9).

b. Detach magneto (11) from the engine by removing the four mounting bolts in the magneto base. Slide magneto outward, parallel to the mounting pad, until the drive shaft is disengaged.

3. MAINTENANCE.

a. Remove the magneto breaker housing cover and wipe the interior of the breaker housing with a gasoline moistened cloth to remove any dirt or oil.

b. Clean contacts by inserting a piece of clean paper between them, pressing the contacts together, and pulling out the paper. However, if the contacts are pitted or corroded, they should first be smoothed with an ignition file or crocus cloth and then cleaned with paper. Reset the contact gap to .018 inch when full open.

c. Excessively pitted or burned contacts indicate faulty condenser operation and replacement of condenser should be made.

4. INSTALLATION.—When assembling the magneto to the engine, it is necessary to engage the magneto drive member with the magneto drive so that the proper ignition timing is attained. To time the magneto, proceed as follows:

a. Turn over the engine until the mark on the outer edge of the cooling fan coincides with the mark on the rear housing.

b. With the engine in the above position and the breaker cover removed, turn magneto over by hand in a clockwise direction, facing the magneto drive, until the breaker points are just beginning to open.

c. Engage the serrated magneto driving member in the magneto drive shaft and bolt in place.

d. Replace the breaker housing cover.

e. Connect ignition cable to the spark plug (9).

(e) GOVERNOR.

1. DESCRIPTION.—The governor is a domed shaped unit on the lower inboard side of the engine. It is connected by a rod to the lever arm of the carburetor throttle. The governor continuously regulates the engine to a speed of 3800 to 4200 rpm.

2. REMOVAL.

a. Detach the clevis pin connecting the throttle lever to the governor arm.

b. Remove the four screws and rotate housing until the internal grooves align with the protruding counterweight holder, after which, remove the housing with lever and plunger assembly attached.

3. ADJUSTMENTS.—Check the no-load and full-load speed range, which should not exceed 3800 to 4200 rpm. If these limits are exceeded, make the following adjustments:

a. Adjust tension on governor plunger spring by means of the nut on the governor housing so that the plunger shaft starts to rise when the engine reaches approximately 3400 rpm.

b. Lock adjusting nut in position with locknut.

c. Adjust throttle lever on butterfly valve shaft so that when connected to the governor control lever, the butterfly valve will be fully opened.

d. Recheck the engine speed and, if necessary, readjust governor spring nut until correct speed is obtained. To increase speed, turn adjusting nut in clockwise direction; to decrease, turn in a counterclockwise direction.

4. INSTALLATION.

a. Retract the governor counterweights and place the housing over the counterweight mechanism.

b. Insert the four flange screws and washers, and safety wire in place.

c. If, for any reason, the governor adjusting nut setting has been disturbed, readjust as outlined in paragraph *c*, (1), *(e)*, *3* above.

(f) OIL METERING PUMP.

1. DESCRIPTION.—The oil metering pump is mounted on the forward end of the engine and consists of a reciprocating plunger valve which is rotated at reduced speed by a worm and wheel combination driven from the engine crankshaft. The reciprocating motion is obtained through the action of an eccentric integral with a plunger which rests on a steel ball mounted on a plate in the base of the pump. A spring on the plunger keeps the eccentric in contact with the steel ball.

Oil enters the pump chamber through a port in the plunger as it rotates past the inlet from the oil supply tank during the forward stroke of the plunger. On the return stroke of the plunger, the oil between the end of the plunger and its stop is forced out through a second port on the plunger as it rotates past the outlet to the carburetor. The length of stroke of the plunger may be changed to vary the amount of oil displaced by moving the steel ball away from or towards the center of the eccentric.

2. REMOVAL.

a. Disconnect oil line from the oil supply tank at the pump.

b. Remove oil line from the pump to the carburetor air horn by disconnecting it at each end.

c. Remove the three stud nuts and separate the pump from the engine.

Note

Complete disassembly of the pump is to be done at a major overhaul base as it requires the use of special tools.

3. MAINTENANCE.

a. Clean the pump thoroughly.

b. If pump does not operate properly, replace with a new pump.

c. The output of the oil metering pump is originally set by the manufacturer and therefore need not be adjusted between major overhaul periods.

4. INSTALLATION.—To install the oil metering pump, reverse the removal procedure as outlined in paragraph *c*, (1), *(f)*, *2* above.

(g) BILGE PUMP.

1. DESCRIPTION.—A Navy Type NED-1, Eclipse Type 543-1-A bilge pump is mounted on the auxiliary drive shaft flange of the engine. The pump is externally supported by means of an adjustable turnbuckle and rod arrangement, which is bolted to the pump cover and rear housing of the engine. A manually operated clutch permits the engagement and disengagement of the pump when required. Adequate provisions are provided for priming, draining, and lubricating the pump. The capacity of the bilge pump is 20 gallons per minute at 1380 rpm without intake and discharge heads, which is equivalent to an engine speed of 4000 rpm when pumping.

2. REMOVAL.

a. Disconnect hose from the bilge pump fittings by loosening hose clamp and slipping hose from fittings.

b. Loosen pump support brace by removing nut from the fan housing bolt.

c. Remove the four nuts from the drive flange studs and detach the pump with support brace attached.

Note

Complete disassembly of the bilge pump is to be done at a major overhaul base as it requires the use of special tools.

3. OPERATION.—The operation of the pump is automatic upon operation of the driving en-

gine and engagement of the clutch. The clutch is engaged when the operating lever is in horizontal position. To disengage the clutch, raise the lever to the vertical position.

Should priming be necessary, remove the priming plug at the top of gear housing and fill with water. Replace plug and engage clutch.

CAUTION

When operating pump at temperatures below freezing, drain the pump after using by removing the plug in the base of the gear housing.

4. MAINTENANCE.

a. After every hour of operation, the pump should be lubricated with grease (Navy Specification M-372) by means of the "Zerk" fitting provided on the gear housing cover.

b. Keep the drainage hole in the gear housing base free from dirt and grease.

c. Any noticeable leakage of water at the drainage hole is an indication of faulty pump packing and return of the unit to an overhaul base or service station is recommended for replacement of packing.

d. After every 150 hours of operation, the pump should be forwarded to a service station, overhaul base, or returned to the factory for a complete overhaul. This procedure constitutes a complete disassembly of the unit involving the use of special tools and equipment available only at the above places.

5. INSTALLATION.—Prior to installing a pump which has been in storage for a period of more than six months, it should be forwarded to a service station, overhaul base, or returned to the factory for cleaning and relubrication. A pump which has been in storage for a period of less than six months may be placed in immediate service.

a. Insert the splined driving member with lock ring attached in the auxiliary drive shaft of the engine.

b. With the clutch engaging lever in the vertical or disengaged position, mount the pump, with support brace attached, on the auxiliary drive flange studs and bolt in place.

c. Secure the upper end of the support brace to the rear housing stud on the engine and turn the adjusting barrel or turnbuckle in a clockwise direction to tighten.

CAUTION

Tighten the bilge pump support brace adjusting barrel until snug. The brace serves as a vibration dampener and too tight an adjustment may result in preloading the housing.

d. After tightening the brace, lock the barrel in place with the locknuts provided at either end.

(h) GENERATOR.

1. DESCRIPTION.
(Refer to Par. 22, *b,* (1).)

2. REMOVAL.
(See figure 160.)

a. Remove the cover from the terminal box on top of the generator (1) and disconnect the wires feeding in through the A.C. (7) and D.C. (6) cables.

b. Loosen the knurled nuts holding the above cables to the box and remove the cables.

c. Remove four bolts holding the generator to the engine and remove the generator.

3. MAINTENANCE.
(Refer to Par. 22, *b,* (3).)

4. INSTALLATION.—Prior to installing a generator which has been in storage for a period of more than one year, it should be forwarded to a service station, overhaul base, or returned to the factory for relubrication and test. A generator which has been in storage for a period of less than one year may be placed in immediate service without relubrication.

Remove end cover and inspect brushes and brush rigging to make certain brushes move freely and that all connections are tight. The field should be "flashed" by connecting the positive field terminal (F+) to the positive side of a 12 volt battery and momentarily touching the negative side of the battery to the negative terminal (A−) of the generator.

a. To install the generator, reverse the removal procedure as outlined in paragraph *c,* (1), *(h), 2* above.

b. When mounting the generator on the engine, make certain that the rubber coupling is interposed between the engine crankshaft and generator drive coupling and the adapter is in position on the mounting studs.

(i) VOLTAGE REGULATOR.

1. DESCRIPTION.
(Refer to Par. 22, *e,* (1).)

2. REMOVAL.
(See figure 160.)

a. Remove the two sections of the shear web door.

b. Remove the cover from the voltage regulator and disconnect wires 181, 204, 219, 220, and 221 from the terminals in the regulator.

c. Disconnect conduit from both ends of the regulator by loosening the knurled conduit nuts.

d. Remove voltage regulator (5) by detaching the four screws and nuts which fasten it to the shear web.

3. MAINTENANCE.
(Refer to Par. 22, *(e),* (1), *(d).*)

4. INSTALLATION.

a. To install the voltage regulator, reverse the removal procedure as outlined in paragraph *c,* (1), *(i), 2* above.

b. Connect the wires to the terminals in the

regulator as follows: wire 181 to terminal L−; wire 204 to terminal L+; wire 219 to terminal A+; wire 220 to terminal F+; and wire 221 to terminal A−.

(j) OIL TANK.

1. DESCRIPTION.—The oil tank is mounted on the port side of the airplane aft of the auxiliary power unit. It contains a filler neck, drain plug, and an outlet fitting. A shut-off valve is attached to the outlet fitting on the oil tank.

2. REMOVAL.

(See figure 160.)

a. Disconnect oil line from tank.

b. Remove bolts and nuts which attach the two semicircular straps to the tank support.

c. Lift oil tank from the support.

3. MAINTENANCE.

a. Keep tank filled with lubricating oil (Specification AN-VV-O-446, grades 1065 to 1100).

b. If the tank develops a leak it may be repaired by welding.

c. Keep mounting bolts tight.

4. INSTALLATION.—To install the oil tank, reverse the removal procedure as outlined in paragraph *c*, (1), *(j)*, *2* above.

(2) PBY-5 AIRPLANES.

(a) CARBURETOR.

1. DESCRIPTION.—The Stromberg Carburetor, Model NA-H1E, provides automatic mixture corrections for variations of altitude and air intake temperature. All adjustments are made and the carburetor sealed at the factory to provide efficient performance throughout the operating range of the auxiliary power unit. A pressure and temperature responsive aneroid, calibrated at the factory, controls the mixture change for altitude operation. An automatic choke, operated by heat from the exhaust manifold, is also included to facilitate cold starting. A choke release button is provided on the carburetor in the event of flooding.

2. REMOVAL.

(See figure 161.)

a. Disconnect the throttle control linkage by loosening screw (16).

b. Disconnect the fuel inlet line (20) by unscrewing nut (18) from elbow.

c. Disconnect choke meter line (61) by unscrewing nut (60) from the choke thermostat.

d. Remove mounting bolts, washers, cotter pins, and nuts (58) at four places.

e. Remove carburetor.

3. ADJUSTMENTS.—The engine idling speed adjustment is made by turning the small fillister head screw (57) assembled on the throttle stop. This screw should be turned clockwise to increase the engine idling speed or counterclockwise to reduce the speed. After making the correct adjustment, tighten the locknut on the adjustment screw.

The idle mixture is adjusted by means of the small knurled screw located on top of the throttle body adjacent to the choke thermostat housing. Clockwise movement of this screw causes the idle mixture to become lean and a counterclockwise movement enriches it. The elastic locknut should be tightened after setting the mixture correctly.

Note

Both the idle speed adjustment and the idle mixture adjustment should be set with the engine hot to obtain the proper idling speed and smooth operation.

4. INSTALLATION.—To install carburetor, reverse the removal procedure as outlined in paragraph *c*, (2), *(a)*, *2* above.

(b) FUEL PUMP.

1. DESCRIPTION.—A variable displacement plunger type fuel pump supplies fuel to the carburetor at a pressure of from four to seven lbs/sq in. This pump is driven by means of an eccentric on the governor drive shaft. A screen is attached to the fitting at the pump inlet to strain the fuel.

2. REMOVAL.

(See figure 161.)

a. Disconnect fuel-in line (21) by loosening hose clamp.

b. Disconnect fuel-out line (20) by unscrewing coupling nut (28).

c. Remove safety wire from attaching nuts (27) and unscrew nuts.

d. Remove fuel pump.

3. INSTALLATION.—To install fuel pump, reverse the removal procedure as outlined in paragraph *c*, (2), *(b)*, *2* above.

(c) MAGNETOS.

1. DESCRIPTION.—Two Scintilla Magnetos, Model SF2RN-6, provide dual ignition for the engine. The right magneto fires the front plugs in both cylinders and the left magneto fires the rear plugs. Each magneto has an automatic advance of 20° and is so timed that the total ignition advance at engine operating speed is 34° before "top center."

2. REMOVAL.

(See figure 161.)

a. Disconnect the magneto ground line (40) by unscrewing coupling nut (39).

b. Disconnect the spark plug cables (41) by unscrewing coupling nuts (32).

c. Remove safety wire from magneto hold down nuts (36).

d. Remove nuts (36).

e. Take off magneto.

3. ADJUSTMENTS. — The timing check should be made as follows:

Note

The magneto timing check is made with the automatic spark control device in the full advance position.

a. Remove one spark plug from the No. 1 cylinder and insert the top center indicator tool (Lawrance No. 100,000). Locate the crankshaft at the exact "top center" position for No. 1 cylinder AT THE END OF THE EXHAUST STROKE.

b. Loosen the generator support hold-down nut nearest the starter drum and attach a piece of stiff wire to the stud. Tighten the nut to hold the wire firmly and then bend the wire so as to form a pointer for the etched marks on the manual starter drum.

c. Engage the starter drum lightly so as not to rotate the crankshaft, taking care that the 0° mark on the starter drum is in a position facing the pointer. Then adjust the pointer so that it indexes exactly with the 0° on "top dead center" mark on the starter drum.

d. Turn the manual starter drum (43) one full revolution and then further until the pointer indexes with the 40° before "top center" mark. *(See figure 161.)*

Note

The piston in No. 1 cylinder will then be at 40° before "top center" ON THE COMPRESSION STROKE.

e. Remove the magneto breaker covers (38) by taking out two screws (37). *(See figure 161.)*

f. Separate the magneto breaker points carefully and insert an arrow strip of .0015 inch steel shim stock. Be sure the shim is clean.

g. Using a screwdriver in the slot in the cam fastening screw (at the end of the magneto magnet shaft), turn the magnet shaft in a counterclockwise direction until the breaker cam is in the full advance position. Hold the cam in this position while the timing check is being made.

h. Have the crankshaft rotated very slowly in the direction of engine rotation while a light finger pull is being exerted on the shim stock.

i. The shim will be released just as the breaker points open. Check the position of the crankshaft by referring to the etched marks on the manual starter drum. The reading should be 34° before "top center."

j. Repeat the operation to check the timing of the other magneto.

k. If the points on either magneto open more than 1° from the specifled position of the crankshaft, the magneto retaining nuts must be loosened just enough to permit the magneto to be swung on the magneto hold-down studs.

l. If the timing was found to be early, the magneto must be swung in a counterclockwise direction. If the timing was late, the magneto must be swung in a clockwise direction.

4. INSTALLATION.—If, for any reason, one or both of the magnetos have been removed from the engine, they must be re-installed and timed as follows:

Note

The installation of the magnetos is done with the automatic spark control device in the full retard position.

a. Locate the crankshaft, make wire pointer, and engage manual starter as outlined in paragraph *c*, (2), *(c)*, *3*, a through paragraph *c*, (2), *(c)*, *3*, c.

Note

Make certain the piston in No. 1 cylinder is at the "top center" position AT EXHAUST END OF THE EXHAUST STROKE.

b. Turn the manual starter drum one full revolution and then further until the pointer indexes with the 14° before "top center" mark.

Note

The piston in No. 1 cylinder will then be at 14° before "top center" ON THE COMPRESSION STROKE.

c. Remove the magneto breaker cover by taking out two screws.

d. Rotate the magneto shaft until the white mark on the chamfered tooth on the distributor gear indexes with the corresponding white timing pointer inside the magneto cover. This can be observed through the window in the magneto cover.

e. Hold the splines on the end of the magneto magnet shaft firmly to prevent rotation of the shaft and guide the splines into engagement with the internal splines in the magneto drive gear.

The magneto should be positioned so that the hold-down studs pass as near as possible through the centers of the flange adjusting slots.

f. Attach the magneto hold-down stud nuts and check the timing.

Note

The magneto timing check must be made with the automatic spark control device in the "full advance" position. Since the crankshaft cannot be turned backward without disengaging the manual starter drum, it will be necessary to turn the shaft forward until the piston in No. 1 cylinder is at approximately 40° before "top center" on the next COMPRESSION STROKE. This will require turning the manual starting drum through three complete revolutions and then enough more so that the pointer indexes with the 40° before "top center" mark.

g. Check the timing as outlined in paragraph *c*, (2), *(c)*, *3*.

h. If the timing varies only slightly from the correct position, it can be corrected by loosening the hold-down stud nuts and swinging the magneto clockwise or counterclockwise as required. (See paragraph *c*, (2), *(c)*, *3*, k and paragraph *c*, (2), *(c)*, *3*, l.

i. If the timing is out more than can be corrected by swinging the magneto through the full limit of the adjusting slots, a further range can be obtained as follows:

1. Cut lockwire and remove the three magneto drive gear adapter retaining nuts and washers.

2. Draw the entire assembly outward just enough to disengage the magneto drive gear inside the housing.

CAUTION

Do not withdraw the adapter far enough outward to clear the studs. If for any reason the adapter has been removed from the studs, do not attempt to reinstall it in any position except where the flange holes and studs are in perfect alignment. This will assure proper indexing of the oil transfer passages.

3. If timing was found to be early, rotate the magneto drive gear counterclockwise and reengage. If timing was late, rotate the gear clockwise and reengage.

Note

Moving the bevel gear one tooth will provide an increased timing range of 11° in the direction selected.

j. After reinstalling and safetying the magneto drive gear adapter, the magneto should be reinstalled as outlined in paragraph *c*, (2), *(c)*, *4*, a through *c*, (2), *(c)*, *4*, h above.

k. Make a final check up of the timing of both magnetos. When it has been proved correct, tighten all magneto hold-down nuts securely and safety with lockwire to the retaining clamps on the upper magneto ventilators.

l. Replace breaker covers and check security of ground wire connections.

(d) GOVERNOR.

1. DESCRIPTION.—The Pierce governor used on the engine operates on the fly-weight principle, namely, a centrifugal force working against spring tension. The main governor shaft carrying two hinged fly-weights is driven (through the accessory drive and driven gears) at one-half crankshaft speed. As the engine rpm increases, the fly-weights move outward from the shaft; as the engine rpm decreases and the centrifugal force lessens, the weights are returned to their inner position by the action of an external coil spring. This outward and inward movement of the weights is translated to an external lever arm which, in turn, is arranged to close and open the throttle through a linkage system.

Both the tension of the spring and the limits of the lever arm movement are fully adjustable, thus providing accurate control of engine speed under all normal operating conditions. The speed is kept constant within the limits of ± 70 rpm over the complete load range, from no load to 150% of normal rated power.

The linkage system is so designated that engine rpm is held within the narrow limits throughout the full operating range except for a short period after the engine is started. During warm-up, a thermostatic device makes the governor action ineffective and holds the engine at idling speed until the lubricating oil and crankcase temperatures have risen sufficiently to permit safe operation at rated engine speed.

2. REMOVAL.

(See figure 161.)

a. Disconnect spark plug cable (41) from the plug nearest the magneto.

b. Remove the portion of the sheet metal housing nearest the magneto by loosening the four fasteners (42) near its edge.

c. Detach lever arm fastened to the governor by removing the pin at its lower connecting point, by removing the bolt from the end of the governor shaft, and by loosening screw which clamps the lever arm to the shaft.

d. Remove bolts which fasten the governor to the auxiliary power unit and pull the governor from the mounting pad.

3. ADJUSTMENTS.

a. GOVERNOR.—It is not recommended that governor adjustments be made in the field. Any governor not giving satisfactory service should be replaced and the unit returned to the overhaul depot for repairs.

However, should special circumstances make a field adjustment necessary, the following instructions should be strictly observed.

Note

Before attempting a governor adjustment, make certain that the trouble is in the governor and not in the throttle control linkage.

(1) Install a tachometer so that the engine speed can be noted. Tachometer mounting pad (19) is located just below the carburetor. *(See figure 161.)*

Note

The tachometer drive on the engine rotates at one-quarter crankshaft speed in a counterclockwise direction when viewed from the rear of the engine.

(2) Loosen speed adjusting locknut and release all tension from the governor spring by turning out speed adjusting bolt.

(3) Disconnect the throttle control linkage by removing the pin from the lower end of the governor control lever.

(4) Operate the engine at from five hundred to eight hundred rpm in order to explode the governor weights to the wide open position.

(5) With the weights open, turn in the bumper screw so that the end of the screw just touches the rocker yoke. The yoke is inside the governor body and cannot be seen. Therefore, the position of the screw must be determined by turning it out, and then turning it in until it just makes contact with the yoke.

(6) Secure the screw in this position with the bumper screw locknut.

(7) Re-connect the throttle control linkage and, by means of the speed adjusting bolt, increase the tension on the governor spring until the no-load engine speed is 4200 rpm.

(8) Apply load to the engine. If the full-load speed drops below 4130 rpm, loosen locknuts on the spring eye adjusting screws, and adjust the governor by shortening or lengthening the effective length of the spring eye adjusting screw. Shortening the effective length of this screw will bring the spring hook closer to the rocker shaft and increase the sensitivity of the governor.

Note

This is a very fine adjustment and must be made slowly and with care.

(9) If the governor holds the engine rpm within the specified limits, but with a tendency to surge, the effective length of the spring eye adjusting screw should be increased to broaden the regulation. Although the re-positioning of the spring eye screw will correct surging, it will change the engine rpm. This requires readjustment of the speed adjusting bolt.

(10) After the final adjustment is completed, tighten locknuts.

b. GOVERNOR-THROTTLE CONTROL LINKAGE.—The governor-throttle control linkage is accurately set at the factory and, under normal operating conditions, requires no adjustment between engine overhauls. If, for any reason, conditions make it necessary to adjust the throttle control linkage in the field, the following instructions should be followed.

(1) Install a tachometer so that engine rpm can be noted.

Note

The tachometer drive rotates at ¼ crankshaft speed in a counterclockwise direction when viewed from the rear of the engine.

(2) Loosen locknuts (31) at each end of carburetor ball joint link rod (30) to permit lengthening or shortening of the rod. *(See figure 161.)*

(3) Start the engine and run it until thoroughly warmed up. If it overspeeds and is, therefore, beyond the governor's working range, the carburetor ball joint link rod (30) should be shortened by fractions of a turn until the speed comes just within the governor's working range. This is the proper link rod setting and locknuts (31) should then be tightened.

(4) If the engine runs too slowly, lengthen the carburetor ball joint link rod (30) by fractions of a turn until the engine begins to overspeed the governor's working range. Then shorten the link rod until the speed comes back within the governor's working range. The point just before the engine overspeeds the governor's working range is the proper link rod setting. Tighten locknuts (31) on the link rod.

(5) If either of the above adjustments fails to bring the engine rpm to within specified limits, a complete check of the linkage system must be made as follows:

(a) Disconnect the carburetor ball joint link rod (30) from the carburetor lever (17).

(b) Make sure the carburetor throttle stop screw (57) is correctly set and then check for the position of the carburetor lever (17). This should be at an angle of from 10 to 12 degrees below horizontal with the throttle fully closed. If not in this position, remove it from the carburetor throttle shaft and re-install it properly.

(c) If the carburetor lever was found to be at the correct angle, the position of the governor control lever (35) should be checked as follows:

1. Remove the clevis pin (34) and disconnect the governor control link (33) from the governor control lever (35). The governor control lever should extend downward as close to vertical as the serrations will allow. If it is not in this position, remove it from the governor shaft and re-install it properly.

2. Re-connect the governor control link (33) and the governor control lever (35). Re-connect the carburetor ball joint link rod (30) to the carburetor level.

3. Adjust the length of the carburetor ball joint rod by shortening it as much as possible and then lengthening it by three turns.

Note

Make sure that the rod turns in both ball joints.

(d) With the linkage system completely connected, open the throttle and, while holding the carburetor lever open, check the position of the thermostat ball socket lever. This should be about seven to ten degrees inward from vertical (upward).

(e) If the thermostat ball socket lever is not in this position, remove it from the thermostat control shaft and re-install it properly as follows:

1. Place the coil spring over the forward end of the thermostat control shaft (long hook

to the rear) and latch the hook over the thermostat control shaft bracket.

2. Open the throttle, and while holding the carburetor lever (17) in the "OPEN" position, set the thermostat ball socket lever on the thermostat control shaft in a position about seven to ten degrees inward from vertical (upward) making sure that the short spring hook is latched over the ball socket end of the lever and that the coil spring is in tension.

3. Secure the thermostat ball socket lever in position.

(f) After the foregoing checks and adjustments have been completed, start the engine and test as in paragraph *c,* (2), *(d), 3,* b, *(3)* and paragraph *c,* (2), *(d), 3,* b, *(4).*

4. INSTALLATION.—Reverse removal procedure as outlined in paragraph *c,* (2), *(d), 2.*

(e) OIL PUMP.

1. DESCRIPTION.—The oil pump is a gear type pump which is mounted on the aft end of the bottom of the engine crankcase on the right side. The pump assembly contains the scavenging pump which is the two upper gears, the pressure pump which is the two lower gears, the strainer, and pressure relief valve assembly. Constant oil pressure is maintained by the pressure relief valve mounted to the rear end of the oil strainer housing. The oil strainer housing contains two screens; the front screen, through which the scavenged oil passes and which has a magnet attached to it for the collecting of metal particles which may get into the oil; the rear screen through which the pressure oil passes and which retains any foreign matter which may have gotten in the oil tank. The strainer screens and relief valve are accessible without removing the oil pump from the auxiliary power unit.

2. REMOVAL.—It is assumed that the auxiliary power unit has been removed from the airplane.

a. Detach the six nuts from the mounting studs and remove the strainer assembly and the pump assembly.

b. To remove the pump assembly from the strainer assembly, detach the nuts from the studs which fasten them together.

c. Remove caps from the ends of the strainer housing and pull strainer screens from the housing.

d. Remove cap from the pressure relief valve.

e. Remove valve assembly by turning large hex on the valve assembly.

f. To disassemble the relief valve, remove the locknut from the adjusting screw and back out the adjusting screw.

3. MAINTENANCE.

a. At time of disassembly, clean all parts of the pump and strainer assemblies with clear gasoline.

b. After every 60 hours of auxiliary power unit operation, remove and clean the oil pump strainers and magnet with clear gasoline.

c. Adjustment of the pressure relief screw valve is attained by removing cap, loosening locknut, and turning adjusting screw OUT to lower the pressure and IN to raise the pressure.

4. INSTALLATION.

a. Insert valve into valve housing, following it with the spring and adjusting screw.

b. Place locknut on the adjusting screw loosely. After oil pump has been completely installed on the auxiliary power unit, operate the unit and adjust the pressure relief valve to obtain the proper oil pressure, which is 55 to 65 lb/sq in. Turn the adjusting screw OUT to reduce the pressure, and IN to increase the pressure.

CAUTION

After adjustment is made, make sure locknut is securely tightened.

c. Insert the strainer screens into the housing and secure them in place with the caps.

d. Attach the pump assembly to the strainer assembly by means of the mounting stud nuts.

e. Place oil pump in position on the bottom of the engine crankcase and secure it by means of the six mounting stud nuts.

(f) GENERATOR.

1. DESCRIPTION.
(Refer to Par. 22, *b,* (1).)

2. REMOVAL.

a. Disconnect the A.C. (44) and D.C. (45) cables from the generator by loosening the knurled conduit nuts and withdrawing plugs from the sockets on the generator.

b. Disconnect the small Luxstat tube at the fitting along side of the generator.

c. Using a 9/16 inch crowfoot type wrench (28U5027) *(See figure 40),* remove the mounting stud nuts.

d. Carefully pull generator from the mounting pad and remove it from the airplane.

3. MAINTENANCE.
(Refer to Par. 22, *b,* (3).)

4. INSTALLATION.

a. Place the generator on the mounting studs, working the large rubber connection hose into position on the extension of the air collector ring. Do not seat the generator on the mounting pad, as about ¼ inch clearance must be allowed to start the attaching nuts on the studs.

CAUTION

Be careful not to injure the small Luxstat tube attached to the generator air outlet housing.

b. After the attaching nuts are started, seat the generator firmly and tighten the nuts, using a 9/16 inch crowfoot wrench (28U5027). *(See figure 40.)*

c. Safety the nuts by locking them all together with a single strand of lockwire. Pass a long piece of lockwire through one stud hole and nut slot. Bring it half way around the nut, guide it under the entering wire and thence on to the next stud. Repeat the operation until all nuts are safetied.

d. Connect the Luxstat tubing in the generator air outlet housing with the forward part of the Luxstat tubing on the engine.

e. Connect the A.C. (44) and D.C. (45) cables to the generator.

(g) VOLTAGE REGULATOR.

1. DESCRIPTION.

(Refer to Par. 22, *e*, (1) and Par. 22, *e*, (2).)

2. REMOVAL.

a. Disconnect conduit from the A.C. and D.C. voltage regulators by loosening the knurled conduit nuts and unplugging the conduit from the regulators.

b. Remove the four screws which attach each regulator to the mounting bracket on the side of the airplane and lift regulator from the bracket.

3. MAINTENANCE.

(Refer to Par. 22, *e*, (1), *(d)* and Par. 22, *e*, (2), *(d)*.)

4. INSTALLATION.—To install the voltage regulators, reverse the removal procedure as outlined in paragraph *c*, (2), *(g)*, *2* above.

(h) OIL TANK.

1. DESCRIPTION.—The oil tank and its support are mounted to the airplane structure directly above the auxiliary power unit. It is of welded aluminum construction and contains a sounding rod, a filler neck a vent fitting, an oil-return fitting, and an oil-out fitting. The tank has a total capacity of 3½ gallons of which three gallons are usable. The tank is readily removable from the airplane.

2. REMOVAL.

(See figure 161.)

a. Drain oil from tank by removing drain cap (56).

b. Disconnect the oil vent line (1), the oil-return line (2), and the oil-to-engine line (55) at the oil tank by loosening hose clamps and sliding hose connectors from the fittings on the tank.

c. On the under side of the oil tank, remove the nut which attaches the support strap to the mounting bracket. Allow strap to swing free and remove tank.

3. MAINTENANCE.

a. If tank leaks, it may be repaired by welding.

b. After every 50 to 60 hours of engine operation drain and flush oil tank and oil lines. Refill tank with at least three gallons of fresh oil (Specification AN-VV-O-446, grades 1065 to 1080).

c. If leak develops at flexible hose connectors, tighten hose clamps.

4. INSTALLATION *(See figure 161.)*—To install oil tank, reverse the removal procedure as outlined in paragraph *c*, (2), *(h)*, *2* above.

(i) OIL HEATER.

1. DESCRIPTION.—A 250-watt, 24-volt oil heater is attached to an adapter mounted in the right, rear side of the crankcase. All incoming oil passes through the adapter and hence past the oil heater. The oil heater is designed to maintain the temperature of this oil between 57°C and 71°C (135°-160°F). When the oil temperature drops below 57°C (135°F) this unit automatically heats the oil until the temperature reaches 71°C (160°F). At the latter temperature the heater automatically cuts off.

If the airplane's batteries are well charged, the oil heater can be turned on for about 10 to 15 minutes before starting the engine and for as long as necessary thereafter. The heater should always be shut off when the engine has warmed up.

CAUTION

The oil heater should never be allowed to remain on for any length of time with the engine idle, as this will cause an excessive drain on the airplane's batteries.

2. REMOVAL. *(See figure 161.)*

a. Disconnect oil line (25) from the supply tank at the fitting in the oil heater.

b. Remove oil line (24) from the heater to the pump by loosening hex fittings at each end of the line.

c. Remove cover from the oil heater by loosening the two nuts which hold it in place.

d. Disconnect the two wires from the terminals under the oil heater cover.

e. Break safety wire and remove the two mounting stud nuts which fasten the oil heater to the mounting pad on the engine.

f. Separate heater from the adapter by unscrewing heater at the large hex.

3. MAINTENANCE.

a. Clean oil heater adapter thoroughly with clear gasoline.

b. If oil heater does not heat oil to the proper temperature, 57° to 71°C (135° to 160°F), replace heater.

c. Keep electrical connections tight. If terminals are corroded or dirty clean them with crocus cloth.

d. Keep oil line connections tight.

4. INSTALLATION.—To install oil heater, reverse the removal procedure as outlined in paragraph *c*, (2), *(i)*, *2* above.

(j) AUXILIARY POWER UNIT FIRE EXTINGUISHER.

(Refer to Par. 24, *g*, (3).)

PARAGRAPH 18.

18. SURFACE CONTROLS.

a. GENERAL.—All surface controls are actuated through cable systems which run forward to the operating controls in the pilot's compartment. A control yoke, which can be operated from both the pilot's and the copilot's position, controls the movement of the elevator and aileron surfaces. A set of rudder pedals for both pilot and copilot controls the movement of the rudder surface. A control box, accessible to both pilot and copilot, controls the movement of both elevator and rudder tabs. A control, accessible to the pilot only, controls the movement of the aileron tabs. Another control, accessible to the pilot only, is provided for locking the rudder surface.

b. CONTROL YOKE.

(1) DESCRIPTION. *(See figure 162.)*—The control yoke is an elliptical tube bent in the form of a channel. It extends across the airplane in front of the pilot and copilot, and is attached to the floor structure outboard of the pilot's and copilot's position by means of a single bolt at each end. This allows the control yoke to be swung forward and aft for elevator control. Masts are provided at each side of the yoke for attaching the elevator cables which run aft. Fastened to shafts, two control wheels, one in front of the pilot, and the other in front of the copilot, are mounted on the control yoke. The wheels are interconnected by a chain loop which runs over a sprocket on each wheel shaft. The chains are connected at the top of the loop by a cable, and at the bottom by two links and a turnbuckle. The aileron control cables are attached to the links and extend outboard around a pulley located at each elbow in the control yoke, down to a pulley located in the base of the yoke at each side of the airplane, and then aft. The cables and chains are completely enclosed by the yoke.

(2) REMOVAL AND DISASSEMBLY.

(a) Remove tension from elevator and rudder cables by first breaking safety wiring and then loosening turnbuckles on the aft port side of bulkhead 2. Repeat operation for starboard side.

(b) Disconnect the aileron cable on the port side of the airplane at the turnbuckle fitting aft of bulkhead 2. Repeat operation for starboard side.

(c) Remove aileron cable guard pin from upper pulley bracket at bulkhead 2 on port side of airplane. Repeat operation for starboard side.

(d) Remove aileron pulley from lower pulley bracket at bulkhead 2 on port side of airplane. Repeat operation for starboard side.

(e) Withdraw the free aileron cable on the port side from the pulley at the upper bracket at bulkhead 2, and from the lower bracket and its cable housing at bulkhead 2. Repeat operation for starboard side.

(f) Disconnect the elevator cable at the control yoke mast on the port side of the airplane by removing clevis bolts. *(See figure 162.)* Repeat operation for starboard side.

(g) Unscrew flexible conduit coupling nut (15) from forward side of ignition switch on control yoke. Remove three screws and slide ignition switch cover forward. This exposes the attachments of the four ignition wires. Remove these wires from the ignition switch terminals. *(See figure 163.)*

(h) Detach conduit (12) from yoke by loosening clips (13). This operation frees the ignition switch wiring and conduit from the yoke.

(i) By removing screws, open the cover to the yoke junction box located on the forward port side of the yoke and detach the wires leading in from the yoke.

(j) By removing screws, open cover on inverter junction box located under the pilot's seat and detach wires 422 and 424.

(k) To remove flexible conduit (9) from the yoke, unscrew coupling nut (8) from the electrical receptacle (7) on the port side of the yoke.

(l) Remove all wiring leading aft from the receptacle on the yoke by pulling the detached wires from the yoke junction box and the inverter junction box.

(m) When all the wiring has been pulled free, coil it, and tape it to the side of the yoke.

(n) Detach bonding wire (50) from base at both sides of airplane by withdrawing bolt (51). *(See figure 162.)*

(o) The final step in the removal of the control yoke is to remove boot (46) and the bolt (47) from the base (44) of the yoke on both sides of the airplane.

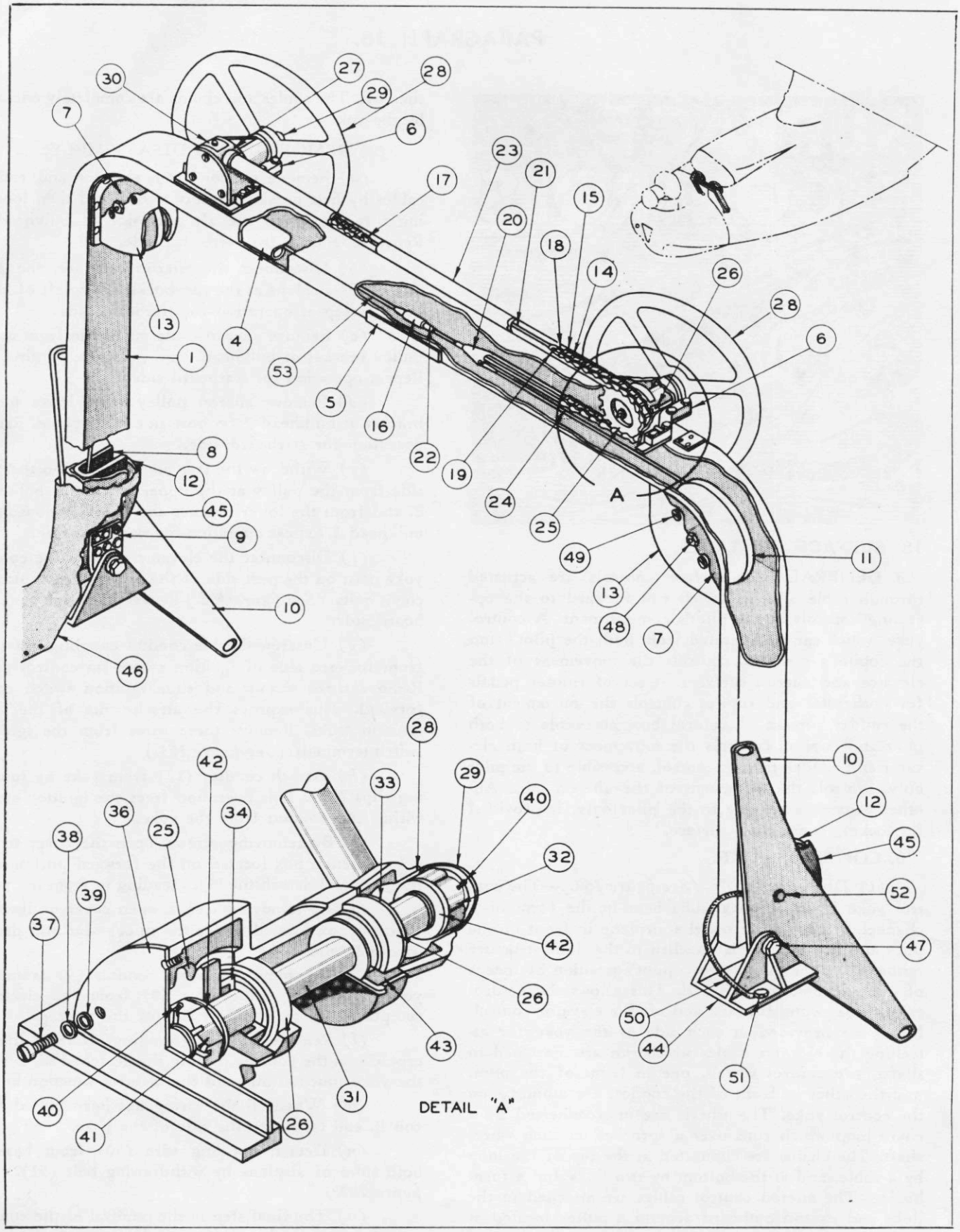


Figure 162—Control Yoke

No.	PART No.	NAME
1	28C004-6	Frame
4	28C004-4	Flexitube
5	22C116	Inspection Hole Cover
6	22C012	Bearing Bracket
7		Upper Pulley Bracket
8		Lower Pulley Bracket
9	28C1154L&R	Bearing Housing
	AN200K3	Ball Bearing
10	28C5138L&R	Mast
11	20C087-4	Pulley
12	20C087-6	Pulley
13	22C067	Pulley Guard
14	28C003-7	Chain
15	28C003-8	Connecting Link
16	AN155-32S	Turnbuckle
17	28C1151-5	Upper Link-Chain
18	28C1151-4	Upper Link-Chain
19	28C1149	Clevis Bolt
20	22C110	Lower Link-Chain
21	28C1119	Cable Assembly
22	22C109L&R	Turnbuckle Eye
23	22C072	Guard Tube
24	28C5512-0	Cable Assembly
25	22C071	Sprocket
26	28C003-4	Ball Bearing
27	22C033L&R	Wheel Bearing Housing
28	28C1041	Wheel
29	22C1030	Cover
30	22C069	Cover Plate
31	22C076	Shaft
32	AN310-9	Nut
33	22C074	Rear Spacer
34	22C075	Front Spacer
36	22C070	Cover
37	AC500-8-4	Screw
38	AN935-8	Washer
39	AN960-8	Washer
40	AN380B4-5	Cotter Pin
41	AN320-9	Nut
42	AN960C916	Washer
43	28C003-2	Gasket
44	22C1031L&R	Base
45	28C2165	Pulley Guard
46	28F1626	Fabric Boot
47	AN23-15	Bolt
	AN320-3	Nut
	AN380-B2-2	Cotter Pin
48	AN24-28	Bolt
	AN320-4	Nut
	AN960-416	Washer
	AN380B2-2	Cotter Pin
49	AC500-8-4	Screw
	AN935-8	Washer
	AN960-8	Washer
50	Q508B-8C	Bonding Braid
51	AN4-7A	Bolt
52	AN24-40	Bolt
	AN320-4	Nut
	AN380B2-2	Cotter Pin
	AN960-416	Washer
53	*28C2086-57	Cable Assembly
	**28C2086-55	

*PBY-5A only.
**PBY-5 only.

This allows the control yoke to be lifted from its place in the airplane.

(p) Disassemble the control yoke as follows:

1. Detach ignition switch (14) by removing four screws. *(See figure 163.)*

2. On PBY-5A airplanes with serial numbers 46610 and on, detach the three fluorescent lights (1), (2) and (3) located on the port side of the yoke by removing the three screws which hold each light to its base. On PBY-5 and PBY-5A airplanes with serial numbers up to 46610, detach the two fluorescent lights (4) from the center of the yoke by removing the four screws which hold each light base to the yoke.

3. Detach the pilot's signal box (5) and the loosened fluorescent lights from the yoke by removing the nine screws which hold the box to the yoke, and withdrawing the wires that lead to the receptacle at the left side of the yoke.

4. Remove snap on cover plate (5); break safety wiring and then connection at turnbuckle (16). *(See figure 162.)*

5. Detach cover plate (36) from casting by removing three screws.

6. Rotate pilot's wheel (28) until attaching point of chain (14) to cable (21) is visible at sprocket (25) on pilot's side. Remove clevis bolt (19) from chain connecting link (15) and cable (21).

7. Remove bearing casting (27) (including wheel assembly) intact from both sides of yoke. This permits removal of the tube (23) by sliding it off the cable (21).

8. Detach pulley guard (13) and pulley (11) from port side of yoke by removing screws (48) and (49). Repeat operation for starboard side of yoke.

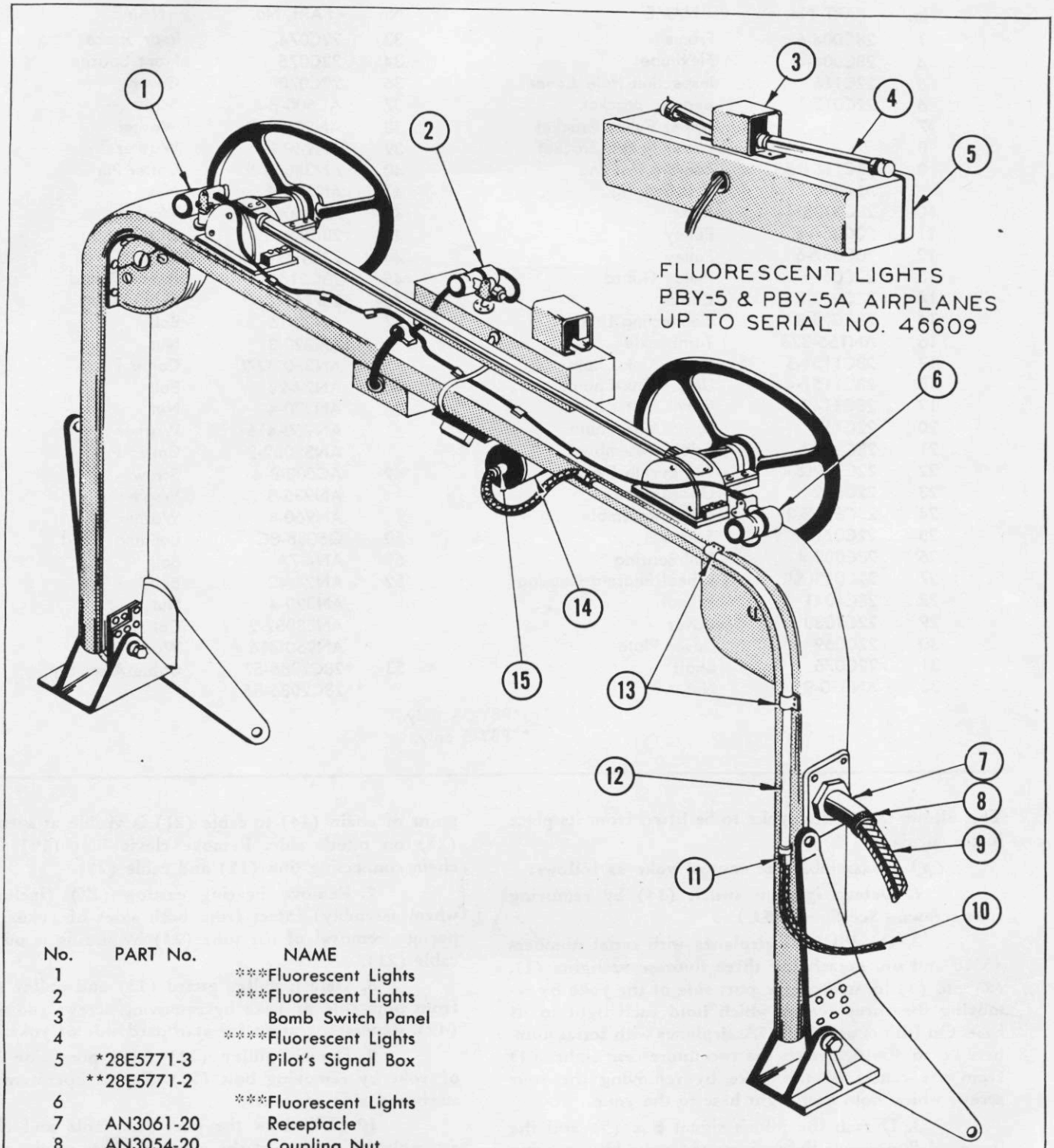
9. Detach pulley (12) from port side base of yoke by removing bolt (52). Repeat operation for starboard side of yoke.

10. Withdraw the port side cable and chain assembly by pulling at the port side base of the yoke. Repeat operation for starboard side.

11. The wheel assembly may be disassembled by removing the wheel snap-on cover (29), nut (32), wheel (28), and bearing (26) from one side of the shaft, and by removing the nut (41), sprocket (25), and bearing (26) from other side of the wheel shaft.

(3) MAINTENANCE.

(a) MAINTENANCE OF CONTROL CABLES.—If cables are coated with dust or dirt, they



No.	PART No.	NAME
1		***Fluorescent Lights
2		***Fluorescent Lights
3		Bomb Switch Panel
4		****Fluorescent Lights
5	*28E5771-3	Pilot's Signal Box
	**28E5771-2	
6		***Fluorescent Lights
7	AN3061-20	Receptacle
8	AN3054-20	Coupling Nut
9		Flexible Conduit
10		Flexible Conduit
11		Coupling Nut
12		Solid Conduit

*PBY-5A only.
**PBY-5 only.
***PBY-5A (Serial numbers 46610 and on)
****PBY-5 and PBY-5A up to serial number 46610.

No.	PART No.	NAME
13	Q908A-10	Clip
	NAF1029A-8C-8	Screw
	AN935-8	Washer
	AN960A8	Washer
14	Type A-2A (Bendix Aviation)	Ignition Switch
15	AN3054-10	Coupling Nut

Figure 163—Control Yoke—Electrical Equipment

should be wiped with a clean cloth and then coated lightly with corrosion-preventive compound (Specification AN-C-52, type I). If a cable is badly frayed, with five or more wires broken, it should be immediately replaced. The presence of broken wires can be detected by running a cloth over the cable. The cloth will catch on the broken wires. The cable tension should be maintained to the value shown in Section IX, Table A by tightening or loosening the turnbuckles.

(b) MAINTENANCE OF PULLEYS.—The pulleys throughout the control system are mounted on bearings which are prelubricated with grease (Specification AN-G-3) and then sealed. They should not require further lubrication. If a pulley, when turned by hand, shows evidence of being contaminated with grit, it should be replaced.

(c) MAINTENANCE OF CHAINS.—At the 25 to 30 hour inspection period, all chains should be wiped clean and then lubricated with grease (Specification AN-G-10). Excess grease should be wiped off with a cloth.

(4) ASSEMBLY AND INSTALLATION.

(a) ASSEMBLY OF CONTROL YOKE.

1. Assemble the control wheel assembly by reversing the removal procedure as outlined in paragraph *b.*, (2), *(p), 11.*

2. Reverse procedure outlined in paragraph *b.*, (2), *(p), 10* by running the port side cable and chain assembly up through the port side of control yoke until the cable end is visible at the bottom opening at the center of the yoke. To insure that cable does not slip back, tie a wire to cable terminal and hook around opening. Repeat operation for starboard side.

3. Attach pulleys (11) and (12) to the yoke on the port side by inserting bolts (48) and (52), and at the same time run the cable over these pulleys. Attach pulley guards (13) and (45) in place with two screws each. Repeat procedure for starboard side. *(See figure 162.)*

4. Place wheel assemblies loosely in position on both sides of yoke; pass cable (21) and starboard chain (14) around sprockets of starboard wheel assembly, then run cable end through tube (23) and attach to connecting link (15) on port side chain by means of clevis bolt (19). Before the connecting link is attached, the port side chain must be passed over the sprocket of the port side wheel assembly.

5. Nest tube (23) properly in place in both port and starboard bearing castings (27). Insert the eight screws, and attach port side bearing castings firmly to the yoke. Repeat procedure for starboard side.

6. Connect cables (53) and (24) at center of yoke by attaching turnbuckle and tightening to correct tension. Safety turnbuckle with safety wire and then snap cover plate (5) in place.

7. Attach the pilot's signal box (5) to the yoke by means of nine screws after threading the electrical wires down the port leg of the yoke and out through the receptacle (7). *(See figure 163.)*

8. On PBY-5A airplanes with serial numbers 46610 and on, attach the three fluorescent lights (1), (2), and (3) to their bases on the yoke by means of three screws. On the PBY-5 and PBY-5A airplanes up to serial number 46610, attach the two fluorescent lights (4) to the center of the yoke by means of four screws through their bases.

9. To complete assembly of control yoke, attach ignition switch (14) to its bracket on the yoke by means of four screws.

(b) INSTALLATION OF CONTROL YOKE.

1. Install control yoke assembly in airplane by attaching it to base (44) by means of bolt (47) at both sides of airplane. By means of the strap, and snap fasteners, attach fabric boot (46) in place at base of control yoke on both sides of airplane. *(See figure 162.)*

2. Attach bonding wire (50) to base (44) by means of bolt (51) at both sides of airplane.

3. Reverse removal procedure of paragraph *b.*, (2), *(l)* by uncoiling wires at port side of yoke and threading the wires back through the conduit, to the yoke junction box outboard of the pilot's seat and to the inverter junction box under the pilot's seat.

4. Attach wire numbers 422 and 424 to their terminals on the inverter junction box and then replace cover to box.

5. Attach all wires leading from the yoke to their terminals on the yoke junction box. Close cover to junction box.

6. Attach flexible conduit (9) to receptacle (7) on yoke by screwing on coupling nut (8). *(See figure 163.)*

7. Attach conduit (12) to yoke by means of clips (13); attach the four ignition switch wires to the ignition switch terminals; attach the conduit to the ignition switch case by screwing on the coupling nut (15); replace ignition switch cover and fasten in place with the three screws.

8. Attach elevator and aileron cables to yoke by reversing the removal procedure in paragraph *b.*, (2), *(a)* through paragraph *b.*, (2), *(f)*. For correct tension of cables, refer to Section IX, Table A.

c. RUDDER PEDALS.

(1) DESCRIPTION. *(See figures 164 and 165.)* —A set of rudder pedals is installed in the pilot's compartment in front of both the pilot and copilot. The pilot's pair of pedals is hinged on a shaft below the pedals. Fastened to each pedal arm is a mast. The two pedals of the pilot are interconnected by a cable linkage between the masts. The cable passes around pulleys located under the rudder pedal shaft. This same arrangement is installed on the copilot's side. In addition, by means of cables passing over pulleys located in struc-

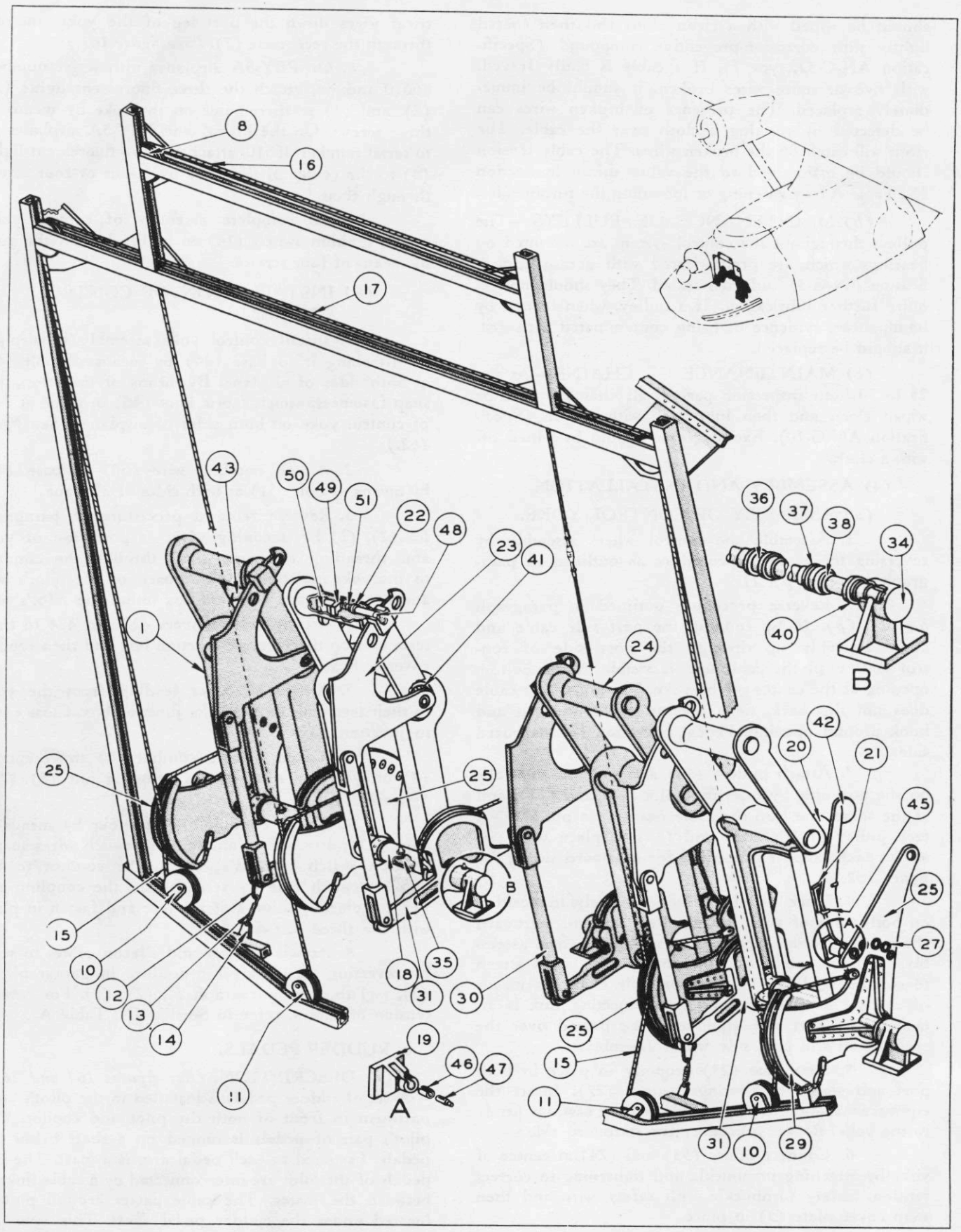


Figure 164—Rudder Pedals (PBY-5A Only)

No.	PART No.	NAME
1	28C5705-2L	Rudder Pedal Assemblies
	28C5705-2R	
8	AN210-4A	Pulley
10	Q4004-O-5	Pulley Bracket
	AN210-4A	Pulley
11	Q4004-2-5	Pulley Bracket
	AN210-4A	Pulley
12	28C5540-6	Tab
13	24P054	Spring
14	28C5540-7	Tab
15	28C2092-15	Cable Assembly
16	28C5563-3	Cable Assembly
17	28C5563-2	Cable Assembly
18	28C6036	Rudder Pedal Hub Assembly
19	28C6035	Lug
20	28C6029-6	Rudder Pedal
21	28C6033	Trip Lever Bracket
22	AN960D8	Washer
23	28C5731-L	Brake Pedal Mast Assembly
	28C5731-R	
24	28C5587-L	Brake Pedal
	28C5587-R	
25	28C2068-O	Pedal Mast (Pilot's Left)
	28C2068-2	Pedal Mast (Pilot's Right)
	28C2068-1	Pedal Mast (Copilot's Right)
	28C2068-3	Pedal Mast (Copilot's Left)
27	28C2065	Bushing
29	28C2071	Mast Guide
30	28C5707	Link Assembly
31	28C5701-L	Brake Lever Assembly
	28C5701-R	
	28C5701-2	
34	28C2061	Bearing Casting
35	28C5716	Shaft
36	22C061	Sleeve
37	22C063	Washer
38	28C5724	Sleeve
40	B543 (Fafnir)	Bearing
41	6A (Fafnir)	Bearing
42	28C2059-2	Trip Lever (Pilot's)
43	28C2059-3	Trip Lever (Copilot's)
45	28C2098	Spring
46	28C2062	Bushing
47	28C2064	Pin
48	28C5522	Pin
49	28C5523	Guide
50	28C5521	Stop
51	NSC034	Spring

ture built over the rudder pedals, the pilot's left rudder pedal is connected to the copilot's right rudder pedal, and the pilot's right rudder pedal is connected to the copilot's left rudder pedal. The interconnecting cables are attached to the masts alongside the rudder pedals. Two cables, one attached to the pilot's left rudder pedal mast, and the other attached to the copilot's right rudder pedal mast, lead aft on the port and starboard sides respectively, to the rudder surface. At the side of each rudder pedal is placed a pedal adjusting lever. By pushing each lever to one side with a foot, a pin is released, and each rudder pedal can then be swung forward or aft until it is in correct position for the pilot's or copilot's leg comfort. Hinged to the upper part of each of the four rudder pedals, (on PBY-5A airplanes only), is a brake pedal. These pedals actuate a linkage which controls the hydraulic brake system. (See Par. 21.)

(2) REMOVAL AND DISASSEMBLY.

(a) PBY-5A.

(See figure 164.)

1. Break safety wiring and loosen turnbuckles on rudder cable aft of station 2.0, port side, to ease cable tension. Repeat operation on starboard side.

2. On port side, detach rudder cable from rudder pedal mast (25) by removing clevis bolt. Repeat operation on starboard side.

3. On pilot's side, detach lower rudder idler cable (15) from rudder pedal masts (25) by removing attaching bolts. Detach both pulleys from their pulley brackets (10) and (11). This permits complete removal of cable (15). Repeat operation for copilot's side.

4. Break safety wiring and loosen turnbuckles to ease tension on overhead rudder connecting cables (16) and (17). Detach ends of cable (17) from copilot's right rudder pedal mast (25) and then from pilot's left rudder pedal mast (25). Detach ends of cable (16) from copilot's left rudder pedal mast (25) and then from pilot's right pedal mast (25). By withdrawing the four pulleys (8) from the overhead structure, the cables (16) and (17) may be completely removed.

5. Detach the four brake cables from the four lower brake lever assemblies (31) by removing the four clevis bolts.

6. Unhook the spring (13) from the brake lever tab (12) on both pilot's and copilot's sides.

7. Detach the four bearings (34) from the airplane structure by removing 16 bolts. This permits both the pilot's rudder pedal assembly and the copilot's rudder pedal assembly to be removed from the airplane.

8. The pilot's or copilot's rudder pedals may be disassembled as follows:

a. Detach both links (30) from upper brake pedal masts (23) and lower brake lever assemblies (31) by removing the four clevis bolts.

b. Detach brake pedal masts (23) from brake pedals (24) by removing the two long bolts which attach the masts to the brake pedal hubs, and then withdraw the spring-loaded pins (48) in order to release masts from upper part of brake pedals.

c. Detach rudder pedal adjusting levers (42) by removing two bolts and the springs (45).

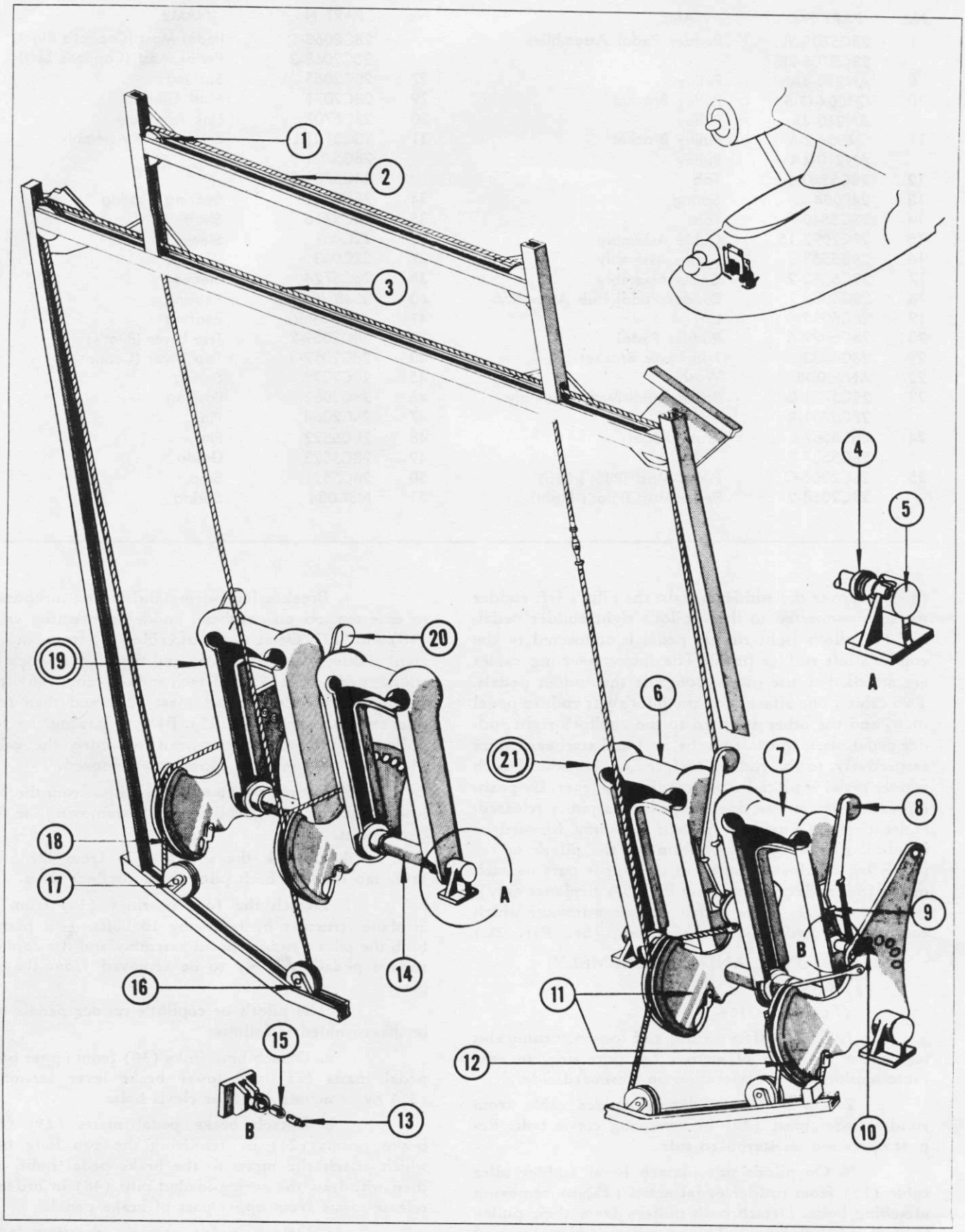


Figure 165—Rudder Pedals (PBY-5 Only)

No.	PART No.	NAME
1	AN210-4A	Pulley
2	28C2091-15	Cable Assembly
3	28C2091-20	Cable Assembly
4	B543 (Fafnir)	Bearing
5	28C2061	Bearing Casting
6	28C6030-2R	Rudder Pedal
7	28C6030-2L	Rudder Pedal
8	28C2059-L	Trip Lever (Pilot's)
9	28C2098	Spring
10	28C2065	Bushing
11	28C2068-0	Pedal Mast (Pilot's Left)
	28C2068-1	Pedal Mast (Copilot's Right)
	28C2068-2	Pedal Mast (Pilot's Right)
	28C2068-3	Pedal Mast (Copilot's Left)
12	28C2071	Mast Guide
13	28C2064	Pin
14	28C2063	Shaft
15	28C2062	Bushing
16	AN210-4A	Pulley
17	AN210-4A	Pulley
18	28C2092-0	Cable Assembly
19	28C2005-2R	Rudder Pedal Assem. (Copilot's)
20	28C2059-R	Trip Lever (Copilot's)
21	28C2005-2L	Rudder Pedal Assem. (Pilot's)

d. Detach the two bearings (34) from the ends of the main rudder pedal shaft by removing two bolts. Further disassembly of the rudder pedal shaft is inadvisable as all bearing retainers, spacers, etc., are fastened in place by means of rivets.

(b) PBY-5. *(See figure 165.)*—The removal and disassembly of the rudder pedals on the PBY-5 airplanes is similar to that on the PBY-5A airplanes with the exception of the brake pedal and linkage.

(3) MAINTENANCE.

(a) For maintenance of cables, see paragraph *b.*, (3).

(b) At 50 to 60 hour intervals, wipe dirt and grease from rudder pedal mechanism, and then lubricate all linkage joints with a light oil (Specification AN-O-6). Also lubricate bearings, through the Zerk fittings, with grease (Specification AN-G-10).

(c) Check to see that cable tensions are held to values shown in Section IX, Table A.

(4) ASSEMBLY AND INSTALLATION.

(a) PBY-5A.
(See figure 164.)

1. Reassemble rudder pedals by reversing procedure given in paragraph *c.*, (2), *(a)*, *8.*

2. Attach both pilot's and copilot's rudder pedal assemblies to structure in airplane by bolting the four bearing supports (34) in place with the 16 bolts.

3. Attach the four brake cables to the four lower brake lever assemblies (31) by means of the four clevis bolts. Hook the spring (13) to the brake lever tab (12) on both pilot's and copilot's sides.

4. By means of clevis bolt, attach end of overhead rudder connecting cable (16) to pilot's right pedal mast (25). Run cable up and around the two pulleys (8), and down to the copilot's left rudder pedal mast (25), to which it is attached by means of a clevis bolt. The two pulleys (8) are to be installed in the overhead structure at the same time the cable is installed.

5. Repeat above procedure for attachment of overhead rudder connecting cable (17) to pilot's left rudder pedal mast (25), and to copilot's right rudder pedal mast (25).

6. On pilot's side, attach both ends of the lower rudder idler cable (15) to the rudder pedal mast (25) by means of the two clevis bolts. During this operation, the cable is passed around the two pulleys, which are installed at the same time in their brackets (10) and (11). Repeat this procedure for installation of lower rudder idler cable on copilot's side.

7. On pilot's side, attach main rudder cable to rudder pedal mast (25) by means of clevis bolt. Repeat operation for copilot's side.

8. Tighten all turnbuckles to give correct cable tension as shown in Section IX, Table A. Safety all turnbuckles as outlined in paragraph *d.*, (4), *(b)*, *6.*

(b) PBY-5. *(See figure 165.)*—The assembly and installation of the rudder pedals on the PBY-5 airplanes is similar to that on PBY-5A airplanes with the exception of the brake pedals and linkage.

d. ELEVATOR CONTROL SYSTEM.

(1) DESCRIPTION. *(See figure 166.)*—The elevator surfaces are actuated by a dual cable system running aft from the pilot's compartment to the elevator. One pair of cables, attached to the control yoke mast on the pilot's side run aft on the port side of the airplane, (one of the cables passes through the automatic pilot servo) and over pulleys to a bell crank in the tail. This bell crank actuates a torque tube which controls the elevator surfaces. The other pair of cables, attached to the control yoke mast on the copilot's side, run aft over pulleys to the other arm on the bell crank in the tail. At a number of places in the aft end of the airplane, fair-leads are provided for the two pairs of cables.

(2) REMOVAL.

(a) Break safety wiring and disconnect the cables at the eight turnbuckles (5) and (16). *(See figure 166.)*

(b) Disconnect the cables (25) and (28) at the automatic pilot servo (27) by detaching the servo rod fittings.

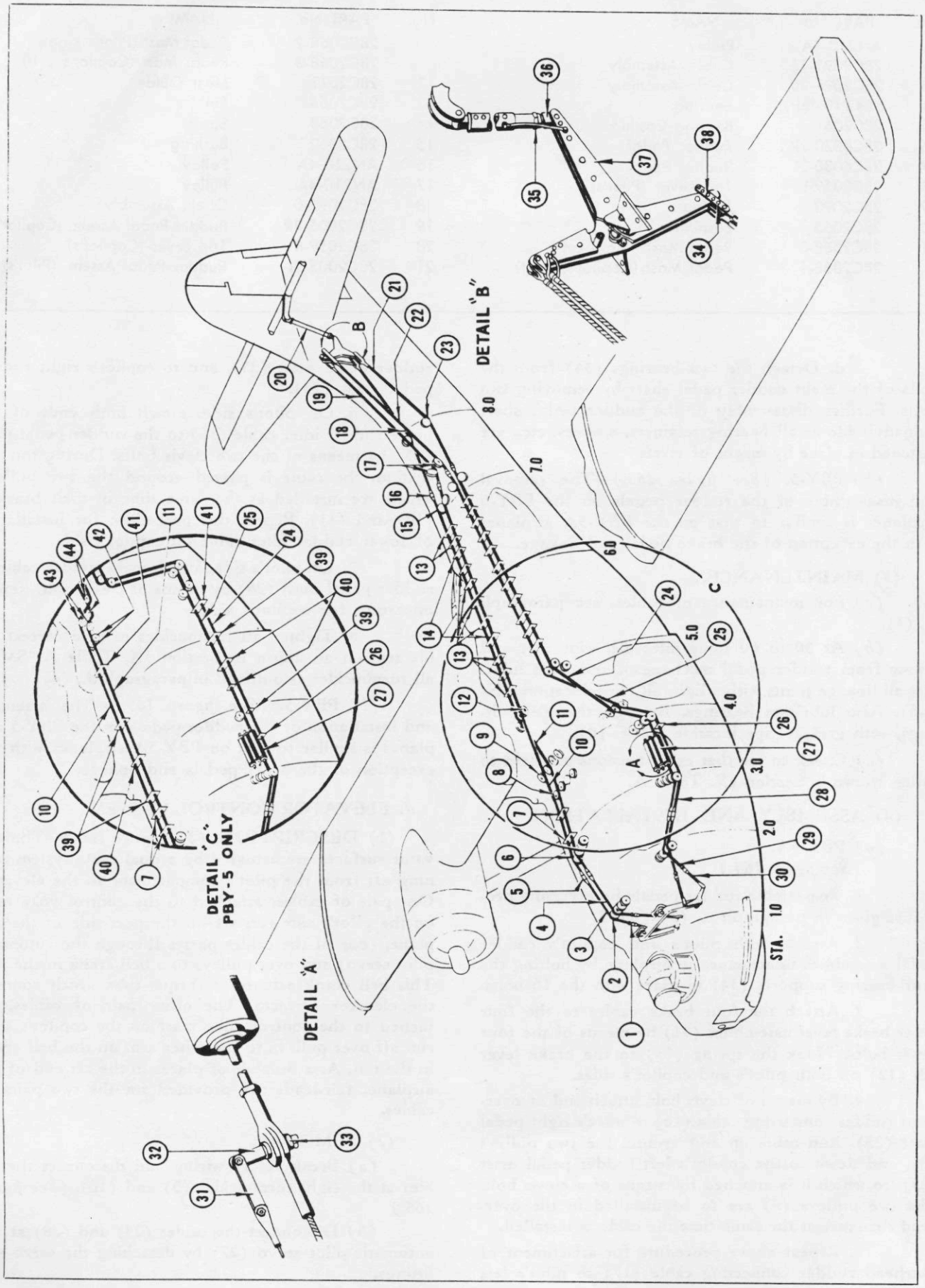


Figure 166—Elevator Control Cable System

No.	PART No.	NAME
1	28C1118	Cable Stop
	28C1117	
2	28C087-6	Pulley
3	28C5017-16	Cable Assembly
4	*28C5017-31	Cable Assembly
	**28C5017-19	
5	AN155-46S	Turnbuckle
6	AN210-3A	Pulley
7	22C185-5	Fair-lead
8	*AN210-4A	Pulley
9	*AN210-4A	Pulley
10	*28C5017-20	Cable Assembly
	**28C5017-19	
11	*28C5017-25	Cable Assembly
	**28C5017-18	
12	*AN210-4A	Pulley
13	22C185-4	Fair-lead
14	28C4034-9	Fair-lead Assembly
	28C4034-10	
	28C4034-11	
15	AN210-3A	Pulley
16	AN155-46S	Turnbuckle
17	AN210-4A	Pulley
18	*28C5017-33	Cable Assembly
	**28C5017-37	
19	28C5017-32	Cable Assembly
20	28C080	Tube Assembly
21	28C5017-32	Cable Assembly
22	28C5510-18	Cable Assembly
23	AN210-4A	Pulley
24	*28C5510-16	Cable Assembly
	**28C5510-14	
25	*28C5017-20	Cable Assembly
	**28C5017-19	
26	22C185-5	Fair-lead
27		Automatic Pilot Servo
28	28C5511-15	Cable Assembly
29	28C5017-16	Cable Assembly
30	28C5511-13	Cable Assembly
31	88-L-1000 (F. S. S. C.)	Shear Link
32	28C1134	Eye Bolt
33	AN320-4	Nut
	AN380-2-2	Cotter Pin
34	28C6027	Adjusting Link
35	AN316D16R	Check Nut
36	28C081	Clevis
37	28C078	Bell Crank
38	AN25-32	Bolt
	AN320-5	Nut
	AN916-516L	Washer
	AN380C2-2	Cotter Pin
39	**28C134	Fair-lead
40	**22C185-5	Fair-lead
41	**22C185-3	Fair-lead
42	**AN210-3A	Pulley
43	**AN210-5A	Pulley
44	**AN210-5A	Pulley

*PBY-5A only.
**PBY-5 only.

(c) Detach the cables (3), (4), (29), and (30) from the control yoke masts on both pilot's and co-pilot's sides by removing the four clevis bolts.

(d) Detach all fair-leads by removing sheet metal or machine screws.

(e) Remove pulley guard pin at pulley bracket on bulkhead 2, on both port and starboard sides. Remove pulleys from rest of elevator cable system brackets aft of bulkhead 2. To remove a pulley, first pull out cotter pin, and then unscrew nut, and remove bolt.

Note

If other pulleys belonging to another cable system are installed on the same bolt, tension on the foreign cable must be eased by loosening the nearest turnbuckle before removing the pulley bolt.

(f) Detach cable adjusting links (34) from bell crank (37) by removing bolts (38).

(g) Detach adjustable operating tube (20) from bell crank (37) and torque tube horn by removing two bolts. Detach bonding braids by removing self-tapping screws in bell crank and torque tube horn.

(h) Remove all elevator system cables from airplane.

(3) MAINTENANCE. (See paragraph *b.*, (3).)

(4) INSTALLATION.

(a) To install elevator cables in airplane, reverse removal procedure of paragraph *d.*, (2).

(b) RIGGING ELEVATOR CABLE CONTROL SYSTEM.

1. Set and then lock control yoke in neutral position. This may be done with control yoke locking bar. (See Section III, Par., 2, *g.*, (2), *(a).)* When in neutral position, the forward end of the control yoke wheel is 35 5/16 inches forward of bulkhead 2. After servo shut-off valve is set in "OFF" position, center automatic pilot servo piston.

2. Set elevator surfaces to neutral position by lining up with stabilizer trailing edge.

3. Adjust cable tensions to correct value by tightening turnbuckles. (See Section IX, Table A for cable tensions.)

4. Check to see that elevator surfaces are still in neutral position. If not, adjust clevis (36) on operating tube (20) by means of check nut (35) until neutral position is obtained.

5. Adjust stops (1) on cables in pilot's cockpit to permit a 7 5/16 inches forward movement and a

10 11/16 inches aft movement of the pilot's and copilot's control wheel from the neutral position.

6. Safety all turnbuckles with .040 zinc coated steel wire (Specification AN-QQ-W-435). There should be a minimum of five wraps of wire around each turnbuckle fitting. *(See figure 167.)* Not more than four threads of turnbuckle fittings should be exposed.

e. AILERON CONTROL SYSTEM.
(See figure 168.)

(1) DESCRIPTION.—The ailerons are actuated by a cable and connecting rod system running from the copilot's position to the ailerons. On port side, one aileron control cable runs from the yoke (See paragraph *b.*, (1).) over two pulleys, through the automatic pilot servo, over three more pulleys, and up through the superstructure to a pulley on the rear spar. The cable wraps around the rear spar pulley and is attached to a transverse push-pull rod on the starboard side and aft face of the wing rear spar. This push-pull rod is connected to an idler lever which, in turn, is connected by cables to a bell crank. The bell crank is linked to an operating tube, whose other end is attached to the hinged aileron surface on the starboard side. On the starboard side of the airplane, a cable runs from the control yoke aft to the rear spar of the wing, and then out to the port aileron in similar fashion. However, this cable run differs in that it does not pass through a servo unit.

(2) REMOVAL.

(a) Break safety wiring and disconnect the cables at the four turnbuckles (4) and (9).

(b) Disconnect the cables (19) and (21) at the automatic pilot servo by detaching the servo rod fittings.

(c) Detach cables (2) and (22) from control yoke as shown in paragraph *b.*, (2).

(d) Remove guard (26) from pulleys (27) on rear spar of wing and then remove all other aileron system pulleys from airplane. (See note under paragraph *d.*, (2), *(e).*)

(e) Detach cables (11) and (18) from push-pull tube (24) by removing the two bolts from connecting links (28) and the screws attaching both bonding braids (23).

(f) Remove all cables in the hull and superstructure from airplane.

(g) Disconnect push-pull tube from idler lever (16) on both port and starboard side of wing.

(h) Separate aileron push-pull tube (24) by detaching sleeve (25) and the two clamps (29). These parts are detached by the removal of eight bolts. *(See figure 20 for access.)*

(i) Slide port push-pull tube outboard until it clears the outboard roller bearing assembly (12). Then, slide push-pull tube inboard and aft of roller assemblies and withdraw tube from airplane through access on upper surface of trailing edge of wing near center line. Repeat operation for removal of push-pull tube from starboard side of airplane.

(j) Detach the aileron operating tube (30) from the bell crank (31) by removing one bolt. Repeat for starboard side.

(k) Detach the four cables (15) from idler lever (16) and bell crank (31) on both port and starboard sides of wing by removing four clevis bolts. *(See figure 20 for access.)*

(l) Detach bell crank (31) from both port and starboard sides of wing by removing hub (13) and bonding braid.

(m) Detach idler lever (16) on both port and starboard sides of wing by removing hub (13) and bonding braid.

(3) MAINTENANCE.
(See paragraph *b.*, (3).)

(4) INSTALLATION.

(a) On port and starboard sides of wing, attach idler levers (16) and bell cranks (31) by means of hubs (13). Attach bonding braids. *(See figure 168.)*

(b) On port and starboard sides, attach aileron operating tubes (30) to bell cranks (31) by means of two bolts.

(c) On port side of wing, attach the two cables (15) to idler lever (16) and bell crank (31) by means of four clevis bolts. Repeat operation for starboard side of wing.

(d) Insert both port and starboard halves of push-pull tube in airplane by reversing removal procedure given in paragraph *e.*, (2), *(i)*. Assemble halves of push-pull tube by attaching the sleeve (25) and two clamps (29) by means of the eight bolts.

(e) Attach both ends of push-pull tube (24) to idler lever (16) by means of two bolts.

(f) Attach ends of cable (11) and (18) to fittings on clamp (29) by means of bolts. Connect bonding braid from each cable end to push-pull tube by means of two screws.

(g) Install all cables in hull and superstructure by reversing procedure outlined in paragraph *e.*, (2), *(a)* through paragraph *e.*, (2), *(d)*.

(h) RIGGING AILERON CONTROLS.

1. Center the pilot's and copilot's control wheel by first removing the snap-on cover on the under side of the yoke *(See figure 162.)* and then turning the wheels until the turnbuckle on the exposed aileron cable is approximately at the center of the opening. At this position, the arrow on each wheel should be pointing down. Clamp the wheel in this position by means of yoke locking bar. (See Section III, Par. 2, *g.*, (2).) After setting servo shut-off valve in "OFF" position, center the automatic pilot servo piston.

2. Droop port aileron one inch by adjusting operating tube (30) at aileron bell crank (31). By loosening the jam nut on the clevis end of the aileron

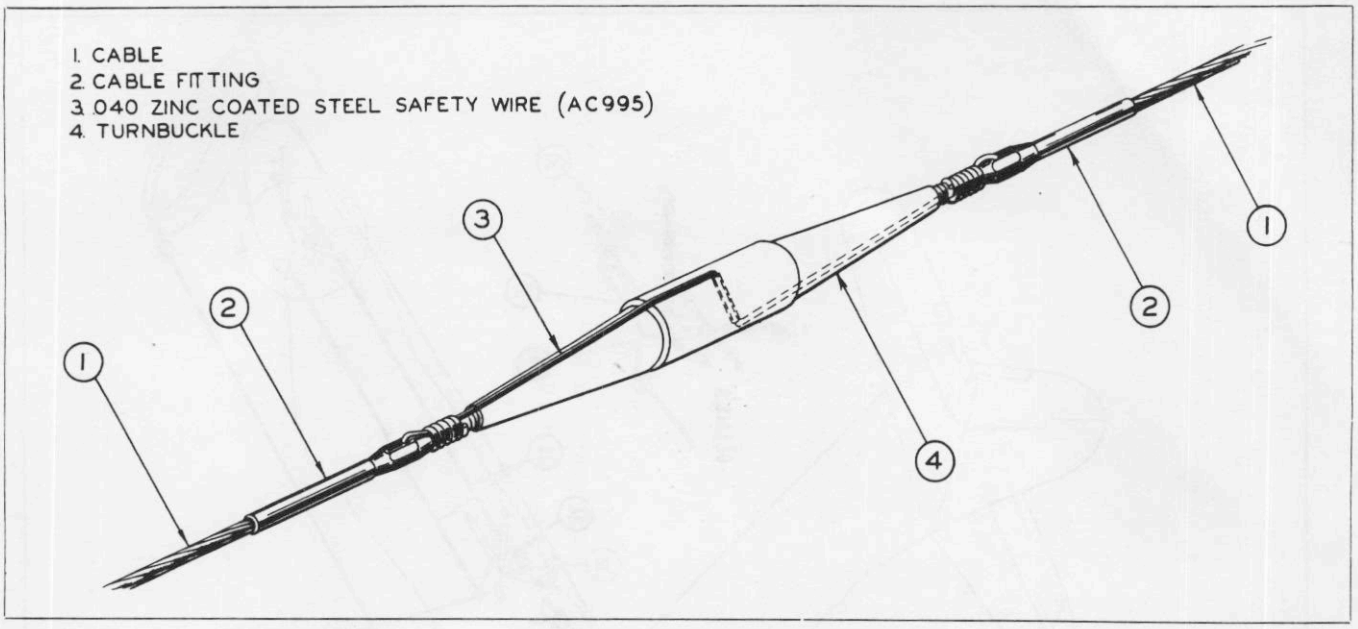


Figure 167—Typical Safetying of Turnbuckle

operating tube, the tube can be extended or withdrawn by adjustment. *(See figure 20 for location of access.)* Repeat above operation for starboard side. The reason for drooping both ailerons one inch is to prevent the nose of the aileron from projecting below the wing lower contour, and thus make possible the formation of ice on the aileron nose.

3. Aileron throw is 19¾° down and 21° up from the line of coincidence of the aileron and the wing trailing edge. Allowable tolerance for aileron throw each way is 1½°. The stops for the limitation of aileron surface travel are located within the ailerons at the hinge nearest the aileron control tube. These stops move with the aileron and bump against the hinge bracket at the limits of travel. The aileron throw corresponds to a rotation of the control wheel of 267° each side of neutral, and a movement of the aileron push-pull tube of 4½ inches each way.

4. Tighten all turnbuckles to tension shown in Section IX, Table A. (For safetying turnbuckles, see paragraph *d.,* (4), *(b), 6.*)

f. RUDDER CONTROL SYSTEM.

(1) DESCRIPTION.—The rudder surface is actuated by a pair of cables that run aft from the rudder pedals in the pilot's compartment to the rudder. On the port side, one rudder control cable is attached to the pilot's rudder pedal mast, and runs aft over three pulleys to the automatic pilot servo piston rod. From here it runs aft over pulleys to the tail, where it is connected to the port side of the rudder horn. On the starboard side of the airplane, the rudder control cable is attached to the copilot's rudder pedal mast, and runs aft over pulleys to the tail, where it is connected to the starboard side of the rudder horn. At a number of places in the aft end of the airplane fair-leads are provided. *(See figure 169.)*

(2) REMOVAL.

(a) Break safety wiring and disconnect the cables at the four turnbuckles (10) and (25).

(b) Disconnect cables (3) and (26) at the pilot's and copilot's rudder pedal masts by removing two clevis bolts.

(c) On port side of airplane, disconnect cables (20) and (23) at piston rod fittings of automatic pilot servo (22).

(d) Remove pulley guard pin from upper pulley bracket at bulkhead 2 on both port and starboard sides. Remove the pulleys from all other pulley brackets. (See note under paragraph *d.,* (2), *(e).*)

(e) Detach all fair-leads by removing sheet metal or machine screws.

(f) Detach cable adjusting links (14) from port and starboard horns (15) of rudder.

(g) Remove all cables from airplane.

(3) MAINTENANCE.

(See paragraph *b.,* (3).)

(4) INSTALLATION.

(a) Reverse removal procedure outlined in paragraph *f.,* (2), *(a)* through paragraph *f.,* (2), *(g)* for installation of rudder cables.

(b) RIGGING RUDDER CABLES.

1. Set all four rudder pedals in neutral adjusting position by means of adjusting levers. (See paragraph *c.,* (1).)

2. Set all four rudder pedals in neutral by adjusting turnbuckles on rudder pedal interconnecting

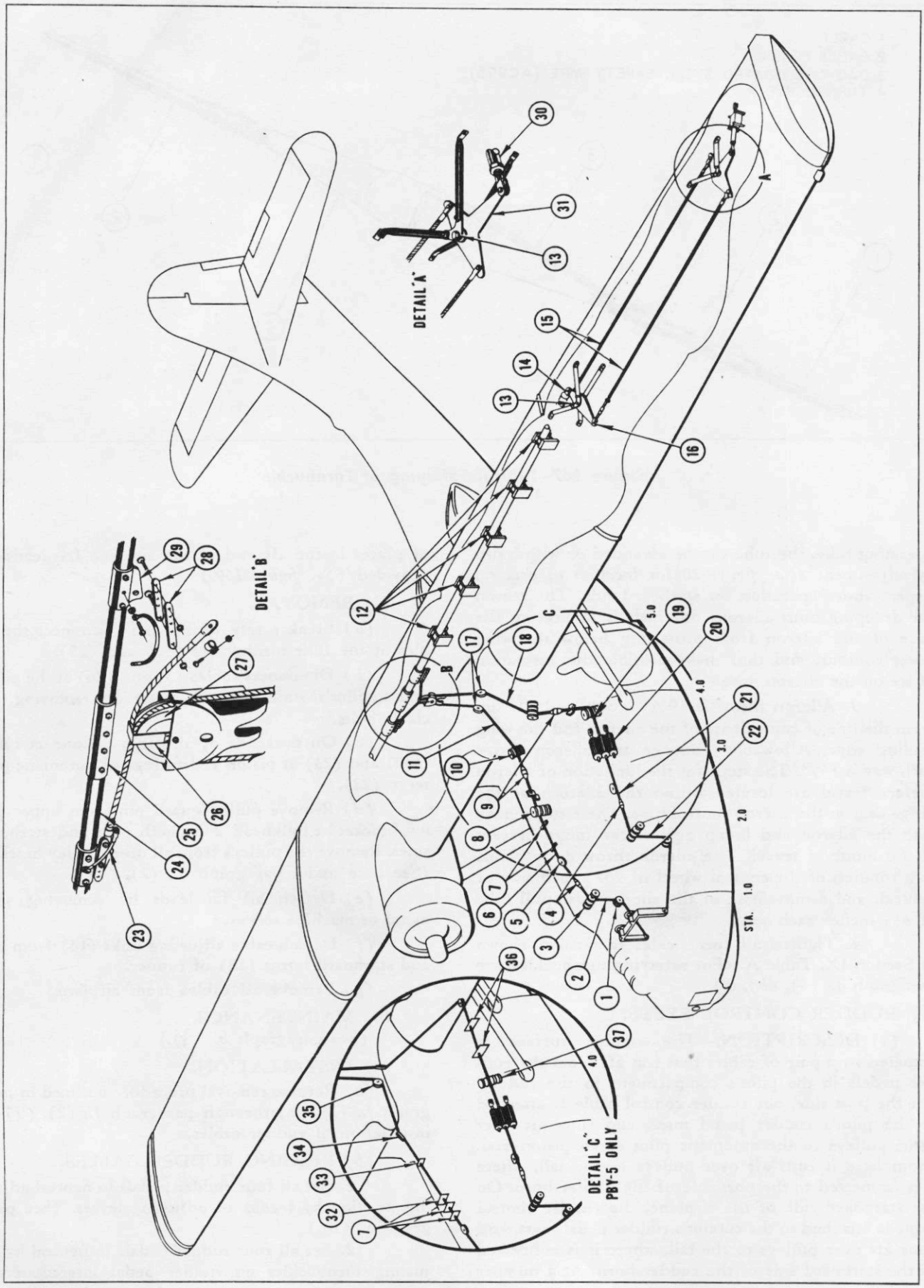


Figure 168—Aileron Control System

No.	PART No.	NAME
1	20C087-6	Pulley
2	28C2086-20	Cable Assembly
3	20C087-6	Pulley
4	AN155-46S	Turnbuckle
5	AN210-3A	Pulley
6	*28C2086-22	Cable Assembly
	**28C2086-21	
7	22C185-3	Fair-lead
8	*AN210-4A	Pulley
	**AN210-3A (Port)	
9	AN155-46L	Turnbuckle
10	*AN210-4A	Pulley
11	*28C2086-24	Cable Assembly
	**28C2086-23	
12	28C055	Bearing Assembly
13	28C056	Hub
14	28C054	Clevis
15	28C1098	Cable Assembly
16	28C064	Idler Lever
17	*AN210-5A	Pulley
18	*28C5512-17	Cable Assembly
	**28C5512-16	
19	*28C5512-14	Cable Assembly
	**28C5512-13	
20		Automatic Pilot Servo
21	28C5512-15	Cable Assembly
22	28C5512-12	Cable Assembly
23	Q506A-2-3	Bonding Braid
24	28C021-3	Push-Pull Tube
25	28C021-4	Sleeve
26	28C051	Guard
27	20C087-6	Pulley
28	28C6027	Link
29	28C6028	Clamp
30	28C024	Operating Tube Assembly
31	28C057	Bell Crank
32	**22C185-3	Fair-lead
33	**28C134	Fair-lead
34	**AN210-5A	Pulley
35	**AN210-5A	Pulley
36	**22C185-3	Fair-lead
37	**AN210-3A	Pulley

*PBY-5A only.
**PBY-5 only.

cable system. *(See figures 164 and 165.)* When the rudder pedals are set in neutral position, the distance from the brake pedal hinge axis (located at the top of the rudder pedals on the PBY-5A or the center of the top rung of the rudder pedals on the PBY-5) to bulkhead 1 is 13¼ inches. Clamp rudder pedals in this position.

3. While the rudder surface and also the automatic pilot rudder servo piston rod is kept in a neutral position, the cables running from the rudder pedals aft to the rudder surface are adjusted to the proper tension by means of the turnbuckles. (See Section IX, Table A for tension values, also paragraph *d.*, (4), *(b)*, *6* for safetying of turnbuckles.)

4. The rudder stops, which are located on the center rudder hinge bracket in the empennage, bump against the rudder horns. These stops are installed at the factory to give a rudder travel of 22° to each side of neutral. This corresponds to a rudder pedal travel of 4 17/32 inches each way from neutral.

g. ELEVATOR TAB CONTROL SYSTEM.

(1) GENERAL.—The elevator tabs, located on the aft inboard edges of the elevators, are actuated by a linkage and cable system that runs from elevator tab control unit in the pilot's compartment aft to the elevators.

(2) ELEVATOR AND RUDDER TAB CONTROL UNIT.

(a) DESCRIPTION. *(See figure 170.)*—The elevator and rudder tab control unit is enclosed by a casting mounted above the pilot and copilot on center line of airplane. The casting contains two drums which are attached to two shafts mounted in anti-friction bearings set in the box. Gears attached to the larger drum shaft mesh with a gear on a pointer indicator shaft and a gear on a crank handle shaft. When either the pilot's or copilot's crank handle is turned, a cable, wrapped around the large drum and fastened to it by a set screw, is moved. The two cable ends lead aft to the elevator tab surfaces. The movement of the crank handle also causes the pointer indicator to move up or down. A scale, located on each side of the box, provides an elevator tab setting reading. A similar pointer indicator and shaft assembly, meshed by gears to the smaller drum and shaft, is actuated by movement of a knob attached to the shaft of the smaller drum. Both ends of a cable, wrapped around and fastened to the smaller drum by means of a set screw, lead aft to the rudder tab surface. By turning the knob on the bottom of the box, the pointer moves up or down, and a reading may be taken on scales provided for rudder tab readings. One scale is located on each side of the box.

(b) REMOVAL AND DISASSEMBLY.

1. Break safety wiring and connections of the ends of the two cables (2) and (36) at the four turnbuckles (4) aft of bulkhead 2. *(See figure 171.)*

2. Detach the two parts of the fair-lead (35) on bulkhead 2 by removing the six screws.

3. Detach elevator crank shaft brace (1) from stringer by removing the three bolts. Remove entire gear box assembly (42) by withdrawing the four bolts (41) that hold it in place. *(See figure 170.)*

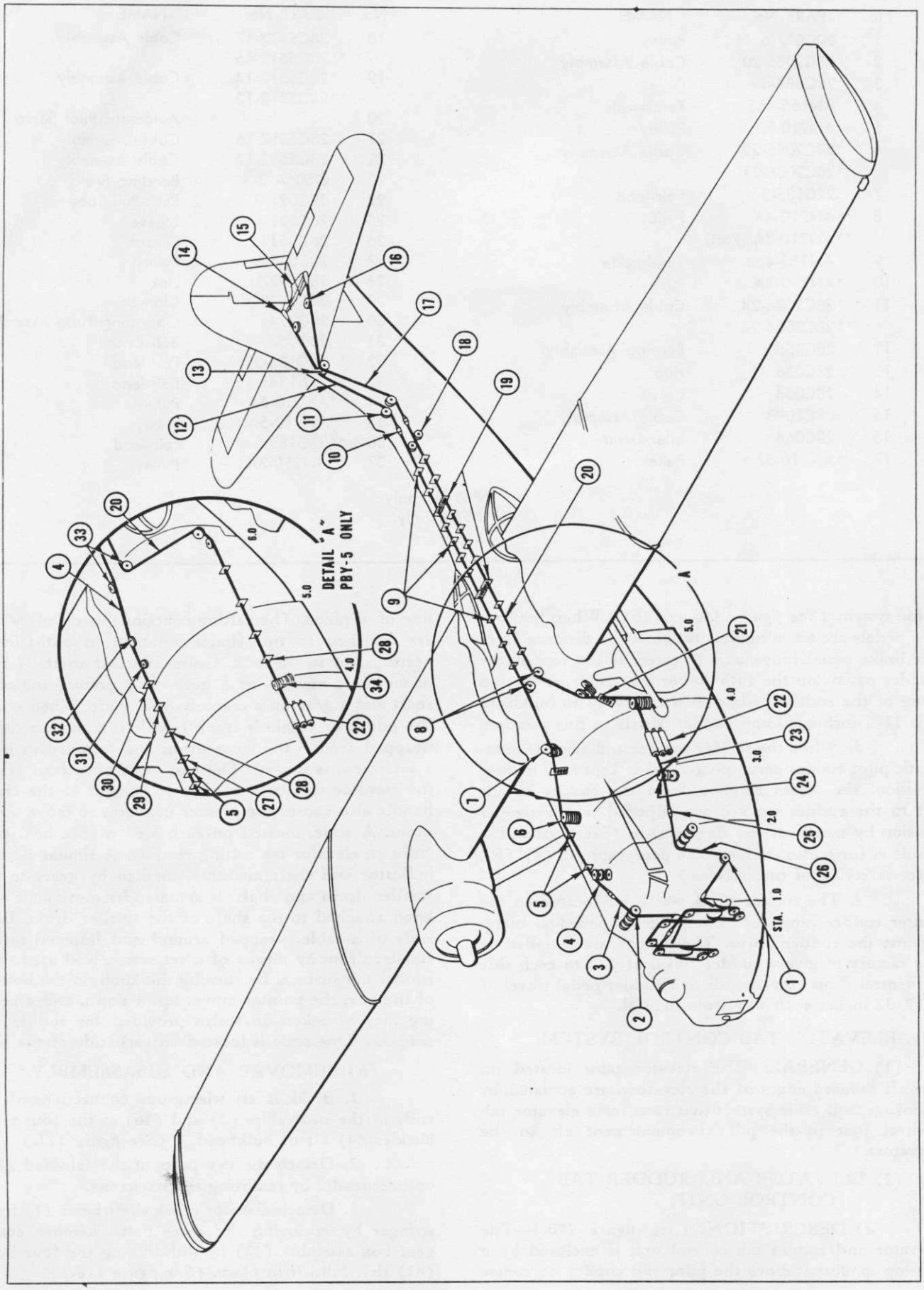


Figure 169—Rudder Control System

No.	PART No.	NAME
1	20C087-6	Pulley
2	20C087-6	Pulley
3	*28C5018-19	Cable Assembly
	**28C5018-12	
4	*28C5018-16	Cable Assembly
	**28C5018-15	
5	22C185-3	Fair-lead
6	*AN210-4A	Pulley
7	*AN210-4A	Pulley
8	*AN210-4A	Pulley
9	22C185-4	Fair-lead
10	AN155-46L	Turnbuckle
11	AN210-4A	Pulley
12	28C5018-23	Cable Assembly
13	AN210-4A	Pulley
14	28C6027	Link
15		Rudder Horn
16	AN210-3A	Pulley
17	*28C5510-25	Cable Assembly
	**28C5510-23	
18	AN210-3A	Pulley
19	28C4034-9	Fair-lead Assembly
	28C4034-10	
	28C4034-11	
20	*28C5510-17	Cable Assembly
	**28C5510-15	
21	*28C5529	Fair-lead
22		Automatic Pilot Servo
23	*28C5511-15	Cable Assembly
	**28C5511-14	
24	AN210-3A	Pulley
25	AN155-46S	Turnbuckle
26	28C5511-12	Cable Assembly
27	**28C134	Fair-lead
28	**22C185-3	Fair-lead
29	**28C134	Fair-lead
30	**22C185-3	Fair-lead
31	**AN210-3A	Pulley
32	**AN210-5A	Pulley
33	**AN210-5A	Pulley
34	**AN210-3A (Port)	Pulley

*PBY-5A only.
**PBY-5 only.

4. Disassemble gear box assembly (42) as follows:

a. Detach cranks (2) and knob (28) by removing the three taper pins (5).

b. Detach the four cable fair-leads (37) by removing the four screws (35).

c. Detach cover plate (26) by removing the four screws (33) and prying the cover plate off the five shafts (17), (24), and (25).

d. Detach the two bearing plates (9) by removing the eight screws (8).

e. By unscrewing shaft (17) from nut (14), withdraw the elevator tab indicator assembly and both rudder tab indicator assemblies from the box.

f. Withdraw elevator tab drum (19) and cable, and rudder tab drum (20) and cable from box (13) through cable opening into box. Detach cables (38) and (39) from both drums by removing the two set screws (22).

g. Remove the ball bearings (27) from the gear box (13), cover plate (26), and the ball bearings (10) from the elevator tab crankshaft plates (9), and the crankshaft brace (1).

h. Detach pinion gear (23) from elevator tab drum (19) by knocking out key and sliding off the gear.

i. Detach gears (21) and (29) from their respective drums by removing the eight attaching screws (31).

(c) MAINTENANCE.—At 50 to 60 hour intervals, remove cover to gear box, and lightly coat gears with grease (Specification AN-G-10). Lubricate threaded indicator shafts with oil (Specification AN-O-6).

(d) ASSEMBLY AND INSTALLATION.

1. Assemble gear box by reversing procedure outlined in paragraph *g.*, (2), *(b)*, *4. (See figure 170.)* However, when cables (38) and (39) are attached to drums (20) and (19) respectively, by means of set screws (22), the arrangement and the number of wraps of each cable and the location of the stops (40) should be as noted in figure 170 to correspond to a neutral setting of each indicator (pointer at zero).

2. Attach the gear box assembly to the airplane structure above the pilot and copilot by means of the four attaching bolts (41). Attach the crank handle brace (1) to stringer by means of the three bolts.

3. Run the tab cable ends aft through bulkhead 2, and then attach the two parts of the fair-lead (35) *(See figure 171.)* to bulkhead 2 by means of the six screws. Connect cable ends to aft cables by tightening turnbuckles to tensions shown in Section IX, Table A. Safety turnbuckles. (See paragraph *d.*, (4), *(b)*, *6.*)

(3) ELEVATOR TAB CONTROL CABLE SYSTEM.

(a) DESCRIPTION. *(See figure 171.)*—The elevator tabs are actuated by two cables leading aft along center line of airplane from the elevator tab control unit in the pilot's compartment to the tab surfaces. From the control box, each of the two cables leads aft over pulleys and fair-leads to the tail. Here, they are attached to a cable and chain run-around assembly. The chain assembly runs around a sprocket, located on both

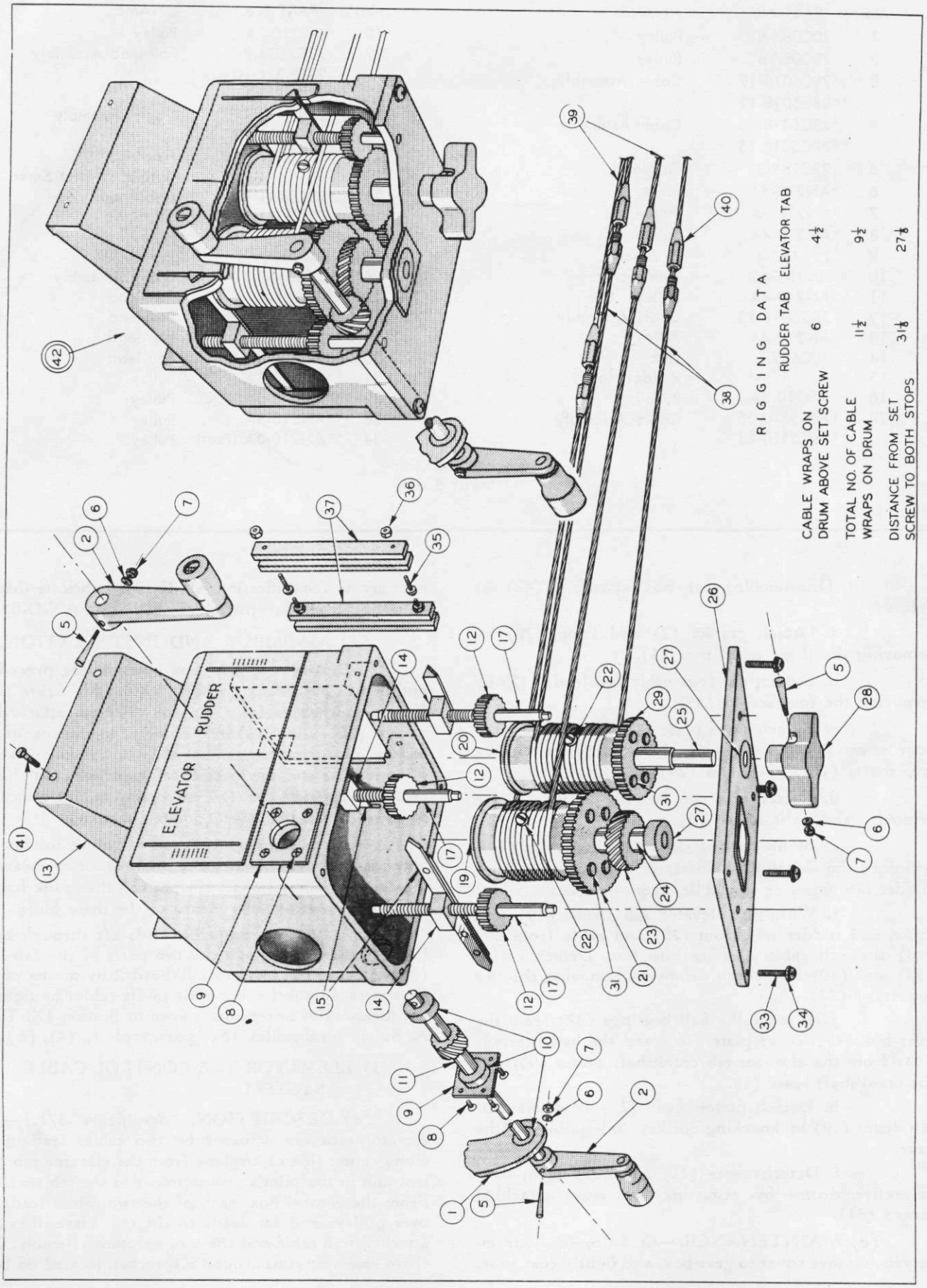


Figure 170—Elevator and Rudder Tab Control Unit

No.	PART No.	NAME
1	28C1075	Brace
2	28C1065-5	Crank Assembly
5	28C1092	Taper Pin
6	AN960-6	Washer
7	AN365-632	Nut
8	AN505-6-6	Screw
9	28C1076-2	Plate
10	AN201-K6A	Bearing
11	28C1068-9	Shaft
12	28C1070-4	Gear
13	28C1072	Box
14	28C1068-7	Nut
15		Pointer
17	28C1068-6	Shaft
19	28C1067-2	Drum
20	28C1067-3	Drum
21	28C1070-5	Gear
22	AN526DD832-6	Set Screw
23	28C1070-3	Gear
24	28C1068-4	Shaft
25	28C1068-5	Shaft
26	28C1073	Cover Plate
27	K-C6(FAFNIR)	Bearing
28	28C1066	Handwheel
29	28C1070-6	Gear
31	AN515-6-8	Screw
	AN935-6	Washer
33	AN515-8-12	Screw
34	AN960A8	Washer
	AN935-8	Washer
35	AN515-6-10	Screw
36	AN365-632	Nut
37	28C1070-10	Fair-lead
38	28C1123-3	Rudder Tab Cable Assembly
39	28C1123-2	Elevator Tab Cable Assembly
40	28C1050	Stops
	28C1051	
41	AN3-D5A	Bolt
	AN365-D1032	Nut
42	28C1070-0	Control Unit Assembly

port and starboard sides of the stabilizer. Each sprocket drives a screw that operates a push-pull tube, which in turn is connected to the elevator tab. This screw arrangement prevents any sudden air gusts from moving the elevator tab surfaces.

(b) REMOVAL.

(See figure 171.)

1. Break safety wiring and disconnect the two turnbuckles (4) aft of bulkhead 2, and by crawling up along the tail interior and through the wide opening in deck aft of hull station 8.66, disconnect the two turnbuckles (15) in the lower fin.

2. Remove all pulleys and fair-leads in the airplane. Open up the split fair-leads.

3. Detach sprocket guards (38) on both port and starboard sides, and then, after detaching chain (19) from cable (22) at turnbuckle (20), lift the chain from both sprockets (37). *(See figure 62 for access to the sprockets.)*

4. To detach cables (16) and (17) from chain and cable run-around assembly, it is necessary to remove the lower fairing (76) *(See figure 60.)* and the elevator crank house fairing (31). *(See figure 62.)* To remove fairings, detach the screws or bolts. By reaching through the access hole in the rear spar of the stabilizer, it is possible to remove the pulleys (39) and the fair-lead (40) in the bracket (41). *(See figure 171.)* The cable and chain run-around assembly may then be drawn forward through the airplane.

(c) MAINTENANCE.—For maintenance of cables, chains, and pulleys, see paragraph *b.*, (3).)

(d) INSTALLATION.

(See figure 171.)

1. Attach a long stiff piece of wire to the loose end of the chain (19). Feed the chain and cable run-around through the access door above the starboard sprocket (37), and by means of the stiff wire, run the chain over to the port sprocket. By making use of the access hole above this sprocket, it is possible to pass the chain over the port sprocket and back to the starboard sprocket. At the access hole above the starboard sprocket, the run-around installation is completed by removing the wire from the chain and attaching it to the cable end by means of the turnbuckle (20). (For location of access doors, see figure 62.)

2. By means of access attained as shown in paragraph *g.*, (3), *(b)*, *4.*, screw the fair-lead (40) in place around the two cables (21) and (22).

3. Attach the pulleys (39) to bracket (41) with cables (16) and (17) in position around the pulleys. By rotating the run-around, it is possible to bring the connecting links (18) on each side of the run-around assembly into position near the pulley bracket (41), where it is possible to connect cables (16) and (17) to the run-around by clevis bolts inserted through the links (18) on the run-around.

4. Replace elevator crank housing and fairing by reversing procedure of paragraph *g.*, (3), *(b)*, *4.*

5. Install cables leading forward to pilot's compartment by reversing procedure outlined in paragraph *g.*, (3), *(b)*, *1.* and paragraph *g.*, (3), *(b)*, *2.*

6. RIGGING ELEVATOR TAB CABLES.

(See figure 171.)

a. With elevator tab cable rigged and clamped to neutral position in control box in pilot's

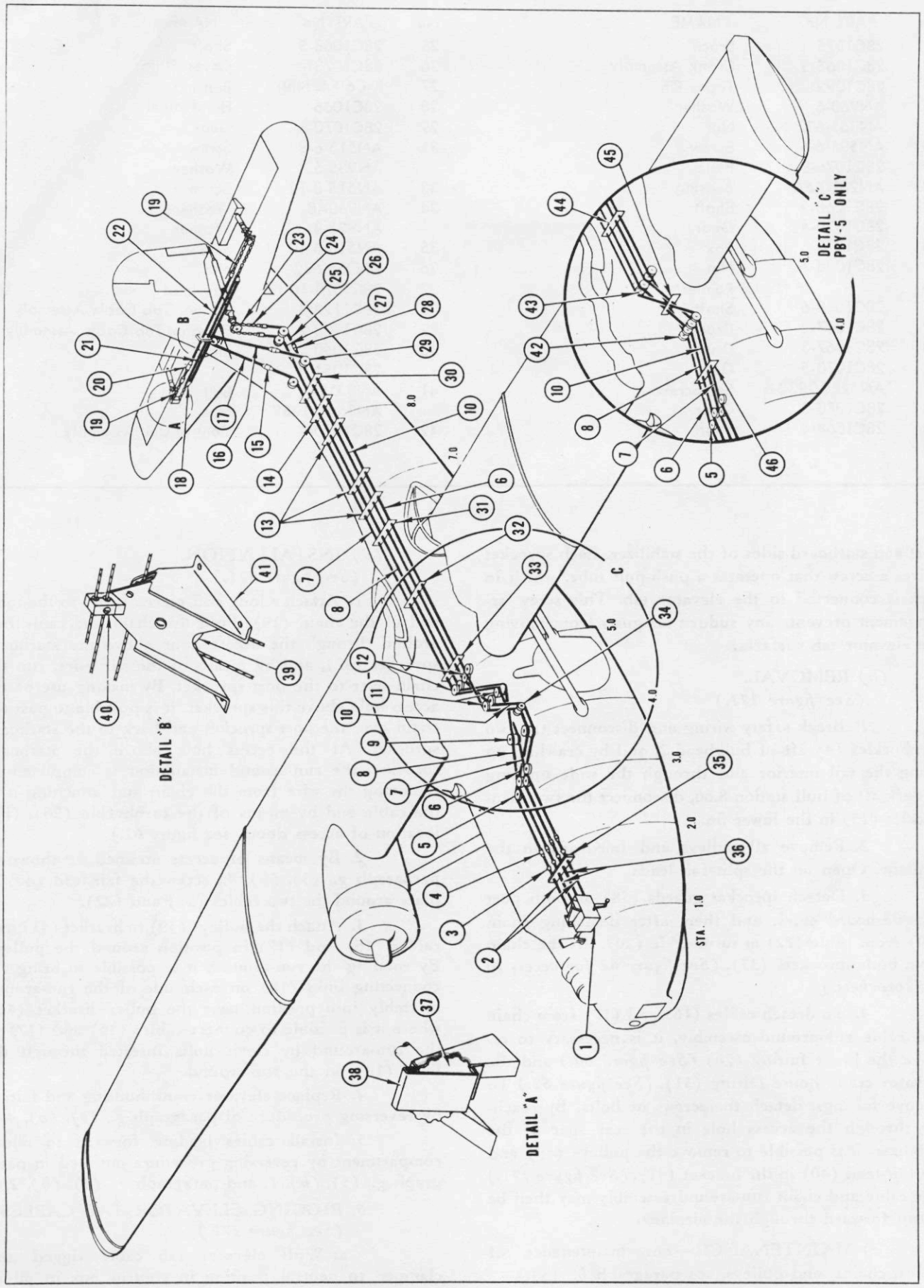


Figure 171—Elevator and Rudder Tab Control System

No.	PART No.	NAME
1		Tab Control Unit
2	28C1123-2	Elevator Tab Cable Assembly
3	28C1050	Stop Assembly
	28C1051	
4	AN155-8S	Turnbuckle
5	AN210-1A	Pulley
6	*28C1124-26	Elevator Tab Cable Assembly
	**28C1124-12	
7	*28C1124-27	Elevator Tab Cable Assembly
	**28C1124-14	
8	*28C2079-26	Rudder Tab Cable Assembly
	**28C2079-22	
9	*AN210-1A	Pulley
10	*28C2079-26	Rudder Tab Cable Assembly
	**28C2079-23	
11	*AN210-1A	Pulley
12	*AN210-1A	Pulley
13	28C1105-4	Fair-lead
14	28C1105-7	Fair-lead
15	AN155-8S	Turnbuckle
16	28C1124-3	Elevator Tab Cable Assembly
17	28C1124-2	Elevator Tab Cable Assembly
18	28C071	Connecting Link
19	28C1100-2	Chain
20	AN155-8S	Turnbuckle
21	28C1091-2	Elevator Tab Cable Assembly
22	28C1091-3	Elevator Tab Cable Assembly
23	28T5090	Sprocket
24	*28C1100-9	Chain
	**28C1100-7	
25	AN210-2A	Pulley
26	28C2079-21	Rudder Tab Cable Assembly
27	28C2079-20	Rudder Tab Cable Assembly
28	AN155-8S	Turnbuckle
29	AN210-2A	Pulley
30	28C1105-6	Fair-lead
31	28C1105-3	Fair-lead
32	*28C1105-3	Fair-lead
33	*28C1105-8	Fair-lead
34	AN210-1A	Pulley
35	28C1094	Fair-lead
36	28C1123-3	Rudder Tab Cable Assembly
37	28C1145	Sprocket
38	28C1087	Guard
39	AN210-2A	Pulley
40	28C1045	Fair-lead
41		Pulley Bracket
42	**AN210-1A	Pulley
43	**AN210-1A	Pulley
44	**28C1105-2	Fair-lead
45	**28C1059	Fair-lead
46	**28C1141	Fair-lead

*PBY-5A only.
**PBY-5 only.

compartment. (See paragraph *g.*, (2), *(d)*, *1.*), loosen turnbuckle (20) on cable (22) and temporarily lift chain off sprocket (37) on starboard side of stabilizer. Then with elevator surfaces set in neutral, turn the sprocket (37) until the elevator tab trailing edge is in alignment with the elevator trailing edge. Drop chain back over sprocket while in this position. Repeat operation at other sprocket, and then tighten and safety turnbuckle (20).

b. With elevator tabs in neutral position, tighten at all turnbuckles until tension noted in Section IX, Table A is obtained. Safety all turnbuckles as noted in paragraph *d.*, (4), *(b)*, *6.*

c. The cable stops aft of bulkhead 2 are set so that the throw of each elevator tab is $5 \pm 1^\circ$ above and $10 \pm 1^\circ$ below the line of coincidence of the tab and elevator trailing edges.

WARNING

Check to see that cable connections are not reversed. When the pointer on the elevator tab control box moves to "NOSE UP," the elevator tab must move down. This causes the elevator to move up and therefore causes the airplane to "NOSE UP."

h. RUDDER TAB CONTROL SYSTEM.

(1) GENERAL.—The rudder tab is actuated by two cables leading aft from the rudder tab control unit in the pilot's compartment to the rudder tab.

(2) ELEVATOR AND RUDDER TAB CONTROL UNIT. (See paragraph *g.*, (2).)

(3) RUDDER TAB CONTROL CABLE SYSTEM.

(a) DESCRIPTION. *(See figure 171.)*—From the rudder tab control unit each of the two cables leads aft over five pulleys to the tail. Here, the two cables are attached to a chain which wraps around a sprocket located in the fin. A screw mechanism, fastened to the sprocket shaft, is connected to a push-pull rod assembly, which in turn is fastened to the rudder tab. This screw arrangement prevents any sudden air gusts from moving the rudder tab surface.

(b) REMOVAL.

1. Break safety wiring and disconnect the two turnbuckles (4) aft of bulkhead 2, and the two turnbuckles (15) aft of station 8.66. *(See figure 171.)*

2. Remove all pulleys and fair-leads in the airplane. Open up the split fair-leads.

3. In order to remove the chain (24) from the sprocket (23), it is necessary for a small man to crawl to the extreme aft end of the hull by passing through the openings in the two sloping fin bulkheads. By standing up, he can reach and detach the chain from the sprocket.

4. Remove the two cables (8) and (10) and the chain assembly from the airplane.

(c) MAINTENANCE.—For maintenance of cables, chains, and pulleys, see paragraph *b.*, (3).

(d) INSTALLATION.

1. Install cables (8) and (10) and chain assembly in airplane by reversing removal procedure outlined in paragraph *h.*, (3), *(b)*.

2. RIGGING RUDDER TAB CABLES.
(See figure 171.)

a. With rudder tab cable rigged and clamped to neutral position in control box in pilot's compartment (See paragraph *g.*, (2), *(d)*, *1.*) temporarily lift chain (24) off sprocket (23) in tail end, and, with rudder surface set in neutral position, turn the sprocket until the rudder tab trailing edge is in alignment with the rudder trailing edge.

b. Drop chain over the sprocket again, and, with the rudder tab clamped in neutral position, tighten the four turnbuckles (4) and (15) until tension as listed in Section IX, Table A is obtained. Safety turnbuckles as noted in paragraph *d.*, (4), *(b)*, *6.*

c. The cable stops aft of bulkhead 2 are set so that the throw on the rudder tab is $20\pm1^\circ$ to port, and $15\pm1^\circ$ to starboard.

WARNING

Check to see that cable connections are not reversed. When the pointer on the rudder tab control box indicates right rudder on the scale, the rudder tab must move to the port. This results in the movement of the rudder surface to starboard while in flight.

i. AILERON TAB CONTROL SYSTEM.

(1) GENERAL.—The adjustable aileron tab located on the port aileron is actuated by a linkage and cable system that runs aft from the aileron tab control unit in the pilot's compartment to the tab in the port wing.

Note

A fixed Fletner tab on the starboard aileron is not controllable from the cockpit. It is set in its fixed position during flight testing. This tab's purpose is to balance out slight wing heaviness resulting from manufacturing variances.

(2) AILERON TAB CONTROL UNIT.

(a) DESCRIPTION. *(See figure 172.)*—The aileron tab control unit is located under the instrument panel on the pilot's side. It consists of a drum mounted on a shaft, which rotates in bearings mounted in a gear box attached to the instrument panel beam. An indicator pointer rides on the shaft, and is actuated by a combination of gears which are rotated by the shaft. On the aft end of the shaft is a control knob accessible to the pilot. The aileron tab control cable wraps around and is secured to the drum in the gear box by a set screw. From the drum, both cable ends run to the pulleys on the port side of the airplane and then aft.

(b) REMOVAL.
(See figure 172.)

1. Break safety wiring and disconnect turnbuckle fittings (5) in navigator's compartment.

2. Remove pulleys (2), (3), and (7) and detach both halves of the fair-lead (4) on the aft face of bulkhead 2 by removing the eight screws.

3. Detach knob (31) by removing taper pin (32).

4. Detach the four screws that hold the aileron tab control unit (1) to the supporting angles.

5. Straighten pointer at end of indicator pointer assembly (30) and then slide control unit (1) forward until handle shaft (29) and pointer (30) clear support bearing. This permits removal of unit from airplane.

6. Disassemble unit (1) as follows:

a. Remove handle shaft (29) from drum shaft (27) by detaching taper pin.

b. Remove gear box cover (24) by detaching the four screws (25).

c. Remove the drum and gear assembly and the smaller shaft and gear assembly from the gear box.

d. To remove the gears or drum from a shaft, it will be necessary to knock out or drill out the pins holding the gear or drum to the shaft.

e. Remove cable (6) from drum by loosening set screw (35).

(c) MAINTENANCE.—Refer to paragraph *b.*, (3) for maintenance of cables and pulleys.

(d) ASSEMBLY AND INSTALLATION.
(See figure 172.)

1. Assemble aileron control unit by reversing disassembly procedure outlined in paragraph *i.*, (2), *(b)*, *6.*

2. Before placing drum in gear box, wrap cable (6) around drum (26) and then clamp to drum with set screw (35). For rigging of cable on drum, see paragraph *i.*, (2), *(d)*, *8.*

3. Place control unit (1) in position on angles and slide it aft to allow the handle shaft (29) to pass through aft bearing support.

4. Attach control unit (1) to angles by means of the four screws.

5. Bend end of pointer (30) to position shown in figure 172.

6. Pass cables (6) outboard around pulleys (20) and (3) as they are installed and then run cable through bulkhead 2.

Note

Attach fair-lead (4) on aft face of bulkhead 2 at time of installation of pulley brackets on the bulkhead.

7. Join cables (6) and (10) by means of turnbuckle (8).

8. RIGGING OF CABLES IN AILERON CONTROL UNIT.

a. Before installing the drum (26) in the gear box, pin the midpoint of the cable (6) to the drum by means of the set screw (35). Then, with the drum in position as shown in figure 172, wrap the number of turns of cable around the drum as shown in figure 172. Install drum as outlined in paragraphs *i.*, (2), *(d)*, *1.* and *i.*, (2), *(d)*, *2*, making sure that cables are kept taut on drum.

Note

When installing drum in gear box, face the head of the set screw (35) to the outboard position and mesh gear (28) with gear (23) in such a manner that the pointer (30) points directly downwards (that is, the pointer is at a 90° angle to the set screw head on the drum).

b. Set both cable stops aft of bulkhead 2 at a distance of 18¾ inches from the aft face of the fair-lead (28) on bulkhead 2. Keep cables taut at bulkhead 2 by means of a clamp until aft cables are rigged. (See paragraph *i.*, (3), *(d)*, *6.*)

Note

The clamp can consist of two metal bars with adjacent cut-outs, a bolt through the center of both bars, and a wing nut for tightening.

(3) AILERON TAB CABLE SYSTEM.

(a) DESCRIPTION.—From their turnbuckle connections to the forward aileron tab control cable ends in the navigator's compartment, each aileron tab cable leads aft on the port side over three pulleys, and up to a pulley on the rear spar of the wing. From here, the cables run outboard along the port side of the wing spar, through three fair-leads, to the aileron tab screw jack mechanism. Here, both ends of the cables attach to a chain which runs over a sprocket. The sprocket drives a screw that operates a push-pull tube, which is connected to the aileron tab.

(b) REMOVAL.

(See figure 172.)

1. Disconnect the two turnbuckles (8) in the navigator's compartment after clamping the cables against bulkhead 2 to prevent ravelling on drum in pilot's compartment. (See note in paragraph *i.*, (2), *(d)*, *8.*, b. on construction of clamp.)

2. Disconnect turnbuckles (14) in port wing trailing edge through one of the access zippers in the lower surface. *(See figure 20 for location of access holes.)*

3. Through zipper access in upper surface of port wing trailing edge, disconnect both ends of the chain (18) from the cables at the connecting links. Remove chain from sprocket (19).

4. Through access holes in wing upper surface, remove fair-lead (17). (Two men are necessary for the removal of this fair-lead from its bracket.) Lift up the cable with its fair-lead attached and then disconnect the fair-lead. The other two fair-leads at brackets (15) and (16) can be reached through access zippers in the wing lower surface trailing edge. Here, only one man is required for loosening the bolts and spreading the fair-leads apart far enough to permit cable (10) to be withdrawn.

5. Remove all pulleys, and the cable (10).

(c) MAINTENANCE.—Refer to paragraph *b.*, (3), for maintenance of cables and pulleys.

(d) INSTALLATION.

1. Connect ends of cable (10) to ends of chain (18) by means of connecting links.

2. Thread cable (10) through outboard fair-lead (17) and then attach fair-lead in place. Thread both ends of the cable through the fair-leads at brackets (16) and (15). The fair-leads must be pried apart while passing the cable through. Tighten down each fair-lead by means of the two screws.

3. At zipper access door, connect the ends of the cable (10) by means of the two turnbuckles (14).

4. Install all pulleys and run cable (10) over the pulleys as they are installed.

5. Connect cable (10) to forward cable (6) ends by means of turnbuckles (8) in navigator's compartment.

WARNING

Check to see that cable connections are not reversed. Cables must be connected in such a manner that, when the tab control knob is turned clockwise, the tab will move upward. This causes the left aileron to move downward.

6. RIGGING AILERON TAB CABLES.

(See figure 172.)

a. Rig cable around drum in control unit in pilot's compartment. (See paragraph *i.*, (2), *(d)*, *8.*)

b. By means of zipper access doors in wing trailing edge, temporarily lift chain (18) off sprocket (19), and with aileron surface in neutral position, rotate sprocket until the aileron tab trailing edge is in alignment with the aileron trailing edge. With tab in this position, drop chain back over sprocket.

c. With aileron tab and pilot's control unit held in neutral position, tighten all turnbuckles to give cable tensions shown in Section IX, Table A. Safety turnbuckles as described in paragraph *d.*, (4), *(b)*, *6.*

d. The cable stops on the cable aft of bulkhead 2 are set to give an aileron tab throw of 15±1°

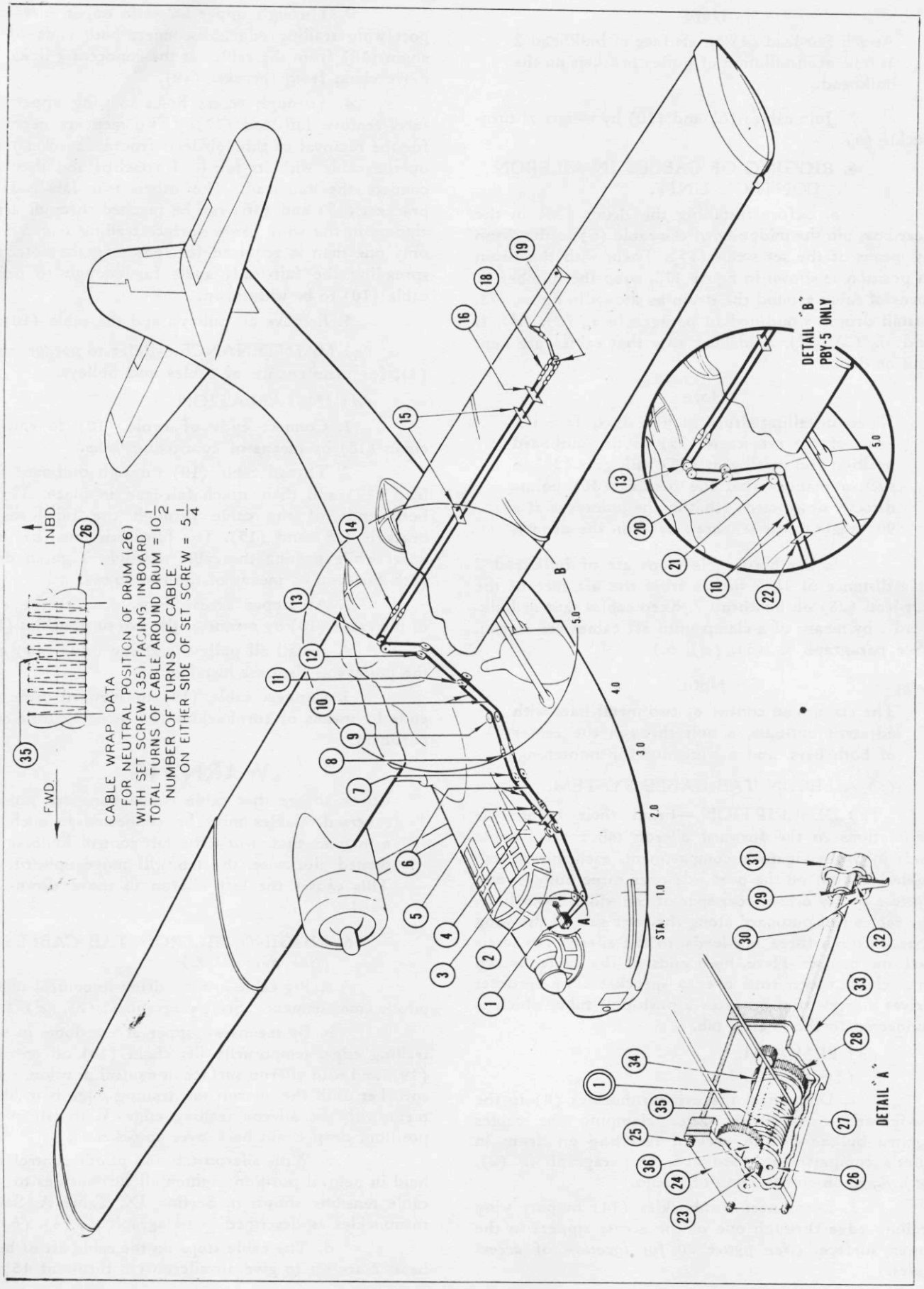


Figure 172—Aileron Tab Control System

No.	PART No.	NAME
1	*28C2030-160	Aileron Tab Control Unit
	**28C2030-158	
2	AN210-2A	Pulley
3	AN210-2A	Pulley
4	28C5768	Fair-lead
5	28C1050	Stop Assembly
	28C1051	
6	*28C2036-52	Cable Assembly
	**28C2036-50	Cable Assembly
7	AN210-2A	Pulley
8	AN155-8S	Turnbuckle
9	*AN210-2A	Pulley
10	*28C2082-57	Cable Assembly
	**28C2082-0	Cable Assembly
11	*AN210-1A	Pulley
12	*AN210-2A	Pulley
13	AN210-2A	Pulley
14	AN155-8S	Turnbuckle
15	28C2158	Fair-lead
16	28C2039	Fair-lead
18	28C1100-6	Chain
19	28C2045-3	Sprocket
20	**AN210-2A	Pulley
21	**AN210-2A	Pulley
22	**28C2081	Fair-lead
23	G45 (Boston)	Gear
24	28C2032	Gear Box Cover
25	AN515D8-12	Screw
	AN960D8	Washer
	AN935-8	Lock Washer
26	28C1067-4	Drum
27	28C2033-3	Shaft
28	28C2034	Gear
29	28C2030-10	Handle Shaft
30	28C2029-58	Pointer
31	28C1066-3	Hand Wheel
32	28C1092	Taper Pin
	AN960-6	Washer
	AN365-632	Nut
33	28C2031-50	Gear Box
34	28C2033-2	Shaft
35	AN526DD832-6	Screw
36	G182 (Boston)	Gear

*PBY-5A only.
**PBY-5 only.

above and $15 \pm 1^{\circ}$ below the line of coincidence of the aileron tab trailing edge and the aileron trailing edge.

j. RUDDER LOCK SYSTEM.

(1) DESCRIPTION.—The rudder is locked by a spring-loaded pin located in the fin just forward of the rudder. This pin, when actuated by a cable and bell crank system leading forward to the pilot's compartment, slides into a socket located in the leading edge of the rudder. The control lever, located to the left of the pilot, is a hinged arm attached to one side of a cable run-around that leads aft to the tail. To lock the rudder, after pulling a spring-loaded pin, the lever is pulled inboard and forward until another spring-loaded pin at the end of the lever snaps into a socket at the side of the airplane. When this occurs, the cable and bell crank system will have been actuated sufficiently to cause the plunger in the fin to enter the socket in the rudder leading edge, and thus lock the rudder. While this operation is being performed, it may be necessary to work the rudder pedals slightly with the feet to insure mating of plunger and socket. To unlock rudder, simply pull back and outward on pilot's lever until stowage pin locks in place. Directions for operation of lever are printed on an instruction plate located near the lever.

(2) REMOVAL.
(See figure 173.)

(a) Break safety wiring and disconnect the two turnbuckles (7) in the navigator's compartment.

(b) Disconnect cable (2) from lever (27) by removing locking screw in quadrant (21).

(c) Disconnect the two cables (9) from bell crank (19) by removing the two clevis bolts from the fittings (16). In order to accomplish this, it will be necessary for a small man to crawl to the extreme aft end of the hull by passing through the openings in the two sloping fin bulkheads.

(d) Detach all fair-leads by removing screws and then remove all pulleys. Withdraw all cables after detaching pulley bracket and removing pulley (1).

(e) Detach handle assembly (27) by removing bolt (22), and then detach hinge support (23) by removing the eight screws. Finally, detach nameplate (24) by removing four screws, and retainer (4) by removing two screws.

(f) Detach the two bonding braids from bell crank (19) by removing the two screws from the bell crank. Unhook spring (20) from the bell crank, and then detach the bell crank by removing the clevis bolt.

(3) MAINTENANCE.—For maintenance of cables and pulleys, see paragraph *b.*, (3).

(4) INSTALLATION.
(See figure 173.)

(a) To install bell crank (19), reverse procedure of paragraph *j.*, (2), *(f)*.

(b) To install pilot's control lever (27), reverse procedure of paragraph *j.*, (2), *(e)*.

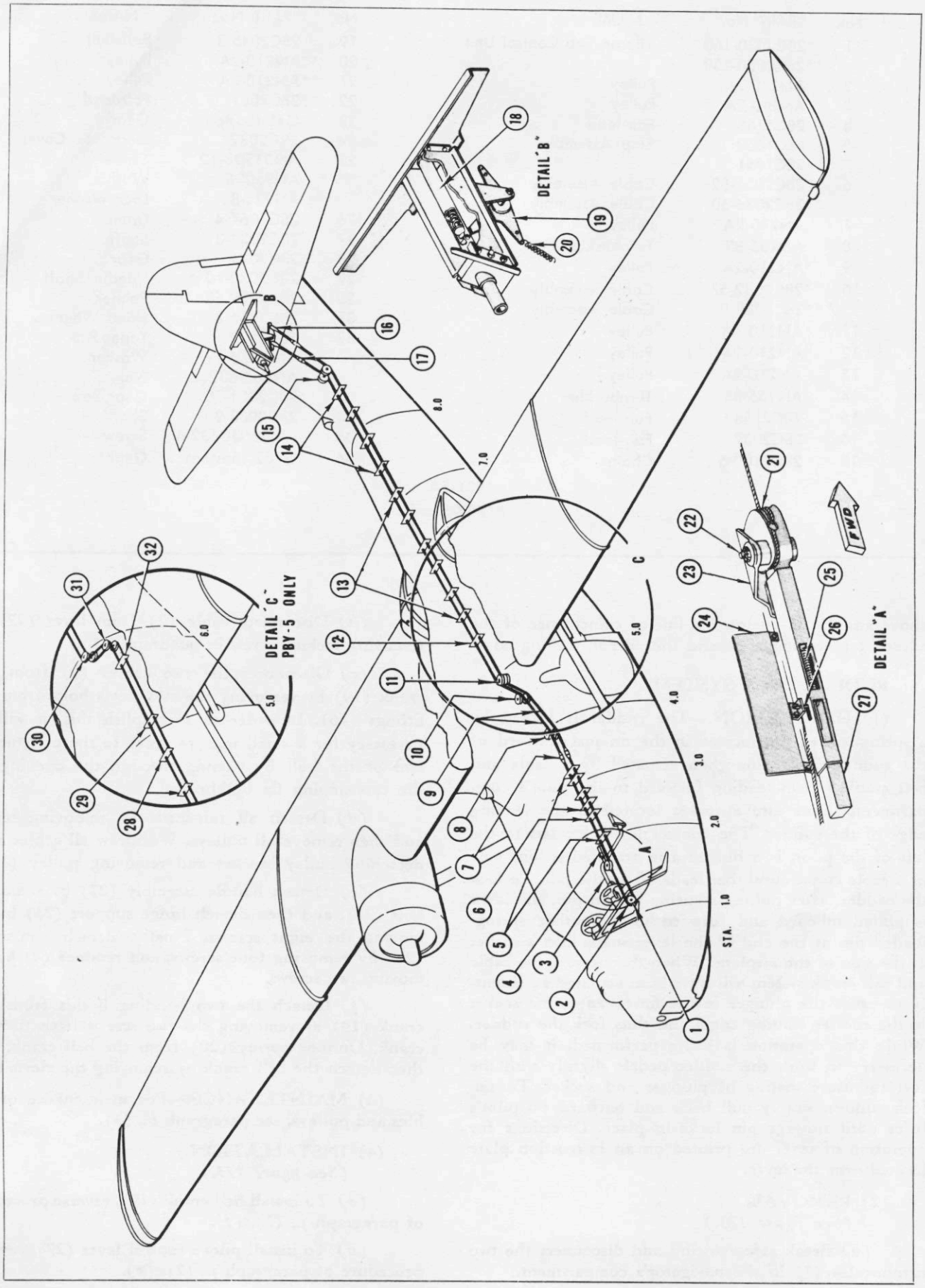


Figure 173—Rudder Lock Control System

No.	PART No.	NAME
1	AN210-2A	Pulley
2	28C4080-10	Cable Assembly
3		Aileron and Elevator Lock
4	28C4067	Retainer
5	28C4078-5	Fair-lead
6	28C4078-4	Fair-lead
7	AN155-8S	Turnbuckle
8	*AN210-2A	Pulley
9	*28C4080-12 **28C4080-11	Cable Assembly
10	*AN210-1A	Pulley
11	*AN210-2A	Pulley
12	28C4078-2	Fair-lead
13	28C4078-1	Fair-lead
14	28C4078-2	Fair-lead
15	AN210-2A	Pulley
16	AN160-8S	Fitting
17	AN155-8S	Turnbuckle
18	28T5102	Pin
19	28C4074	Bell Crank
20	28T5105	Spring
21		Quadrant
22	AN5-25	Bolt
23	28C4062	Support
24	NNF-002	Nameplate
25		Spring
26		Pin
27	28C4066-0	Handle Assembly
28	**28C4078-4	Fair-lead
29	**28C4078-3	Fair-lead
30	**AN210-2A	Pulley
31	**AN210-2A	Pulley
32	**28C4078-6	Fair-lead

*PBY-5A only.
**PBY-5 only.

(c) Install all fair-leads and pulleys and at the same time, string the cables (9).

(d) Attach ends of cables (9) to bell crank (19) by means of clevis bolts and fittings (16). Connect bonding braids to bell crank.

(e) Connect one end of cable (2) to forward end of cable (9), and then, after wrapping cable (2) around and pinning to quadrant (21), run the cable forward around pulley (1) and aft to connect to the other end of cable (9).

(f) After wrapping cable (2) around pulley (1), assemble the pulley and its bracket and install in airplane.

(g) Adjust turnbuckles (7) and (17) so that bell crank (19) forces pin (18) into socket in rudder at the same time that the pin (26) in the pilot's control lever engages its socket.

(h) While maintaining above adjustment, tighten all turnbuckles to the cable tension as listed in Section IX, Table A. Safety turnbuckles as noted in paragraph *d.*, (4), *(b)*, 6.

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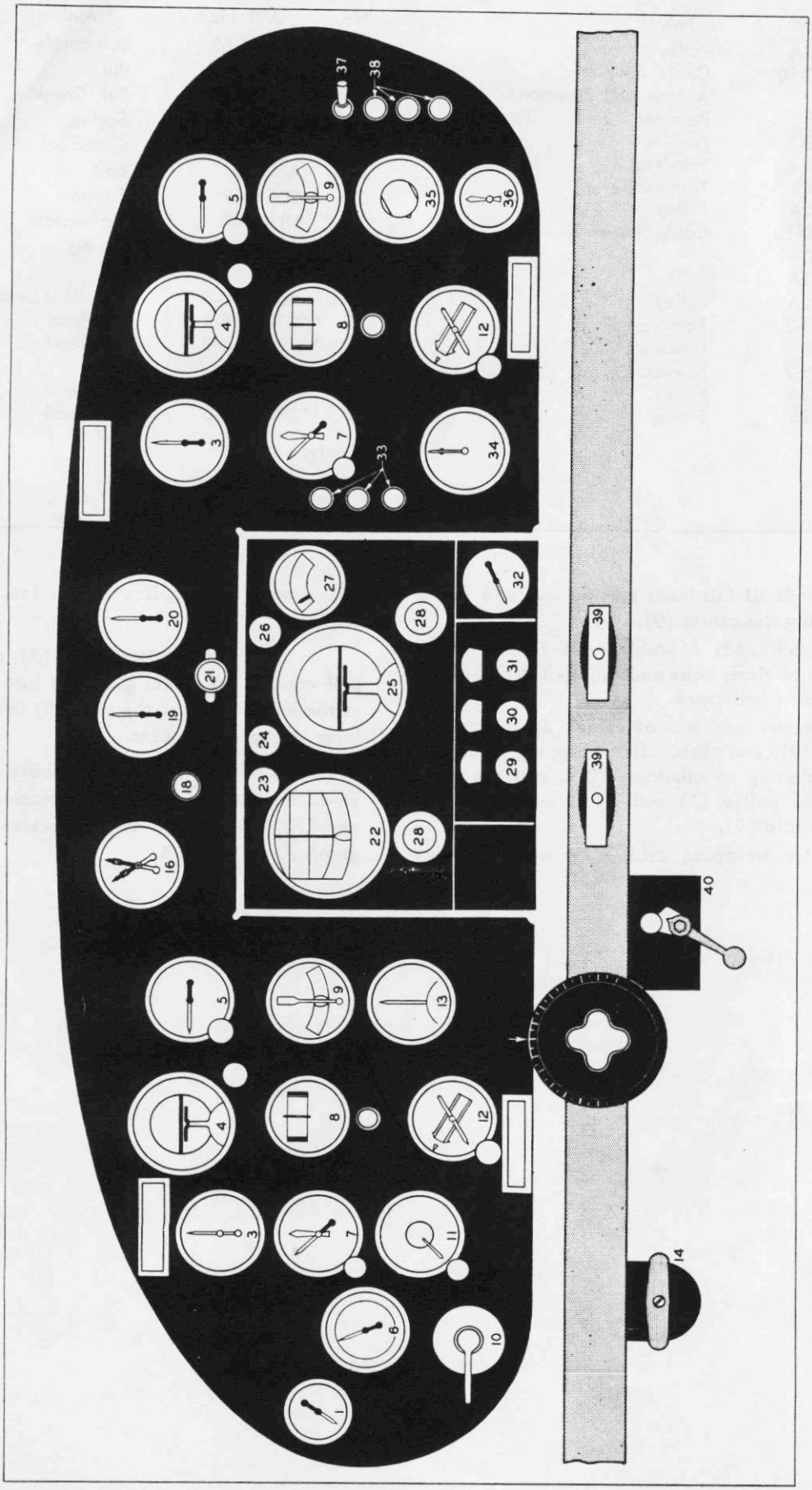


Figure 174—Pilot's Instrument Panel (PBY-5A, Serial Number 46624 and on)

PARAGRAPH 19.

19. INSTRUMENTS.

a. GENERAL.—Instruments for flight, power plant, navigation, etc., are installed in panels in the pilot's compartment, in the engineer's compartment, at the navigator's station, near the auxiliary power plant, and in the bombardier's compartment. All electrical circuits are described in Par. 22.

b. INSTRUMENT PANELS.

(1) PILOT'S INSTRUMENT PANEL.

(a) DESCRIPTION. *(See figure 174.)*—The pilot's instrument panel is located in the pilot's compartment at station 1.33.

This panel has eight supporting points: four located at the bottom of the panel, and four along the top of the panel. The four lower supports consist of brackets (riveted to the panel) with shock mounts which are supported by a lateral beam. The four upper supports are brackets shock mounted to the panel and to the hull structure over the panel.

Note

On PBY-5A airplanes with serial numbers 46624 and on, the panel is supported vertically by only two shock mounts on the beam. Fore and aft support is obtained by two rods running forward from the panel to shock mount supports on bulkhead 1.

A cut-out provided for the automatic pilot is located in the center of the instrument panel. The automatic pilot is supported separately from the instrument panel but forms a part of the installation. The automatic pilot is discussed in Par. 20.

(b) REMOVAL.

1. To obtain additional access, remove the access door on the deck just forward of the windshield by detaching the screws. Also remove the access door

No.	PART No.	NAME	No.	PART No.	NAME
1	88-G-924	Suction Gage	25	88-U-110	Bank and Climb Indicator
3	88-I-350	Airspeed Indicator	26		Elevator Control Knob
4	88-I-1350	Gyro Horizon Indicator	27		Auto Pilot Suction Gage
5	88-I-725	Rate of Climb Indicator	28		Caging Knob
7	88-A-340	Altimeter	29	88-V-180	Rudder Speed Control Valve
8	88-I-970	Directional Gyro Indicator	30	88-V-180	Aileron Speed Control Valve
9	88-I-3255	Turn and Bank Indicator	31	88-V-180	Elevator Speed Control Valve
10	28F12004	Vacuum Selector Valve	32	88-G-855	Auto Pilot Oil Pressure Gage
11	1D-14/APN-1	Radio Altimeter	33	NAF1056-18 NAF1056-16 NAF1056-17	Radio Altimeter Lights
12	88-I-800	Remote Indicator Compass			
13	B/O 300206	Pilot's Directional Indicator			
14	88-V-375	Rudder Control Transfer Valve	34	88-C-590 or 88-C-573	Clock
15		Aileron Tab Control			
16	88-I-2380	Dual Tachometer			
18	NAF1056-16	Marker Beacon Light	35	SA-11ARN-1	Radio Altimeter Selector Switch
19	88-G-773	L. Eng. Manifold Pressure Gage	36	88-G-620	Hydraulic Pressure Gage
20	88-G-773	R. Eng. Manifold Pressure Gage	37	AN3022-3B	L. G. Warning Light Switch
21	NAF1016-2	Float Warning Light	38	NAF1056-17	Landing Gear Warning Light
22	88-U-165	Auto Pilot Directional Gyro	39	28F1272	Emergency Bomb Release Handle
23		Rudder Control Knob			
24		Aileron Control Knob	40	28F6597-4	Landing Gear Selector Valve

Items number 1, 3, 4, 5, 7, 8, 9, 12, 14, 16, 19, 20, 22, 25, 29, 30, 31, 32, 34, and 36 are Federal Standard Stock Catalog part numbers. Items number 6, 11 and 35 are Bu/Aer part numbers.

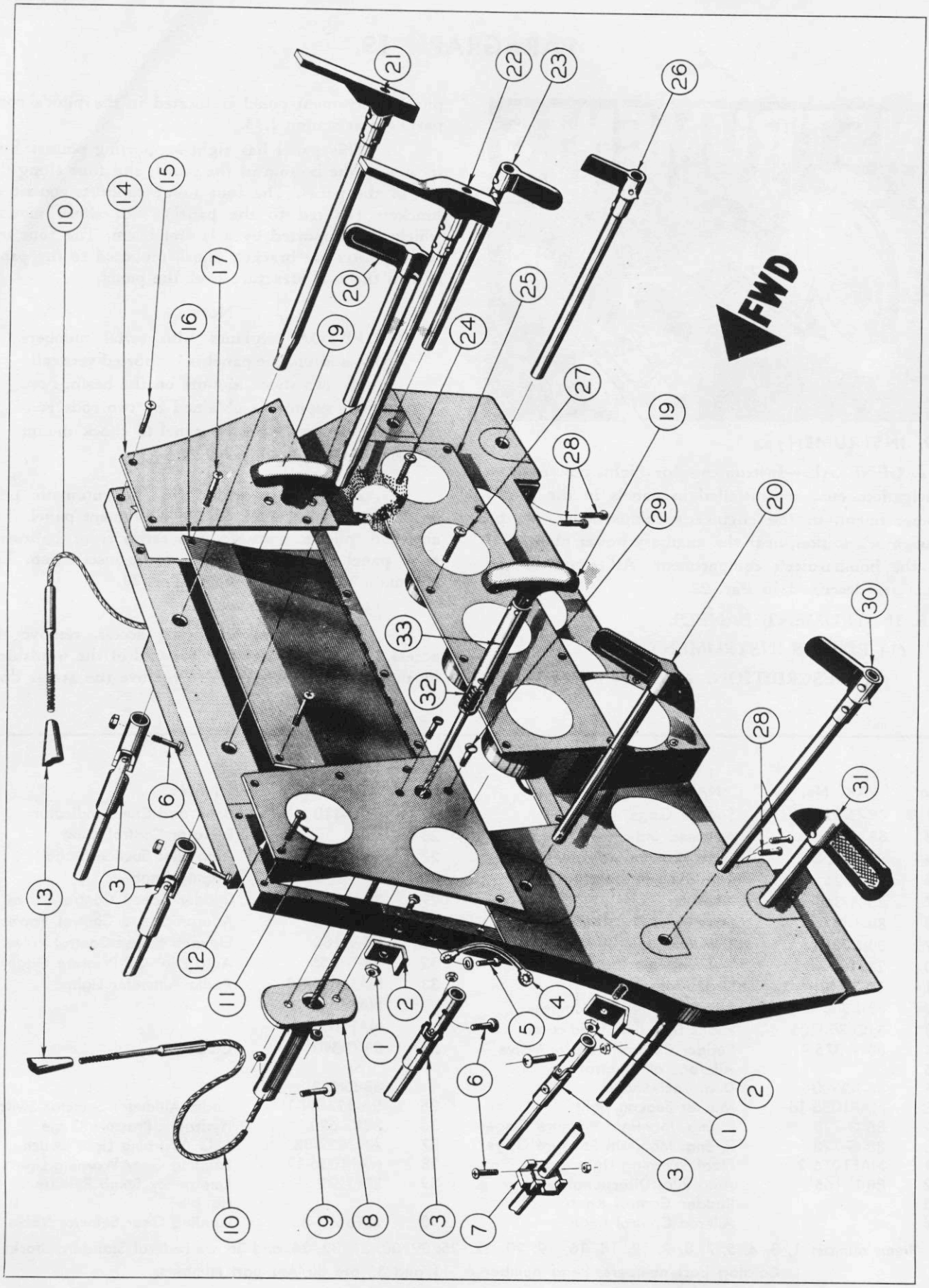


Figure 175—Engineer's Instrument Panel Assembly

No.	PART No.	NAME
1	AN3-DD4A	Bolt
	AN365D1032	Nut
2	28F5004-8	Clip
3	AC270B8	Universal Joint
4	Q506-A2-2	Bonding Braid
5	AN515D8-7	Screw
	AN960-A8	Washer
	AN365D832	Nut
6	AN23-13A	Bolt
	AN365-1032	Nut
7	28G1064	Valve Yoke
8	28P5136	Carburetor Air Control Housing
9	AN3-DD13A	Guide Bolt
	AN372D1032	Nut
	Q810D6-18	Spacer
10	*28P5138-0	Cable Assem.—Port
	*28P5138-2	Cable Assem.—Stb'd.
	**28P5138-3	Cable Assem.—Port
	**28P5138-4	Cable Assem.—Stb'd.
11	AN515D8-8	Screw
12	28F2136-40	Access Panel
13	AN155-8S	Turnbuckle
14	28F2136-31	Access Panel
15	AN515D8-8	Screw
16	*28E6052-4	Electrical Panel
	**28E6052-2	
17	AN515D8-8	Screw
19	28P5132	Carburetor Air Control Handle
20	28G2012-50	Fuel Selector Valve Handle
21	28G2019-3	Wobble Pump Handle
22	28G2019-2	Wobble Pump Handle
23	28G2016-2	Aux. Power Unit Valve Handle
24	AN515D8-8	Screw
25	28F2136-32	Access Panel
26	28G2016-6	Strainer Drain Valve Handle
27	AN515D8-10	Screw
28	AN515D8-8	Screw
	AN935-8	Lock Washer
	AN960-D8	Washer
29	AN502-10-8	Screw
	AN365-1032	Nut
30	28G2016-2	Strainer Drain Valve Handle
31	28G2017-55	Fuel Crossfeed Valve Handle
32	28P5131	Spring
33	28P5137	Sleeve

*PBY-5A only.
**PBY-5 only.

in bulkhead 1 by detaching the screws. To expose this door, it is necessary to rotate the turret.

2. By working through access doors and from underneath the panel, disconnect all electrical and plumbing connections and bonding braid.

Note

Mark each line with the name of the instrument to which it attaches.

3. Remove four-way valve handle at instrument panel by detaching screw.

4. Remove aileron tab indicator knob by detaching taper pin and then straighten indicator pointer.

5. Detach the bolt which passes through the center of each supporting shock mount and then remove the panel.

6. Close all open ports in all instruments with tape to prevent any foreign matter from entering the instruments.

7. Close all open ends of instrument lines with tape to prevent any foreign matter from entering.

8. Remove automatic pilot and support. (See Par. 20, *d*, (2).)

(c) MAINTENANCE.

1. The enlargement of small cracks in the panel may be stopped by drilling a small hole at the end of the crack. Parts having extended cracks should be replaced.

2. Tighten all loose bolts and screws.

3. Replace shock mounts if they are worn or defective.

CAUTION

Make sure that the load sides of shock mounts are not inverted.

(d) INSTALLATION.

1. Install automatic pilot supporting bracket assembly. (See Par. 20, *d*, (4).)

2. Install automatic pilot. (See Par. 20, *d*, (4).)

3. Hold instrument panel in place and attach to the lateral beam by passing a bolt through each of the eight pairs of shock mounts.

CAUTION

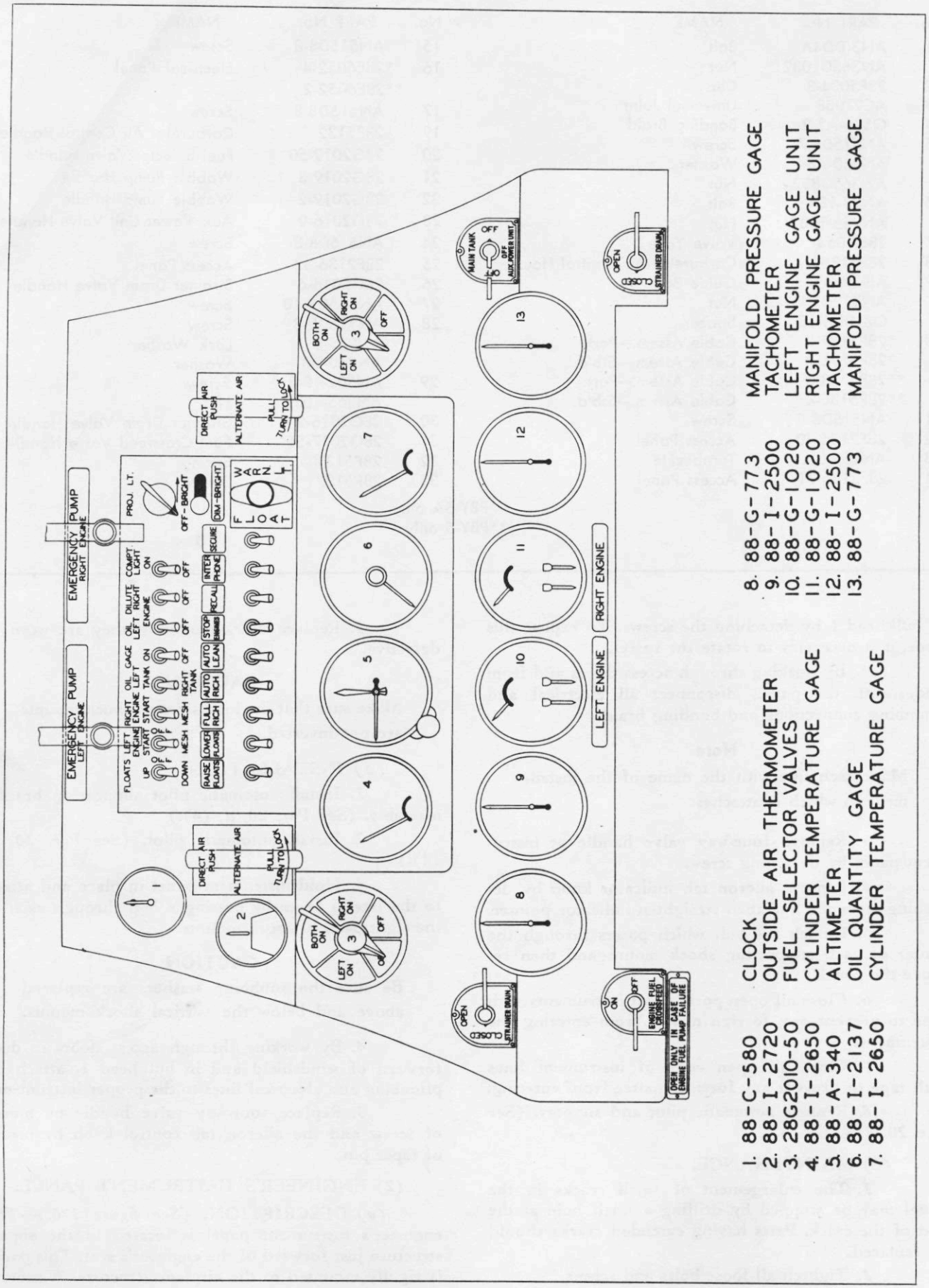
Be sure the snubbing washers are replaced above and below the vertical shock mounts.

4. By working through access doors in deck forward of windshield and in bulkhead 1, attach all plumbing and electrical lines to the proper instruments.

5. Replace four-way valve handle by means of screw and the aileron tab control knob by means of taper pin.

(2) ENGINEER'S INSTRUMENT PANEL.

(a) DESCRIPTION. *(See figure 176.)*—The engineer's instrument panel is located in the superstructure just forward of the engineer's seat. This panel is rigidly mounted to the airplane structure. A remov-



1. 88-C-580 CLOCK
2. 88-I-2720 OUTSIDE AIR THERMOMETER
3. 28G2010-50 FUEL SELECTOR VALVES
4. 88-I-2650 CYLINDER TEMPERATURE GAGE
5. 88-A-340 ALTIMETER
6. 88-I-2137 OIL QUANTITY GAGE
7. 88-I-2650 CYLINDER TEMPERATURE GAGE
8. 88-G-773 MANIFOLD PRESSURE GAGE
9. 88-I-2500 TACHOMETER
10. 88-G-1020 LEFT ENGINE GAGE UNIT
11. 88-G-1020 RIGHT ENGINE GAGE UNIT
12. 88-I-2500 TACHOMETER
13. 88-G-773 MANIFOLD PRESSURE GAGE

Figure 176—Engineer's Instrument Panel—View Looking Forward

able panel in the center gives access behind the instrument panel.

(b) REMOVAL.

(See figure 175.)

1. Remove access panel (25) by removing nine screws (24) and the one screw (27) that secure it to the main panel.

2. Remove superstructure access panel (3). *(See figure 64.)*

3. Disconnect all plumbing and electrical connections at the rear of the instruments.

Note

Mark each line with the name of the instrument to which it attaches.

4. Cover all open lines with tape to prevent foreign matter from entering.

5. Cover all open ports in all instruments with tape.

6. Disengage fuel wobble pump rod assemblies at the universal joints (3) by removing bolt and nut (6) from the wobble pump handles (21) and (22), fuel selector handles (20), auxiliary power unit, fuel shut-off valve handle (23) and fuel strainer drain valve handles (26) and (30), and fuel cross-feed valve handle (31).

7. Remove carburetor air control assembly (19) by detaching the five screws (11) and the four screws (15). Disconnect cables (10) at turnbuckles (13) and remove panels (12) and (14).

8. Remove bonding braids (4) on each side of panel by loosening screws (5).

9. Withdraw instrument panel after detaching the four bolts (1) from clips (2) and the four screws (28) from the lower supporting brackets.

(c) MAINTENANCE.

1. The enlargement of small cracks in panel may be stopped by drilling a small hole at the end of the crack. If crack is extended, panel must be replaced.

2. Tighten all loose bolts and screws.

3. Replace nameplates that are defective or damaged.

(d) INSTALLATION.

(See figure 175.)

1. Hold engineer's instrument panel (with access panel (25) and panels (12) and (14) removed) in place and insert the four bolts (1) through clips (2) and the four screws (28) through the lower supporting brackets.

2. Connect all electrical wiring and plumbing at rear of instruments and switch box.

3. Install the panels (12) and (14) along with the carburetor air control handles (19) by holding panels in place and inserting five screws (11) on the left-hand side and four screws (15) on the right-hand side.

4. Connect electrical wiring leading to instruments located on each of the panels (12) and (14).

5. Connect bonding braid (4) with screw (5), one each on both port and starboard sides.

6. Connect all electrical wiring and plumbing to the instruments located on the access panel (25).

7. Install access panel (25) with instruments attached by holding in place and then attaching with the nine screws (24) and the screw (27).

8. Connect both carburetor air control cables (10) by means of turnbuckles (13).

9. Insert the eight operating handle assemblies in their proper places and attach them to their universal joints (3) by means of bolts (6).

10. Re-install superstructure panels.

(3) BOMBARDIER'S INSTRUMENT PANEL.

(a) DESCRIPTION.—The bombardier's instrument panel is located in the nose of the airplane to the right of the center line. It is shock mounted near the top at two places for vertical support and one place at the bottom for fore-aft stability. It mounts an altimeter, airspeed indicator, air thermometer, and inclinometer.

(b) REMOVAL.

1. Disconnect electrical connections and plumbing at the rear of the instruments.

2. Close all open ends of instrument lines with tape to prevent any foreign matter from entering.

3. Close all open ports in all instruments with tape to prevent any foreign matter from entering the instrument.

4. Remove fore-aft support from panel by detaching nut at panel.

5. Remove screw that passes through the center of each vertical shock mount.

6. Remove instrument panel.

(c) MAINTENANCE.

1. Enlargement of small cracks in the panel may be stopped by drilling a small hole at end of the crack.

2. Replace parts that have extended cracks.

3. Tighten all loose bolts and screws.

4. Replace shock mounts if they are worn or defective.

(d) INSTALLATION.

1. Hold instrument panel in place and attach vertical shock mounts by means of a screw through the center of each shock mount.

2. Attach fore-aft support to panel with nut.

3. Connect plumbing and electrical lines at back of instruments.

(4) NAVIGATOR'S INSTRUMENT PANEL.

(a) DESCRIPTION.—This instrument panel is located at station 3.0 just above the navigator's table. It is shock mounted at three points, two at the bottom and one at the top of the panel. The panel mounts an altimeter, airspeed indicator, air thermometer, and a clock.

(b) REMOVAL.

1. Disconnect electrical connections and plumbing at the rear of the instruments.

2. Remove the screw that passes through the center of each supporting shock mount.

3. Remove instrument panel.

(c) MAINTENANCE.

1. Enlargement of small cracks in the panel may be stopped by drilling a small hole at the end of the crack.

2. Replace parts that have extended cracks.

3. Tighten all loose bolts and screws.

4. Replace shock mounts if they are worn or defective.

(d) INSTALLATION.

1. Hold panel in place and install the screw through the center of each shock mount.

2. Attach electrical connections and plumbing at rear of instruments.

(5) AUXILIARY POWER UNIT INSTRUMENT PANEL (PBY-5 ONLY).

(a) DESCRIPTION.—This panel is shock mounted to an electrical panel located under the starboard food locker aft of bulkhead 4. The panel mounts an oil pressure gage, oil temperature gage, and an engine cylinder temperature gage.

Note

On the PBY-5A airplanes no instruments were provided for the auxiliary power unit.

(b) REMOVAL.

1. Disconnect the electrical connections and plumbing at the rear of the instruments.

2. Remove the attaching screw from each of the three pairs of shock mounts and then withdraw panel.

(c) MAINTENANCE.

1. The enlargement of small cracks in the panel may be stopped by drilling a small hole at the end of the crack.

2. Replace parts that have extended cracks.

3. Tighten all loose screws.

(d) INSTALLATION.

1. Hold panel in place and insert a screw through each of the three pairs of shock mounts.

2. Connect electrical wiring and plumbing at the rear of the instruments.

(6) PILOT'S STAND-BY COMPASS BRACKET.

(a) DESCRIPTION.—The pilot's stand-by compass installation is located on the center line of the airplane, in front of and above the pilot. It consists of an upper bracket mounted to the airplane and a bracket and compass assembly which, by means of snap-slide fasteners, attaches to shock mounted studs located on the upper bracket. The bracket and compass assembly is demountable and may be stowed elsewhere in the airplane.

Note

This compass was installed on PBY-5A airplanes with serial numbers 46588 to 46639. On all PBY-5 and all previous PBY-5A airplanes, the compass is to be installed by service action.

(b) REMOVAL.

1. Disengage the compass and bracket assembly by withdrawing the snap-slide fasteners.

2. Disconnect electrical wiring at the rear of the compass.

3. Remove upper bracket by detaching the six screws that secure it to the top structure of the airplane and then replace the six screws.

(c) MAINTENANCE.

1. Enlargement of small cracks in brackets may be stopped by drilling a small hole at the end of the crack.

2. Replace parts that have extended cracks.

3. Tighten all loose screws.

4. Replace shock mounts if they are worn or defective.

(d) INSTALLATION.

1. Mount the upper bracket to the top structure with the six existing screws.

2. Attach the compass and bracket assembly to the shock mount studs on the upper bracket by engaging the studs with the snap-slide fasteners.

3. Plug in the electrical connection at back of instrument.

(7) APERIODIC COMPASS BRACKET.

(a) DESCRIPTION.—This installation is located on the aft end of the navigator's table. The compass is shock mounted on a sheet metal bracket which is attached to the table top with screws.

Note

This compass is shock mounted on PBY-5A airplanes with serial numbers 46588 to 46639. On PBY-5 and on previous PBY-5A airplanes, the compass is to be shock mounted by service action.

(b) REMOVAL.—Remove three wood screws and four machine screws which hold the bracket to the

table and then remove the bracket and compass while still assembled.

(c) MAINTENANCE.

1. The enlargement of small cracks in the bracket may be stopped by drilling a small hole at the end of the crack.

2. Replace the bracket if it has extended cracks.

3. Tighten all loose screws.

4. Replace shock mounts if they are worn or defective.

(d) INSTALLATION.—Place instrument and bracket assembly in position and attach to navigator's table top with the three wood screws and the four machine screws.

Note

Care should be taken to hold the compass fore-aft line parallel to the center line of the airplane to within ¼°.

(8) HEAT ANTI-ICING TEMPERATURE INDICATORS PANEL.

(a) DESCRIPTION.—Three anti-icing temperature indicators are mounted on a panel on the port side of the engineer's seat. The panel, which also serves as a guard for the control cables which pass in that vicinity, is rigidly supported by the engineer's seat bracing.

Note

No anti-icing indicators were mounted on this panel on PBY-5 airplanes prior to serial number 08349, since heat anti-icing was not provided on these earlier airplanes.

(b) REMOVAL.

1. Disconnect thermocouple leads from the rear of each instrument.

2. Remove the seven mounting screws and withdraw panel.

(c) MAINTENANCE.

1. Enlargement of small cracks in the panel may be stopped by drilling a small hole at the end of the crack.

2. Replace panel if it has an extended crack.

3. Tighten all loose screws.

4. Re-stencil if lettering is scratched or worn off.

(d) INSTALLATION.

1. Hold panel in place and then attach by means of the seven mounting screws.

2. Connect thermocouple leads at rear of instrument.

(9) LONGITUDINAL INCLINOMETER BRACKET.

(a) DESCRIPTION.—This inclinometer is installed on the starboard side of the engineer's seat just aft of beltframe 4.125. The inclinometer is located so that when the airplane is in level position, the inclinometer reads 6°.

(b) REMOVAL.—Remove the two screws that secure the mounting bracket to the stringer.

(c) MAINTENANCE.

1. Replace bracket if it shows evidence of cracks.

2. Replace or re-stencil graduated scale if lettering is not legible.

3. Tighten all loose screws.

(d) INSTALLATION.—Hold in position and insert supporting screws.

c. INDIVIDUAL INSTRUMENTS.—The following are the latest type instruments used on PBY-5A airplanes. These instruments will also be satisfactory for use in PBY-5 airplanes.

(1) ALTIMETER (F. S. S. C. NO. 88-A-340).

(a) DESCRIPTION.—Five sensitive altimeters are located in the airplane: two on the pilot's panel, one on the engineer's panel, one on the bombardier's panel, and one on the navigator's panel. Each instrument is connected by tubing to the static pressure connection of the pitot-static tube. *(See figure 181.)*

The sensitive element of this type of altimeter is an aneroid cell which expands as the outside air pressure is reduced. The pointer is actuated by the aneroid through a system of levers and gears. A knob located on the lower left-hand corner of the instrument face is provided for zero setting of the pointer. This knob also actuates a barometric scale or counter on the face of the instrument. When the altitude pointer is set at zero, the barometric pressure scale will indicate the actual atmospheric pressure in inches of mercury.

The altitude range of this instrument is zero to 35,000 feet. When maximum and minimum barometric scale readings are reached, a clicking sound is heard and the counter wheels jump slightly. This in no way affects the accuracy of the instrument.

(b) REMOVAL.

1. Disconnect the flexible hose from the rear of the instrument.

2. Close opening in line with tape to prevent foreign matter from entering.

3. Label line with the name of the instrument from which it was disconnected.

4. Remove three mounting screws and withdraw the instrument.

5. Close opening in instrument with tape.

6. Tag instrument with its name and the serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. When the barometric pressure counter is set at the altitude barometric pressure, all indicator

hands should be on zero. In case this relationship does not hold true, a correction may be made as follows:

a. Turn the knob until the counter indicates the barometric reading as taken from a known standard corresponding to the known altitude of the instrument.

b. Loosen the screw at the left of the knob at least four turns.

c. All hands may now be moved to zero by turning the knob. The counter reading will not change.

d. The screw should then be tightened to engage the counter.

2. Keep static line tight.

3. Tighten loose screws.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and secure with three mounting screws.

2. Connect static line to back of instrument.

(2) AIRSPEED INDICATOR.
(F. S. S. C. NO. 88-I-350).

(a) DESCRIPTION.—Four airspeed indicators are located in the airplane; two on the pilot's instrument panel, one on the navigator's instrument panel, and one on the bombardier's instrument panel. This instrument shows the speed of the airplane in relation to the body of air through which it is traveling. Its range is zero to 430 knots per hour.

Air pressure from the pitot tube enters the airtight capsule in the instrument case. The capsule expands with increasing pressure and actuates the pointer through a system of levers and gears. The case is airtight and is vented by a static line connected to the pitot-static tube. *(See figure 181.)*

(b) REMOVAL.

1. Disconnect pressure and static lines from the rear of the instrument.

2. Close open lines with tape and label with name of instrument from which they were disconnected.

3. Remove the four mounting screws and withdraw the instrument.

4. Close open ports in instrument with tape to prevent foreign matter from entering.

5. Tag instrument with its name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep static and pressure lines tight.

2. Keep mounting screws tight.

3. Replace instrument if it has a leaky case.

Note

To test the case for airtightness, connect a rubber hose to the static connection of the indicator and apply sufficient suction until the dial indicates 80 knots. If the pointer does not hold steady, the case leaks.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert mounting screws.

2. Connect pressure and static lines at rear of case.

(3) TURN AND BANK INDICATOR
(F. S. S. C. NO. 88-I-3255).

(a) DESCRIPTION.—Two of these instruments (both on the pilot's panel) are located in the airplane.

The turn and bank indicator is a visual aid to the pilot enabling him to control the flight of the airplane, to accomplish a turn at a certain angle, or to eliminate yawing. When the pointer is used in conjunction with the ball bank indicator which is built into the dial, the pilot is able to maintain a laterally level altitude while flying straight and to bank at the proper angle when turning.

The turn indicator pointer is actuated by a small air-driven gyro operated by vacuum from an engine-driven suction pump.

(b) REMOVAL.

1. Disconnect the flexible tube connection at rear of instrument.

2. Close the open line with tape to prevent foreign matter from entering and label it with the name of the instrument from which it was disconnected.

3. Remove mounting screws and withdraw instrument.

4. Cover open port in instrument with tape.

5. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep suction connection tight.

2. Keep mounting screws tight.

3. After every 400 hours of service, remove plug under word "OIL" on the right side of the case, and put approximately eight drops of oil (Specification AN-O-6) on the wick.

CAUTION

The gyro should not be running during lubrication.

4. The filter material in the filter assembly (F. S. S. C. NO. 88-F-1000) at the rear of the case should be renewed every 500 hours. Wash the body and hood of the filter in benzine and allow to dry before re-installing.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert the four mounting screws.

2. Connect the vacuum line flexible hose to fitting at back of instrument.

(4) RATE OF CLIMB INDICATOR
(F. S. S. C. NO. 88-I-725).

(a) DESCRIPTION.—Two rate of climb indicators (both on the pilot's instrument panel) are located in the airplane. This instrument is temperature compensated and indicates the rate of change in altitude in feet per minute.

The instrument's sensitive element is a mechanical manometer which operates from the differential between outside atmospheric pressure and the pressure in a chamber which is vented to atmosphere through a small calibrated opening. As the airplane gains or loses altitude, the outside atmospheric pressure changes comparatively rapidly while the pressure inside the chamber changes slowly due to the small opening. The measure of this rate of change of atmospheric pressure is indicated on the dial in rate of change in altitude in feet per minute.

A zero adjusting knob is provided at the lower left-hand corner of the instrument face for setting the pointer. The fitting on the back side of the case is attached to the static line of the pitot-static tube. *(See figure 181.)*

(b) REMOVAL.

1. Disconnect the two flexible hose connections, one on each side of the tee at the rear of the instrument.

2. Close the open lines with tape to prevent foreign matter from entering and then label with name of instrument from which they were disconnected.

3. Remove the three mounting screws and withdraw the instrument.

4. Cover the open holes in the instrument with tape.

5. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep tubing connections tight.

2. Keep mounting screws tight.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert the three mounting screws.

2. Attach tee fitting at rear of instrument and then connect the static line flexible hoses to the tee.

(5) GYRO HORIZON INDICATOR
(F. S. S. C. NO. 88-I-1350).

(a) Two of these instruments (both on the pilot's instrument panel) are located in the airplane.

Note

Two of these indicators were installed on PBY-5A airplanes with serial numbers 46624 to 46639. On previous PBY-5A airplanes (which contain only one gyro horizon indicator), the second indicator is to be installed by service action. Only one gyro horizon indicator was installed on PBY-5 airplanes.

The instrument is used as a reference for lateral and longitudinal control. The indicator dial contains an artificial horizon (for a background) which is kept level at all times by a vacuum driven gyro, and a miniature airplane which moves with the airplane. Thus the relationship of the miniature airplane to the artificial horizon is always the same as the airplane to the natural horizon. On the lower right hand corner is a knob which is used to cage ("OFF") and uncage ("ON") the gyro in the instrument. The knob at the bottom is used to lower or raise the miniature airplane so it can be aligned with the horizontal bar in case it becomes necessary during flight to fly slightly nose up or nose down. The air inlet is connected to a central air filter and any of the other plugged openings may be connected to the vacuum pump line.

(b) REMOVAL.

1. Disconnect the two flexible hoses at the rear of the instrument.

2. Close the open lines with tape to prevent foreign matter from entering, and label them with the name of the instrument from which they were disconnected.

3. Remove the three mounting screws and withdraw instrument.

4. Close open holes in the instrument with tape.

5. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep the tubing connections tight.

2. Keep the mounting screws tight.

3. Lubricate caging mechanism externally when necessary.

4. Clean air filter by removing the air filter body cover and lifting the screen out of its seat. Immerse in benzine and dry it thoroughly before reinstalling.

Note

The suction may be checked by connecting a suction gage to one of the other outlets in the instrument case.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert the three mounting screws.

2. Connect suction and air filter lines at rear of instrument.

(6) DIRECTIONAL GYRO INDICATOR
(F. S. S. C. NO. 88-I-970).

(a) DESCRIPTION.—Two of these instruments (both on the pilot's instrument panel) are located in the airplane.

Note

Two of these indicators were installed on PBY-5A airplanes with serial numbers 46624 to 46639. On previous PBY-5A airplanes (which contain only one directional gyro indicator), the second indicator is to be installed by service action. Only one directional gyro indicator was installed on PBY-5 airplanes.

This instrument is used for indicating longitudinal direction along with the compass. During turns, it does not oscillate or swing as a compass does, and, therefore, gives the compass time to settle. This indicator has no directive force like that of a magnetic compass, and, therefore, must be checked with the compass every 15 or 20 minutes.

Just below the face of the instrument, a knob is located for setting, caging, and uncaging. The indicator dial is actuated by a universally mounted gyro rotor.

(b) REMOVAL.

1. Disconnect flexible tubing from the rear of the instrument.

2. Remove the four mounting screws and withdraw the instrument.

3. Close open lines with tape to prevent any foreign matter from entering and then label with name of instrument from which they were disconnected.

4. Close open ports in instrument with tape.

5. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep tubing connections tight.

2. Keep mounting screws tight.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert the four mounting screws.

2. Connect air inlet and suction lines to back of instrument.

(7) RADIO ALTIMETER INDICATOR.

(a) DESCRIPTION.—This indicator is located on the pilot's panel. It shows the absolute altitude of the airplane relative to the terrain over which the airplane is flying. A power switch is located on the lower left-hand side of the indicator and a range switch on the upper right-hand side of the indicator. The power switch merely turns on the power for the system. The range switch selects the range desired, zero to 400 or zero to 4000 feet.

(b) REMOVAL.

1. Disconnect electrical plug from the rear of the instrument.

2. Remove the two mounting screws and withdraw indicator.

(c) MAINTENANCE.

1. Keep switches lubricated externally with oil (Specification AN-O-6).

2. Keep electrical contacts cleaned with crocus cloth.

3. Keep mounting screws and electrical connections tight.

4. Replace instrument if defective.

(d) INSTALLATION.

1. Place indicator in cut-out provided in panel and insert mounting screws.

2. Plug in electrical connection at rear of indicator.

(8) CLOCKS (F. S. S. C. NO. 88-C-590, F. S. S. C. NO. 88-C-573, F. S. S. C. NO. 88-C-580).

(a) DESCRIPTION.—Two civil date clocks (either F. S. S. C. NO. 88-C-590 or F. S. S. C. NO. 88-C-573) and one standard clock (F. S. S. C. NO. 88-C-580) are located in the airplane. One civil date clock is located on the pilot's instrument panel, and the other on the navigator's instrument panel. The standard clock is located on the engineer's instrument panel. All clocks are eight-day instruments and are adjustable.

(b) REMOVAL.—Remove mounting screws and withdraw instrument.

(c) MAINTENANCE.—The regulator lever for varying the rate of the clock is easily accessible by removing the cover at the rear of the instrument. The lever is moved as desired for adjustment.

(d) INSTALLATION.—Place instrument in cut-out provided in panel and insert the mounting screws.

(9) REMOTE INDICATING COMPASS INDICATOR (F. S. S. C. NO. 88-I-800).

(a) DESCRIPTION.—Two of these indicators (both on the pilot's instrument panel) are located in the airplane. They are operated by electrical impulses originating in the magnesyn compass transmitter in the wing. A knob on the lower left-hand corner of the instrument operates the course setting marker.

Note

A third indicator, located on the aft face of bulkhead 6 over the door, is being deleted by service action.

(b) REMOVAL.

1. Disconnect electrical plug at rear of instrument.

2. Remove the three mounting screws and withdraw the instrument.

3. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep electrical plug clean with crocus cloth.

2. Replace instrument if defective.

(d) INSTALLATIONS.

1. Place instrument in cut-out provided in panel and insert the three mounting screws.

2. Plug in electrical connection at rear of instrument.

(10) MAGNESYN COMPASS TRANSMITTER (F. S. S. C. NO. 88-T-1950).

(a) DESCRIPTION.—This instrument, which controls the repeater indicators on the pilot's panel, is shock mounted on a bracket located in the port wing outer panel just outboard of wing station 14.0. It contains a sensitive magnet whose indications are converted electrically to operate the remote compass indicators on the pilot's panel.

(b) REMOVAL.

1. Remove wing splice manhole (22). (See figure 20.) to gain access to the compass transmitter.

2. Disconnect electrical connection at the bottom of the transmitter.

3. Remove the three screws that secure the shock mounts to the supporting bracket.

4. Remove the instrument carefully.

5. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep electrical connections clean with crocus cloth.

2. Keep screws tight.

3. Replace instrument if defective.

(d) INSTALLATION.

1. Place transmitter in position and then secure by inserting the three screws through the shock mounts and the supporting bracket.

2. Plug in electrical connection.

(11) DUAL TACHOMETER AND SYNCHRONIZER INDICATOR (F. S. S. C. NO. 88-I-2380).

(a) DESCRIPTION.—On PBY-5A airplanes with serial numbers 46624 to 46639, two of these instruments are located in the airplane, one on the pilot's panel and the other on the engineer's panel. The instrument, by means of a synchronous connection to a transmitting generator on each engine, measures the speed of the crankshaft of each engine. Each engine speed is indicated on a dual tachometer dial. In addition to the tachometer dial, the instrument contains a synchronizer dial to show the relation between the speed of the crankshaft of each engine. The range of the tachometer is zero to 4500 rpm.

Note

On PBY-5 airplanes and on PBY-5A airplanes with serial numbers 33960 to 46624, two single type tachometers (F. S. S. C. NO. 88-I-2500) were provided on both the pilot's and engineer's instrument panels and one synchronizer (F. S. S. C. NO. 88-I-2200) on the pilot's instrument panel.

(b) REMOVAL.

1. Disconnect electrical connections at back of instrument.

2. Remove the four mounting screws and withdraw instrument.

3. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep electrical connections clean with crocus cloth.

2. Keep mounting screws tight.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert four mounting screws.

2. Plug in the two electrical connections at the rear of the instrument.

(12) MANIFOLD PRESSURE GAGE (F. S. S. C. NO. 88-G-773).

(a) DESCRIPTION.—Four manifold pressure gages are located in the airplane; two are located on the pilot's panel, and the other two on the engineer's panel. This instrument is used to indicate the loss in power due to high altitude or other causes, to indicate safe power output, and to be used in conjunction with the tachometer for best cruising power.

The instrument contains a pointer which indicates the manifold pressure on a dial calibrated from 10 to 75 inches of mercury. The sensitive element in the case consists of a sealed and evacuated aneroid which is operated by pressure from the intake manifold.

(b) REMOVAL.

1. Disconnect the pressure connection at rear of instrument.

2. Seal open line with tape to prevent foreign matter from entering.

3. Remove the four mounting screws and withdraw instrument.

4. Close opening in instrument with tape.

5. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep the pressure connection tight.

2. Keep mounting screws tight.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert the four mounting screws.

2. Connect pressure fitting at rear of instrument.

(13) HYDRAULIC PRESSURE GAGE (F. S. S. C. NO. 88-G-620).

(a) DESCRIPTION.—Two hydraulic pressure gages are provided in the airplane (PBY-5A only); one is located on the pilot's instrument panel, and the other is located on top of the large accumulator on the starboard side of the airplane in the pilot's compartment. The instrument is calibrated to indicate up to 2,000 psi. of fluid pressure. The sensitive element within the case is a Bourdon tube which operates the pointer through a system of gears and levers.

(b) REMOVAL.

1. To remove the hydraulic pressure gage which is installed on top of the large accumulator: make sure that the hydraulic pressure is zero, then simply unscrew gage from fitting. Close open hole in accumulator with tape. Close open hole in instrument with tape and label instrument with name and serial number of airplane from which it was removed.

2. To remove the hydraulic pressure gage which is installed on the pilot's instrument panel: first make sure that the hydraulic pressure is zero; then disconnect the pressure connection at the rear of the instrument; remove the four mounting screws; and then withdraw the instrument. Close the open line with tape and label it with the name of the instrument from which it was detached. Close the open hole in the instrument with tape and label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep pressure connections tight.

2. Keep mounting screws tight.

(d) INSTALLATION.

1. To install the hydraulic pressure gage which is located on the large accumulator, simply connect the instrument pressure port to the fitting on the accumulator.

2. To install the hydraulic pressure gage which is located on the pilot's instrument panel; insert instrument into cut-out provided and install mounting screws; attach flexible connections at rear of instrument.

(14) PILOT'S DIRECTIONAL INDICATOR (B/O 300206).

(a) DESCRIPTION.—A pilot's directional indicator is located on the pilot's panel on PBY-5A airplanes with serial numbers 46624 to 46639.

Note

On previous PBY-5A airplanes (which contain two pilot's director indicators), one of the indicators is to be removed by service action. On all PBY-5 airplanes, two pilot's director indicators are installed on the pilot's instrument panel.

It is operated by electrical impulses which originate in the bomb sight. A pointer on the face of the instrument indicates to the pilot any change of course desired by the bombardier. Movement of the airplane in the desired direction returns the pointer to zero.

A zero adjusting screw is located on the face of the instrument for adjusting the pointer.

(b) REMOVAL.

1. Disconnect the electrical connection at the rear of the instrument. Label line with name of instrument from which it was detached.

2. Remove the four mounting screws and withdraw instrument.

(c) MAINTENANCE.

1. Keep electrical connections clean with crocus cloth.

2. Replace instrument if defective.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert four mounting screws.

2. Connect electrical wiring to rear of instrument.

(15) OIL QUANTITY GAGE (F. S. S. C. NO. 88-I-2137).

(a) DESCRIPTION.—The oil quantity gage, located on the engineer's instrument panel, indicates the quantity of oil in each tank, selectively.

The gage is operated electrically from the transmitters which are located in each oil tank. A selector switch on the engineer's panel is turned to the particular tank of which it is desired to ascertain the oil quantity. A zero adjusting screw at the center of the dial adjusts the pointer.

(b) REMOVAL.

1. Disconnect electrical connections at rear of instrument.

2. Label wires with the name of the instrument from which they were removed.

3. Remove the four mounting screws and withdraw the instrument.

4. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep electrical connections clean with crocus cloth.

2. Keep electrical connections tight.

3. Keep mounting screws tight.

4. Replace instrument if defective.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert the four mounting screws.

2. Connect electrical wiring at rear of instrument.

(16) ELECTRIC THERMOMETERS (F. S. S. C. NO. 88-I-2650).

(a) DESCRIPTION.—Five of these indicators are provided on PBY-5A airplanes. Two, which indicate the cylinder head temperature of each engine, are located on the engineer's panel. The other three are used to indicate the temperature of the heat anti-icing system and are located on the anti-icing panel to the left of the engineer's seat.

Note

On PBY-5 airplanes, a sixth indicator was installed on the auxiliary power unit instrument panel to record the engine cylinder head temperature of the auxiliary power unit.

This type of instrument is operated by the electric current generated in the thermocouple to which the instrument is attached through the thermocouple leads. The pointer can be adjusted to a zero setting located on the face of the instrument.

(b) REMOVAL.

1. Disconnect electrical connections at rear of the instrument.

2. Label wires with name of instrument from which they were removed.

3. Remove the four mounting screws and withdraw instrument.

4. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Set the pointer to read zero at room temperature before the circuit is connected.

2. Keep electrical connections clean with crocus cloth.

3. Keep electrical connections tight.

4. Keep mounting screws tight.

5. Replace instrument if defective.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert the four mounting screws.

2. Connect electrical wiring at rear of instrument.

(17) OUTSIDE AIR TEMPERATURE INDICATOR (F. S. S. C. NO. 88-I-2720).

(a) DESCRIPTION.—Three outside air temperature indicators are provided in the airplane. One is located on the navigator's instrument panel, one on the bombardier's instrument panel, and one on the engineer's panel. A fourth indicator (F. S. S. C. NO. 88-I-2815) is mounted on the auxiliary power unit instrument panel on PBY-5 airplanes only. It measures oil temperature of the auxiliary power unit.

This type of instrument is operated by a resistance bulb located at the source of the temperature. Its range is $-70°$ to $+150°$C ($-94°$ to $+302°$F)

(b) REMOVAL.

1. Disconnect electrical plug connection at back of instrument.

2. Label conduit with name of instrument from which it was detached.

3. Remove the four mounting screws and withdraw the instrument.

4. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep electrical plug connection tight.

2. Keep prongs of plug connection clean with crocus cloth.

3. Keep mounting screws tight.

(d) INSTALLATION.

1. Place the instrument in cut-out provided in panel and insert the four mounting screws.

2. Connect electrical plug at rear of instrument.

(18) ENGINE GAGE UNIT (F. S. S. C. NO. 88-G-1020).

(a) DESCRIPTION.—Two engine gage units are provided in airplane. Both are located on the engineer's panel.

The instrument has three indicator dials, one for engine oil temperature with the range of $-70°$ to $+150°$C ($-94°$ to $+302°$F); one for engine oil pressure with the range of zero to 200 psi; and one for engine fuel pressure with the range of zero to 25 psi. The temperature indicator pointer is operated electrically by a resistance bulb located at the source of the temperature while the two pressure gage pointers are operated by Bourdon tubes.

(b) REMOVAL.

1. Disconnect plumbing and electrical connections from rear of instrument.

2. Close open lines with tape to prevent foreign matter from entering.

3. Label plumbing and electrical lines with name of instrument from which they were removed.

4. Remove the four mounting screws and withdraw the instrument.

5. Close open ports in the instrument with tape.

6. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep electrical connections clean with crocus cloth.

2. Keep plumbing and electrical connections tight.

3. Keep mounting screws tight.

(d) INSTALLATION.

1. Place instrument in cut-out provided in panel and insert the four mounting screws.

2. Connect electrical wiring and plumbing at rear of instrument.

(19) NAVIGATOR'S APERIODIC COMPASS (F. S. S. C. NO. 88-C-845).

(a) DESCRIPTION.—This compass is shock mounted on the aft end of the navigator's table. It has a rotatable azimuth ring with two parallel grid lines which may be set for the course desired. The balance between damping and magnetic strength is so maintained that the indicator dial assembly returns to its heading slowly and positively and will not oscillate about the point of reading. A filling plug is located on the side of the case for replenishing of damping fluid.

(b) REMOVAL.—To remove this instrument, detach the three screws that secure it to the shock mounts.

(c) MAINTENANCE.

1. COMPASS COMPENSATION. — Place the airplane on the compass rose so that it is in normal flying attitude. First head the airplane toward magnetic north. Note the error and then eliminate it by adjusting the N-S compensating screw. Then, with the engines running and speeded up sufficiently so that the maximum charge is shown on the ammeter, note whether the compass still indicates north (0°). If the compass heading is affected by the electrical current flow, it will be necessary to make further magnet corrections in order that the compass will indicate north under flight conditions. Now head the airplane east and remove error by turning the E-W compensating screw. If during the compensation of the compass on the north and east headings, there is no apparent change noted in the indications of the compass as a result of running the engines, there will be no further occasion to keep them running during the remaining period of compensation.

The aircraft should now be headed south and the deviation noted. Half this error should be taken out by turning the N-S compensating screw. Head the ship west and again remove one-half the error by turning the E-W compensating screw.

2. GENERAL.

a. Replace shock mounts if defective.

b. Keep mounting screws tight.

(d) INSTALLATION.—To install this instrument, place in position on top of shock mounts and insert the three mounting screws.

(20) PILOT'S MAGNETIC STAND-BY COMPASS (F. S. S. C. NO. 88-C-800).

(a) DESCRIPTION.—This compass is used as a check on directional instruments in the pilot's compartment. It is a direct reading magnetic type compass. It is provided with a light for illumination and screws for compensation.

Note

On all PBY-5 and on PBY-5A airplanes previous to serial number 46588, this compass is to be installed by service action. On PBY-5A airplanes with serial numbers 46588 and on, the compass is contractor installed.

(b) REMOVAL.

1. Take off bracket and compass assembly from the permanent bracket by disengaging the snap-slide fasteners.

2. Disconnect electrical connection at rear of instrument.

3. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. For compensation of this compass, see paragraph *c*, (19), *(c)*, *1.*

2. Keep mounting screws tight.

3. Replace burnt out bulbs.

(d) INSTALLATION.

1. Attach instrument to supporting brackets with mounting screws.

2. Attach bracket and compass assembly to mount by engaging studs with snap-slide fasteners.

3. Plug in electrical connection.

(21) SUCTION GAGE (F. S. S. C. NO. 88-G-924).

(a) DESCRIPTION.—A suction gage is located on the pilot's instrument panel (on PBY-5A airplanes only) and indicates to the pilot the amount of suction existing in the vacuum system at the point where the instrument is connected. It has a range of zero to 10 inches of mercury.

Its internal mechanism consists of a diaphragm as the actuating element. The pointer is moved by this diaphragm through a system of levers and gears.

Note

The suction gage is contractor installed on PBY-5A airplanes with serial numbers 46624 to 46639. On previous PBY-5A airplanes, the suction gage is being installed by service action.

(b) REMOVAL.

1. Disconnect flexible hose from rear of instrument.

2. Remove the four mounting screws and withdraw instrument.

3. Close open line with tape and label with name of instrument from which it was disconnected.

4. Close open hole at rear of instrument with tape.

5. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep plumbing connection tight.

2. Keep mounting screws tight.

(d) INSTALLATION.

1. Hold instrument in place on panel and insert four mounting screws.

2. Connect flexible hose to fitting at rear of instrument.

(22) OIL PRESSURE GAGE (F. S. S. C. NO. 88-G-855).

(a) DESCRIPTION.—An oil pressure gage for indicating the pressure of oil in the auxiliary power unit is located on the auxiliary power unit instrument panel on PBY-5 airplanes. Its range is zero to 200 lb/sq in.

Its internal mechanism consists of a Bourdon tube which actuates the pointer through a system of levers and gears.

(b) REMOVAL.

1. Disconnect fitting at rear of instrument.

2. Remove the four mounting screws and withdraw the instrument.

3. Close open line with tape to keep foreign matter from entering.

4. Close opening in rear of instrument with tape. Label instrument with name and serial number of airplane from which it was removed.

(c) MAINTENANCE.

1. Keep plumbing connection tight.

2. Keep mounting screws tight.

(d) INSTALLATION.

1. Hold instrument in place on panel and insert four mounting screws.

2. Connect fitting to rear of instrument.

d. PROTECTION AND MAINTENANCE OF INSTRUMENTS.

(1) EMERGENCY PROTECTIVE TREATMENT.—The practicability of giving emergency protective treatment to instruments that have been submerged in water will depend primarily on the time available for salvage and treatment and secondarily on the cost of the instrument. Every effort should be made to salvage all instruments that have been submerged; in some cases, however, an attempt to salvage all instruments might interfere with the salvage of considerably more expensive equipment.

Aircraft instruments that have been submerged in water should, as soon as practicable after submergence, be given the following treatment to minimize corrosion of parts:

(a) The instrument case is to be opened and the mechanism disassembled to the extent warranted for the particular type of instrument in question. All parts of the mechanism then are to be flushed thoroughly with a water-displacing, rust-preventive compound conforming to Bureau of Ships Specification 14-C7 (INT), Grade III. The flushing action may be carried out in a three or four gallon container, or the instrument filled with the protective compound in any convenient manner. The instrument should be shaken vigorously to insure thorough contact of the protective compound with all parts of the mechanism. The instrument then is to be emptied of liquid so that water will not be allowed to settle in the bottom of the instrument case. This operation should be repeated at least twice.

After treatment, the mechanism is to be allowed to drain and dry. The instrument along with all parts which have been removed is to be packed carefully and shipped to the overhaul base for immediate repair. The instrument should be tagged and the shipment marked externally, "IMMERSED IN WATER."

The flushing compound may be poured into a container and allowed to settle. The part that does not contain water should be returned to the original stowage container for further use.

(b) Navigational watches and stop watches should have only the back opened, for the sole purpose of exposing the mechanism prior to receiving the treatment specified in paragraph *d*, (1), *(a)*, above.

(c) Clocks should have the cover glass removed. Also, any screws in the back of the case, such as the screw permitting access to the hairspring adjustment, should be removed to insure thorough flushing of all parts of the mechanism.

(d) Gyroscopic instruments, such as gyro horizons, directional gyros, turn and bank indicators, automatic pilot turn and bank control units, and automatic pilot directional control units are to be partially disassembled prior to protective treatment described above in order to insure contact between the flushing compound and the more inaccessible parts of the mechanism during the flushing operation. If any considerable delay will result from the disassembly operations, the complete instrument with cover glasses removed, should be treated as specified in paragraph *d*, (1), *(a)* above, and, when time permits, the gyro instrument should be partially disassembled and the above treatment repeated.

(e) In general, instruments should be disassembled to the extent that the various parts of the mechanism will be thoroughly flushed. For treating some cartridge vented types of manifold pressure gages, it will be necessary to remove the back cover in order for the rust-preventive compound to have free access to the aneroid compartment. The judgment of operating personnel should be exercised in treating instruments of similar type and instruments which have been developed since this writing, according to the instructions outlined in paragraph *d*, (1), *(a)* above.

(f) ALTERNATE PROCEDURE FOR GYRO INSTRUMENTS.—If the following procedure can be carried out, disassembly of the gyroscopic instruments will not be necessary for the flushing operation:

With the instrument completely immersed in the rust-preventive compound, a vacuum supply is to be connected in series with a glass bottle trap to the vacuum fitting of the instrument. All connections on the instrument, other than the air inlet supply and the vacuum fitting, are to be higher than the rest of the instrument. This filling operation, which fills every part of the instrument with liquid, is completed as soon as rust-preventive compound enters the trap. The instrument then is to be shaken vigorously and allowed to drain off liquid as described in paragraph *d*, (1), *(a)* above. The trap should consist of a glass bottle to which has been fitted a stopper with two holes, one of which is vented to the vacuum supply and the other to the vacuum fitting of the instrument. The purpose of the trap is to prevent water and flushing compound from entering the vacuum pump.

(2) MAINTENANCE AND OVERHAUL.—The maintenance and major repair or overhaul of Class 88 aircraft instruments should be accomplished in accordance with the following instructions:

"Maintenance" should include the proper handling and storage of instruments, inspection of instrument drawn from stock, periodic inspection of instruments installed in aircraft to insure that only instruments in a satisfactory operating condition are in use, and all other work of maintenance nature which will insure that the best possible service is being obtained from the instruments.

The terms "major repair" and "overhaul" should include all work which requires disassembly of any part of the instrument mechanism inside the case. Major repair or overhaul of Class 88 aircraft instruments is to be done only by those activities so authorized by the Bureau of Aeronautics.

In general, it is not economical to repair the more inexpensive instruments or those instruments not readily repaired except by the use of spare parts or assemblies which comprise a major part of the instrument. Bourdon tube pressure gages and resistance type thermometer bulbs are examples of the latter class. When aircraft instruments are repaired, they must, in so far as is practicable, be equal to new instruments in both performance and appearance.

Instruments in need of repair should be handled with the same care that is exercised in handling new instruments in order that additional damage due to improper handling may be avoided. In order to prevent damage in handling and storage, all instruments in so far as practicable should be stored and transported in individual cartons. Care must be taken in packing damaged instruments to insure that no additional damage will result during shipment. Individual cartons should be packed for shipment in strong wooden boxes, except when the means of shipment, such as air shipment prohibits such packing.

Instruments requiring caging, such as directional gyros, gyro horizons, etc., must be caged prior to shipment.

The application of radium luminous material to instrument dials and pointers by unauthorized activities or personnel is prohibited, as elaborate precautions are necessary in handling this material due to its toxic nature. Only Naval Air Stations and Marine Corps Air Stations listed in the most recent Bureau of Aeronautics Technical Order for "Safe Handling of Radioactive Luminous Compound" are authorized to apply radium luminous material. As the necessity becomes evident other stations may request authority from the Bureau of Aeronautics to accomplish this work. Applicable safety precautions must be observed in handling of radium luminous material and radium treated dials and pointers.

(3) INSTRUMENT TROUBLE SHOOTING CHART.

(a) ALTIMETER.

TROUBLE	POSSIBLE CAUSE	REMEDY
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Defective mechanism.	Replace instrument.
High reading.	Improper venting.	Eliminate leak in static pressure system and check alignment of pitot-static tube.
Setting knob turns hard.	Wrong lubrication or lack of lubrication.	Replace instrument.
Pointers and barometic scale fail tc move when setting knob is rotated.	Out of engagement.	Replace instrument.
Setting knob lock screw is 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 instrument.
Dull or discolored luminous markings.	Age.	Replace instrument.

TROUBLE	POSSIBLE CAUSE	REMEDY
	(b) TURN AND BANK INDICATOR.	
Pointer does not set on zero; otherwise smooth pointer operation.	Gimbal and rotor assembly out of balance.	Replace instrument.
	Pointer incorrectly set on its staff.	Replace instrument.
	Sensitivity spring adjustment pulls pointer off zero.	Replace instrument.
Incorrect sensitivity.	Vacuum too high or too low.	Examine tubing, connections, control valve, etc., for leaks or stoppage.
	Air inlet screen dirty.	Remove screen, clean, and replace.
	Sensitivity spring out of adjustment.	Adjust sensitivity by means of screw on right side of case.
Vibrating pointer.	Excessive vibration.	Check instrument panel shock mounts. Replace if defective.
	Damping screw out of adjustment.	Adjust damping screw on top of case until proper operation is obtained.
	Lack of oil.	Lubricate instrument through plug on right side of case with oil (Specification AN-O-6).
Pointer sluggish in returning to zero or does not return to zero; erratic pointer operation.	Oil or dirt between damping piston and cylinder. Case leaks.	Replace instrument.
Broken inclinometer tube.	Excessive vibration. Rough handling.	Replace instrument.
Ball in inclinometer does not center.	Instrument out of alignment in panel.	Correct alignment.
Dull or discolored luminous markings.	Age.	Replace instrument.
Loose or broken cover glass.	Excessive vibration.	Replace instrument.
	(c) GYRO HORIZON INDICATOR.	
Sluggish operation.	Insufficient vacuum.	Check and adjust vacuum.
	Dirty screens.	Clean screens.
	Case leaks.	Replace instrument.
Failure of horizon bar to settle.	Excessive vibration.	Check instrument panel shock mounts. Replace if defective.
	Vacuum too high.	Check and adjust vacuum.
	Worn rotor pivots or bearings.	Replace instrument.
	Gimbals out of balance. Fouled vanes in rotor.	
	Insufficient suction.	Check and adjust vacuum.
	Dirty screens.	Clean screens.
Horizon bar oscillates or shimmies.	Excessive vibration.	Check instrument panel shock mounts. Replace if defective.
	Vacuum too high.	Check and adjust vacuum.
	Worn rotor pivots or bearings.	Replace instrument.
	(d) RATE OF CLIMB INDICATOR.	
Pointer does not set on zero.	Aging of diaphragm.	Reset pointer to zero by means of setting knob. Tap instrument while resetting.
Pointer fails to respond.	Obstruction in static line.	Disconnect all instruments from static line. Open drain plugs and blow line clear.

TROUBLE	POSSIBLE CAUSE	REMEDY
	Defective mechanism.	Replace instrument.
Pointer indicates inaccurately.	Leaks in static line.	Check line and individual instruments separately for leaks by applying suction.
	Defective mechanism.	Replace instrument.
Pointer oscillates.	Leaks in static line.	Check line and individual instruments separately for leaks by applying suction.
	Defective mechanism.	Replace instrument.
	(e) DIRECTIONAL GYRO INDICATOR.	
Excessive drift of indicating dial.	Improper suction.	Check and adjust suction.
	Excessive vibration.	Check instrument panel shock mounts. Replace if defective.
	Defective mechanism.	Replace instrument.
Caging mechanism works hard.	Lack of lubrication or corrosion around shaft.	Lubricate external part of shaft with oil (Specification AN-O-6).
Loose or broken cover glass.	Excessive vibration.	Replace instrument.
Instrument lacks sensitivity.	Insufficient gyro rotor speed.	Check suction.
	Dirty screens.	Clean screens.
	(f) AIR SPEED INDICATOR.	
Pointer fails to respond.	Connections are wrong.	Correct.
	Tubing or connections leak.	Disconnect all instruments from lines.
		Check for leaks and repair.
	Static or pitot line may be clogged.	Disconnect all instruments from lines; open drain plugs; and blow out lines.
	Defective mechanism.	Replace instrument.
Pointer indicates incorrectly.	Leak in tubing from pitot-static tube or in connection.	Disconnect all instruments from lines. Check for leaks and repair.
	Leak in indicator case.	Replace instrument.
	Defective mechanism.	Replace instrument.
Pointer vibrates.	Excessive vibration of instrument panel.	Check instrument panel shock mounts. Replace if defective.
Pointer oscillates.	Leak in pitot tubing.	Disconnect pitot tubing from instruments. Check for leaks and repair.
	Leak in indicator case.	Replace instrument.
	Leak in rate of climb indicator or altimeter installations.	Check lines for leaks. If an instrument is at fault, replace the instrument.
Broken or loose cover glass.	Vibration.	Replace instrument.
	(g) SUCTION GAGE.	
Excessive scale error.	Pointer loose on staff.	Replace instrument.
	Excessive suction.	Replace instrument.
	Improper calibration.	Replace instrument.
	Rough relief valve seat.	Adjust or replace relief valve.
	Defective mechanism.	Replace instrument.

TROUBLE	POSSIBLE CAUSE	REMEDY
	(h) HYDRAULIC PRESSURE GAGE.	
Excessive scale error.	Pointer loose on staff.	Replace instrument.
	Excessive pressure.	Replace instrument.
	Improper calibration.	Replace instrument.
	Defective mechanism.	Replace instrument.
	(i) MANIFOLD PRESSURE GAGE.	
Excessive error at existing barometric pressure.	Pointer loose on staff.	Replace instrument.
Excessive error when engine is running.	Case leaks.	Replace instrument.
	Line leak.	Check line and repair.
Broken or loose cover glass.	Vibration. Excessive pressure.	Replace instrument.
Dull or discolored luminous marking.	Age.	Replace instrument.
	(j) ENGINE GAGE UNIT.	
Excessive pointer oscillation.	Rough relief valve.	Repair relief valve.
Excessive scale reading.	Excessive pressure.	Check and correct pressure.
	Excessive vibration.	Check instrument panel shock mounts and replace if defective.
	Improper calibration.	Replace instrument.
	Pointer loose on staff.	Replace instrument.
	(k) RESISTANCE BULB THERMOMETERS (FREE AIR, AND OIL TEMPERATURE).	
No reading with panel switch on.	Panel switch defective.	Replace or repair switch.
	Poor connections at switch terminals.	Clean and tighten connections.
	Break in battery or ground leads.	Repair or replace leads.
	Open or short circuit in instrument.	Replace instrument.
Readings off scale at low temperature end.	Short circuit in leads to resistance bulbs.	Repair or replace lead.
	Ground in lead from resistance bulb to instrument.	Repair or replace lead.
	Short circuit in resistance bulb.	Replace resistance bulb.
Readings off scale at high temperature.	Break in leads to resistance bulbs.	Repair or replace leads.
	Open circuit in resistance bulb.	Replace resistance bulb.
	Open or short circuit in instrument.	Replace instrument.
Low or high reading, either permanent or intermittent.	Battery low.	Charge battery.
	Poor connection in leads to battery.	Repair.
	Poor connections in leads to switch.	Repair.
	Defective panel switch.	Replace or repair switch.
	Defective indicator.	Replace indicator.
	Defective resistance bulb.	Replace resistance bulb.

TROUBLE	POSSIBLE CAUSE	REMEDY
(l) THERMOCOUPLE TEMPERATURE INDICATORS (ENGINE AND A.P.U. CYLINDER AND HEAT ANTI-ICING TEMPERATURE GAGES).		
No reading, either permanent or intermittent.	Break in leads.	Replace leads.
	Break in indicator or switch.	Replace indicator or switch.
Low reading.	High resistance caused by poor connections at terminals.	Clean terminals and tighten connections.
	Short circuit in leads.	Replace or repair leads.
	Short circuit in thermocouple.	Repair.
Loose or cracked cover glass.	Excessive vibration.	Replace instrument.
	Rough handling.	Replace instrument.
Dull or discolored luminous markings.	Age.	Replace instrument.
Excessive pointer oscillation.	Broken lead or connections.	Check lead and replace if broken.
(m) DUAL TACHOMETER AND SYNCHRONIZER.		
Pointers move backward.	Reversed polarity.	Change leads at terminals on generator.
No reading on indicator.	Break or short circuit in leads.	Repair leads.
Low reading on indicator.	Poor connections in system.	Clean and tighten terminals.
	Generator brushes worn.	Replace brushes. Clean commutator.
Excessive scale error.	Defective mechanism.	Replace instrument.
(n) CLOCKS.		
Clock fails to start when wound.	Excessive friction or congealed oil.	Shake violently. If trouble persists, replace instrument.
Dull or discolored luminous markings.	Age.	Replace instrument.
Excessive rate of gain or loss.	Improperly adjusted.	Remove cover from back of case and adjust with adjusting lever.
Broken or loose cover glass.	Excessive vibration or rough handling.	Replace instrument.
Failure of winding knob to turn.	Wound too tight.	Replace instrument.
Hands not moving when clock is wound.	Hands loose on shaft.	Replace instrument.
Winding knob turns freely.	Main spring broken.	Replace instrument.
(o) NAVIGATOR'S COMPASS.		
Excessive dial card error.	Compass not properly compensated.	Compensate compass.
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
Excessive dial card oscillation.	Insufficient liquid.	Remove instrument and refill with liquid (Specification AN-VV-C-551).
	Excessive vibration of instrument.	Check shock mounts and replace if defective.
Dial card not level.	Leaking float chamber.	Replace instrument.
	Dial card magnets detached from dial card.	Replace instrument.

TROUBLE	POSSIBLE CAUSE	REMEDY
Dial card sluggish.	Weak dial card magnets.	Replace instrument.
	Excessive pivot friction, or broken jewel.	Replace instrument.
	Instrument heavily compensated.	Remove excessive compensation.
Liquid leakage.	Broken cover glass.	Replace instrument.
	Defective sealing gasket.	Replace instrument.
Discolored luminous markings.	Age.	Replace instrument.
	(p) PILOT'S STAND-BY COMPASS.	
Excessive dial card error.	Compass not properly compensated.	Compensate instrument.
Excessive dial card oscillation.	Insufficient liquid.	Refill with liquid (Specification AN-VV-C-551).
Dial card not level.	Dial card magnet detached from dial card.	Replace instrument.
	Insufficient liquid.	Refill with liquid (Specification AN-VV-C-551).
Dial card sluggish.	Weak dial card magnets.	Replace instrument.
Broken or cracked cover glass.	Excessive vibration.	Replace instrument.
	(q) OIL PRESSURE GAGE.	
Excessive scale error.	Calibrated incorrectly.	Replace instrument.
Low scale reading.	Leak in line.	Check line for leaks.
	Defective internal mechanism.	Replace instrument.
Pointer fails to move.	Pointer loose on shaft.	Replace instrument.
Broken or cracked cover glass.	Excessive vibration.	Replace instrument.

e. VACUUM SYSTEM.

(1) GENERAL. *(See figure 177.)*—The source of suction for vacuum operated instruments is two vacuum pumps, one in each nacelle. Two oil separators serve to remove any oil that may enter the vacuum pumps; one is located in each nacelle and connected to each vacuum pump. Two relief valves, one in each nacelle, provide automatic control over the vacuum system. Two check valves, one in each line running from the relief valves, prevent any back pressure from entering the system and thus damaging the instruments.

On PBY-5A airplanes with serial numbers 46624 and on, the two lines running from the check valves converge into one line which passes down from the wing through the superstructure and into the hull on the port side. A drain plug is located in the line just forward of station 1.33; it is used for blowing out and draining the system. From the drain plug, the tubing diverges into two lines, one of which is connected to a two-way valve mounted to the port side of the pilot's instrument panel. To the other side of this two-way valve is connected a small suction regulating valve. From the valve, the lines connect to the automatic pilot instruments, the co-pilot's turn and bank indicator, and the bombsight rudder control device. The other line running from the drain trap is connected to another suction regulating valve to which are connected the two directional gyros, two gyro horizons, pilot's turn and bank indicator, and the suction gage.

On all PBY-5 airplanes and on PBY-5A airplanes up to serial number 46624, two separate vacuum lines run down the superstructure to a four-way valve on the port side of the pilot's compartment. *(See figure 177.)* From the four-way valve, the vacuum lines run to two suction regulating valves which act as distributing manifolds. The valve on the port side controls the suction to the pilot's directional gyro, gyro horizon, and turn and bank indicator. The valve on the starboard side controls the suction to the automatic pilot, the bombsight rudder, control unit, and the co-pilot's turn and bank indicator.

Note

On PBY-5A airplanes up to serial number 46624, the port suction regulating valve also controls the pressure to a copilot's directional gyro and gyro horizon which were added by service action on these airplanes.

Two air filters are provided for filtering the incoming air to this system. One filter is connected to the automatic pilot instruments and the other serves the rest of the vacuum operated instruments.

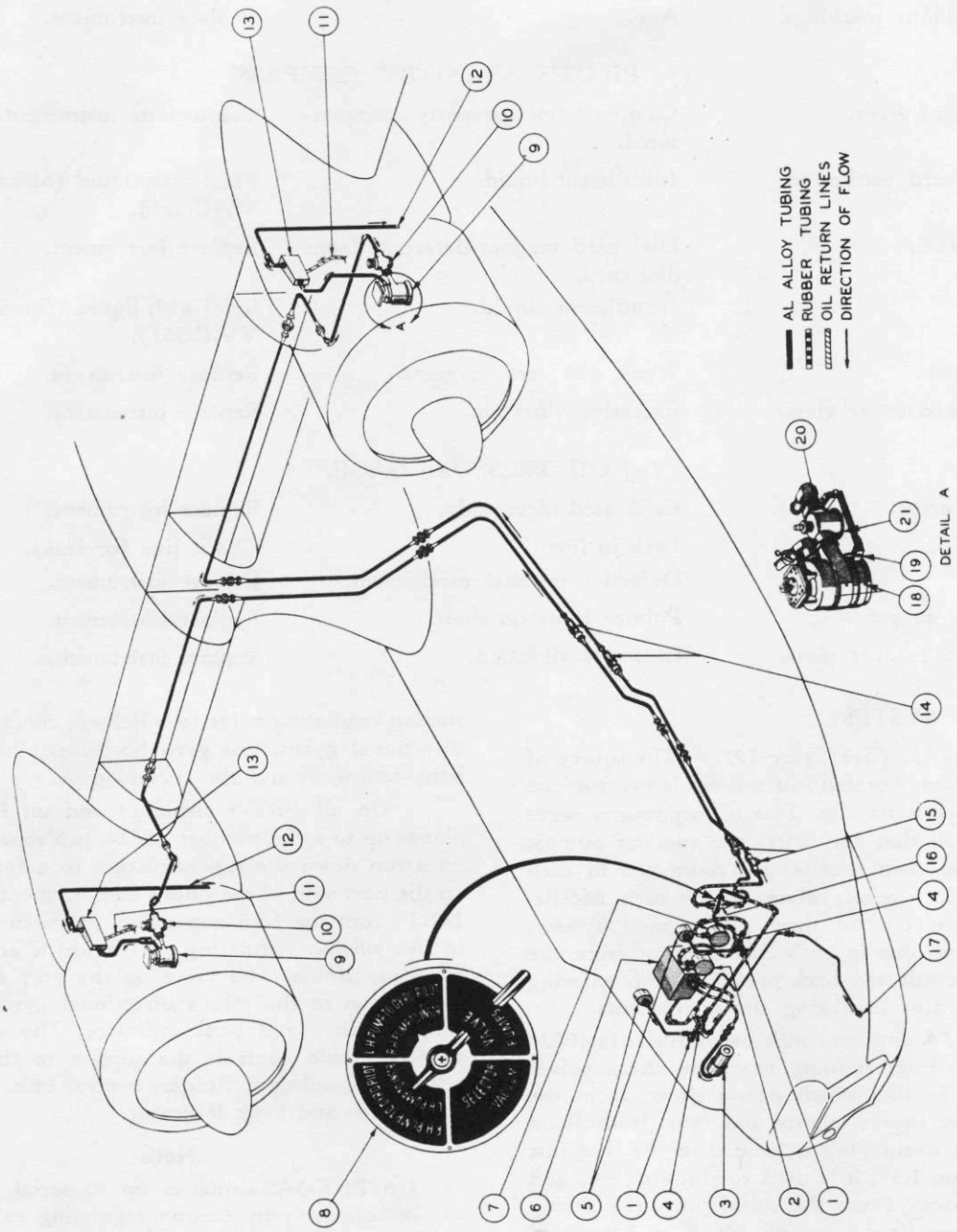


Figure 177—Vacuum System Diagram

No.	PART No.	NAME	No.	PART No.	NAME
1		Needle Valve	12		Air Pressure Vent Line
2		Gyro Horizon	13	561-M2	Oil Separator
3	88-F-1035	Automatic Pilot Air Filter	14	AN5830-6	Backfire Check Valves
4	88-V-395	Vacuum Control Valve	15		Drain Fittings
5		Turn and Bank Indicator	16	28F1270-0	Four-Way Valve Assem.
6		Automatic Pilot	17		Vacuum Line to Bombsight
7		Directional Gyro	18	28-O-5032-10	Strap
8		Four-Way Valve Faceplate	19		Mounting Nut
9	3P-207JA	Vacuum Pump	20	28-O-5032-9	Strap
10	3V-216D	Vacuum Relief Valve	21	28-O-5032	Bracket
11		Oil Return Line			

Items 3 and 4 are Federal Standard Stock Catalog part numbers.
Items 9 and 10 are Pesco Products Co. part numbers.
Item 13 is an Eclipse Co. part no.

Note

Only one air filter was provided on PBY-5 airplanes since they were not equipped with a copilot's gyro horizon and directional gyro.

(2) VACUUM PUMP.

(a) DESCRIPTION. — Two vacuum pumps (PESCO NO. 3P-207-JA) which provide the source of vacuum for the vacuum system have a maximum capacity of 10 inches of mercury pressure each. They are of the rotor type and are gear driven from the engine.

(b) REMOVAL.
(See figure 177.)

1. Open accessory cowl panels and disconnect vacuum lines at the pump (9).

2. Detach the four pump mounting nuts (19) and remove pump.

3. To disassemble vacuum pump and relief valve, remove the relief valve support bracket (21) by detaching strap (18) from the pump and strap (20) from the valve.

4. Remove valve from fitting in pump and cover the openings in the pump and valve.

(c) MAINTENANCE.—This pump needs no maintenance except at major overhaul periods when it is to be disassembled, cleaned, and inspected.

All tubing connections and mounting bolts should be kept tight at all times.

(d) ASSEMBLY AND INSTALLATION.—To install the vacuum pump, reverse the procedure as outlined in paragraph *e*, (2), *(b)*.

CAUTION

Make sure that the mounting gasket is installed so that its holes line up with the oil ducts. Do not permit gasket to rotate.

(3) OIL SEPARATOR.

(a) DESCRIPTION.—An oil separator (ECLIPSE TYPE 561, MODEL 2) is installed in the exhaust line of each vacuum pump. Each oil separator, whose purpose is to prevent oil from entering the vacuum system, is mounted directly to the engine mount. The separator is a welded assembly of steel and contains internal baffle plates which deflect and drain the oil out of the vacuum system.

(b) REMOVAL.
(See figure 177.)

1. Disconnect the three hose connections from the oil separator. Close all open lines with tape to prevent foreign matter from entering.

2. Disconnect clamps that attach the oil separator to the engine mount and remove the oil separator.

3. Close all open ports on oil separator to prevent foreign matter from entering.

(c) MAINTENANCE.—No maintenance is required for the oil separators between major overhaul periods other than keeping hose connections and mounting screws tight.

(d) INSTALLATION.

1. Hold oil separator in place and attach the two clamps supporting it to the engine mount.

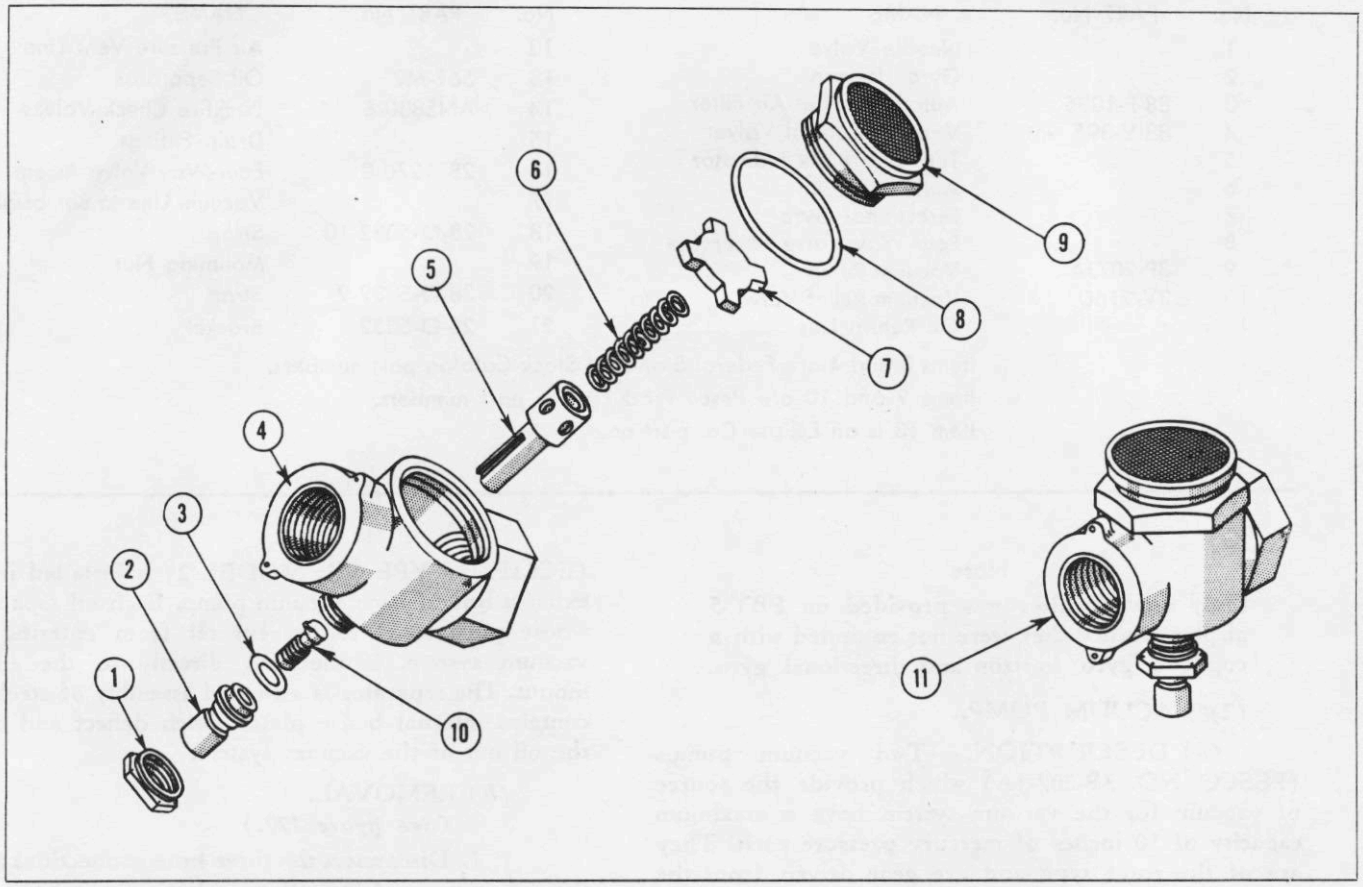
2. Attach hose connections to proper ports.

(4) VACUUM RELIEF VALVE.

(a) DESCRIPTION. *(See figure 178.)*—This valve (PESCO NO. 3V216D) is of the spring loaded disc type. By means of an adjustable turn screw at the bottom of the valve, it serves to regulate the vacuum in the system and to protect the vacuum pump against overloads. It is adjusted so that a suction equal to four inches of mercury pressure will be present at the instruments. Two of these valves are installed in the vacuum system, one adjacent to each vacuum pump.

(b) REMOVAL AND DISASSEMBLY.
(See figure 177.)

1. Disconnect flexible hose from aft side of



No.	PART No.	NAME	No.	PART No.	NAME
1	R400-29	Locknut	7	216-12	Valve
2	195-2	Nut	8	216-9	Gasket
3	195-12	Gasket	9	216-2	Seat Assembly
4	216-1	Body	10	195-4	Screw
5	216-14	Guide	11	3V216D	Relief Valve
6	216-13C	Spring			

All items are Pesco Products Co. part numbers.

Figure 178—Vacuum Relief Valve

valve. Close open line with tape to prevent foreign matter from entering.

2. Detach bracket from pump by removing the two screws.

3. Detach strap holding valve to bracket by removing the two screws.

4. Disconnect valve from pump and remove valve.

5. Cover all open ports with tape to prevent foreign matter from entering.

6. Disassemble valve as follows:
(See figure 178.)

a. Unscrew locknut (1) from body (4) and remove adjusting nut (2), gasket (3), and screw (10).

b. Unscrew valve seat (9) from body (4) and withdraw gasket (8), valve (7), spring (6), and guide (5).

(c) MAINTENANCE.

1. Should this valve fail to function properly, disassemble and clean all parts with unleaded gasoline.

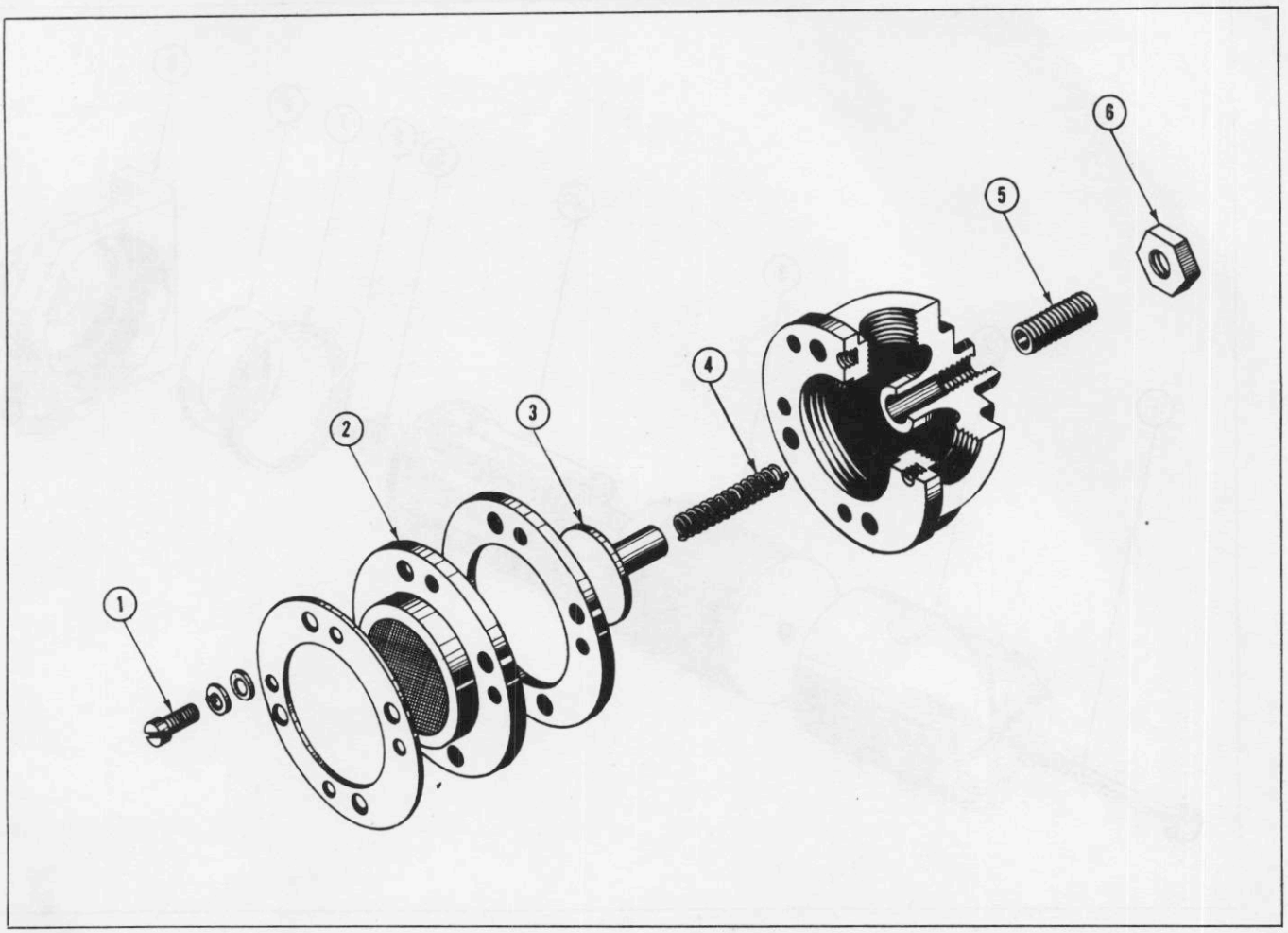
2. Test spring for compression and if unsatisfactory replace with new one.

3. Keep all connections and mounting screws tight.

(d) ASSEMBLY AND INSTALLATION.—To assemble and install the vacuum relief valve, reverse the removal procedure as outlined in paragraph *e*, (4), *(b)* above.

(5) CHECK VALVE.

(a) DESCRIPTION.—This valve (AN 5830-6) is of the flapper type containing a spring. The valve protects the instruments when the suction decreases to a low quantity or a back pressure occurs. Two valves



No.	PART No.	NAME	No.	PART No.	NAME
1	BAH-38	Screw	4	NMP-410	Spring
2		Valve Seat	5	NPF-1346	Setscrew
3	NSA-310	Valve	6	NPF-999	Locknut

All items are Manning, Maxwell and Moore Co. part numbers.

Figure 179—Suction Regulating Valve

of this type are installed in the vacuum lines, both on the hull wall above the navigator's table.

(b) MAINTENANCE.—No maintenance should be required for this valve between major overhaul periods other than keeping connections tight. Should difficulty arise in the system due to these check valves, they should be removed, disassembled, and cleaned with unleaded gasoline.

To disassemble the valve, remove the six screws which hold the two parts of the body together and separate the body. Remove the rubber gasket that seals the assembly. The flapper valve is now exposed and may be cleaned. To reassemble the valve, simply reverse the procedure.

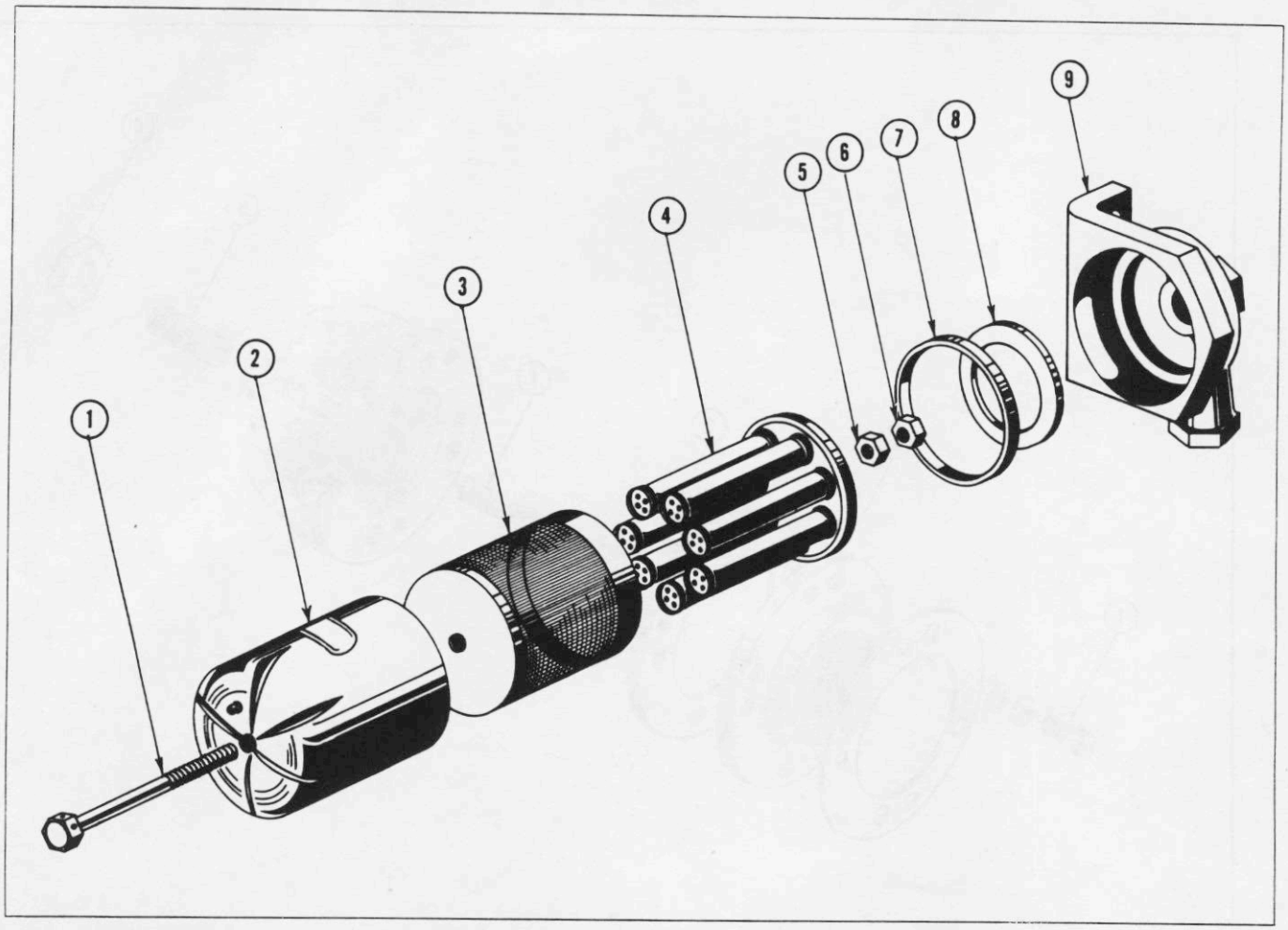
(6) SUCTION REGULATING VALVE.

(a) DESCRIPTION. *(See figure 177.)*—Two of these valves (F. S. S. C. NO. 88-V-395) are located just forward and below the pilot's instrument panel. They are of the spring loaded type with an adjusting screw on top to regulate the amount of suction in the valve. Each outlet is marked to correspond to the instrument to which it is attached; "P" for vacuum lines, "H" for gyro horizon, "T" for turn and bank indicator, and "G" for directional gyro. In the "T" port a restrictor is inserted to reduce the suction to that required by the turn and bank indicator.

(b) REMOVAL AND DISASSEMBLY. *(See figure 177.)*

1. Disconnect tubing from valve and close open lines with tape. Mark lines with name of port from which they were disconnected.

2. Remove four bolts attaching the valve to the supporting channel and withdraw the valve.



No.	NAME	No.	NAME
1	Bolt	6	Locknut
2	Filter Bowl	7	Gasket
3	Diffuser	8	Gasket
4	Filter Element	9	Filter Head
5	Bowl Puller Nut		

Figure 180—Air Filter

3. Close valve ports with tape to prevent foreign matter from entering.

4. Disassemble valve as follows:

a. Remove the four screws (1) and take off the valve seat (2). *(See figure 179.)*

b. Remove valve (3) and spring (4).

c. Remove locknut (6) and setscrew (5).

(c) MAINTENANCE.—It is recommended that at all major overhaul periods, the valve be disassembled and cleaned with unleaded gasoline. Tighten any loose tubing connections or loose mounting screws.

(d) ASSEMBLY AND INSTALLATION.—To assemble and install this valve, reverse the procedure outlined in paragraph *e*, (6), *(b)* above.

(7) VACUUM FOUR-WAY VALVE.

(a) DESCRIPTION.—This is a plug type valve (28F1270-0) containing four ports. It is located on the left side of the pilot's instrument panel, where it is operated manually by a handle. This valve controls the vacuum supply to the automatic pilot instruments, the turn and bank indicators, the bombsight rudder control unit, the gyro horizon, and directional gyro indicators.

Note

The four-way valve is provided on PBY-5 and PBY-5A airplanes up to serial number 46624. A two-way valve is used on PBY-5A airplanes with serial numbers 46624 and on.

(b) REMOVAL AND DISASSEMBLY.

1. Disconnect the lines on each side of the

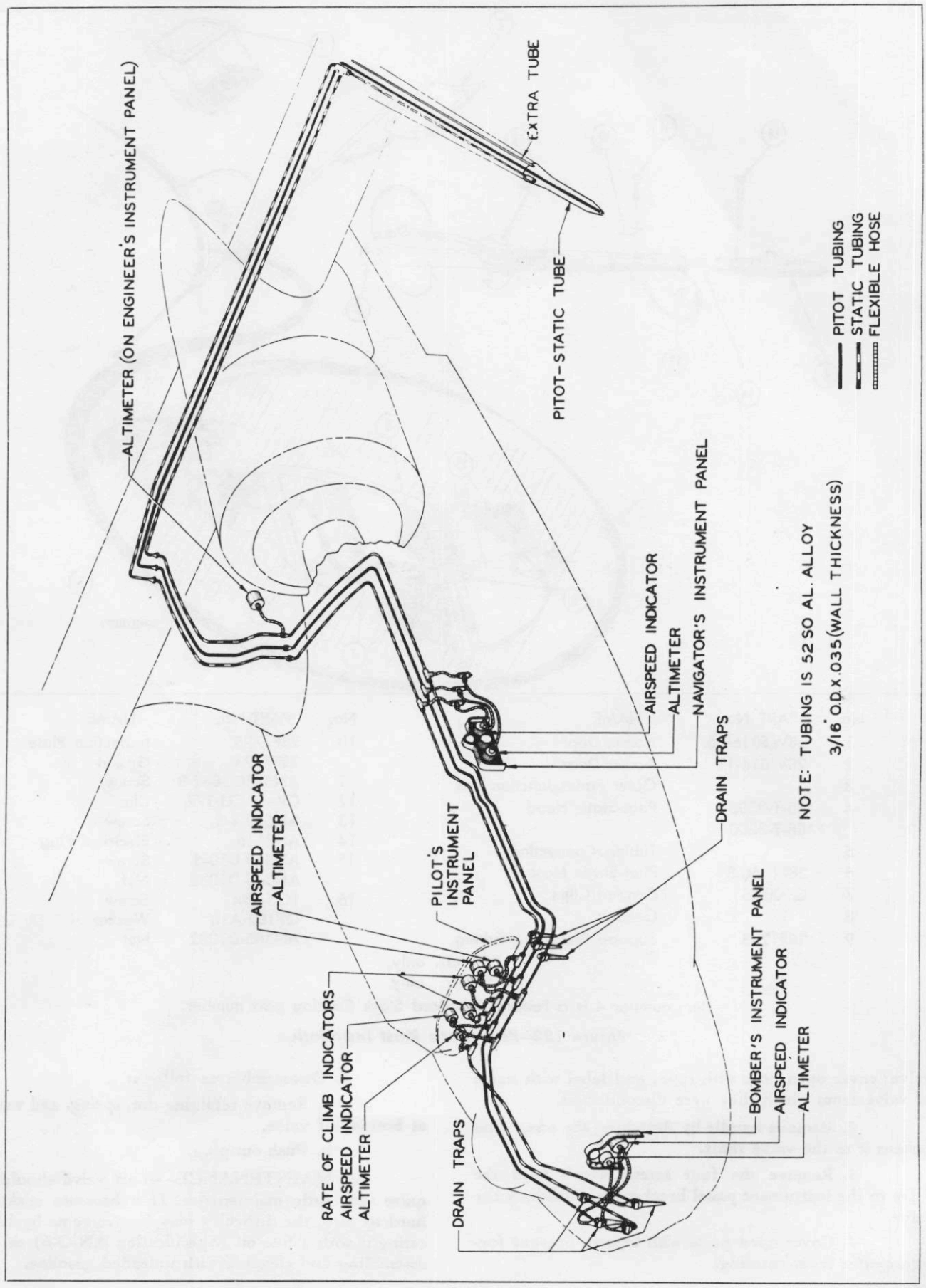
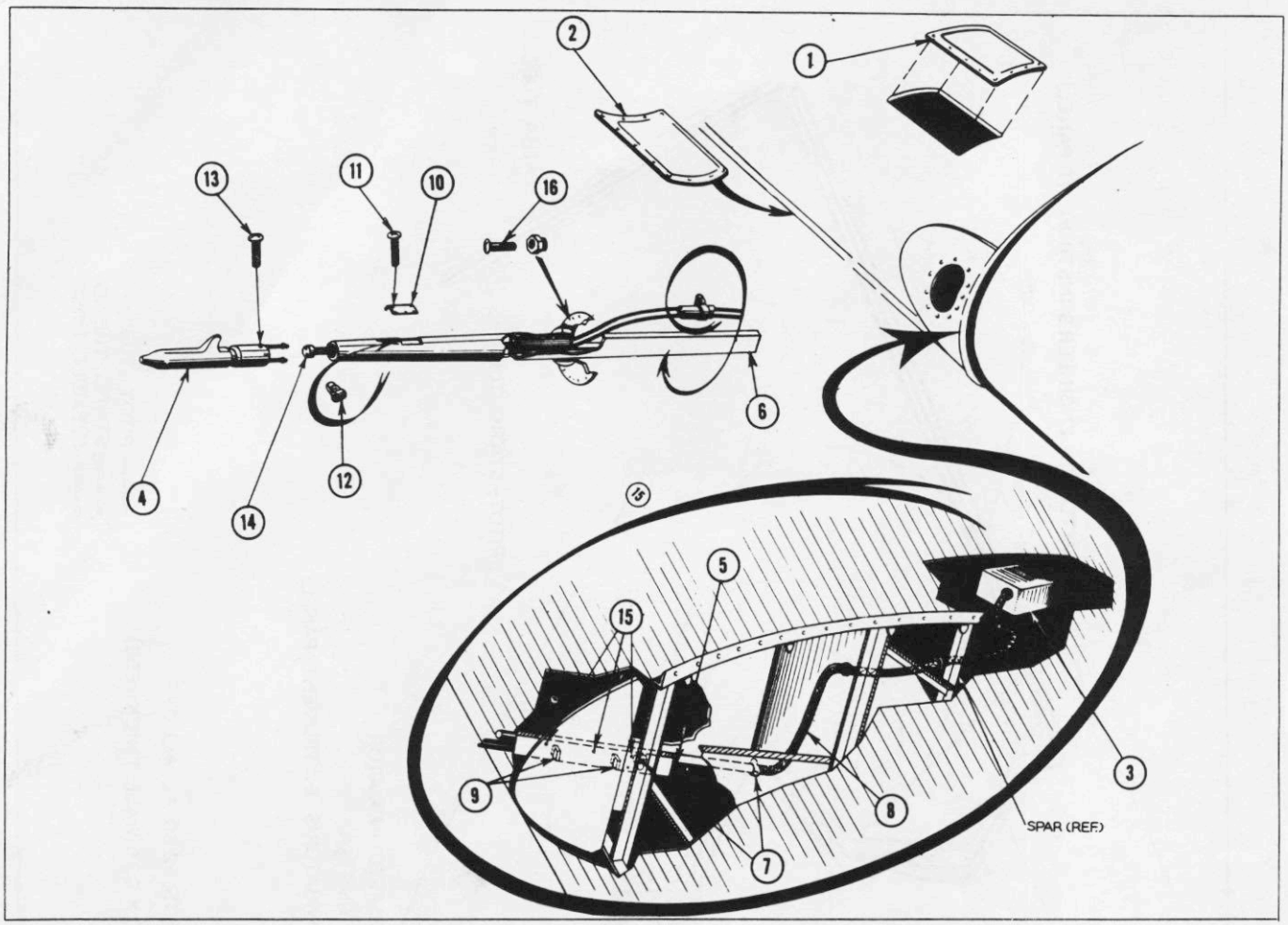


Figure 181—Pitot-Static Instrument Lines



No.	PART No.	NAME
1	28W5016-66	Access Door
2	28W016-11	Access Door
3		Outer Panel Junction Box
4	*88-T-3305	Pitot-Static Head
	**88-T-3300	
5		Tubing Connections
6	28F1460-8	Pitot-Static Mast
7	Q908A6	Conduit Clips
8		Conduit
9	28F1283	Support Blocks for Tubing
10	28F7795	Inspection Plate
	28F7794	Gasket
11	AN526DD832-8	Screw
12	CVAC CLI-177	Clip
13	AN520-4-5	Screw
14	AN3115	Electrical Plug
15	AN520-D10-6	Screws
	AN365-D1032	Nut
16	1Q548-4	Screw
	Q7102-A10	Washer
	AN365-D1032	Nut

*PBY-5A only.
**PBY-5 only.

Item number 4 is a Federal Standard Stock Catalog part number.

Figure 182—Pitot-Static Mast Installation

valve; cover open lines with tape; and label with name of valve from which they were disconnected.

2. Remove handle by detaching the screw that fastens it to the valve shaft.

3. Remove the four screws which hold the valve to the instrument panel bracket and withdraw the valve.

4. Cover open ports with tape to prevent foreign matter from entering.

5. Disassemble as follows:

a. Remove retaining nut, spring, and washer at bottom of valve.

b. Push out plug.

(c) MAINTENANCE.—This valve should require very little maintenance. If it becomes sticky or hard to turn, the difficulty may be overcome by lubricating it with a fine oil (Specification AN-O-6) or disassembling and cleaning with unleaded gasoline.

(d) ASSEMBLY AND INSTALLATION.—To assemble and install this valve, simply reverse the procedure as outlined in paragraph *e*, (7), *(b)* above.

(8) AIR FILTERS.

(a) DESCRIPTION.—Two air filters (F. S. C. C. NO. 88-F-1035) are installed on the starboard side of the airplane just forward of the pilot's instrument panel on PBY-5A airplanes with serial numbers 46624 and on. One of the filters is connected to the automatic pilot and the other one is connected to the two gyro horizons and the two directional gyros.

Note

On PBY-5A airplanes up to serial number 46624, the second air filter is to be installed by service action. On PBY-5 airplanes, only one air filter was provided since these airplanes were not equipped with a copilot's gyro horizon and directional gyro.

The filter consists essentially of a filter body with inlet and outlet ports and a filter element. It must be mounted with the inlet port down so that proper drainage of moisture condensation is assured.

(b) REMOVAL AND DISASSEMBLY.

1. Remove the two screws that support the filter to the mounting bracket.

2. Disconnect the tubing connection at the outlet port of the filter. Close open lines with tape to prevent foreign matter from entering.

3. Disassemble filter as follows:
(See figure 180.)

a. Break lockwire; disengage bolt (1) and remove the filter bowl (2).

b. Remove diffuser (3) and filter element (4) from bowl by removing nuts (5) and (6).

(c) MAINTENANCE.

1. Keep tubing connections tight.

2. Keep mounting screws tight.

3. To clean filter, proceed as follows:

a. Disassemble filter as outlined in paragraph *e*, (8), *(b)*.

b. Clean tubular filter elements by using compressed air applied to the open ends of the tubular elements. This reverses the normal flow of air and loosens any surface deposits.

c. Any dust that remains can be blown off by directing the compressed air along the elements from each end.

CAUTION

Do not apply air at right angles to the element tubes as this will have a tendency to wedge impurities between filter discs.

d. Using a clean cloth, wipe off any dust remaining on filter elements, bowl, diffuser, filter head, ports, etc.

(d) ASSEMBLY AND INSTALLATION.

1. Insert diffuser (3) and filter element (4) in filter bowl (2).

2. Insert bolt (1) and puller nut (5) loosely by hand and then lock with the locknut (6).

3. Place filter head (9) along with gaskets (7) and (8) over filter bowl (2) and engage with bolt (1).

4. Lock bolt (1) with lockwire.

5. Install filter by attaching it to its mounting bracket by means of two attaching screws and then connecting the tube to the outlet port.

(9) VACUUM LINES.

(a) DESCRIPTION. — The vacuum system lines are made from 52SO aluminum alloy tubing assembled with standard fittings. At the instrument panel, flexible hose connections are used to allow for the deflection of the shock mounts and for hinging of the panel aft for maintenance. (PBY-5A airplanes, serial numbers 46624 and on).

(b) MAINTENANCE.

1. Keep connections tight.

2. Replace dented or damaged tubing.

3. Remove any obstruction such as water, dirt, etc., from the system by blowing it out through the drain plug.

CAUTION

When blowing out vacuum lines, be sure all instruments are disconnected to prevent damage to instruments.

(c) TEST.

1. Place suction gage in line near the instrument panel. It may be connected into the line with a Tee or connected to one of the extra ports in the directional gyro or gyro horizon.

2. Run engines at cruising rpm.

3. The suction gage should show four inches of mercury (2½ inches of mercury for the turn and bank indicator).

4. If proper amount of vacuum is not indicated, check the lines for leaks. Also check the relief valves, check valves, regulating valves, and vacuum pumps for operational difficulties.

f. PITOT-STATIC SYSTEM.

(1) DESCRIPTION.—To provide for the operation of the airspeed indicator, altimeter, and rate of climb indicator, a pitot-static head is installed on the airplane. The pitot-static head is supported by the pitot-static mast located on the leading edge of the port wing just inboard of the wing splice. The head has two chambers, one for pitot or impact pressure, and the other for atmospheric or static pressure.

To prevent ice from forming at the openings of the chambers, the head is electrically heated. Tubing

connects the head with the altimeters, airspeed indicators, and rate of climb indicators. As the airplane passes through air, the impact of the air at the pitot opening causes a pressure in the pitot lines which actuates the aneroid in the air speed indicator. The static pressure passes through the static lines to the altimeter, airspeed indicator, and rate of climb indicator. (See figure 181 for the routing of the lines.)

Drain traps are located at the low points of the system to drain any moisture which may have accumulated in the system.

(2) REMOVAL.

(a) Clips support the lines to structural parts of the airplane. By disconnecting these clips and disconnecting the tubing at intervals where couplings are located, all the tubing of the system may be removed.

(b) Remove the pitot-static mast as follows: *(See figure 182.)*

1. Remove the access doors (1) and (2) in leading edge of center section near splice.

2. Disconnect the two pitot-static head electric wires (one wire on PBY-5 airplanes) in the outer panel junction box (3) by entering the wing through the man-hole in the outer panel near the splice.

3. Disconnect the tubing leading to the pitot-static head (4) by unscrewing the connections (5) inside the leading edge near the mast (6).

4. Near the base of the mast, disconnect the two clips (7) that support the conduit (8) to the mast and the two blocks (9) that support the aluminum tubing to the mast.

5. Remove the inspection plate (10) by unscrewing four screws (11) and then disconnect the clip (12) that holds the aluminum tubing and electrical wiring to the mast.

6. Remove the four screws (13) that hold the pitot-static head (4) to the mast and pull the pitot-static head out a short distance together with the tubing and electrical wiring.

7. Remove the pitot-static head (4) by disconnecting the tubing connections and disengaging the electrical plug (14).

8. Remove five screws (15) that attach the mast inside the leading edge and 12 screws (16) that attach the mast to the front of the leading edge, and then withdraw the mast.

9. Close all open lines with tape so that foreign matter will not enter.

(3) MAINTENANCE.

(a) Remove the plugs at the drain traps in order to drain any moisture in the system. After draining is complete, replace plugs.

(b) Keep all screws tight.

(c) Keep electrical connection at pitot-static mast tight and clean with crocus cloth to insure positive connection.

(d) Keep tubing connections tight.

(e) Test for leakage as follows:

1. PITOT PRESSURE LINES.—With the drain plugs closed and all the instruments connected to the pitot and the static lines, place a rubber tube over the pitot opening in the pitot tube; carefully apply sufficient pressure to deflect the airspeed indicator needle to read 130 knots; shut off the pressure and pinch the tube. The needle on the airspeed indicator should not drop more than two knots in one minute.

2. STATIC PRESSURE LINES.—Apply a suction through the static opening in the pitot-static head to produce an altimeter reading of 1000 feet. The altimeter should not change more than 50 feet over a period of one minute.

(4) INSTALLATION.—Install pitot-static mast by reversing removal procedure outlined in paragraph *f*, (2).

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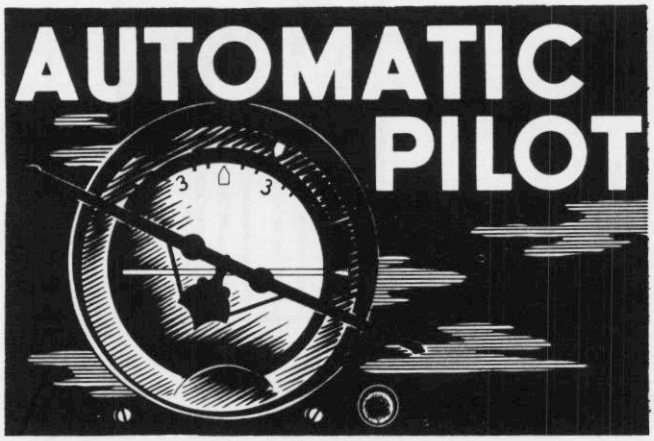
PARAGRAPH 20.



20. AUTOMATIC PILOT SYSTEM.

a. GENERAL.

(1) DESCRIPTION. *(See figures 183 and 184.)*—The automatic pilot (gyropilot) equipment consists essentially of a directional gyro control unit, a bank and climb gyro control unit, a mounting unit, and a servo unit, together with the necessary accessories for the proper working of the equipment as a whole.

When the automatic pilot is set to fly the airplane in a straight, level course, and this attitude is disturbed by a gust of wind or otherwise, the gyros in the control units operate the air pick-offs so that a difference of pressure is obtained across the diaphragm in the air relays. This causes the balanced oil valves to open and allow oil to flow to the servo unit. This oil is under pressure and moves the piston in the servo in the direction that will cause a corrective movement in the airplane's control. This movement causes the airplane to assume its original straight, level flight position.

When a maneuver is desired, the indices on the control units are moved slowly by the knobs until the maneuver is complete. When the indices are moved, a difference in pressure across the diaphragm in the air relays will result. This will operate the balanced oil valves and allow hydraulic fluid to flow to the servo. The servo will then move the controls so that the desired maneuver is performed.

An oil filter is located in the system to keep the oil clean. On the PBY-5 airplanes up to serial number 08318, a servo by-pass valve is located between the automatic pilot and the servo unit.

On PBY-5A airplanes *(See figure 183)*, the oil flows from an unloading valve to a pressure regulator which reduces the pressure to 150 lbs/sq in. then to a four-way valve which by-passes the oil either to the automatic pilot or to the basic hydraulic system. On PBY-5 airplanes, the oil flows from the hydraulic pump to a pressure regulator near the pump. The oil flows through the regulator, which reduces the oil pressure to 150 lbs/sq in., and then to a four-way valve which passes the oil to the automatic pilot or by-passes it to the oil reservoir near the pump. *(See figure 184.)*

From the four-way valve, the oil passes through the oil filter and then to the inlet side of the automatic pilot mounting unit. From the balanced oil valves, the oil travels through the manifold block to the servo unit (or to the servo by-pass valve) and back through the manifold block into the mounting unit. The oil is then metered through the speed control valves and leaves the system through the four-way valve.

A certain amount of oil must be drained from the balanced oil valves. This oil comes out of the drain side of the mounting unit and flows into an overflow reservoir and then to the sump pump which pumps it back into the system.

When the bombsight is operating the rudder, the rudder transfer valve cuts out the directional gyro control unit in the mounting unit and the oil that operates the rudder servo passes through the bombsight rudder control unit. The servo is connected to the automatic pilot system by means of the servo "ON"-"OFF" control located above the pilot on the forward face of bulkhead 2.

For a description of the vacuum system, see Par. 19, *e.*

(2) MAINTENANCE.—Detailed instructions for the maintenance of each unit in the system is given under the paragraphs dealing with the individual units. However, in general, the following items should be noted, keeping in mind that the purpose of any inspection or maintenance is to forestall trouble or failure by detecting maladjustment, wear, or weakness before it becomes serious and to make the necessary correction to prevent a failure of the apparatus:

(a) Inspect all tubing, including flexible hoses, and all fittings. Tighten fittings or replace tubing where necessary to stop leaks. Replace any flexible hoses showing signs of seepage at connections or pimples on surface of hose.

(b) Inspect all cables, cable connections, and pulleys. Main cables, follow-up cables, and servo "ON"-"OFF" cable should be free working, positive, and free from any signs of wear.

(c) The following units should be removed and overhauled at the 600-800 hour period to put them in first class condition. The overhaul operations should only be performed by organizations trained in the overhaul of automatic pilot equipment and having the necessary tools and fixtures required.

1. Directional gyro control unit.
2. Bank and climb gyro control unit.

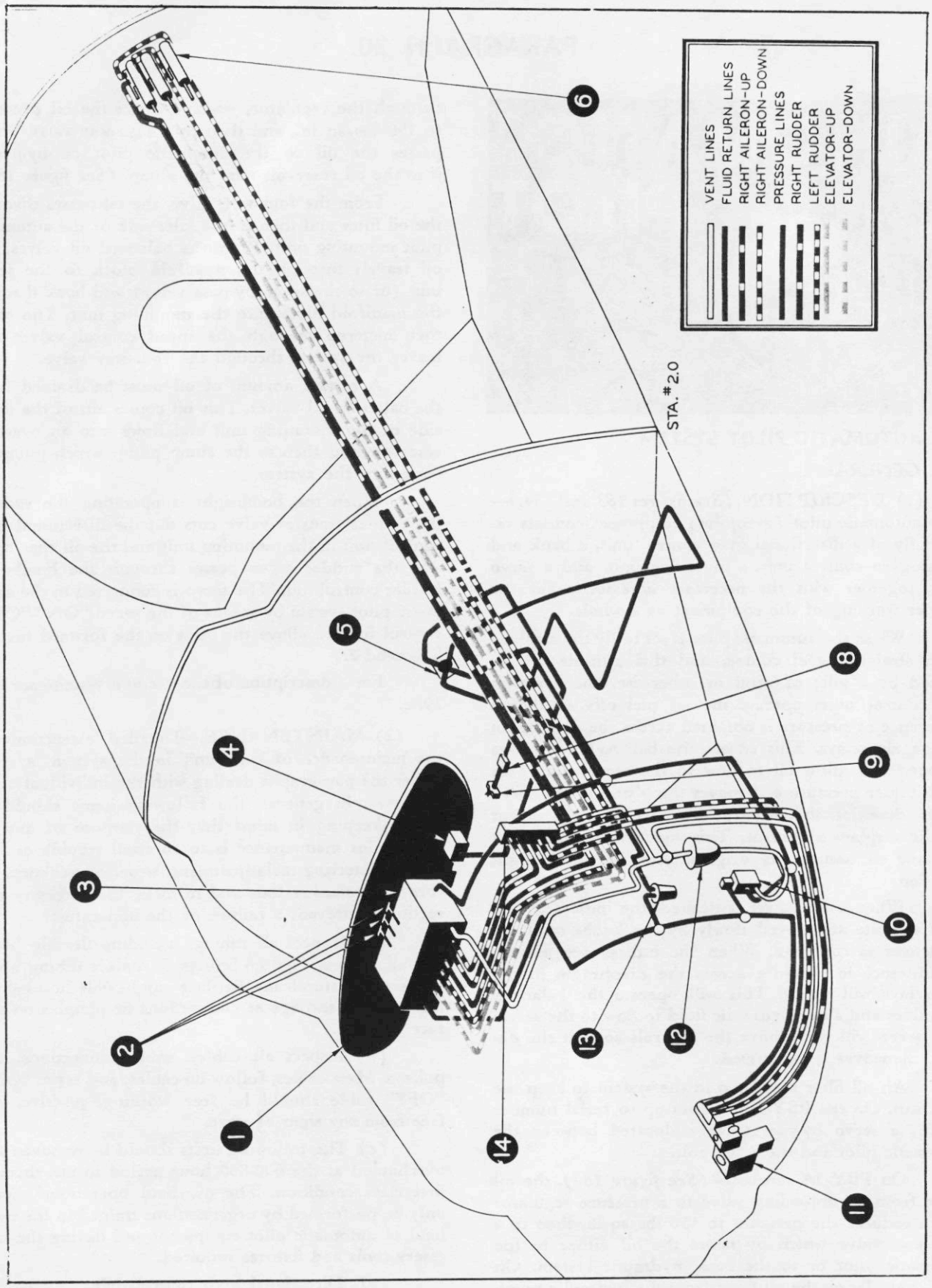


Figure 183—Automatic Pilot Hydraulic System (PBY-5A Only)

No.	PART No.	NAME	No.	PART No.	NAME
1		Instrument Panel	9	88-R-255	Oil Pressure Regulator
2	88-V-180	Speed Control Valves	10	58002A	Sump Pump
3		Automatic Pilot	11	Mark 15-5	Bombsight
4	4V4001	Landing Gear Selector Valve	12	28F6687	Overflow Reservoir
5	28F1208-3	Automatic Pilot Four-Way Valve	13	88-F-1060	Oil Filter
6	88-S-270	Servo Unit	14	88-V-375	Rudder Control Transfer Valve
8	CVAC-VA-346	Check Valve			

Items number 2, 6, 9, 13 and 14 are Federal Standard Stock Catalogue part numbers.
Item number 10 is an Aircraft Accessories Corporation part number.
Item number 4 is an Aerodraulics Corporation part number.

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3. Balanced oil valves.

4. Pressure regulator.

5. Oil filter.

6. Sump pump.

(d) The following units should be removed and tested at the 600-800 hour period but not disassembled for overhaul unless their performance is not satisfactory:

1. Air relays.

2. Speed control valves.

3. Servo unit.

(3) TESTS.

(a) PROPORTIONAL BANK ADAPTER.

1. GROUND TEST (50-100 hour).

a. With the gyro control units removed, a check should be made to see that the large hexagonal nuts holding the adapter unit to the mounting brackets are tight. If loose, they should be drawn up tight and a portion of the lockwasher bent over for security.

b. The discs on the proportional bank adapter should be checked for tightness on their shafts to eliminate any tendency toward backlash. The nuts holding these discs should be drawn up tight. On the other end of the shaft the pulleys should be tight on their shafts.

c. The pulley follow-up springs should work freely in their housings. Add a small amount of engine oil if necessary. If grit is present, the pulleys and spring housings should be removed for cleaning. Before removing the pulleys, they should be marked so that they will be replaced on their proper shafts. Note also whether the springs in the housings are for right or left-hand rotation so that they will be reassembled properly. The spring housing on each pulley should be disassembled and all parts cleaned in gasoline, then reassembled carefully. Before the spring housing covers are replaced, the springs and housings should be lubricated with a mixture of light machine oil and flaked graphite. When reassembling the spring housings and pulleys on the spindles, the keys must be inserted in the keyway first, because they cannot be inserted after the other parts have been applied to the spindle.

2. GROUND TEST (600-800 hour).—After this longer period of service, the adapter should be removed from its mounting bracket and given a bench check to see if an internal overhaul is necessary. This test involves the dismantling of the unit and should be performed by trained personnel only.

3. FLIGHT TEST.—After having made a careful check of the entire proportional bank adapter and automatic pilot, the plane can be taken to a safe altitude for trial operation. With the plane properly trimmed and the rudder control unit indicator on zero when in straight flight, the automatic pilot can be thrown in and trimmed for straight, level flight.

By caging the directional unit and offsetting the rudder control index, turns may be made in each direction. During the entry into the turns and during the turns, it is desirable to set the unit so that a slight skidding turn is made as this facilitates the coming out of the turn on the correct heading. The plane should be able to execute turns up to 20° bank without difficulty which gives a rate of turn of approximately 250° to 300° per minute.

When making a full turn either to the right or left and uncaging the gyro of the automatic pilot, the plane should come to its heading with wings level with less than 1° overswing.

(b) AUTOMATIC PILOT.

1. GROUND TEST.

a. After closing speed control valves, turn automatic pilot "OFF" by means of the servo "ON"-"OFF" control.

b. Start the engine and run at 600 to 700 rpm and note whether the oil pressure gage and vacuum gage indicate. Within one or two minutes, the oil pump should prime and indicate pressure. Do not allow the pump to run dry more than five minutes. After oil and vacuum pumps are operating, run engines at 1000 rpm and set vacuum regulator for four inches of mercury at the gage and set oil pressure regulator to provide a pressure of approximately 150 lbs/sq in. The speed valves should be closed while the oil pressure adjustment is being made. The vacuum should not be less than 3 inches of mercury at 1000 rpm or more than five inches of mercury at maximum ground rpm.

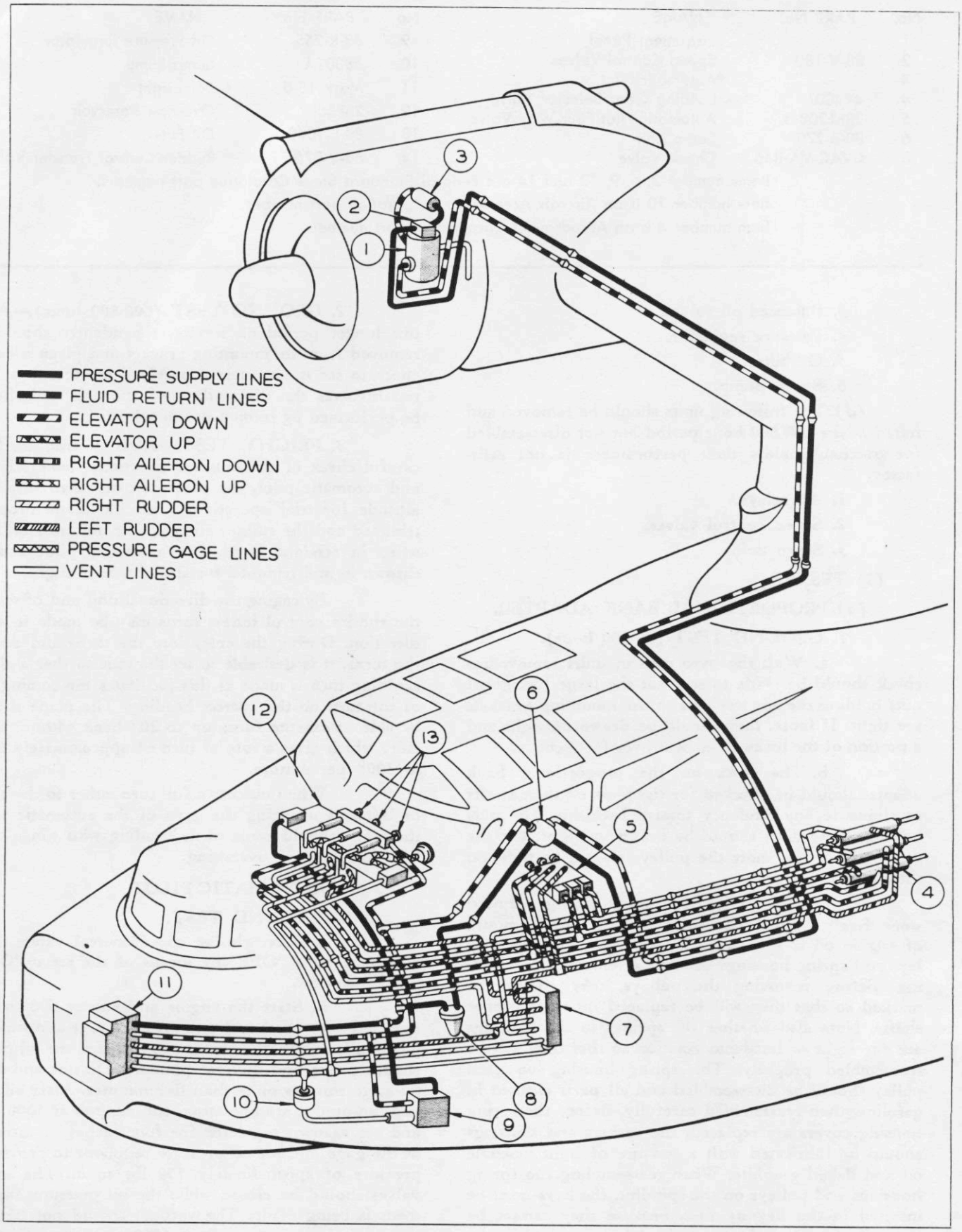


Figure 184—Automatic Pilot Hydraulic System (PBY-5 Only)

No.	PART No.	NAME	No.	PART No.	NAME
1	88-T-375	Reservoir	8	88-F-1060	Oil Filter
2	88-R-255	Oil Pressure Regulator	9	58002A	Sump Pump
3	1P203P	Engine Driven Pump	10	28F6687	Overflow Reservoir
4	88-S-270	Servo Unit	11	Mark 15-5	Bombsight
5	SD29035	Servo By-Pass Valve	12		Automatic Pilot
6	28F1208-3	Four-Way Valve	13	88-V-180	Speed Control Valve
7	88-V-375	Rudder Control Transfer Valve			

Items number 1, 2, 4, 7, 8 and 13 are Federal Standard Stock Catalog part numbers.
Item number 3 is a Pesco Products Corporation part number.
Items number 5 and 9 are Aircraft Accessories Corporation part numbers.

c. Open speed valves at least four turns. Each numeral represents one turn of the knob.

d. Center the controls; align the follow-up indices on the control units; and then operate the controls manually from one extreme to the other, first independently and then collectively a few times. Then hold each control at each extreme position for at least 30 seconds two or three times. This allows time for air in the servo to be pushed through the system by oil flow until it reaches the main reservoir.

e. Shut down engines for a few moments to check for air in the servos and replenish oil in the main reservoir. To check for air in the servos, turn the automatic pilot to "ON" and, with the engines shut down, the controls should then act as though locked. A resiliency indicates air in the servo which is compressed when pressure is applied to the controls and which expands when the force is removed. Do not confuse stretching of cables with air in the servo. If any doubt exists, observe the dials on the control units when checking for air.

f. Adjust the servo relief valves in accordance with the directions given in paragraph *l*, (3), *(e)*.

g. Start the engines and run at 1000 rpm. Center all three controls, uncage gyros, open speed valves, align the follow-up indices with the gyro indications, and turn the automatic pilot "ON." All three controls should remain in position.

h. Check for direction of control by moving each setting knob back and forth a small amount, making sure that each control moves in the direction indicated on the knob.

i. Check for control speed balance as follows: Open all three speed control valves wide. Turn the automatic pilot "OFF" for a moment and move the aileron control to one extreme position. Turn automatic pilot "ON" quickly and count the number of seconds for the wheel to come to neutral. Repeat from opposite side. Time to return should coincide within 25 per cent. Follow the same procedure with the elevator and rudder. Up elevator may be somewhat slower than down elevator due to the weight of the elevator surface itself. Be sure that the tail of the airplane is not caused to rise when the elevator control is pushed all the way forward.

j. If any of the above tests show improper operation, correct in accordance with the "TROUBLE SHOOTING CHART." (See paragraph *a*, (3), *(c)*.)

2. FLIGHT TEST.

a. Be sure both control gyros are uncaged.

b. Check vacuum. Desired vacuum is four inches of mercury. It should not be less than three or more than five inches.

c. Check oil pressure.

d. Trim the airplane for "hands off" (level flight) condition.

e. Open servo speed control valves. A closed speed valve locks its control in position when the automatic pilot is "ON." Therefore it is important that the valves be open prior to engaging the automatic pilot.

f. Check directional gyro control setting.

g. Set follow-up dials to coincide with gyro indications on control units.

h. Engage automatic pilot slowly. By holding the controls while the automatic pilot is engaged, the pilot can feel when the automatic pilot is flying the airplane. If oscillations are noticed when the automatic pilot is engaged, they can be stopped by adjusting the speed control valves.

On completion of flight test, a final inspection of the entire installation should be made. Check for oil leaks, stretched cables, and loose pulley brackets. Check oil in main reservoir and refill if necessary.

(c) TROUBLE SHOOTING CHART.—In order to perform ground test at all, it is necessary to have the proper vacuum, oil in the main reservoir, and oil pressure. Possible causes of vacuum and oil troubles are listed below and followed by other troubles which might occur when vacuum and oil pressures are sufficient.

TROUBLE	POSSIBLE CAUSE	REMEDY
1. Low or no vacuum (under three in. mercury).	a. Vacuum relief valve set too low.	a. Screw in adjusting screw. If increased vacuum does not result, valve is defective or trouble lies elsewhere. If vacuum does not increase with hand held over air intake of valve, trouble is definitely elsewhere.
	b. Vacuum pump failure.	b. Repair or replace pump. Be sure that some other defect in the installation is not responsible for pump failure.
	c. Leak or break in vacuum line.	c. Locate and repair.
	d. Collapsed inner wall of flexible hose, or obstruction in lines.	d. Locate and repair.
2. Excessive vacuum (over five in. mercury).	a. Vacuum relief valve set too high.	a. Reset.
	b. Air intake filter clogged.	b. Clean filter element or replace with new one.
	c. Vacuum relief valve stuck closed.	c. Remove screen and push valve free with finger. Replace screen. If sticking persists, replace or repair.
	d. Shipping plug not removed from inlet end of air filter.	d. Remove plug.
3. Low or no oil pressure.	a. Insufficient oil in system.	a. Fill main oil reservoir to red line on PBY-5A sight gage and ¾ full on PBY-5 sight gage.
	b. Pressure regulator out of adjustment.	b. Adjust with speed valves closed. After removing cap, screw in to raise pressure and out to lower pressure.
	c. Pressure regulator dirty or defective.	c. Clean or repair and then adjust.
	d. Pump intake line or filter clogged.	d. Check line and filter.
	e. Defective oil pump.	e. Test and replace if necessary.
	f. By-pass valve open.	f. Close by-pass valve.
	g. Broken line or leak.	g. Locate and repair.
4. Excessive oil pressure.	Oil pressure regulator set too high or stuck.	Adjust with speed valves closed.
5. Foaming of oil.	a. Leak in line leading from main reservoir to oil pump.	a. Locate and repair.
	b. Leak in oil pump.	b. Repair or replace pump.
6. No operation of any control.	a. Low or no oil pressure.	a. See paragraph *a*, (3), *(c)*, *3*, in Trouble Shooting Chart.
	b. Low or no vacuum.	b. See paragraph *a*, (3), *(c)*, *1*, in Trouble Shooting Chart.
	c. Defective operation of "ON"-"OFF" control.	c. Check for full 90° throw of valve at servo unit.

TROUBLE	POSSIBLE CAUSE	REMEDY
	d. "ON"-"OFF" control set in "OFF" position.	d. Set control in "ON" position.
	e. Speed control valves closed.	e. Open two to four turns.
7. Failure of one of the controls.	a. Speed valve closed.	a. Open speed valve.
	b. Servo relief valve by-passing.	b. Reset valve. (See paragraph *l*, (3), *(e)*.)
	c. Balanced oil valve on mounting unit stuck.	c. Remove rear cap and work valve back and forth by hand with oil pressure on and automatic pilot off.
	d. Air relay stuck.	d. Clean or replace.
8. Controls hunting (oscillating).	a. Air in oil system.	a. Set follow-up dials on the directional gyro and the bank and climb gyro control units at neutral with controls in neutral. Move controls back and forth manually with engines running and automatic pilot "OFF." Hold each control at one and then the other extreme position for one minute.
	b. Lag in follow-up system.	b. Examine follow-up cables and pulleys and remove any lag present.
	c. Sticking oil valve.	c. With automatic pilot "ON"-"OFF" lever in "OFF" position, work valve manually until free, and then hold in each extreme position for about two minutes to allow any dirt to be carried back to the main reservoir.
	d. Unbalanced oil valve or end play in oil valve.	d. Reset valve. (See paragraph *d*, (3), *(d)*.)
	e. Gyros caged. (A caged gyro will oscillate back and forth against the caging stops, causing the controls to follow.)	e. Uncage gyros.
	f. Incorrect speed valve adjustment.	f. Reduce speed valve setting.
9. Jerky control.	a. Sticking in follow-up pulleys.	a. Check condition of follow-up pulley springs and if necessary, lubricate with oil (Specification AN-VV-O-446).
	b. Excessive friction in follow-up cables.	b. Examine cable system and replace defective pulleys or cables.
	c. Sticky balanced oil valve.	c. Free valve. Clean if necessary. Re-balance valve, if removed for cleaning.
10. Lagging control in one direction only.	a. Follow-up pulley not wound sufficiently.	a. Shorten follow-up cables so that when control is hard over in the direction to wind the spring, the spring will be within ¼ turn of being wound.

TROUBLE	POSSIBLE CAUSE	REMEDY
	b. Dirt in balanced oil valve.	b. Free valve. Clean if necessary. Re-balance after assembly.
	c. Oil valve not properly balanced.	c. Balance oil valve with control units removed. (See paragraph d, (3), *(d)*.) Replace control unit and check.
	d. Unbalanced air pick-off in control unit.	d. Remove control unit and determine if control speed is equal in both directions with equal pressure applied to either side of air relay. If so, this indicates trouble in the control unit. Repair or replace.
11. Lagging control in both directions.	a. Speed control valves closed too much.	a. Open valves.
	b. Oil pressure too low.	b. Reset oil pressure regulator.
	c. Oil supply choked.	c. Check oil lines, suction lines, and oil filter. Clean oil filter if necessary.
	d. Vacuum too low.	d. Adjust suction regulator to four in. mercury pressure.
	e. Servo relief valve set too low.	e. Reset *(See paragraph l,* (3), *(e)*.)
12. Control in one direction only.	a. Dirty balanced oil valve.	a. Free and clean valve.
	b. Air leak at air pick-off grommet between control unit and mounting bracket.	b. Install new grommet and then check.
	c. Follow-up cables or tubing reversed.	c. Connect according to control or tubing diagrams.
13. Controls move to extreme position when automatic pilot is turned "ON."	a. Reversed connections between balanced oil valve and servo.	a. Check with diagram and correct.
	b. Follow-up direction reversed.	b. Correct.
14. Reversed control. (Control moves in wrong direction in response to knob movement.)	a. Reversed follow-up plus reversed connections between balanced oil valve and servo.	a. Check with diagram and correct.
	b. Reversed follow-up cable.	b. Correct according to diagram.

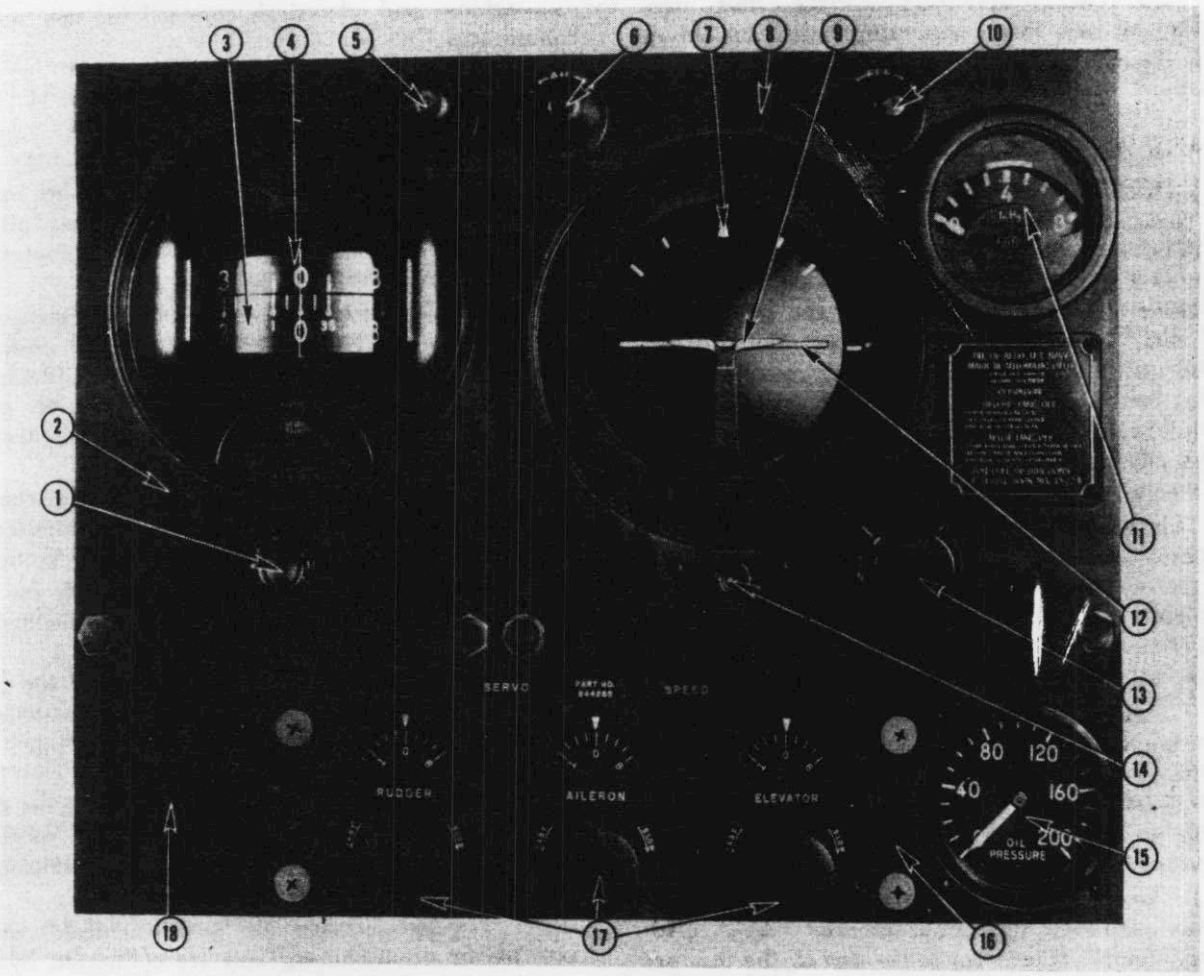
b. DIRECTIONAL GYRO CONTROL UNIT.

(1) DESCRIPTION. *(See figure 185.)*—This unit (F. S. S. C. No. 88-U-165) is used for directional control, both manual and automatic. It contains a directional gyro, air pick-offs, a clutch plate to connect to the rudder follow-up pulley, lighting circuit contacts, and a dial containing two knobs, one for setting the desired heading of the airplane and the other for caging the gyro. The dial consists of an upper or follow-up card attached to the air pick-offs and a lower or directional gyro card which is attached to the gyro. The follow-up card can be set by means of the rudder knob. The directional gyro card can be set to any heading by pushing and turning the caging knob.

When the airplane is flying on the set course, the air pick-offs are in neutral and there is no difference in pressure across the two air relay connections to the rudder balanced oil valve. As soon as a change of direction occurs, the gyro operates the air pick-offs, causing a difference in pressure across the two air relay connections. This pressure difference operates the rudder balanced oil valve.

To change course during flight, the rudder setting knob, located on the upper right-hand corner of the face of the unit, is operated to turn the follow-up card. The airplane will then turn until the directional gyro card coincides with the follow-up card.

The setting and caging knob for the directional gyro is located at the bottom of the instrument. A



No.	PART No.	NAME	No.	PART No.	NAME
1		Caging Knob	10		Elevator Knob
2	88-U-165	Directional Gyro Control Unit	11		Suction Gage
3		Directional Gyro Card	12		Horizon Bar
4		Rudder Follow-Up Card	13		Caging Knob
5		Rudder Knob	14		Miniature Airplane Adjusting Knob
6		Aileron Knob			
7		Banking Scale	15	88-G-855	Oil Pressure Gage
8	88-U-110	Bank and Climb Gyro Control Unit	16		Plate
			17	88-V-180	Speed Control Valves
9		Miniature Airplane	18		Plate

Items number 2, 8, 15 and 17 are Federal Standard Stock Catalogue part numbers.

Figure 185—Automatic Pilot

ball bank indicator is also provided on the face of the instrument.

The directional gyro unit is carried in the mounting unit along with the bank and climb gyro control unit. Its operational limits are 55 degrees in climbing, 55 degrees in diving, and 55 degrees in banking.

(2) REMOVAL.—Remove the two bolts at the bottom of the instrument, and slide unit out of tracks on mounting unit.

(3) MAINTENANCE.

(a) Keep the instrument clean.

(b) Keep electrical connections clean with crocus cloth.

(c) Keep mounting bolts tight.

(d) Replace instrument if:

1. The cover glass is cracked or broken.

2. There is excessive drift of the directional gyro card.

3. Setting knobs fail to turn, or turn hard.

(4) INSTALLATION. — Place unit into the mounting unit and insert mounting bolts. All tubing and the electrical connections are automatically completed.

c. BANK AND CLIMB GYRO CONTROL UNIT.

(1) DESCRIPTION. *(See figure 185.)*—This unit (F. S. S. C. No. 88-U-110) is used for lateral and longitudinal control by manual or automatic means. It contains a gyro, mounted with its axis vertical, as the sensitive element. On the face of the unit are located a dial, caging knob, suction gage, miniature airplane adjusting knob, and an aileron setting knob. The dial contains an artificial horizon bar, a miniature airplane, a banking scale, an elevator follow-up index, an aileron follow-up index, a banking index, and an elevator alignment index.

This unit operates similarly to the directional gyro control unit in that the gyro operates the aileron or elevator air pick-offs, depending on the position of the airplane, causing a difference in pressure in the respective air relay connections, and thus operating the respective balanced oil valves.

The position of the airplane is indicated on the face of the unit by the miniature airplane which is fixed with respect to the airplane. When the airplane banks, climbs, or dives, the miniature airplane indicates this with respect to the artificial horizon, which is controlled by the gyro.

To operate the unit manually to perform a particular maneuver, the knobs marked "AIL" (Aileron) and "ELE" (Elevator) at the top of the unit are turned to operate the respective alignment indices. This will cause the airplane to bank, climb, or dive, depending on the setting of the indices, until the bank or elevator indices line up with the respective follow-up indices. In order to compensate for load conditions, the miniature airplane can be raised or lowered with respect to the horizon bar by means of the small knob beneath the dial. The caging knob is located to the right of the miniature airplane adjusting knob. The operational limits for this unit are 50° in banking, 50° in climbing, and 50° in diving.

(2) REMOVAL.—Remove the two bolts at the bottom of the instrument and slide unit out of tracks on the mounting unit.

(3) MAINTENANCE.

(a) Keep the instrument clean.

(b) Keep electrical connection clean with crocus cloth.

(c) Keep mounting bolts tight.

(d) Replace instrument if:

1. The cover glass is broken or cracked.
2. The suction gage fails to indicate correctly.
3. Knobs do not turn freely.

(4) INSTALLATION.—Place the unit in the mounting unit and insert the two mounting bolts. All tubing and electrical connections are automatically completed.

d. MOUNTING UNIT.

(1) DESCRIPTION. *(See figure 186.)* — The mounting unit (F. S. S. C. No. 88-U-700) consists of a frame to which air relays, follow-up pulleys, balanced oil valves, and pressure and drain oil manifolds are attached. The proportional bank adapter is also attached to the mounting unit.

The mounting unit is also the support for the control units (directional gyro control unit, and bank and climb gyro control unit) which slide in place on tracks. All electrical, mechanical, and air connections are established when the control units are bolted in place.

The mounting unit is installed in the center of the pilot's instrument panel and is mounted on four shock mounts which provide protection from vibration.

The follow-up pulleys, to which the follow-up cables are attached, are provided with clutches which carry their motion to the control units.

All air intake connections both for the air relays and the gyros are connected to the suction manifold, permitting the entire automatic pilot system to be connected through one air filter. The interaction of the pick-offs and the air relays causes the diaphragm to move the pistons in the balanced oil valves, thereby opening and closing their ports and causing the hydraulic oil to operate the servo unit.

The pressure and drain manifolds on the bottom of the mounting unit are connected by tubing to the three balanced oil valves and serve to distribute pressure oil to, and collect drain oil from these valves. They provide a junction between the flexible oil lines from the mounting unit and the rigid oil lines to the servo unit.

(2) REMOVAL. *(See figure 186.)*—The mounting unit (1) and the proportional bank adapter (4) are removed as a unit. To remove:

(a) Remove the directional gyro control unit and the bank and climb gyro control unit as outlined in foregoing paragraphs *b,* (2) and *c,* (2).

(b) Remove the servo speed control valves as outlined in paragraph *f,* (2).

(c) Disconnect the follow-up cables (5), (6), (7) and (8) from the spring loaded follow-up pulleys (3) and (13).

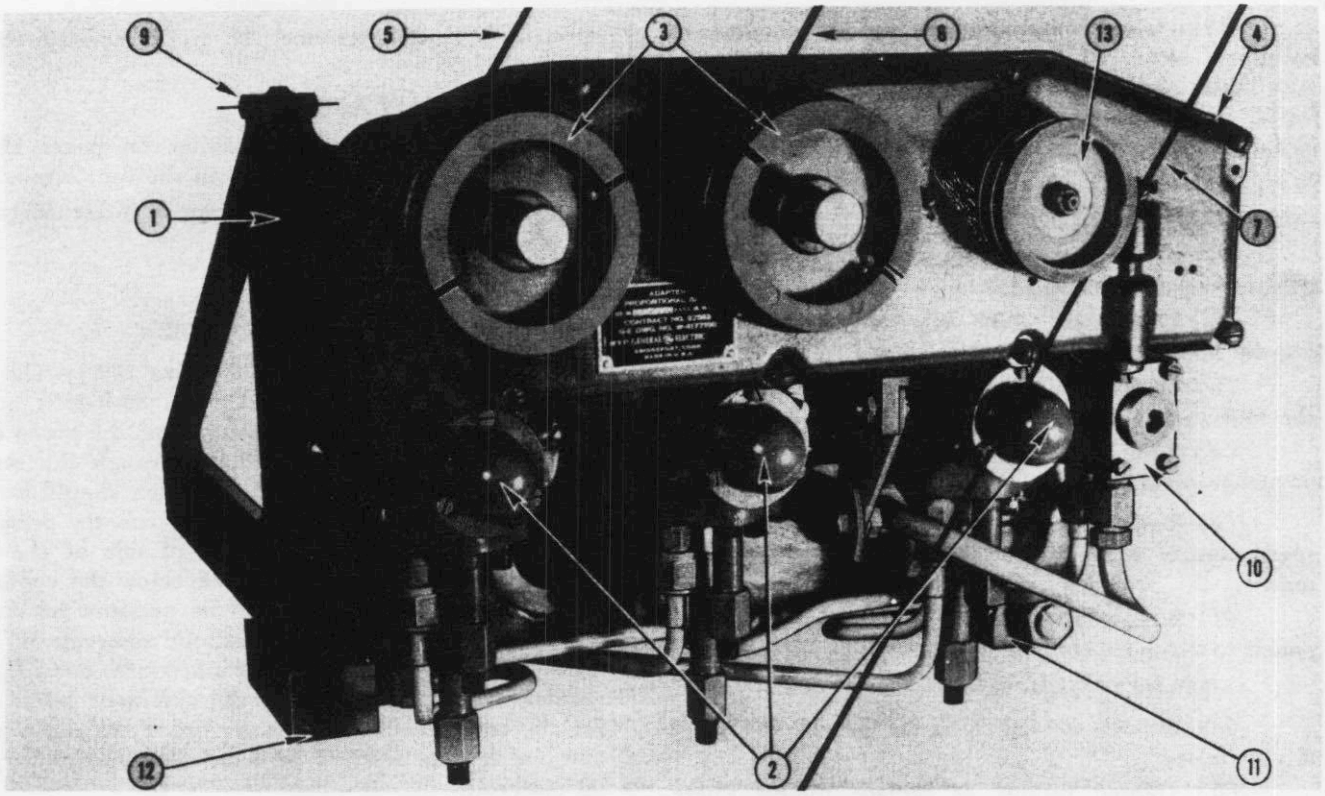
(d) Disconnect the six hydraulic lines from the three balanced oil valves (2).

(e) Disconnect the flexible hose from the pressure (12) and drain manifolds (11).

(f) Disconnect tubing attaching suction manifold (10) to the air filter.

(g) Remove the screws which hold the shock mounts (9) to their supporting brackets, leaving the shock mounts attached to the mounting unit.

(h) Lift the mounting unit from its support.



No.	PART No.	NAME
1	88-U-700	Mounting Unit
2		Balanced Oil Valves
3		Follow-Up Pulley
4	88-A-210	Proportional Bank Adapter
5	*28C5592-2 **Q6302-C-204	Elevator Follow-Up Cable
6	*28C5592-0 **Q6302-C-198	Aileron Follow-Up Cable
7	Q6302-DLDR-155½	Rudder Follow-Up Cable
9	142020	Shock Mounts
10		Suction Manifold
11		Drain Manifold
12		Pressure Manifold
13		Follow-Up Pulley

Items No. 1 and 4 are Federal Standard Stock Catalog part numbers.
Item No. 9 is a Sperry Gyroscope Co. part number.

*PBY-5A airplanes serial numbers 46580 and on.
**PBY-5 and PBY-5A airplanes up to serial number 46580.

Figure 186—Automatic Pilot Mounting Base and Equipment

(3) MAINTENANCE.

(a) Inspect all tubing and fittings including flexible hoses. Tighten or replace fittings or tubing where necessary to stop leaks. Replace any flexible hoses showing signs of seepage at connections or pimples on surface of hose.

(b) Check follow-up pulleys on mounting unit with gyro control units removed, and lubricate springs, if dry. Use oil (Specification AN-VV-O-446).

(c) Replace defective or worn shock mounts.

(d) The adjustment and centralizing of the balanced oil valves require special tools and equipment and should not be attempted except by specially trained personnel at an authorized base.

(4) INSTALLATION.—To install mounting unit, reverse removal procedure outlined in above paragraph *d*, (2).

e. VACUUM RELIEF VALVE.
(See Par. 19, *e*, (4).)

f. SERVO SPEED CONTROL VALVES.

(1) DESCRIPTION. *(See figure 185.)*—The speed control valves (F. S. S. C. No. 88-V-180) serve to control the rate of flow of oil from each servo cylinder to the pump, and thereby to control the rate of response of each servo. The speed valve assembly consists of three identical units, one for rudder, one for aileron, and one for elevator control.

These units are mounted as one and are attached to the lower center of the automatic pilot mounting unit by means of screws. The face of the speed control valves is flush with the automatic pilot instrument panel face. The numbers on the valve dials represent turns of the valve.

(2) REMOVAL.

(a) Check to make certain that all hydraulic pressure has been relieved.

(b) Disconnect tubing to each valve by removing the nut attaching the sleeve and elbow.

(c) Unscrew flexible hose which is connected to the four-way valve.

(d) Remove the oil pressure gage as outlined in paragraph *h*, (2).

(e) Remove the three screws attaching the speed control valves to the automatic pilot mounting unit.

(f) Remove the four screws attaching the two panels to the speed control valves.

(3) MAINTENANCE.

(a) Inspect all tubing and fittings including flexible hose.

(b) Tighten fittings or replace tubing where necessary to stop leaks.

(c) Replace any flexible hose showing signs of seepage at connections or pimples on surface of hose.

(d) The construction of the speed control valves is such that there is little chance of internal wear. In case of failure, no repairs should be made except by specially trained personnel at an authorized repair base.

g. HYDRAULIC PUMP.
(See Par. 21, *b*, (2).)

h. OIL PRESSURE GAGE.

(1) DESCRIPTION. *(See figure 185.)*—The oil pressure gage (F. S. S. C. No. 88-G-855) indicates the pressure at which oil is being supplied to the automatic pilot. This gage is a direct indicating pressure gage with readings from 0 to 200 lb/sq in.

The oil pressure gage is installed below the automatic pilot mounting unit, on the starboard side of the servo speed control valves.

(2) REMOVAL.

(a) Check to make certain that all hydraulic pressure has been relieved.

(b) Disconnect the tubing connected to the gage.

(c) Remove the four bolts attaching the gage to the panel.

(3) MAINTENANCE.

(a) No lubrication is required.

(b) No repair should be attempted except by specially trained personnel at an authorized repair base.

(4) INSTALLATION.

(a) Attach gage in position on panel below automatic pilot mounting unit with the four screws.

(b) Connect tubing to rear of pressure gage.

i. VACUUM PUMP.
(See paragraph 19, *e*, (2).)

j. OIL PRESSURE REGULATOR.

(1) DESCRIPTION. *(See figure 187.)*—The oil pressure regulator (F. S. S. C. No. 88-R-255) automatically regulates the oil pressure from the pump and permits the excess oil to circulate through the reservoir. It is an adjustable regulator which should be set at 150 lb/sq in. On the PBY-5A airplanes, the pressure regulator is mounted on the inboard side of the hydraulic platform, outboard of and below the copilot's seat. On the PBY-5 airplanes, the pressure regulator is mounted on top of the hydraulic reservoir in the starboard nacelle. It has three connections; one for the regulated oil pressure line to the automatic pilot, one for the unregulated oil pressure line from the pump, and one for the overflow oil from the regulator to the oil reservoir.

(2) REMOVAL AND DISASSEMBLY.
(See figure 187.)

(a) Remove oil pressure regulator as follows:

1. Check to make certain that all hydraulic pressure has been relieved.

2. Disconnect the three lines at the unit.

3. Cover openings in lines with tape.

4. Cover ports in oil pressure regulator with tape.

5. Remove the three bolts which attach the regulator to the hydraulic platform on the PBY-5A airplanes or to the reservoir on the PBY-5 airplanes.

(b) Disassemble oil pressure regulator as follows:

1. Using a 7/16 inch wrench, remove the three castellated nuts (1) from the end of the unit.

2. The pressure regulator cover (2) will be pushed free by the internal spring (3).

3. The spring (3), piston (4), and sealing ring (5) may then be withdrawn.

Note

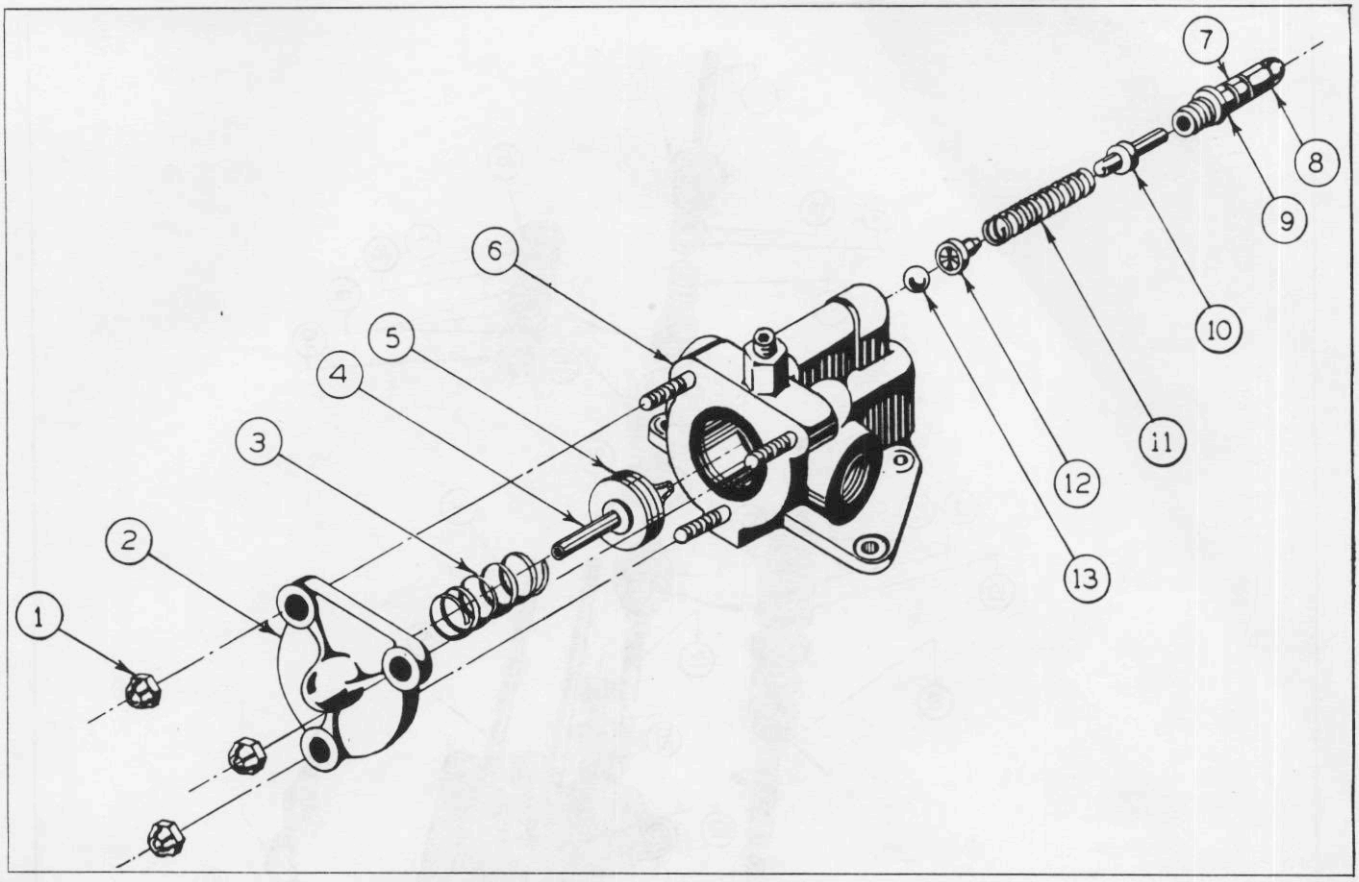
Do not attempt to remove the piston seat.

4. Using a 7/16 inch wrench, remove the retainer adjusting screw (9).

5. The control valve spring (11), spring seat (10), spring retainer (12), and ball (13) may then be removed.

(3) MAINTENANCE.

(a) When the regulator is disassembled, wash all parts thoroughly in cleaning solvent and blow dry.



No.	PART No.	NAME	No.	PART No.	NAME
1	170040	Castellated Nuts	8	170036	Acorn Nut
2	170038	Cover	9	170034	Adjusting Screw
3	170098	Spring	10	170032	Spring Seat
4	170027	Piston	11	170099	Spring
5	170039	Sealing Ring	12	170031	Spring Retainer
6	76585	Body	13	170030	Ball
7	170101	Locknut			

All items are Sperry Gyroscope Co. part numbers.
Part number of complete assembly is F.S.S.C. No. 88-R-255.

Figure 187—Oil Pressure Regulator

(b) Examine the parts carefully for any sign of corrosion or damage.

(c) The ball (13) in the adjusting valve must be free from any corrosion or scratches.

(d) Make sure that the sealing ring (5) is in good condition. Replace if necessary.

(e) The piston (4) must fit freely in the pressure regulator body (6) and cover (2). It is important that the small hole near the outer diameter of the piston is clean and unobstructed.

(f) The adjustment of the pressure regulator is accomplished by the tightening or loosening of a spring weighted valve. The adjusting screw (9) is beneath an acorn nut (8) on the upper end of the regulator. To change the pressure adjustment, remove the acorn nut and insert a screw driver into the opening; turn the screw in to raise the pressure, or out to lower the pressure. The regulator may be adjusted by removing it from the airplane and using a test stand, or by running the automatic pilot with the plane grounded, and adjusting according to the oil pressure gage on the automatic pilot panel. This may be done by either running the engine, or by detaching the hydraulic lines to the engine-driven pump, and connecting directly to a test stand.

(4) ASSEMBLY AND INSTALLATION.—To assemble and install the oil pressure regulator, reverse procedure outlined in foregoing paragraph j, (2), making sure that the retainer adjusting screw (9) and the castellated nuts (1) are set up tightly.

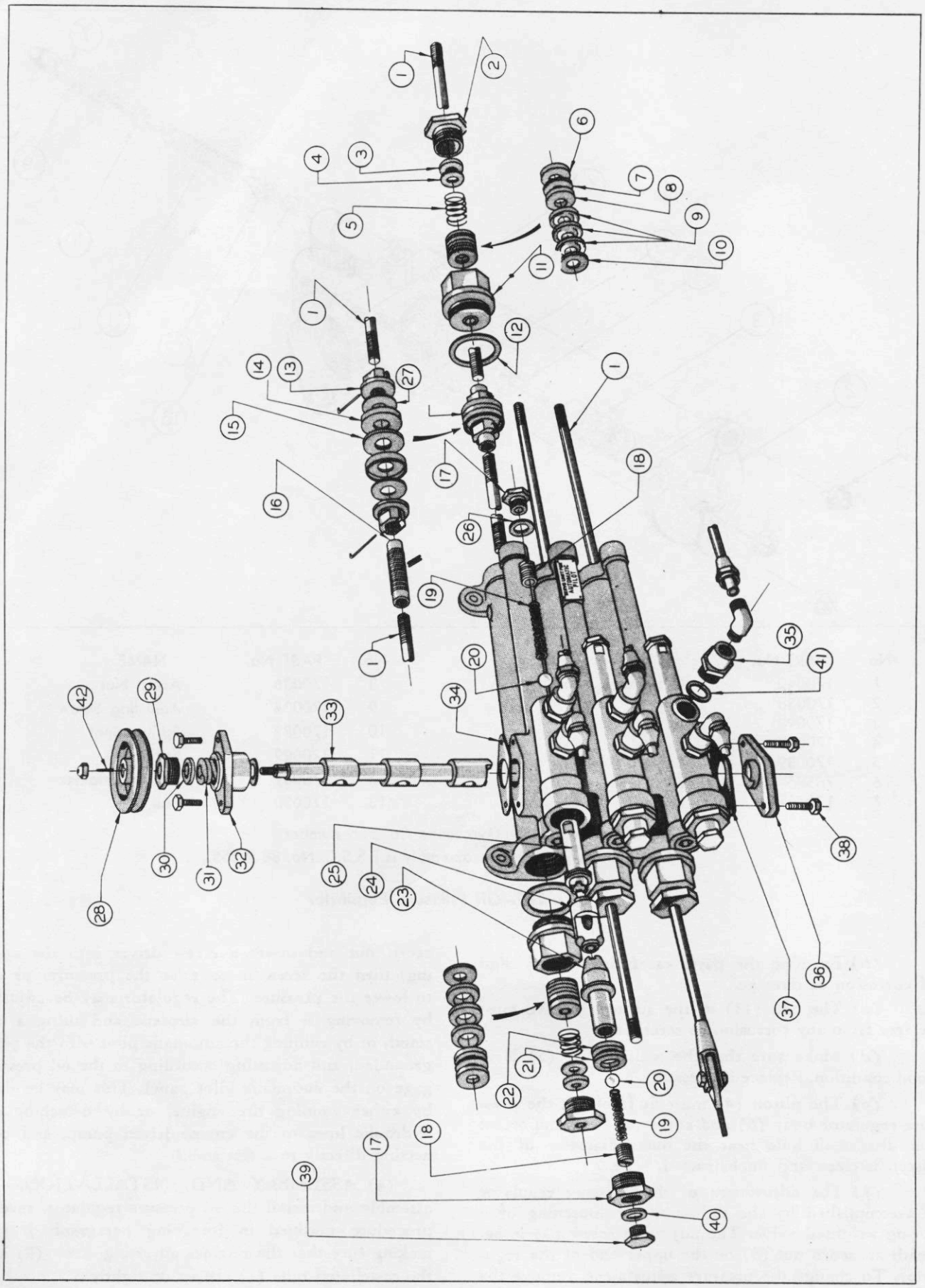


Figure 188—Servo Unit

No.	PART No.	NAME
1	171022	Piston Rod
2	144830	Cylinder Gland Nut
3	144831	Felt Washer
4	146085	Washer
5	146086	Spring
6	170519	Spacer
7	170385	Neoprene Washer
8	168946	Outer Seal Ring
9	183701	Seal Leathers
10	168944	Inner Seal Ring
11	170511	Packing Nut
12	144826	Gasket
13	144824	Piston Nut
14	144822	Piston Leathers
15	144821	Piston Spacer
16	145611	Piston Rod Connector Barrel
17	168954	Valve Nut
18	168956	Spring Adjusting Screw
19	168955	Valve Spring
20	200576	Ball
21	168952	Seal Ring
22	168951	Valve Packing
23	168950	Front Overpower Valve Body
24	168949	Valve Seat
25	168947	Rear Overpower Valve Body
26	168958	Gasket
27	144823	Thrust Washer
28	142856	"On-Off" Pulley
29	144816	Valve Gland Nut
30	144814	Gland Ring
31	⅛ Dia. x 5½ Mogul	Packing
32	144812	Valve Flange
33	144811	"On-Off" Valve
34	144815	Gasket
35	172929	Servo Connecting Fitting
36	144813	Stop Valve Flange
37	144815	Gasket
38	157468	Screw
39	168957	Valve Seal Screw
40	168958	Gasket
41	144795	Gasket
42	3/32 in. sq. by ⅜ in. B.T.S.	Key

All items are Sperry Gyroscope Co. part numbers.

k. OIL FILTER.

(1) DESCRIPTION.—The oil filter (F. S. S. C. No. 88-F-1060) provides a means of maintaining a flow of clean oil through the hydraulic system. The filter is located on the aft port side of bulkhead 1 just forward of the rudder pedals. It is installed in the hydraulic line and removes foreign matter from the fluid flowing through the system. The filter element can be removed for cleaning without disconnecting any of the tubing or fittings.

(2) REMOVAL.

(a) Make certain that there is no oil pressure in the lines attached to the filter.

(b) Disconnect the two hydraulic lines from the top of the filter body.

(c) Remove the two nuts which hold the unit to the bracket. If desired, the filter element may be removed before removing the housing by unscrewing the bowl nut which holds it to the housing.

(3) MAINTENANCE.—Remove filter element, clean in gasoline, and replace. Filter should be cleaned every 100 hours.

(4) INSTALLATION.

(a) Place the filter housing against the mounting bracket and insert the two mounting bolts. Tighten evenly.

(b) Connect the two oil lines at the top of the unit.

l. SERVO UNIT.

(See figure 188.)

(1) DESCRIPTION.—The servo unit (F. S. S. C. No. 88-S-270) is located on the port side of the airplane between station 3.33 and station 3.66. For the purpose of catching any oil dripping from the servo, an oil pan is installed under the servo. The servo unit is made up of three cylinders cast in one block with piston rod assemblies extending from each end of the pistons. When fluid is admitted to the cylinders by the balanced oil valves, the pistons operate the airplane control surfaces through the control cables which are attached to the piston rod ends.

This unit can be placed in operation or shut off by means of a by-pass valve consisting of a triple type plug cock which serves all three cylinders. Rotation of this cock is accomplished by means of a pulley fixed to one of its ends, while its motion is limited by a stop at the opposite end. The pulley is connected by a cable to the "ON"-"OFF" control lever. *(Refer to paragraph r.)*

Each of the cylinders is equipped with two adjustable spring loaded relief valves which allows the human pilot to overpower the automatic pilot by applying increased force to the controls.

(2) REMOVAL.

(a) Check to make certain that all hydraulic pressure has been relieved.

(b) Remove the servo unit oil pan by detaching the five bolts in the back of the pan and the four bolts in front which hold it in place.

(c) Loosen the elevator, rudder, and aileron cable turnbuckles and disconnect the follow-up and main cables from the piston rods by removing the special eye bolt in the end fittings.

(d) Remove the hydraulic lines from the servo unit and plug or tape all open ends of the lines.

(e) Remove "ON"-"OFF" cable by removing "ON"-"OFF" pulley from servo unit.

(f) Detach the four bolts which hold the unit to the mounting brackets and remove unit.

(3) MAINTENANCE.

(a) If leaks are found at the joints of the oil lines, tighten the fittings. If leakage continues, replace tubing and fittings. If leakage occurs at the piston rods, tighten the packing nuts. Do not tighten these nuts excessively as this will produce binding on the piston rods.

(b) If leaking still occurs at servo pistion rods, install new packing as follows:

1. Remove cylinder gland nut (2), felt washer (3), washer (4), and spring (5). *(See figure 188.)*

2. Remove packing washers and seals (6), (7), (8), (9) and (10) and replace with new parts.

3. Assemble by reversing above procedure.

(c) Drain the hydraulic fluid, flush out the system, and refill the tank every 240 to 250 hours.

(d) Lubricate the follow-up clevis pin guide slot on the servo unit if necessary. Use oil (Specification AN-O-6).

(e) Adjust the servo relief valves. Set these valves so that they will open to permit the human pilot to overpower the automatic pilot without applying excessive force, but so that they will not open during normal flight conditions in smooth or rough air. The best setting is usually between 75 and 100 per cent automatic pilot operating pressure. Adjust servo relief valves as follows:

1. Run the engines at approximately 1000 rpm; set the automatic pilot control lever to "ON"; align the gyro cards and indices; and be sure that the vacuum and oil pressures are normal.

2. Remove the hexagonal nuts from the overpower valve bodies adjacent to the end of the unit at which the greatest length of rod extends.

3. Insert a screw driver in the valve body and turn each servo relief valve adjustment screw clockwise until it is all the way in.

4. Adjust the oil pressure regulator of the automatic pilot to the pressure which is desired for opening the servo relief valve.

5. Rotate the automatic pilot control knob of the control being adjusted until the control surface has reached its top. Rotate the control knob beyond this point until the indices are approximately 10 degrees apart.

6. Disconnect the servo line which is not under pressure (this is the line nearest the end of the servo unit toward which the piston is moving). Place the end of this line in an empty container.

7. Unscrew the proper servo relief valve adjustment screw until oil begins to flow from the disconnected line. At this point, the servo relief valve setting will be the same as the oil gage indication.

8. Re-connect the servo line and rotate the automatic pilot control knob to move the control surfaces hard over against the opposite stop. Continue rotating the control knob beyond this point until the follow-up indices are approximately 10 degrees apart. Disconnect the opposite servo connections and adjust the other relief valve for the same servo cylinder in the manner just described.

(f) Remove air from the servo unit as follows:

1. Set the automatic pilot control lever to "ON" and be sure that the hydraulic pressure is normal.

2. Operate the engines at approximately 1000 rpm.

3. Center the controls and align the follow-up indices.

4. Move the manual controls through their complete length of travel from hard over in one direction to hard over in the opposite direction.

5. Hold each control in its hard over position until the hydraulic fluid has had time to circulate completely through the system. This will usually require about 20 or 30 seconds.

6. Repeat this operation two or three times to allow the hydraulic fluid to push the air into the main reservoir where it can escape.

7. Move the control lever to its "OFF" position.

(4) INSTALLATION.

(a) Place the servo unit on its mounting bracket; insert the four bolts in the mounting lugs; and then tighten them evenly.

(b) Put the by-pass valve cable on the pulley and adjust the turnbuckle to the proper tension.

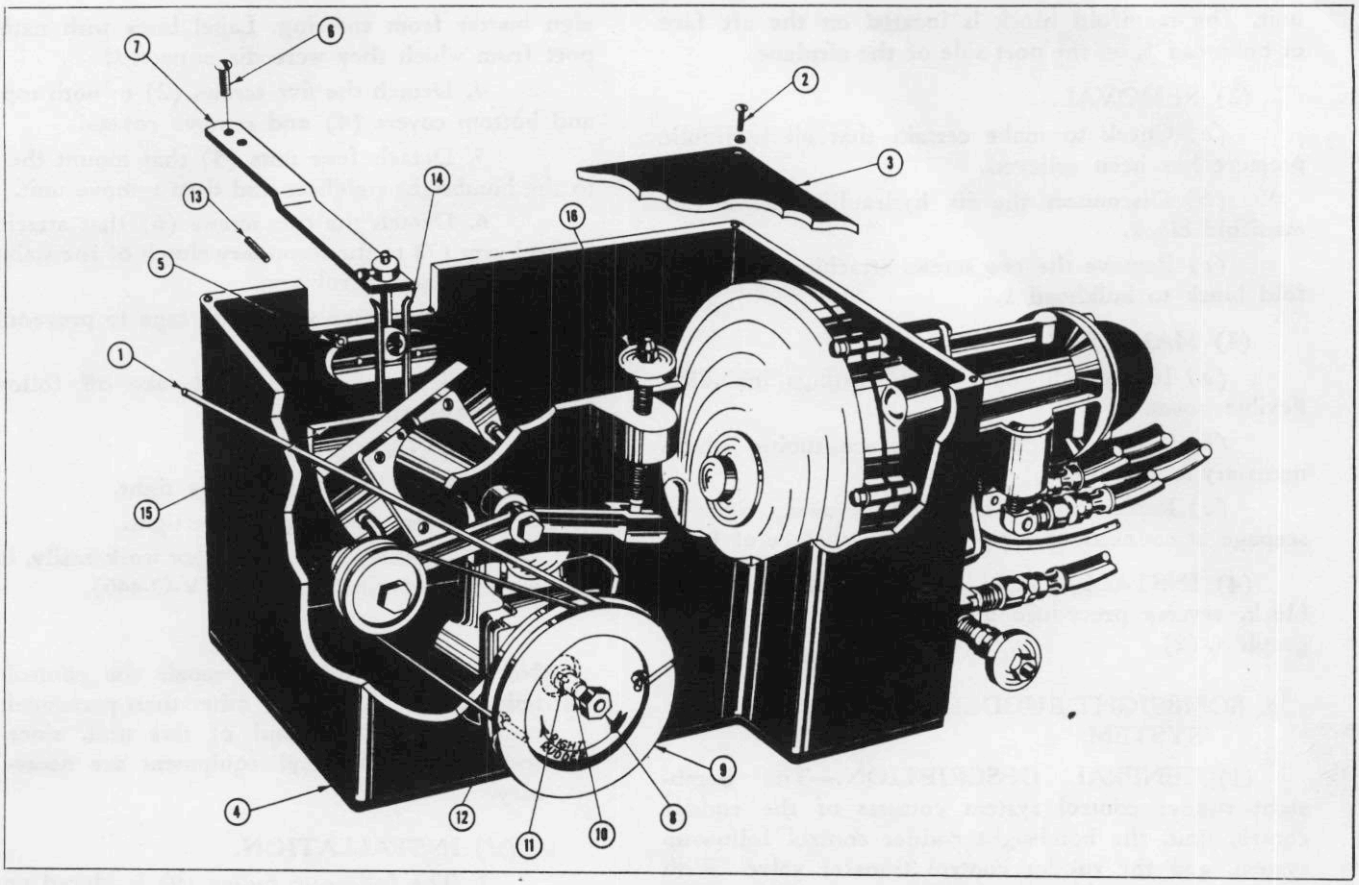
(c) Attach the main surface control cables and the follow-up cables to the piston rod end fittings by installing the special eye bolts and adjust the turnbuckles to give the proper tension.

(d) Connect the the hydraulic lines and tighten them evenly.

(e) Attach the servo unit oil pan in place by means of the five bolts in the back and the four bolts in the front end of the pan.

m. OVERFLOW RESERVOIR.

(1) DESCRIPTION.—The overflow reservoir is an aluminum alloy tank used to collect fluid seepage from the automatic pilot, bombsight control unit, and rudder transfer valve. The sump pump draws the fluid from the reservoir and returns it to the system by way of the fluid return line. The overflow reservoir is located on the forward face, port side of bulkhead 1 on the PBY-5A airplanes and on the aft face, port side of bulkhead 1 on the PBY-5 airplanes. It is held in position by two clamps.



No.	PART No.	NAME	No.	PART No.	NAME
1	28C5133-12	Follow-Up Cable	9	88-P-1084	Follow-Up Pulley
2	289009	Screw	10	288365	Pick-Off Body Shaft
3	289027	Top Cover	11	288983	Coil Spring Pin
4	288989	Bottom Cover	12	288978	Pin
5	AN340-G	Nut	13	No. 6-32	Mounting Studs
6	AN500-B4-4	Screw	14	289020	Blade Yoke
7	288980	Control Arm	15	288357	Pick-Off Blade
8	AN315-3R	Nut	16	288995	Centering Adjustment Screw

All part numbers are Weatherhead Co. part numbers excepting items 1, 5, 6, 8, 9, and 13.
Item No. 9 is a Federal Standard Stock Catalog part number.

Figure 189—Bombsight Rudder Control Unit

(2) REMOVAL.

(a) Check to make certain that all hydraulic pressure has been relieved.

(b) Disconnect the two hydraulic lines.

(c) Remove the four screws attaching the clamps to bulkhead 1.

(3) MAINTENANCE.—Inspect all tubing and fittings. Tighten fittings or replace tubing where necessary to stop leaks.

(4) INSTALLATION.—To install overflow reservoir, reverse removal procedure outlined in foregoing paragraph *m*, (2).

n. AIR FILTER.
(See Par. 19, *e*, (8).)

o. MANIFOLD BLOCK.

(1) DESCRIPTION.—The manifold block (F. S. S. C. No. 88-M-62) provides a junction between the flexible hydraulic lines from the mounting unit, which is shock mounted, and the rigid lines to the servo

unit. The manifold block is located on the aft face of bulkhead 1, on the port side of the airplane.

(2) REMOVAL.

(a) Check to make certain that all hydraulic pressure has been relieved.

(b) Disconnect the six hydraulic lines at the manifold block.

(c) Remove the two screws attaching the manifold block to bulkhead 1.

(3) MAINTENANCE.

(a) Inspect all tubings and fittings including flexible hoses.

(b) Tighten fittings or replace tubing where necessary to stop leaks.

(c) Replace any flexible hose showing signs of seepage at connections, or pimples on surface of hose.

(4) INSTALLATION. — To install manifold block, reverse procedure outlined in foregoing paragraph *o*, (2).

p. BOMBSIGHT RUDDER CONTROL SYSTEM.

(1) GENERAL DESCRIPTION.—The bombsight rudder control system consists of the rudder control unit, the bombsight rudder control follow-up system, and the rudder control transfer valve. With this system, the airplane may be controlled by the bombsight when on a bombing run.

By means of the rudder transfer valve, the rudder servo can be connected by either the bombsight rudder control unit or the directional control unit in the automatic pilot.

The bombsight rudder control follow-up system is described in paragraph *s*, and the rudder control transfer valve in paragraph *w*. A description of the control unit is outlined below.

(2) BOMBSIGHT RUDDER CONTROL UNIT.

(a) DESCRIPTION. *(See figure 189.)*—The bombsight rudder control unit (F. S. S. C. No. 88-C-1425), which is operated by the secondary clutch arm of the bombsight stabilizer, consists essentially of an air pick-off, an air relay, and a balanced oil valve. The air pick-off is controlled by the secondary clutch arm extension and operates the air relay. The air relay then operates the balanced oil valve which controls the flow of oil to the rudder servo. With the secondary arm clutched in, the airplane will remain on the course fixed by the bombsight stabilizer.

(b) REMOVAL.

1. Disconnect the follow-up cable (1) by removing it from slot in pulley (9).

2. Disconnect the six flexible hoses from the unit.

3. Close open lines with tape to prevent foreign matter from entering. Label lines with name of port from which they were disconnected.

4. Detach the five screws (2) in both top (3) and bottom covers (4) and remove covers.

5. Detach four nuts (5) that mount the unit to the bombsight stabilizer and then remove unit.

6. Detach the two screws (6) that attach the control arm (7) to the secondary clutch of the stabilizer and remove the control arm.

7. Close open ports with tape to prevent foreign matter from entering.

8. Remove nut (8) and take off follow-up pulley (9) and spring.

(c) MAINTENANCE.

1. Keep hose connections tight.

2. Keep mounting screws tight.

3. If pulley spring does not work easily, lubricate with oil (Specification AN-VV-O-446).

CAUTION

No attempt to adjust or repair the control unit should be made by other than personnel trained in the overhaul of this unit, since special procedure and equipment are necessary.

(d) INSTALLATION.

1. The follow-up pulley (9) is placed on the shaft (10) with pin (11) inserted into the loop of the pulley spring, and the pulley slot pushed over the shaft pin (12). A lock washer and nut (8) are then tightened down on the pulley. The pulley spring should be wound to approximately the mid-position of its effective range, with the follow-up control arm (7) vertically upward.

2. Insert the four studs (13) in the four tapped holes on the port side of the stabilizer.

3. With top and bottom cover removed, install the unit onto the studs and fasten it with the four nuts (5).

4. Fasten the control arm (7) to the secondary clutch of the stabilizer with the two screws (6). The ball fitting must lie between the spring blade yoke (14).

5. Connect the four hydraulic pressure lines, one drain line, and one vacuum line to the proper ports in the unit.

6. Attach the follow-up cable (1) as outlined in paragraph *s*, (4), *(d)*. At the time the cable is attached, the follow-up control arm (7) must be vertically upward, with the rudder and servo in neutral position. The pulley must rotate clockwise when right rudder is applied.

7. Attach the top (3) and bottom (4) covers with five screws (2).

(e) ADJUSTMENT.—For best control in straight course flight, the radius of the follow-up arm (7) may be varied by moving the follow-up pin (12).

The knife edge (15) must cover both air pick-off ports when the system is in neutral. To obtain this relationship, either the centering adjustment (16) may be used or the ball in the control arm (7) may be moved, or both. This adjustment should be attempted only by experienced personnel.

q. PROPORTIONAL BANK ADAPTER.

(1) DESCRIPTION.—The proportional bank adapter (F. S. S. C. No. 88-A-210) is an automatic device used to give the airplane the correct amount of bank for any desired turn. It is mounted on the forward side of the automatic pilot in back of the pilot's instrument panel, and forms a part of the automatic pilot installation.

In addition to automatically banking the airplane for any turn, this device also automatically provides "up elevator" during the turn so as to compensate for loss of altitude which would otherwise occur.

The principle of operation is essentially as follows:

When the rudder is moved (in order to make a turn), the rudder follow-up cable moves, causing the rudder shaft in the proportional bank adapter to rotate. This shaft, by being geared to the aileron shaft and also to the elevator shaft in the proportional bank adapter, transmits a certain amount of correction to the elevator and aileron follow-up cables, which in turn move the respective surfaces.

When the aileron and elevator shafts are turned, the elevator and aileron balanced oil valves are either opened or closed as the case may be, depending upon the direction of turn of the airplane. This opening or closing of the balanced oil valves causes oil to flow to the elevator and aileron servos, which thereby control the airplane through the main control cables.

The rudder follow-up cable runs from the forward end of the servo unit to the rudder shaft pulley on the proportional bank adapter. The cable is wrapped around and attached to the pulley by a dab of solder. From here, the cable is routed over an idler pulley located below the proportional bank adapter and then back to the aft end of the servo unit. A follow-up cable coming from the bombsight rudder control is attached to this cable. *(See figure 190.)*

(2) REMOVAL.—The proportional bank adapter is bolted to the forward side of the automatic pilot mounting unit and should not be removed except by personnel at authorized repair bases. For removal of mounting unit, see paragraph *d,* (2).

(3) MAINTENANCE.—If adjustments are necessary on this unit, it should be sent together with the automatic pilot mounting unit to an authorized repair base where special tools necessary for disassembly are available.

(4) INSTALLATION.

(Refer to mounting unit installation, paragraph *d,* (4).)

r. AUTOMATIC PILOT "ON"-"OFF" CONTROL SYSTEM.

(1) DESCRIPTION.—The "ON"-"OFF" control for the servo unit is installed above the pilot's head in the pilot's compartment on the center line of the ship immediately forward of bulkhead 2. The two cables to the "ON"-"OFF" pulley on the servo unit are attached to the handle which pivots in a bracket. The handle has a movement of 60 degrees and is pushed forward to turn the servo "ON," and aft to turn the servo "OFF."

(2) REMOVAL.

(See figure 190.)

(a) Disconnect cables (51) from handle (49) by removing the two bolts holding fork fittings to handle.

(b) Remove handle (49) from bracket (50) by detaching bolt.

(c) Remove pulleys (52), (53), and (54) from their brackets.

(d) Disconnect turnbuckles (58) and remove cables (51).

(3) MAINTENANCE.—For maintenance of cables, see Par. 18, *b,* (3).

(4) INSTALLATION.—To install "ON"-"OFF" control system, reverse removal procedure outlined in foregoing paragraph *r,* (2).

s. FOLLOW-UP CABLE SYSTEM.

(1) DESCRIPTION. *(See figure 190.)*—The follow-up cable system provides a means of removing the applied control of the servo unit as the airplane is returning to its normal attitude so that the control surface will be back in its neutral or centered position when the disturbance has been fully corrected.

The elevator follow-up cable is connected to the forward end of the elevator servo piston rod. From here, it is routed forward over a series of pulleys to the spring loaded elevator follow-up drum on the forward side of the proportional bank adapter in front of the pilot's instrument panel.

The aileron follow-up cable is connected at one end to the aileron servo piston rod, and at the other end to the aileron follow-up drum on the proportional bank adapter in a similar manner as the above-mentioned elevator follow-up cable.

The rudder follow-up cable is, however, routed in a different manner than either the elevator or aileron follow-up cables. This cable is connected at one end to the forward side of the rudder servo rod. From here it is routed forward over a series of pulleys to the rudder follow-up drum on the proportional bank adapter. This drum is not spring loaded as are the elevator and aileron follow-up drums. In order to obtain the return motion on this drum, the cable is wrapped around and fastened to the drum by a dab of solder, and then routed aft over a series of pulleys

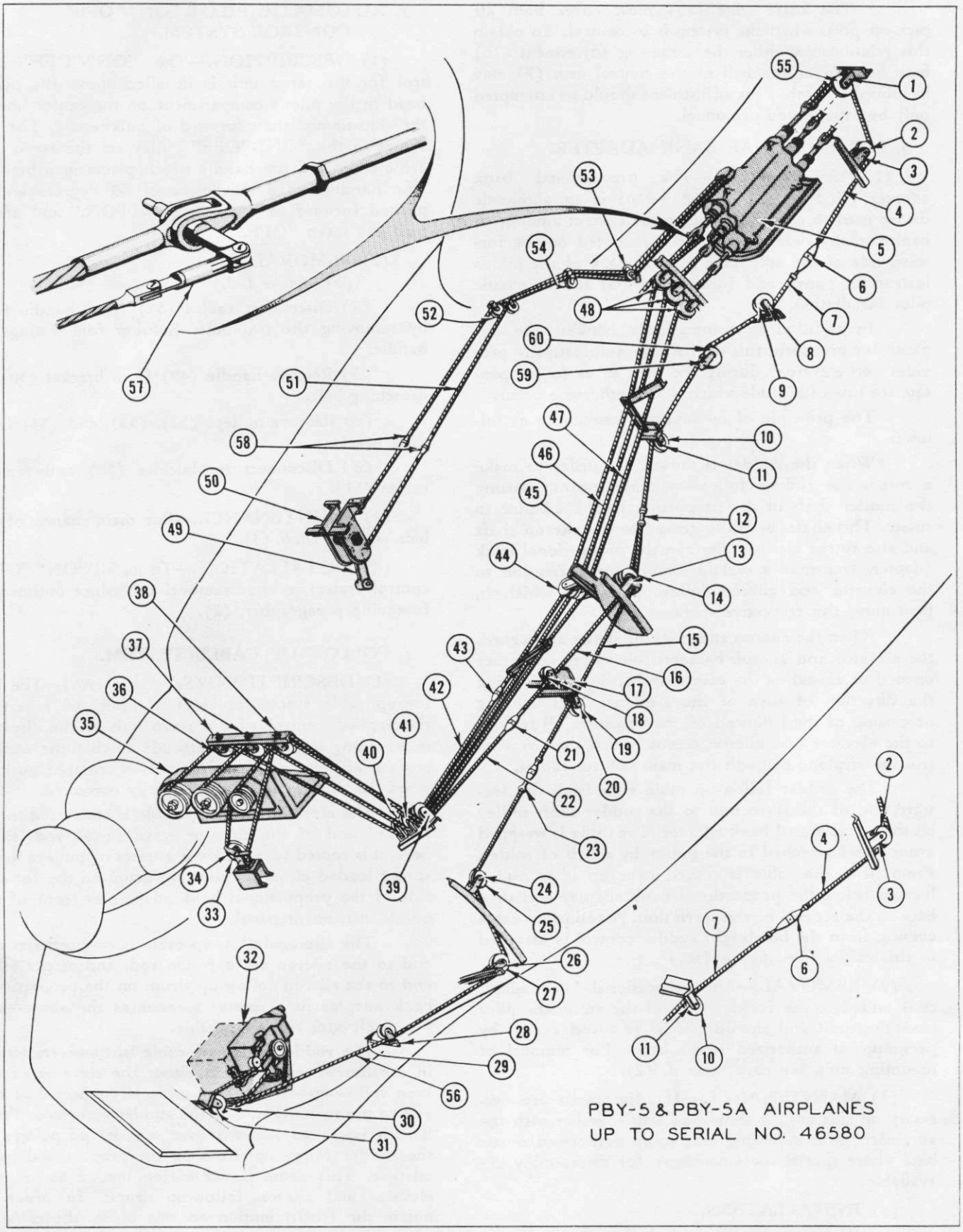


Figure 190—Follow-Up Cable System

No.	PART No.	NAME
1	Q4002-1-1	Bracket
2	AN210-2A	Pulley
3	Q4002-2-1	Bracket
4	*Q6302CDR-57	Rudder Follow-Up Cable
	**Q6302CDR-58⅞	
5	88-S-270	Servo Unit
6	AN155-8S	Turnbuckle
7	*Q6302CDL-74	Rudder Follow-Up Cable
	**Q6302CDL-60	
8	*Q4002-0-1	Bracket
9	*AN210-2A	Pulley
10	*AN210-2A	Pulley
	**AN210-1A	
11	*Q4002-1-1	Bracket
	**Q4001-0-1	
12	28C5105	Splice Plate
13	Q4012-1-1	Bracket
14	AN210-2A	Pulley
15	Q6302CDL-56	Bombsight Rudder Cable
16	Q6302CDR-54	Rudder Follow-Up Cable
17	Q4001-0-1	Bracket
18	AN210-1A	Pulley
19	AN210-1A	Pulley
20	Q4001-0-1	Bracket
21	AN155-8S	Turnbuckle
22	Q6302-DLDR-155½	Rudder Follow-Up Cable
23	AN155-8S	Turnbuckle
24	Q4002-2-3	Bracket
25	AN210-2A	Pulley
26	Q4002-2-3	Bracket
27	AN210-2A	Pulley
28	Q4001-1-1	Bracket
29	AN210-1A	Pulley
30	AN210-2A	Pulley
31	Q4002-2-1	Bracket
32	88-C-1425	Bombsight Rudder Control Unit
33	AN210-2A	Pulley
34	Q4002-2-1	Bracket
35	88-A-210	Proportional Bank Adapter
36	AN210-2A	Pulley
37	Q4002-2-1	Bracket
38	Q4012-2-1	Bracket
39	Q4012-2-1	Bracket
40	AN210-2A	Pulley
41	Q4002-2-1	Bracket
43	AN155-8S	Turnbuckle
44	AN210-1A	Pulley
45	*Q6302CDL-97¾	Rudder Follow-Up Cable Assy.
	**Q6302CDL-105	
46	*28C5592-0	Aileron Follow-Up Cable Assy.
	**Q6302-C-198	
47	*28C5592-2	Elevator Follow-Up Cable Assy.
	**Q6302-C-204	
48	AN210-1A	Pulley
49	28C1060	Handle Assembly
50	28C1006-2	Bracket
	28C1006-6	Bracket
51	28C1122	Cable Assembly
52	AN210-2A	Pulley
53	AN210-2A	Pulley
54	AN210-1A	Pulley
55	AN210-2A	Pulley
56	28C5133-12	Bombsight Rudder Cable
57	88-L-1000	Shear Link
58	AN155-8S	Turnbuckle
59	Q4002-0-1	Bracket
60	AN210-2A	Pulley

Items number 5, 32, 35 and 57 are Federal Standard Stock Catalog part numbers.

*PBY-5A airplanes with serial numbers 46580 and on.

**PBY-5 and PBY-5A airplanes up to serial number 46580.

and attached to the aft end of the rudder servo piston rod.

Just forward and below the servo unit, a bombsight rudder control cable is attached to the returning rudder follow-up cable. From this attaching point, the bombsight rudder control cable is routed over a series of pulleys forward to the bombsight rudder control unit. The purpose of this cable is the same as that stated above for the other follow-up cables, except that this cable comes into use only when the airplane is being controlled by the bombardier by means of the bombsight rudder control unit. The three follow-up cables are attached to the drums on the proportional bank adapter by hooking the cable into a slot on the drum and securing by means of a drop of solder.

On PBY-5A airplanes with serial numbers 46580 and on, each follow-up cable is provided with a shear link which will break in case a follow-up cable should jam. These links are located at the ends of the follow-up cables where they attach to the servo unit. The shear links are set to separate at a cable tension of 35 pounds.

(2) REMOVAL.

(See figure 190.)

(a) Disconnect the ends of the follow-up cables where they attach to the forward ends of the piston rods on the servo unit. Disconnect the rudder follow-up cable from the aft end of the rudder servo piston rod.

(b) Remove all pulleys in the follow-up cable system.

(c) Detach the cables from the drums on the proportional bank adapter and remove cables.

(d) Detach the bombsight rudder control follow-up cable at the bombsight rudder control unit and remove cable.

(3) MAINTENANCE.

(For maintenance of cables and pulleys, see Par. 18, *b*, (3).)

(4) INSTALLATION.
(See figure 190.)

(a) INSTALLATION OF AILERON FOLLOW-UP CABLE.

1. Fasten the end of the aileron follow-up cable to the forward end of the aileron piston rod on the servo unit.

2. Lock the control wheel in the extreme right wing down position.

3. Wind the aileron follow-up drum to its fully wound position.

4. Allow the drum to release ¼ turn.

5. While holding the drum in this position, insert the end of the cable in the slot in the drum.

6. In case a new follow-up cable is being installed, mark the cable first at the place where it passes through the slot in the drum with the follow-up drum wound to within ¼ turn of its fully wound position; then slide a small washer over the end of the cable; cut the cable close to the washer; bend the strands over the washers; and solder them securely.

7. Allow the drum to slowly unwind itself. The tension in the follow-up cable will be correct as it is governed by the tension of the spring in the drum.

8. Return the control wheel to its neutral position.

(b) INSTALLATION OF ELEVATOR FOLLOW-UP CABLE.—The procedure for installing the elevator follow-up cable is the same as that given for the aileron follow-up cable with the exception of step No. 2. In this case, the control column is locked in the extreme nose down position.

(c) INSTALLATION OF RUDDER AND RETURN RUDDER FOLLOW-UP CABLES.

1. Fasten the end of the rudder follow-up cable to the forward end of the rudder piston rod on the servo unit.

2. Lock the rudder pedals in the extreme right rudder position.

3. Run cable over pulleys and over the forward pulley of the dual pulley assembly above the proportional bank adapter.

4. Wind the rudder follow-up drum to its fully wound position.

5. Allow drum to release ¼ turn; pass the cable under the rudder follow-up drum and wrap $2 \pm \frac{1}{4}$ counterclockwise turns (facing aft) around the forward groove of the drum; pass the cable through a slot in the flange separating the two grooves in the drum; secure cable at slot with a dab of solder; and then wrap $2 \pm \frac{1}{4}$ counterclockwise turns (facing aft) of the cable around the aft groove of the drum.

6. From the rudder follow-up drum route the cable to the idler pulley located just under the drum and then up to the aft pulley of the dual pulley assembly above the proportional bank adapter.

7. From here route the cable over pulleys to the aft end of the servo unit.

8. Tighten turnbuckles and lock with safety wire.

(d) INSTALLATION OF BOMBSIGHT RUDDER CONTROL FOLLOW-UP CABLE.

1. Fasten end of cable (15) to attaching plate (12) by bolting in place.

2. Route cable forward through all brackets leading to bombsight.

3. Bolt pulleys for above brackets in place and set turnbuckles in their approximate mid-positions.

4. With the pulley spring on the bombsight rudder control (32) wound to approximately the mid-position of its effective range of action, the follow-up control arm on the unit vertically upward, and the centering adjustment in the middle of its range, set the rudder servo in straight flight position.

5. Wrap the cable smoothly onto the pulley and centering adjustment.

6. Place cable through slot on pulley and knot securely. The pulley must rotate clockwise when right rudder is applied.

7. Tighten and then safety turnbuckle.

t. SERVO BY-PASS VALVE.

(1) DESCRIPTION. *(See figure 191.)* — The servo by-pass valve (Aircraft Accessories No. SD 29035) is a three unit valve, one for by-passing each cylinder of the servo unit. This valve unit is installed only on PBY-5 airplanes up to serial number 08318. Each unit consists of a spool valve and a push-pull knob to operate the valve.

When one of the by-pass valves is "OFF," the oil by-passes that particular cylinder to which the valve is connected, and the control surface is then disengaged from the automatic pilot. The control surface can then be operated manually.

The servo by-pass valve is installed on the port side forward of station 1.66, convenient to the pilot.

(2) REMOVAL AND ASSEMBLY.

(a) To remove servo by-pass valve:

1. Check to make certain that all hydraulic pressure has been relieved.

2. Disconnect the six lines from the unit.

3. Remove the valve from its bracket by detaching the four screws.

(b) To disassemble each valve:

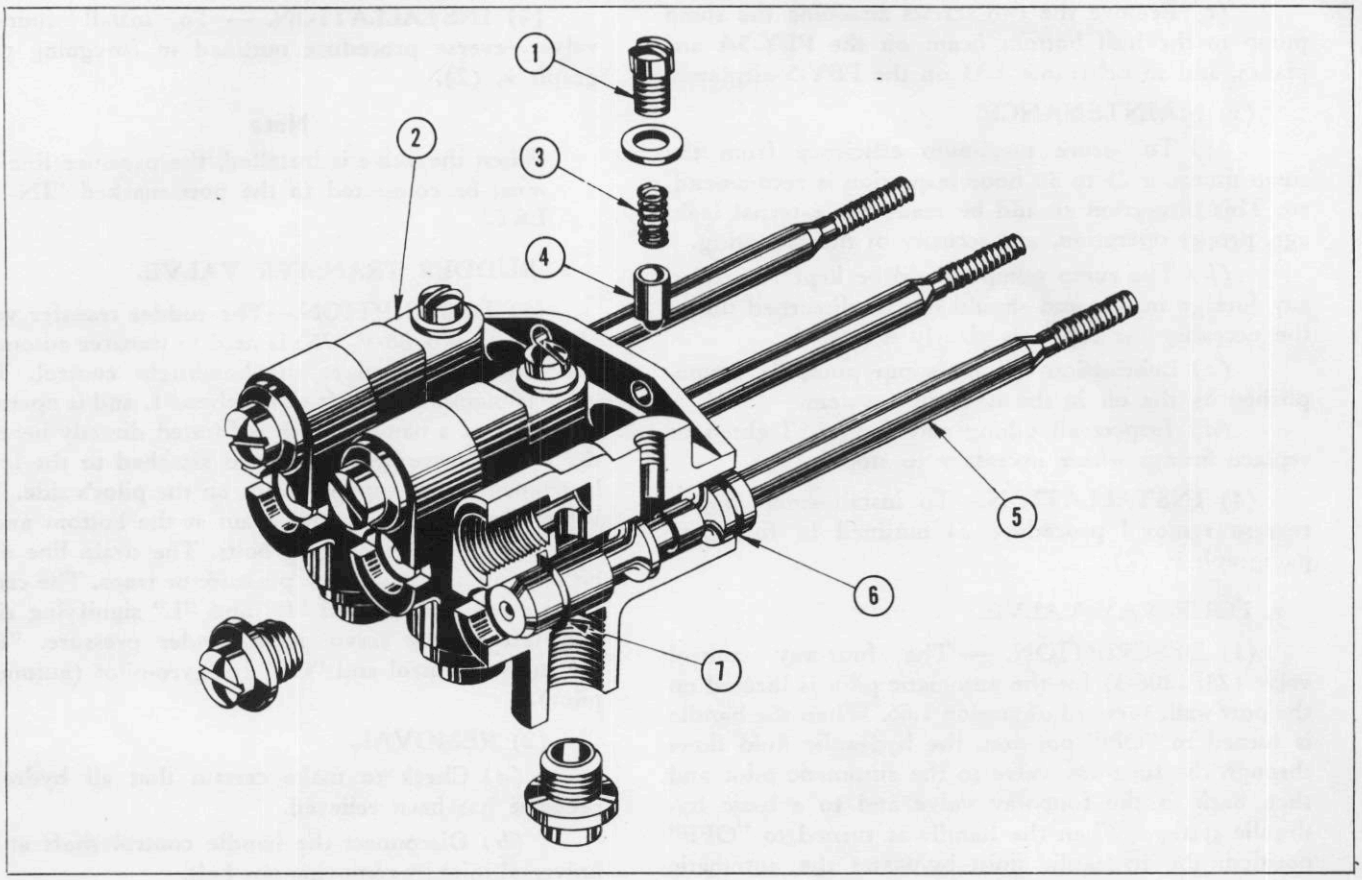
1. Remove screw (1) at top of housing (2).

2. Lift spring (3) and detent (4) from housing.

3. Pull piston (5) from housing.

4. Remove packing (7) from housing, being careful not to damage or distort corners.

5. Remove packing (6) from piston (5).



No.	PART No.	NAME	No.	PART No.	NAME
1	29405	Screw	4	29404	Detent
	29406	Washer	5	29403	Piston
2	29402	Housing	6	AN6227-6	Packing
3	29223	Spring	7	AN6227-9	Packing

All items except 6 and 7 are Aircraft Accessories Corp. part numbers.

Figure 191—Servo By-Pass Valve (PBY-5 Only)

(3) MAINTENANCE.

(a) In case of leakage of valve, remove and replace packings.

(b) Inspect all tubing and fittings for leaks.

(4) ASSEMBLY AND INSTALLATION.—To assemble and install servo by-pass valve, reverse removal procedure outlined in paragraph *t*, (2) above.

u. SUMP PUMP.

(1) DESCRIPTION.—The automatic pilot sump pump (Aircraft Accessories Corporation No. 58002A) is activated by the hydraulic pressure and delivers both the overflow fluid and the actuating fluid to the main fluid return lines. The pump has a capacity of 100 cubic centimeters per minute. Its operating pressure is 175 psi.

On the PBY-5A airplanes, this pump is mounted on the port floor, forward of station 1.0 and on the PBY-5 airplanes on the port floor and forward face of beltframe 1.33. It has an aluminum alloy housing with a transparent window for visual inspection of the operating mechanism and fluid flow.

Hydraulic fluid, at the correct pressure, is supplied to the pressure inlet port. The return or outlet port is connected to the reservoir return line. The suction port is connected to the overflow reservoir from which the surplus hydraulic fluid is being pumped.

(2) REMOVAL.—To remove sump pump from airplane:

(a) Check to make certain that all hydraulic pressure has been relieved.

(b) Disconnect the three hydraulic lines.

(c) Remove the two screws attaching the sump pump to the hull bottom beam on the PBY-5A airplanes, and to beltframe 1.33 on the PBY-5 airplanes.

(3) MAINTENANCE.

(a) To assure maximum efficiency from the sump pump, a 25 to 30 hour inspection is recommended. This inspection should be made for external leakage, proper operation, and security of the mounting.

(b) The sump pump should be kept free from any foreign matter and should not be disturbed unless the necessity for repair is clearly indicated.

(c) Lubrication of the sump pump is accomplished by the oil in the hydraulic system.

(d) Inspect all tubing and fittings. Tighten or replace fittings where necessary to stop leaks.

(4) INSTALLATION.—To install sump pump, reverse removal procedure as outlined in foregoing paragraph *u*, (2).

v. FOUR-WAY VALVE.

(1) DESCRIPTION. — The four-way control valve (28F1208-3) for the automatic pilot is located on the port wall, forward of station 1.66. When the handle is turned to "ON" position, the hydraulic fluid flows through the four-way valve to the automatic pilot and then back to the four-way valve and to a basic hydraulic system. When the handle is turned to "OFF" position, the hydraulic fluid by-passes the automatic pilot and returns immediately to the basic hydraulic system.

(2) REMOVAL.

(a) Check to make certain that all hydraulic pressure has been relieved.

(b) Disconnect the four hydraulic lines.

(c) Remove the four bolts attaching the four-way valve to the mounting bracket.

(3) MAINTENANCE.

(a) Inspect valve for leaks.

(b) Replace packing if valve leaks.

(c) Inspect fittings for leaks and replace if necessary.

(4) INSTALLATION. — To install four-way valve, reverse procedure outlined in foregoing paragraph *v*, (2).

Note

When the valve is installed, the pressure line must be connected to the port marked "INLET."

w. RUDDER TRANSFER VALVE.

(1) DESCRIPTION.—The rudder transfer valve (F. S. S. C. No. 88-V-375) is used to transfer automatic pilot rudder control to the bombsight control. This valve is mounted just aft of bulkhead 1, and is operated by means of a handle which is located directly beneath the pilot's instrument panel and attached to the lower instrument panel support beam on the pilot's side. The valve is mounted with the drain at the bottom and is attached by four mounting bolts. The drain line must be absolutely free of back pressure or traps. The center valve ports are stamped "R" and "L" signifying right and left rudder servo action under pressure. "RC" for rudder control and "GP" for gyro-pilot (automatic pilot).

(2) REMOVAL.

(a) Check to make certain that all hydraulic pressure has been relieved.

(b) Disconnect the handle control shaft at the universal joint by removing one bolt.

(c) Disconnect the six hydraulic lines running to the valve.

(d) Unscrew the four mounting bolts and remove valve.

(3) MAINTENANCE.

(a) Inspect valve for leaks.

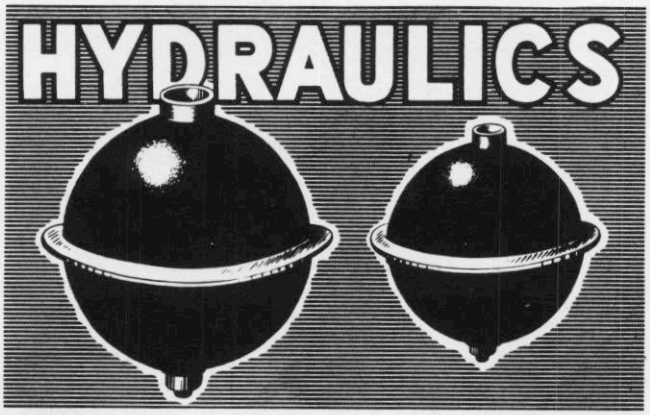
(b) Overhaul or replace if valve leaks.

(c) Inspect lines and fittings for leaks. If after tightening fittings, leaks persist, new fittings should be installed.

(4) INSTALLATION.—To install transfer valve, reverse the removal procedure outlined in the foregoing paragraph *w*, (2).

★ ★ ★

PARAGRAPH 21.



21. HYDRAULIC SYSTEM.

a. GENERAL. *(See figure 193.)*—The hydraulic system for the PBY-5A airplane is a high pressure, accumulator type system. This system is arranged to supply hydraulic power to operate the nose and main landing gear, nose wheel doors, and brakes. It also provides power used by the bombsight and automatic pilot to operate the servos controlling the flight of the airplane.

The hydraulic system for the PBY-5 airplanes is designed to provide power for only the bombsight rudder control unit and the automatic pilot. *(See figure 184.)*

The hydraulic fluid used is oil (Specification AN-VV-O-366).

b. BASIC HYDRAULIC SYSTEM.

(1) GENERAL DESCRIPTION.

(a) PBY-5A AIRPLANES. *(See figure 192.)*—Hydraulic pressure is furnished by an engine-driven pump (12) which draws fluid from the reservoir (1) and expels it under pressure through a safety relief valve (13) (set to relieve at 1250 lb/sq in.) to the unloading valve (7) which maintains the system pressure from a minimum of 850 ± 50 lb/sq in. to a maximum of 1050 ± 50 lb/sq in. The function of the unloading valve is to act as a pressure control valve, which will automatically divert pump delivery through a filter (6) to the reservoir (1) without flow restriction, when the accumulators reach a desired maximum pressure of 1050 ± 50 lb/sq in. or to direct pump delivery to the accumulators when the accumulator pressure drops to a minimum of 850 ± 50 lb/sq in.

If the accumulators are charged, the fluid is diverted through the automatic pilot hydraulic system relief valve (4), set at 150 lb/sq in., and on to the automatic pilot four-way valve. When the four-way valve is "ON," the fluid flows to the automatic pilot; return fluid from the automatic pilot flows back through the four-way valve into the return line. The automatic pilot hydraulic system relief valve sends the excess fluid through the main system oil filter to the return line.

When the four-way valve is "OFF," fluid from the landing gear selector valve (8) flows through the four-way valve directly to the return line.

A hydraulic pressure gage (See Par. 19, *c*, (13).) on the pilot's instrument panel indicates the pressure of the landing gear system. A pressure gage located on the top side of the 10 inch accumulator indicates the pressure of the brake system.

A check valve (11) separates the five-inch accumulator (3) and the ten-inch accumulator (5) thus separating the source of power for the brakes from that for the landing gear or automatic pilot.

An emergency power source is provided by a hand pump (2) which upon operation draws fluid from the reservoir (1) through a separate fluid supply line and delivers the fluid under pressure directly to the accumulators, thus by-passing the unloading valve. This hand power system is used in case of the failure of the starboard engine or the engine-driven pump. The hand pump may also be used to supply pressure while the airplane is on the ground and engines are not running.

(b) PBY-5 AIRPLANES. *(See figure 184.)*—Fluid power for the PBY-5 hydraulic system is furnished by an engine-driven pump (3) which draws fluid from a reservoir (1). A pressure regulator valve (2) for this system is mounted on top of the reservoir and operates to release excess fluid pressure to vent directly into the reservoir.

Fluid flows from the regulator valve (2) to a four-way valve (6), which controls the flow of the hydraulic fluid either to the automatic pilot (12) or back to the hydraulic reservoir. When the automatic pilot is in operation, fluid flows through the four-way valve to a filter (8). From the filter fluid pressure travels to the automatic pilot, bombsight rudder control unit, and sump pump (9). The fluid to the bombsight is utilized only when the rudder transfer valve (7) has transferred rudder control from the automatic pilot to the bombsight rudder control unit.

Fluid seepage from the automatic pilot, bombsight rudder control unit, and rudder transfer valve is routed to an overflow reservoir (10), from which the fluid is drawn by the sump pump and returned to the system by way of the fluid return lines. The return fluid then flows through the four-way valve (6) to the reservoir. Hydraulic fluid is in constant circulation as long as the starboard engine is running, the only direct control for the system being the four-way valve

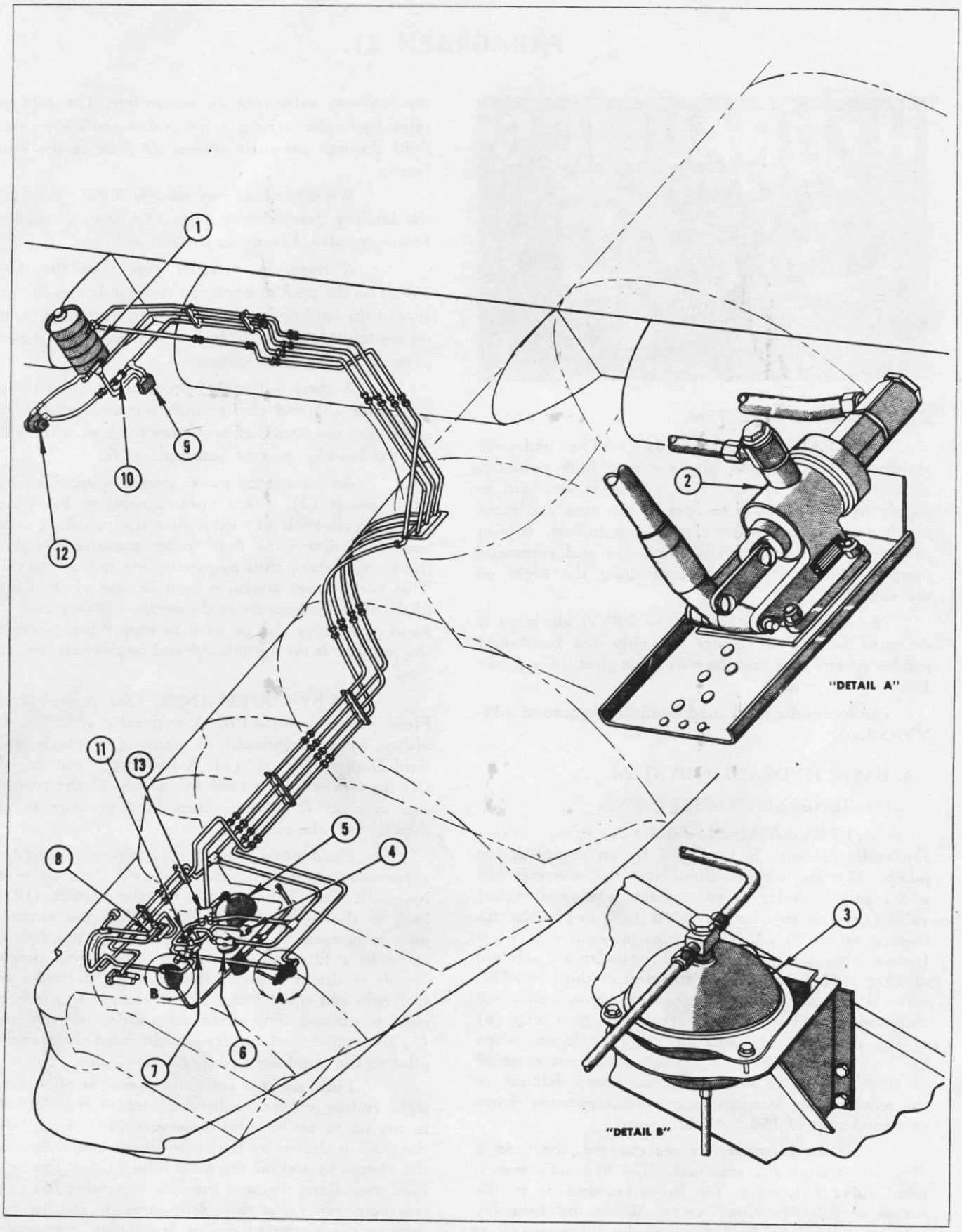


Figure 192—Basic Hydraulic System Diagram (PBY-5A Only)

No.	PART No.	NAME	No.	PART No.	NAME
1	28F6514	Reservoir	8	4V4001	Selector Valve
2	437F	Hand Pump	9	28F6539	Test Outlets
3	AA14002A	5 inch Accumulator	10	475HT-8D	Check Valve
4	88-R-255	Oil Pressure Regulator	11	475HT-8D	Check Valve
5	AA14005A	10 inch Accumulator	12	1P-582FB	Engine-Driven Pump
6	11279	Filter	13	1V-575-D	Pressure Relief Valve
7	AA14510	Unloading Valve			

Items number 2, 12 and 13 are Pesco Products part numbers.
Items number 3, 5 and 7 are Vickers Inc. part numbers.
Item number 4 is a Federal Standard Stock Catalog number.
Item number 6 is a Cuno Engineering Corp. part number.
Item number 8 is an Aerodraulics Corp. part number.
Items number 10 and 11 are Parker Appliance Co. part numbers.

which is used to divert the hydraulic fluid from open circulation to the automatic pilot.

(2) ENGINE-DRIVEN PUMP.

(a) DESCRIPTION. *(See figure 194.)*—The engine-driven pump (Pesco 1P-582FB on PBY-5A airplanes) is a two gear, positive displacement pump. The rated capacity of the pump is 2 gal/min at 1500 rpm and 1000 lb/sq in. discharge pressure. The pump is reversible and will operate satisfactorily in either direction. It is provided with a positive seal which is under constant pressure to prevent air leakage into the pump. Bushings are pressure loaded to compensate for thermal variation and wear. The engine driven pump is mounted on the starboard engine.

Note

On PBY-5 airplanes, the engine-driven pump (Pesco 1P203P) is rated at 1.4 gal/min. at 1500 rpm and 1000 lb/sq in. discharge pressure.

(b) REMOVAL AND DISASSEMBLY.

1. To remove the hydraulic pump:

a. Remove the accessory cowl panels. (See Par. 7, *e*, (1), *(b)*.)

b. Remove the pressure line and suction line from the pump.

c. Remove lockwire, and four nuts attaching pump to engine.

2. To disassemble pump (Pesco 1P-582FB): *(See figure 194.)*

a. Remove the cover (22) from the pump body (7) by unscrewing the stud nuts (18) securing it. If the assembly tends to stick, tap it lightly with a wooden mallet to free the parts.

Note

Identify the bushings with respect to their original position in the pump housing so as to ensure their proper reassembly position.

b. Remove the cover bushings (2), the spacers (1), and the springs (19).

c. Disassemble the check valve by removing the valve retainers (21) in the cover.

d. Extract the drive gear (5) and the driven gear (3). Also remove the spring (4) from the drive gear (5).

e. Identify, then remove the body bushings (6), being careful not to scratch or damage them.

f. Remove the screw (14) and lock plate (15) from the retainer nut (16).

g. Unscrew retainer nut (16) and remove seal ring retainer (17), disc (13), seal cup (12), seal ring (11), spring (10), gasket (9), and drive shaft (8).

(c) MAINTENANCE.

1. Lubrication is provided by fluid passing through the pump. No other lubrication is required.

2. After the complete disassembly of the pump, wash all of the parts in a suitable cleaning fluid, preferably clean gasoline.

3. Inspect each part for wear and defects.

4. Discard all seal rings and gaskets and replace them with new parts at reassembly.

5. All defective parts must likewise be replaced.

(d) ASSEMBLY AND INSTALLATION.

1. To assemble pump, reverse procedure outlined in foregoing paragraph *b*, (2), *(b)*, *2*, observing the following:

a. Be sure that the seal rings are perfect and that any metallic seal surface is free of grit.

b. Be sure that all bushings are returned to their proper identified positions.

c. Before securing the cover to body, be sure that the bushings are loose enough to work freely without binding. Spring action of the cover and body will be noted by squeezing the two parts together.

2. To install pump in airplane, reverse the re-

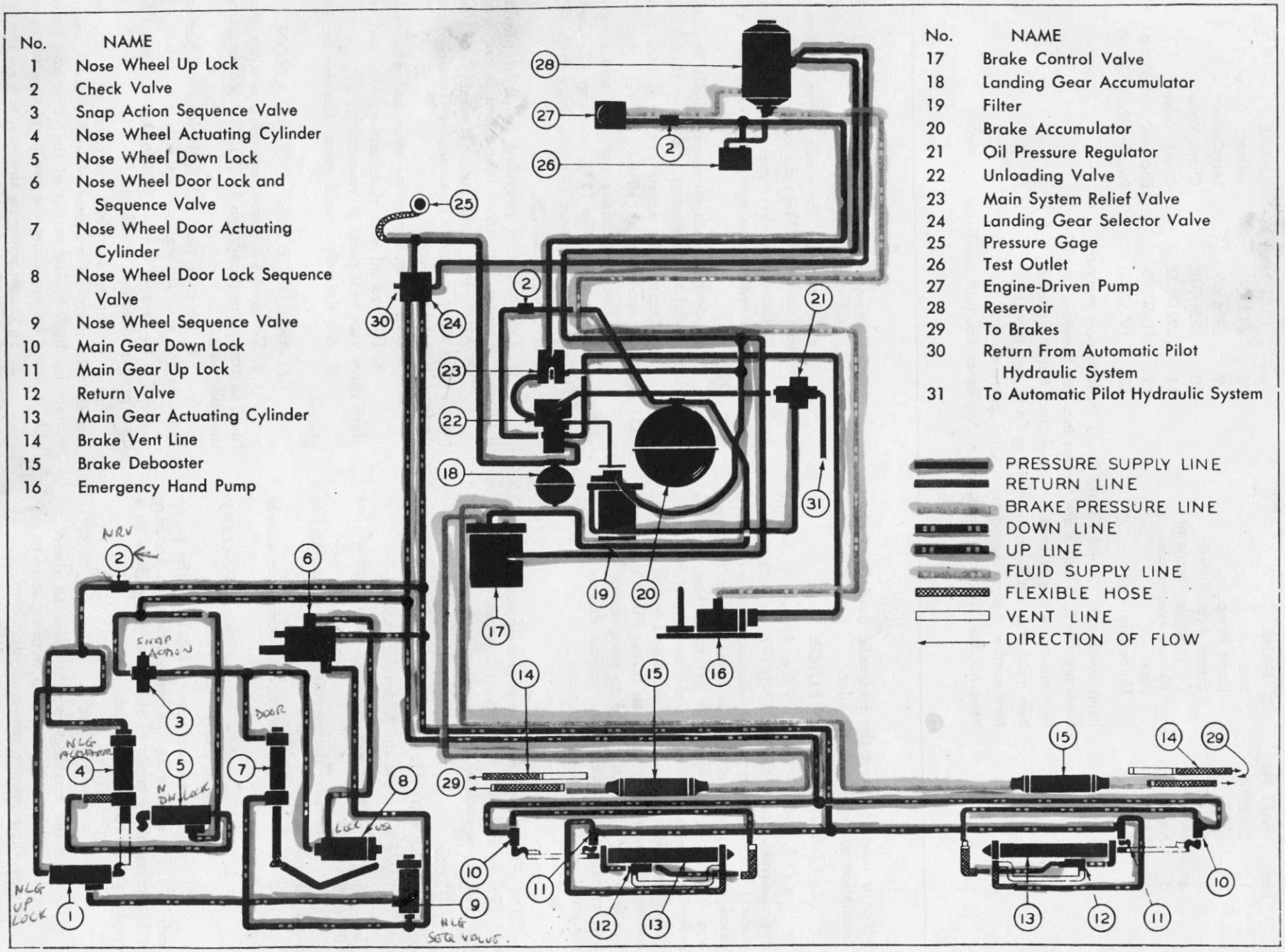


Figure 193—Main Hydraulic System—Schematic Diagram (PBY-5A Only)

moval procedure outlined in foregoing paragraph *b*, (2), *(b)*, *1*.

(3) RESERVOIR.

(a) DESCRIPTION.

1. PBY-5A AIRPLANES.—The reservoir is an aluminum alloy welded cylindrical tank which is mounted on the right-hand side of the starboard nacelle immediately aft of the firewall. On the inside of the reservoir, a baffle subdivides the reservoir into two sections. The lower section is the main portion of the tank and the upper section acts as foaming space to remove air from the oil. A cellulose acetate narrow slit window is installed in the lower half of the reservoir wall to serve as a fluid level gage. The reservoir has a capacity of 2.4 U. S. (2.0 Imp.) gallons. The filler cap is at the top of the reservoir and has a screen strainer.

Five lines are attached to the reservoir. Two are return lines from the system—one being the return line from the landing gear selector valve, and the other the return line from the brake valve and unloading valve. The third line is a suction line to the engine-driven pump. The other two lines are suction lines for the hand pump and the test connection.

2. PBY-5 AIRPLANES.—The hydraulic reservoir is a Sperry No. 644229 part with a useful capacity of 0.75 U. S. gallon (0.62 Imp. gallon) and a total capacity of one U. S. gallon (.83 Imp. gallon). A drain is provided at the bottom of the reservoir, and a filter plug is located at the top. The sight gage on the forward part of the reservoir is located at the three-quarter full position and will show the fluid level when the tank is three-quarters full. The strainer at the bottom of the reservoir may be removed by opening the door at the forward bottom of the tank. The reservoir is mounted on the right-hand side of the starboard firewall on the forward side.

(b) REMOVAL.

1. To remove reservoir from airplane:

a. Disconnect the five lines on the PBY-5A and the three lines on the PBY-5 airplanes at the fittings.

b. Remove the six screws on the PBY-5A and the four screws on the PBY-5 airplanes which attach the reservoir to the face of the firewall.

(c) MAINTENANCE.

1. Make certain that the vent hole in the filler cap is free from obstruction.

2. Replace neoprene seal on window, if damaged.

3. The maintenance of the cellulose acetate is the same as for Plexiglas. (See Par. 3, *d*, (3).)

(d) INSTALLATION.—To install reservoir, reverse removal procedure outlined in foregoing paragraph *b*, (3), *(b)*.

(4) UNLOADING VALVE (PBY-5A Only).

(a) DESCRIPTION.—The unloading valve (Vickers AA14510) is a spool type, externally drained pressure regulating valve having a normal capacity of 10 U. S. (8.3 Imp.) gallons per minute. It is adjusted to maintain a pressure in the hydraulic accumulators of 850 ± 50 to 1050 ± 50 lb/sq in.

The primary function of the valve is to maintain the accumulator pressures while imposing the least possible load on the hydraulic pump. When the system pressure reaches 1050 ± 50 lb/sq in. all fluid is bypassed into the return line. When the pressure drops to 850 ± 50 lb/sq in., the unloading valve directs fluid into the system. The unloading valve is mounted on the forward, outboard edge of the hydraulic platform outboard of the copilot's seat.

(b) REMOVAL.

(See figure 195.)

1. Relieve pressure from accumulators by applying and releasing the brakes until the pressure is dissipated. To relieve pressure from five-in. accumulator, rotate the landing gear selector valve back and forth rapidly until pressure is dissipated.

CAUTION

While rotating the selector valve, the airplane must be either mounted on the beaching gear or cradled.

2. Disconnect the four hydraulic lines.

3. Remove the two bolts (2) attaching the valve to the hydraulic platform.

4. Cap all open tube ends and ports to keep out dirt.

(c) MAINTENANCE.

1. Inspect the unloading valve for evidence of leakage. All nuts must be tight and there must be no leakage at gaskets, seals, or plugs.

2. Lubrication of internal parts is provided entirely by hydraulic oil. No additional lubrication is required.

3. In case of failure of the unloading valve, replace with a new valve. No repairs should be attempted except by specially trained personnel at an authorized base.

(d) INSTALLATION.—To install unloading valve, reverse removal procedure outlined in foregoing paragraph *b*, (4), *(b)*.

(5) PRESSURE RELIEF VALVE (PBY-5A Only).

(a) DESCRIPTION.—The relief valve (Pesco 1V-575-D) is located on the hydraulic platform, starboard of the 10-inch accumulator. Its function is to dissipate excessive pressure from the engine-driven pump. The relief valve is adjustable and is preset to relieve at 1250 lb/sq in.

(b) REMOVAL AND DISASSEMBLY.

1. Remove the relief valve as follows: *(See figure 195.)*

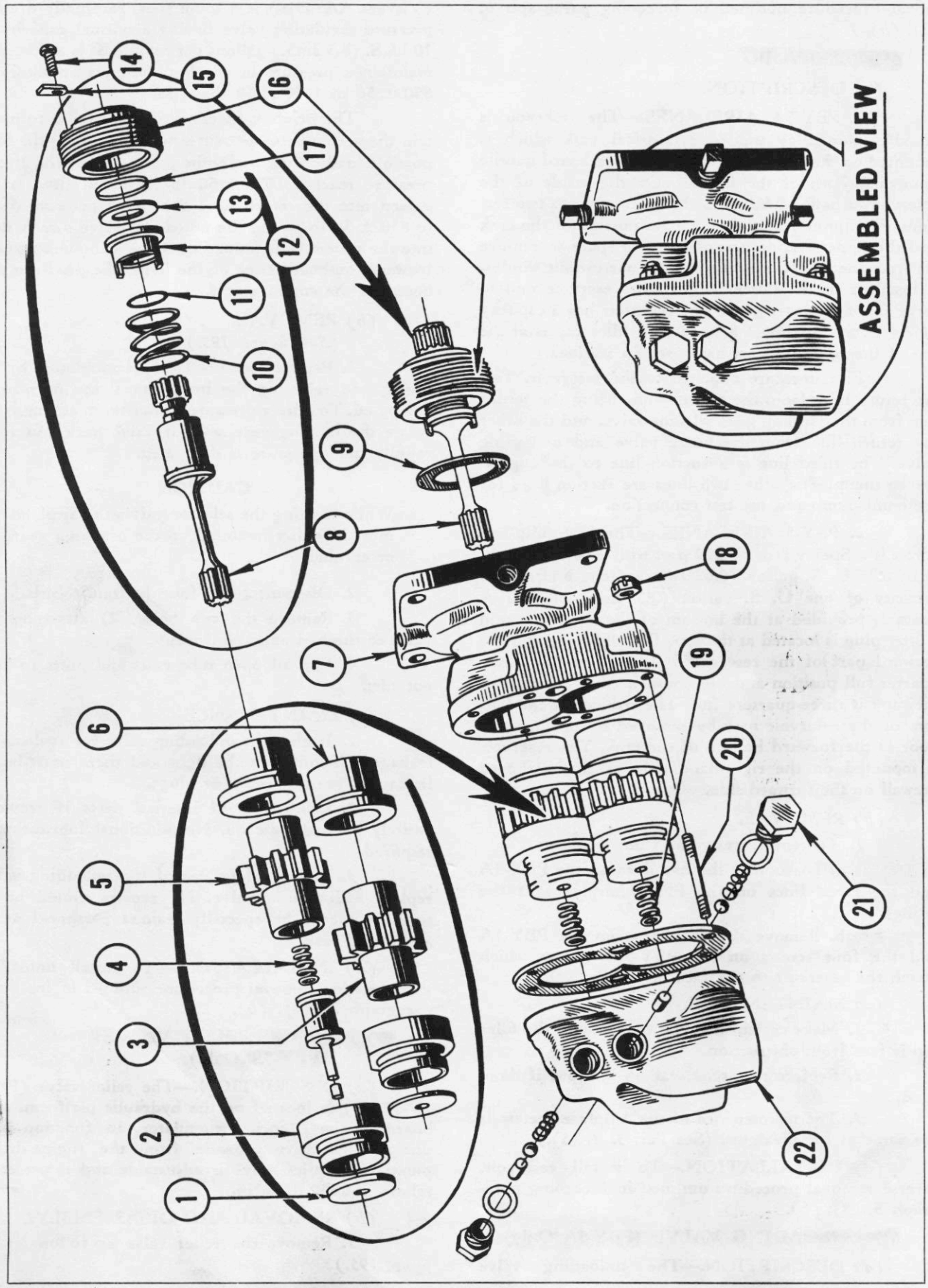


Figure 194—Engine-Driven Hydraulic Pump (PBY-5A Only)

No.	PART No.	NAME	No.	PART No.	NAME
1	549-7	Spacer	12	349-32A	Seal Cup
2	582-11	Cover Bushing	13	320-9B	Disc-Seal
3	549-4C	Driven Gear	14	248-26	Screw
4	394-9	Spring	15	320-11	Lock Plate
5	563-4B	Drive Gear	16	349-31A	Retainer
6	549-5	Bushing	17	AN6227-16	Seal Ring Retainer
7	582-1	Body	18	AN330-5	Nut
8	563-5B	Drive Shaft	19	320-18	Spring
9	320-10	Gasket	20	549-9	Stud
10	349-36	Spring	21	349-20-A	Retainer
11	AN6227-13	Seal Ring	22	582-2C	Cover

All items except 11, 17 and 18 are Pesco Products Co. part numbers.

The pump assembly part number is 1P-582FB.

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a. Disconnect the three lines connected to the relief valve.

b. Remove the two screws (3) mounting the valve on the platform.

2. Disassemble the valve as follows: *(See figure 196.)*

a. Unscrew the locknut (1) and the adjusting screw (4) allowing the removal of the spring (5) and the valve (6).

b. Remove the gasket (3).

c. Remove seal ring (2).

d. Do not attempt to remove valve seat from valve body (7). It is pressed into body and staked.

(c) MAINTENANCE.—If the relief valve does not function properly:

1. Disassemble and clean all parts thoroughly in good commercial grade of kerosene.

2. Replace worn or damaged gaskets and seals.

3. If the tension of the spring has been weakened, replace spring.

4. Make sure the valve seat is clean, and probe valve passages for any foreign matter which may be lodged there.

(d) ADJUSTMENT.

1. Loosen the locknut.

2. With a screwdriver, turn adjusting screw clockwise to increase pressure, and counterclockwise to decrease pressure. When a relief pressure of 1250 lb/sq in. is obtained, tighten the locknut.

(e) ASSEMBLY AND INSTALLATION.—Reverse the procedure for removal and disassembly as outlined in paragraph *b*, (5), *(b)*.

(6) FIVE-INCH ACCUMULATOR (PBY-5A Only).

(a) DESCRIPTION.—The Vickers No. AA 14002-A five-inch accumulator is located forward of the hydraulic platform outboard of the co-pilot's seat. This accumulator is used to store hydraulic pressure for partial operation of the landing gear. It consists of an air chamber and an oil chamber which are threaded at the flange and when screwed together form a sphere. Clamped between the two chambers, is a synthetic rubber diaphragm which completely seals the oil chamber from the air chamber.

To charge the accumulator completely, vent the hydraulic pressure and then fill the accumulator air chamber with dry compressed air to 600 lb/sq in.

As fluid is delivered to the accumulator through the unloading valve, the diaphragm moves down compressing the air to a pressure equal to the pressure of the hydraulic fluid being delivered. The compressed air will force the oil into the landing gear system upon operation of the landing gear selector valve.

(b) REMOVAL.

1. Release all pressure, air, and oil.

2. Unscrew the fittings to disconnect the hydraulic line and air charging line connected to the accumulator.

3. Remove the three bolts attaching the accumulator to the mounting bracket.

(c) MAINTENANCE.

1. Check the air charging line for leaks.

2. Use saliva test to check air valve core for leakage.

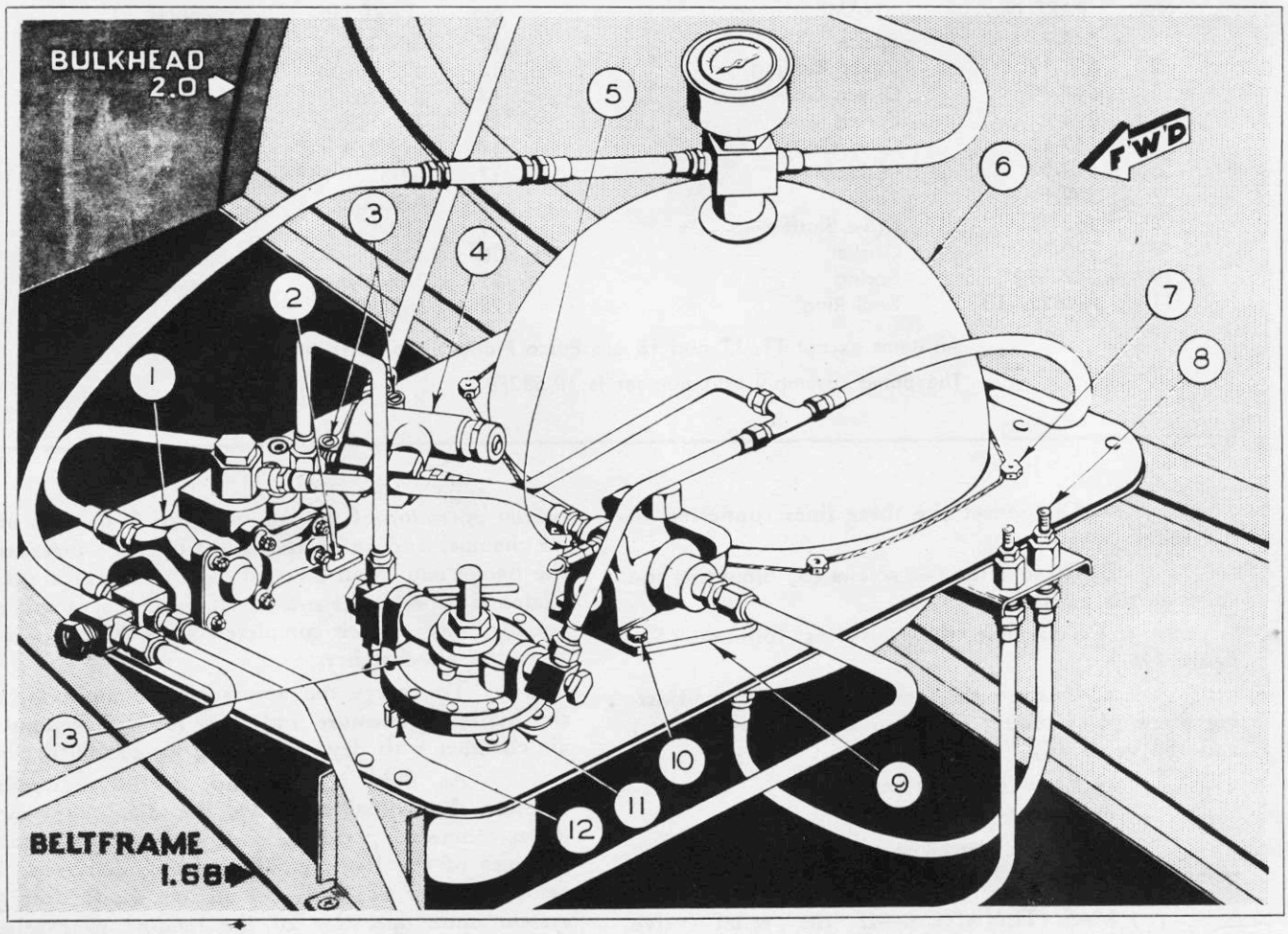
WARNING

Do not use standard tire type valve cores as this may result in failure of the hydraulic system. Use only Schrader No. 2300 or Dill No. 100-DBB.

3. If accumulator develops internal or external leaks, or becomes damaged in any way, replace with new accumulator.

(d) INSTALLATION.—Reverse removal procedure as outlined in paragraph *b*, (6), *(b)* above.

(7) SELECTOR VALVE (PBY-5A Only).



No.	PART No.	NAME
1	AA14510	Unloading Valve
2	AN3-5A	Bolt
	AN365-1032	Nut
3	AN526-1032-28	Screw
	AN365-1032	Nut
	Q816D6-16	Washer
4	1V-575-D	Pressure Relief Valve
5	AN4-5A	Bolt
	AN365-428	Nut
6	AA14005A	10 inch Accumulator
7	AN73-5	Bolt
8	60093	Air Valve
9	88-R-255	Oil Pressure Regulator
10	AN4-13A	Bolt
	AN365-428	Nut
11	28F6517	Bracket
12	AN526-1032-10	Screw
	AN365-1032	Nut
13	11279	Filter

Items number 1, 6 and 8 are Vickers Inc. part numbers.

Item number 4 is a Pesco Products Corp. part number.

Item number 9 is a Federal Standard Stock Catalog part number.

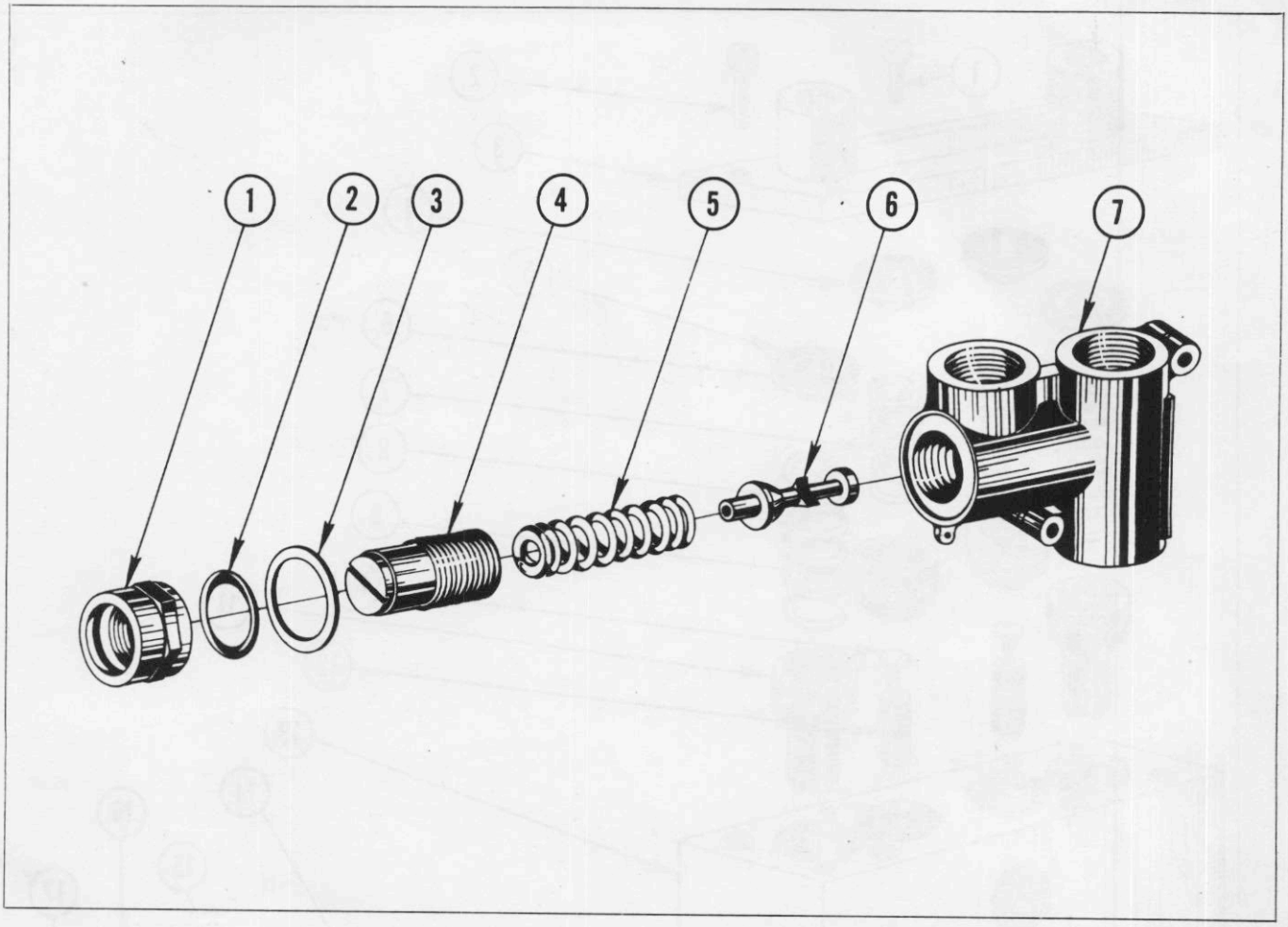
Item number 13 is a Cuno Engineering Co. part number.

Figure 195—Hydraulic Platform (PBY-5A Only)

(a) DESCRIPTION. *(See figure 73.)*—The selector valve (Aerodraulics 4V001, which is used on airplanes with serial numbers 46580 and on), locking knob, and nameplate for operation of the landing gear units are located below the pilot's instrument panel slightly to port of the airplane center line.

Note

On airplanes previous to 46580, an Adel Precision Products Co. D9305 selector valve, which is interchangeable with the Aerodraulics selector valve, was installed.



No.	PART No.	NAME	No.	PART No.	NAME
1	575-5	Locknut	5	575-7	Spring
2	575-6	Seal Ring	6	575-3	Valve
3	535-38	Gasket	7	575-20	Body
4	575-4	Adjusting Screw			

All items listed are Pesco Products Corporation part numbers.
The part number of the valve assembly is 1V-575-D.

Figure 196—Pressure Relief Valve (PBY-5A Only)

The purpose of the selector valve is to control the operation of the landing gear to an extended or retracted position. Complete operating instructions appear on the instruction plate. It will be noted that the selector valve handle can always be turned to the "DOWN" position without releasing the locking knob, but to turn the handle to the "UP" position requires pulling out the locking knob.

CAUTION

The selector valve should always be left in either the "DOWN" or "UP" position, and never in the neutral position, as putting the valve in neutral position will dissipate the pressure from the landing gear accumulator.

(b) REMOVAL AND DISASSEMBLY.
(See figure 197.)

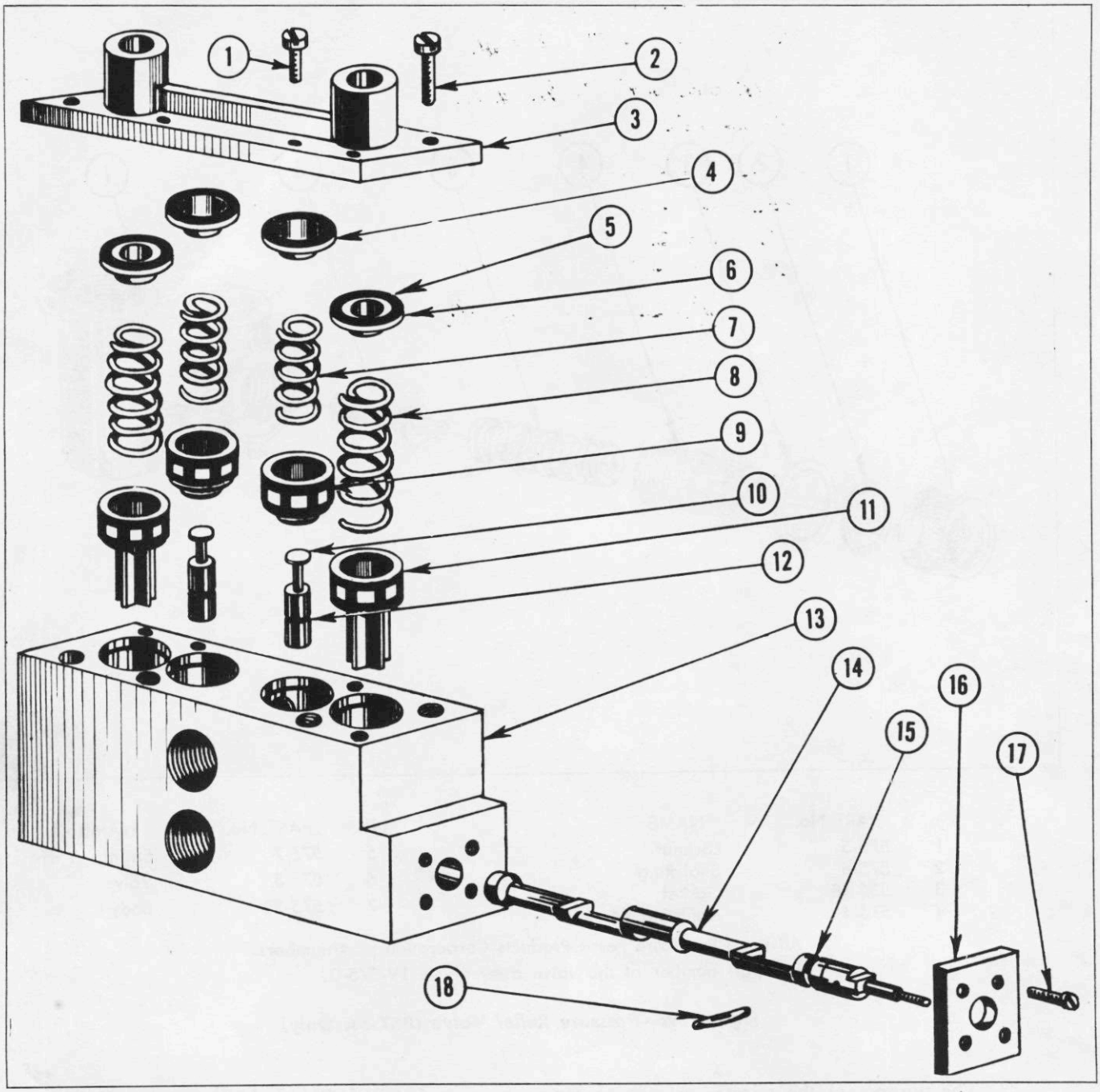
1. Disconnect hydraulic lines at the fittings in the valve.

2. Remove selector valve and handle assembly by removing the four bolts attaching selector valve handle housing to the supporting brackets on the instrument panel beam, and the two bolts attaching forward end of mounting to the rudder pedal brace.

3. Remove valve assembly from its mounting by detaching four screws.

4. Disassemble the selector valve as follows:

a. Remove the cover (3) by unscrewing the eight screws (1) and (2).



No.	PART No.	NAME
1	AC503-416-10	Screw
2	AC503-10-10	Screw
3	40208	Cover
4	10226	Plug
5	AN6227-13	Seal Ring
6	10225	Plug
7	10211	Spring
8	10214	Spring
9	10212	Poppet
10	10207	Pin
11	20215	Poppet
12	AN6227-5	Seal Ring
13	50224	Valve Body
14	20509	Camshaft
15	AN6227-7	Seal Ring
16		Retainer
17	AC503-8-6	Screw
18		Stop Pin

All part numbers except 1, 2, 5, 12, 15 and 17 are Aerodraulics Co. part numbers.

Figure 197—Landing Gear Selector Valve (PBY-5A Only)

b. The valve assemblies may then be removed from the four valve chambers as follows:

(1) Remove the plugs (6) and (4), seals (5), springs (7) and (8), and poppets (9) and (11).

(2) Pull the pin (10) out of the valve body (13) and remove the seal (12).

5. Remove camshaft as follows:

a. Remove four screws (17).

b. Remove camshaft (14) and seal ring (15).

c. To remove retainer (16) from camshaft, drive stop pin (18) out of camshaft.

(c) MAINTENANCE.

1. Wash all parts in a good commercial grade of kerosene.

2. Corrosion, if present, may usually be removed by polishing with crocus cloth.

3. Replace worn or damaged seals.

4. If valve seats are worn or damaged, replace the entire valve.

5. Replace worn or damaged plastic poppets.

(d) ASSEMBLY AND INSTALLATION.—Reverse the procedure for removal and disassembly as outlined in paragraph *b*, (7), *(b)* above.

(8) CHECK VALVES (PBY-5A Only).

(a) DESCRIPTION.—The check valves (Parker 475-HT) permit the flow of fluid in one direction only. The valve is a poppet-type made up of a body, cone, spring, and seat. The spring compresses the cone against the seat closing the valve. Fluid pressure entering from the spring end of the valve, therefore, seats the cone tighter. Fluid pressure entering the valve in the free flow direction pushes the cone from the seat, by compressing the spring, thus allowing fluid to flow through the valve in one direction only.

There are four check valves used in the system. One is under the system reservoir in the pressure line from the engine pump. Its function is to prevent pressure in the system from backing up through the pump. A second is located in the line between the Vickers unloading valve and 10 inch brake accumulator to prevent pressure in 10 inch accumulator from backing up into the main system. A third is located in the return line of the brake valve, and prevents surges created by the unloading valve from affecting delicate mechanism inside the brake valve. The fourth is in the vent line from the nose wheel cylinder to the fluid return line. The arrow on this last check valve should always point starboard. This vent line is used to reduce back pressure when the nose gear is being retracted. Indicators on all check valves previously mentioned should point aft.

(b) REMOVAL AND DISASSEMBLY.

1. Disconnect the two hydraulic lines from check valve.

2. Disassemble as follows:

a. Unscrew cap.

b. Remove spring, cone, and gasket.

(c) MAINTENANCE.

1. Wash all parts in a good commercial grade of kerosene.

2. Replace gasket if worn or damaged.

3. If leakage past the valve cone is evident, lap the cone and seat with a fine lapping compound.

4. All lapping compound must be removed before assembly. Replace the check valve if lapping does not stop leakage.

(d) ASSEMBLY AND INSTALLATION.—Reverse the procedure for removal and disassembly as outlined in paragraph *b*, (8), *(b)* above.

(9) HYDRAULIC FILTER (PBY-5A Only).

(a) DESCRIPTION.—The filter (Cuno No. 11279) is mounted on the hydraulic platform and is used to filter all foreign material out of the hydraulic system. The filter element consists of a number of closely spaced discs on a central shaft. The fluid enters the filter housing, passes from the outside to the inside of the discs, and discharges to the outlet in the cover. In so doing any foreign matter that might be in the fluid is collected on the discs. There is a by-pass valve in the filter set to open at 15 $\pm$ 1.5 lb/sq in. If the filter becomes clogged, or for any reason more than 15 $\pm$ 1.5 lb/sq in. is required to force the fluid through the discs of the filter, the by-pass valve will open to let fluid flow directly through the filter cover without passing through the filtering element.

To clean the filter, turn the handle (which is a part of the shaft holding the discs) on top of the filter. Turning the handle rotates the discs against a series of fixed scrapers and clears them of foreign matter, which settles to bottom of filter. A plug in the bottom of the case is provided for removal of the sludge. The filter should be drained at every 50 to 60 hour check.

WARNING

A dirty filter may cause malfunctioning of the hydraulic system. Turn filter handle at least one complete revolution before each flight.

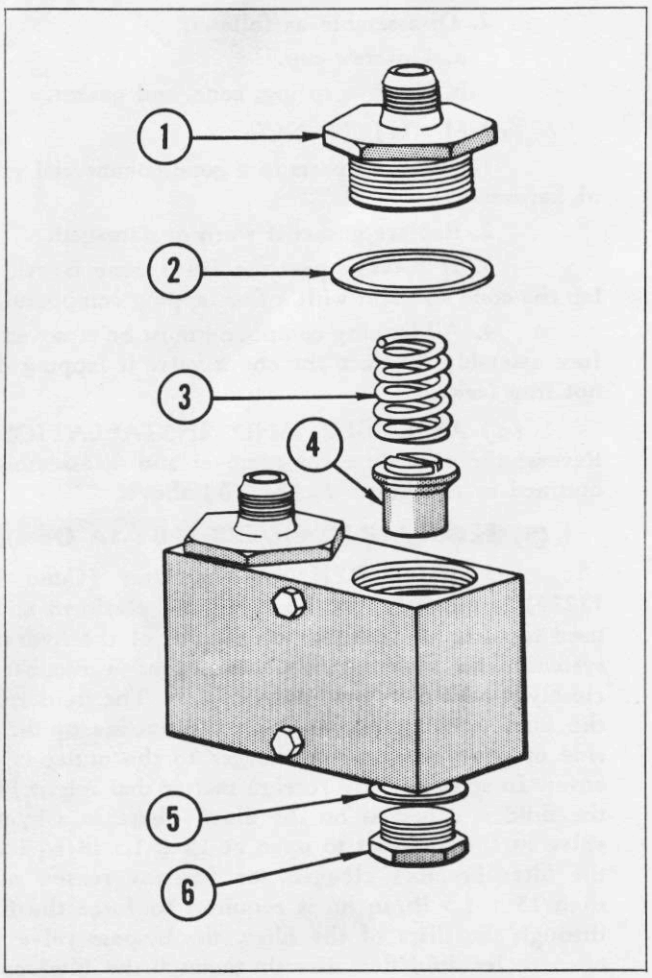
(b) REMOVAL AND DISASSEMBLY. *(See figure 195.)*

1. Disconnect the two hydraulic lines connected to the filter (13).

2. Remove two screws (12) attaching filter (13) to the mounting bracket (11).

3. It will seldom, if ever, be necessary to completely disassemble the filter. The cover may be removed by taking out the ten screws.

(c) MAINTENANCE.—The filter should require no maintenance except draining. If for some reason, it does become clogged, it is easily serviced by re-



No.	PART No.	NAME
1	28F6537	Fitting
2	28F6535	Gasket
3	28F6534	Spring
4	28F6536	Valve
5	32F5712-8	Gasket
6	AN41B25-8D	Plug

The assembly part number is 28F6539.

Figure 198—Test Outlet (PBY-5A Only)

moving the cover and cleaning the discs with a solvent solution and air blast. Leaking packing in the shaft through the cover may be renewed without removing the unit or any of its parts by unscrewing the packing nut and inserting new packing.

(d) ASSEMBLY AND INSTALLATION.—Reverse the procedure for removal and disassembly as outlined in paragraph *b*, (9), *(b)* above.

(10) TEST OUTLETS (PBY-5A Only).

(a) DESCRIPTION. *(See figure 192.)*—The test outlets or test block is located under the hydraulic reservoir in the starboard engine nacelle. The test block provides a connection for a test stand to test the hydraulic system when it is not desirable to run the starboard engine. In connecting test stand to test block, use type hose (AC 39 G 1030W-10-180) specified on nameplate of the test block and special fittings 28F6696. *(See figure 40.)* The check valves in the block will not operate if the wrong hose is used. If test stand does not incorporate a reservoir, the reservoir in the wing should be filled and a man should be stationed there to continue filling the reservoir until system is completely full. If a test stand is used, the hydraulic pump should not deliver more than two gallons per minute.

(b) REMOVAL AND DISASSEMBLY. *(See figure 198.)*

1. Disconnect the two hydraulic lines.
2. Remove the two mounting bolts.
3. Disassemble as follows:

a. Unscrew the two fittings (1), allowing the gasket (2), spring (3), and valve (4) to be removed.

b. Unscrew two plugs (6) and remove two gaskets (5).

(c) MAINTENANCE.

1. Wash all parts in kerosene.
2. If leaking occurs at the valve, lap the valve seat with a fine lapping compound. If leaking still persists, replace the test block.

(d) ASSEMBLY AND INSTALLATION.—Reverse the procedure for removal and disassembly as outlined in paragraph *b*, (10), *(b)*.

(11) EMERGENCY HAND PUMP (PBY-5A Only).

(a) DESCRIPTION. *(See figure 192.)*—The hand pump (Pesco No. 437-F), is located on the floor inboard of the copilot's seat where it is accessible to either pilot or copilot. The pump has a removable handle, which is stowed on the forward, starboard face of bulkhead 2.

A suction line from the reservoir is connected to the aft end of the pump. The pressure line from the top of the pump delivers fluid directly to the accumulators, thereby by-passing the unloading valve. The hand pump is primarily used to supply pressure for the landing gear and brakes in event the engine-driven pump is rendered inoperative.

(b) REMOVAL AND DISASSEMBLY. *(See figure 199.)*

1. Relieve accumulator pressure. (See paragraph *b*, (4), *(b)*.)
2. Disconnect the two hydraulic lines from the pump (8).
3. Remove nuts (19) from the four mounting studs (18).
4. Disassemble pump as follows:

a. Remove lock ring (2) from the cap (1).

b. Unscrew cap (1).

c. Remove the following parts from the cap: snap ring (7), cage (6), spring (4), ball (5), and gasket (3).

d. Remove clevis bolt (17) attaching links (16) to piston.

e. Remove the piston from the cylinder through the cap end.

f. Remove seal ring (11) from piston (12).

g. Unscrew gland nut (9) and remove seal ring (10) from the cylinder.

(c) MAINTENANCE.

1. Wash all parts in a good commercial grade kerosene.

2. Replace any damaged parts or packing.

3. The cap gasket (3) should be replaced before reassembly.

(d) ASSEMBLY AND INSTALLATION.—Reverse the procedure for removal and disassembly as outlined in paragraph *b*, (11), *(b)* above.

c. MAIN LANDING GEAR HYDRAULIC SYSTEM (PBY-5A Only).

(See figure 200.)

(1) GENERAL.—Retraction or extension of the landing gear is controlled by the landing gear selector valve *(See figure 73.)* below the instrument panel.

When the selector valve (1) handle is rotated to the "DOWN" position, the fluid is transmitted directly to the main landing gear up-lock (5). When the hydraulic pressure reaches the up-lock, the lock is released and the fluid pressure continues to the actuating cylinder (4), which extends to lower the gear.

A fluid return valve (3) or by-pass valve and a by-pass line are incorporated on the actuating cylinder (4) to allow fluid at the bottom of the cylinder, which is being put under pressure by the weight of the landing gear, to pass directly to the top of the cylinder, and so aid the extension of the landing gear. When retracting the landing gear, the fluid flows from the selector valve to the down-locks (2). Once the down-locks are released, the fluid travels to the actuating cylinder (4), which retracts to raise the landing gear.

(2) MAIN LANDING GEAR ACTUATING CYLINDER.

(a) DESCRIPTION. *(See figure 200.)*—There are two main landing gear actuating cylinders (United Aircraft Products No. 41522), one to operate each of the landing gears, located in the landing gear wheel wells. The actuating cylinders contain a steel cylinder and piston rod, with aluminum alloy cylinder end caps. The actuating cylinder floats between a bracket near the upper end of the main strut and a bracket on the forward leg of the upper "Vee" struts. The operation of this actuating cylinder is similar to the usual type of hydraulic double acting cylinder or jack. Reversal of motion is accomplished by reversing the direction of flow of fluid by means of the selector valve. By piston retraction, the actuating cylinder applies torque to the strut system, folding the main strut inward and pulling the gear upward and into the well.

(b) REMOVAL AND DISASSEMBLY.

1. Relieve accumulator pressure. (See paragraph *b*, (4), *(b)*.)

2. To remove, see Par. 4, *b*, (5), *(b)*.

3. Disassemble cylinder as follows: *(See figure 201.)*

a. Remove the return valve. (See paragraph *c*, (5), *(b)*.)

b. Loosen the locknut (2) on the piston rod (7) and unscrew the yoke (1).

c. Unscrew piston rod packing nut (3).

d. Unscrew the radial locknuts (5) (one located at each of the cylinder heads (4) and (15)) by using a spanner wrench and a strap wrench (22U173). *(See figure 40.)*

e. Remove the cylinder heads from the cylinder barrel (6).

f. Withdraw the piston and rod assembly (14) from the cylinder barrel.

g. Remove the piston nut cotter pin (9) and unscrew the piston nut (8). Remove the two rings (10) and (13), the four chevron packings (11), and the spacer (12).

(c) MAINTENANCE.

1. If the cylinder is scored, scratched, or dented, see Par. 4, *b*, (5), *(c)* for repairs.

2. Replace all damaged packing.

3. To adjust the packing nut to stop minor fluid leakage around the piston rod, see Par. 4, *b*, (5), *(c)*, 3. Chevron packing is used to prevent leakage around the piston shaft and the piston. "O" or doughnut packing is used to seal the cylinder heads to the barrel.

(d) ASSEMBLY AND INSTALLATION.

1. Wash all parts in a good commercial grade of kerosene.

2. Use vaseline or neutral petroleum jelly on all threads.

3. Reverse the procedure as outlined for disassembly in paragraph *c*, (2), *(b)*, *3* above.

4. For installation see Par. 4, *b*, (5), *(e)*.

(3) MAIN LANDING GEAR UP-LOCK JACK.

(a) DESCRIPTION. *(See figure 200.)*—There are two up-lock jacks (Pesco No. 523 or Weston Aero Hydraulics No. 523) on the main landing gear, one at each of the gear up-locks. These jacks perform two functions: The first is to unlock the up-lock; the second is to act as a sequence valve and transfer fluid under pressure to the actuating cylinder. The jacks are located on the inside of the hull near the center of the wheel well and their shafts protrude through the hull and couple to the up-lock mechanism. The unit is made

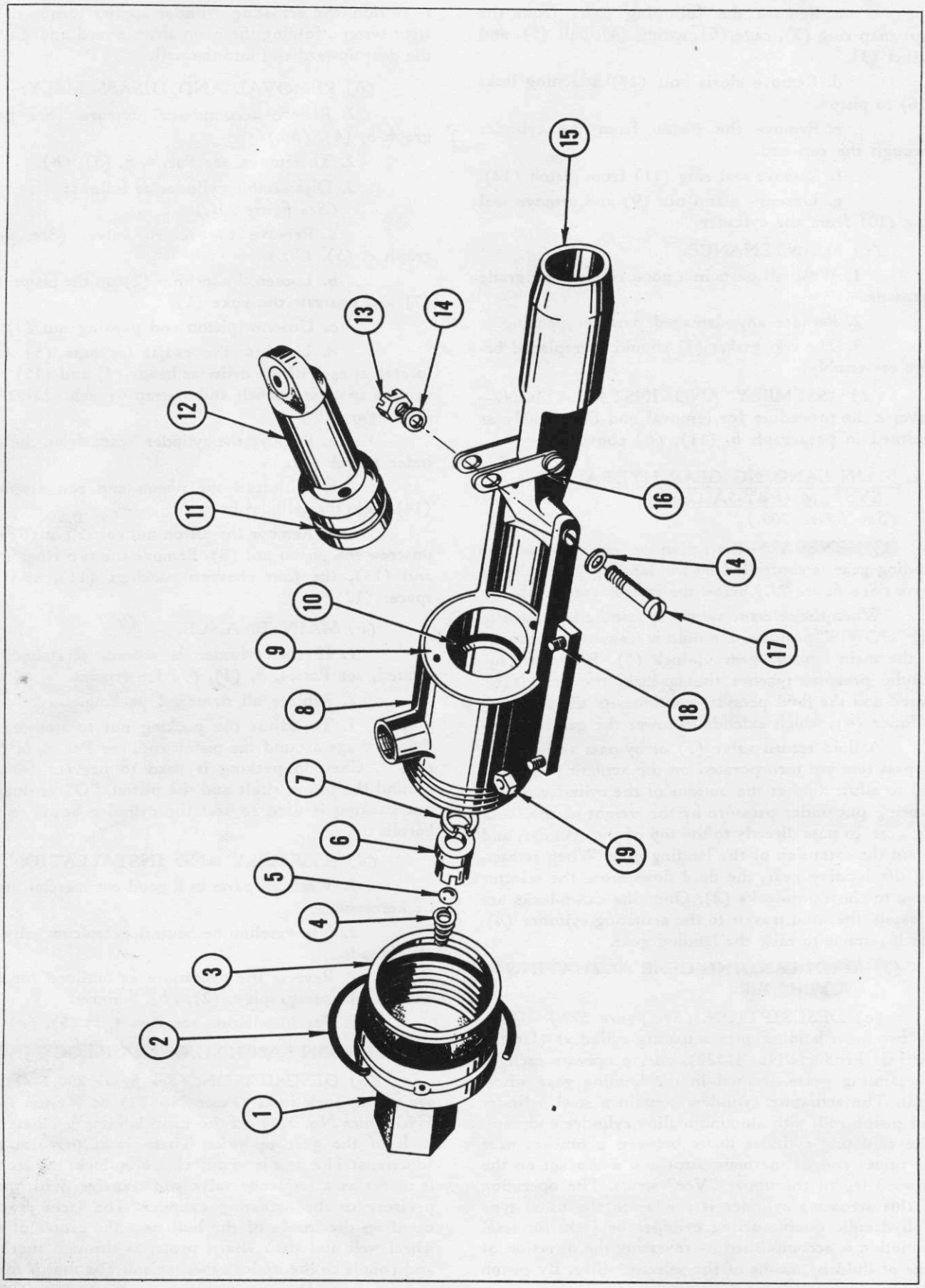


Figure 199—Emergency Hand Pump (PBY-5A Only)

No.	PART No.	NAME	No.	PART No.	NAME
1	437-2A	Cap	11	AN6227-22	Seal Ring (Piston Rod)
2	437-9	Lock Ring	12	437-3C	Piston
3	437-11A	Cap Gasket	13	AN320-4	Clevis Nut
4	437-13	Spring	14	AN960-416	Washer
5	227-13	Ball	15	437-54	Handle Bracket
6	437-12	Cage	16	437-8	Link
7	437-21	Snap Ring	17	437-28	Clevis Bolt
8	1H-437-F	Pump	18	28F6524	Mounting Stud
9	437-22	Gland Nut	19	AN365-428	Nut
10	AN6227-26	Seal Ring (Cylinder)			

All items except 10, 11, 13, 14, 18 and 19 are Pesco Products Corp. part numbers.
Hand pump assembly part number is 437F.

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up of a body, a valve, and a spring loaded piston. Fluid under pressure enters the jack, compresses the spring, and extends the piston to unlock the up-lock latch. Excess pressure opens a valve and allows the fluid to continue to the actuating cylinder. When the pressure is relieved, the spring brings the piston back to its retracted position. Return fluid is free to pass directly through the jack.

(b) REMOVAL.

1. Relieve accumulator pressure. (See paragraph *b*, (4), *(b)*.)

2. Remove the two hydraulic lines from the jack.

3. Disconnect mechanical linkage from jack to up-lock latch.

4. Remove four bolts attaching body of jack to hull sheer web.

(c) MAINTENANCE.—Replace the jack if it is not operating properly.

(d) INSTALLATION.—Reverse the procedure for removal as outlined in paragraph *c*, (3), *(b)* above.

(4) MAIN LANDING GEAR DOWN-LOCK JACK.

(a) DESCRIPTION. *(See figure 200.)*—There are two down-lock jacks, one at each gear, located inside the hull sheer web near the upper end of the main strut attachment point. Their shafts protrude through the hull and connect to a mechanical linkage (a bell crank and push-pull rod to the down-latch.) The operation and function of these jacks is the same as that for the up-lock jacks.

(b) REMOVAL.—Removal is similar to that as outlined in paragraph *c*, (3), *(b)* above.

(c) MAINTENANCE.—Replace the jack if it is not operating properly.

(d) INSTALLATION.—Installation is similar to that outlined in paragraph *c*, (3), *(d)* above.

(5) RETURN VALVE.

(a) DESCRIPTION.—The return valves are located on the upper end of the main landing gear actuating cylinders. These valves are used to return or by-pass fluid from the lower end of the cylinder to the upper end of the cylinder, reducing the volume of fluid required to lower the gear.

(b) REMOVAL.

1. Release pressure from landing gear accumulator. (See paragraph *b*, (4), *(b)*.)

2. Disconnect the three hydraulic lines from the return valve.

3. Remove the two mounting bolts.

(c) MAINTENANCE.

1. Wash all parts in a good commercial grade of kerosene.

2. Replace any worn or damaged parts.

(d) INSTALLATION. — Reverse procedure for removal as outlined in paragraph *c*, (5), *(b)* above.

d. NOSE WHEEL DOOR HYDRAULIC SYSTEM (PBY-5A Only).
(See figure 202.)

(1) GENERAL.—When the landing gear selector valve is rotated to the "DOWN" position, the fluid pressure is transmitted directly to the nose wheel door lock and sequence valve. After the fluid pressure has actuated the nose wheel door lock, the sequence section of the valve allows the pressure to proceed to the nose wheel door actuating cylinder (8) which opens the nose wheel doors.

When the landing gear selector valve is rotated to the "UP" position and the nose wheel actuating cylinder has fully extended and contacted the snap action sequence valve (7), the fluid pressure flows to the nose wheel door actuating cylinder (8). As the nose wheel doors close, a bell crank on the nose door torque arm actuates a sequence valve which passes the fluid pressure to the nose wheel door lock and sequence valve (1) to lock the door in the closed position.

(2) NOSE WHEEL DOOR ACTUATING CYLINDER.

(a) DESCRIPTION.—The nose wheel door actuating cylinder (Interstate No. 0625H) is a double

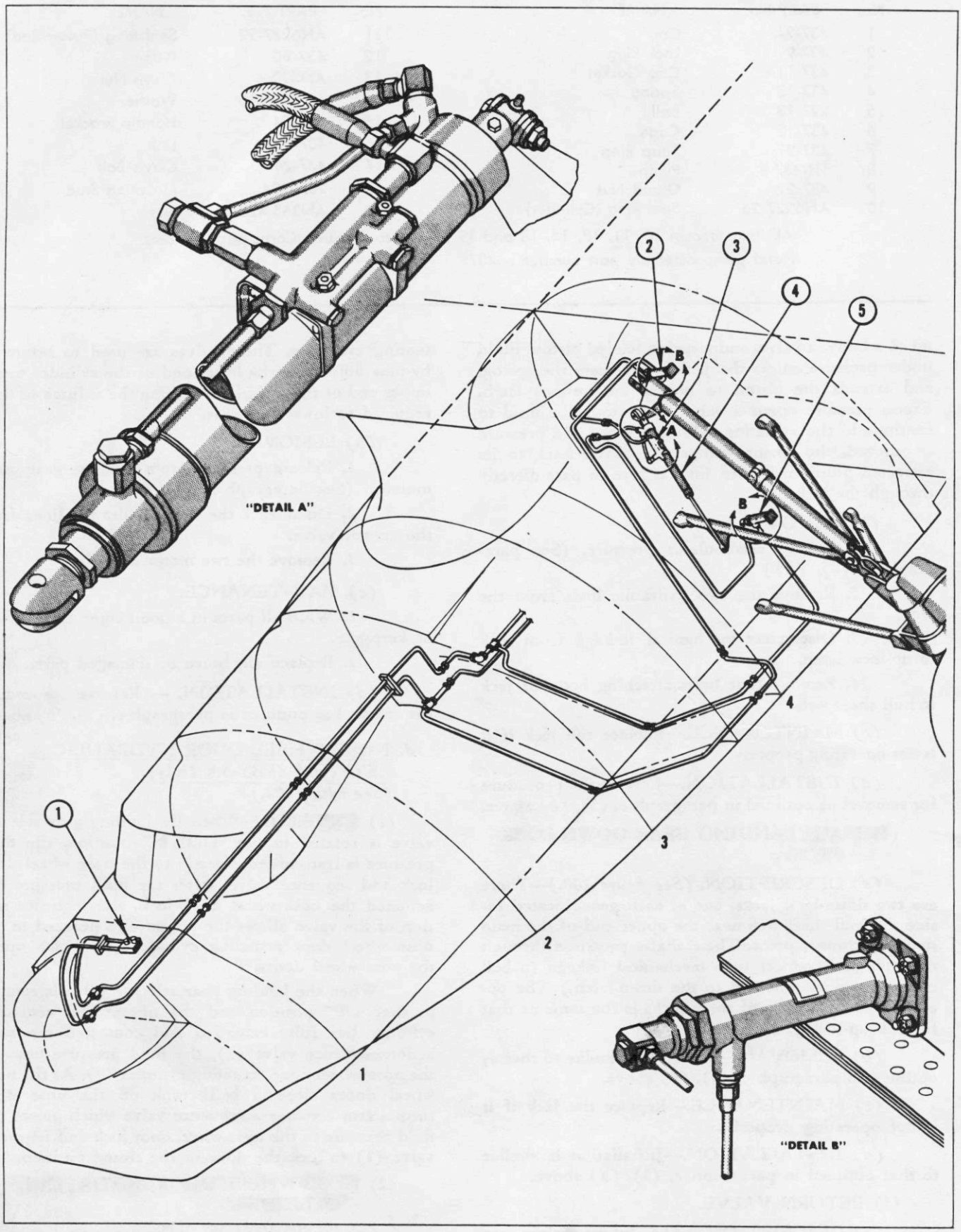

Figure 200—Main Landing Gear Hydraulic System Diagram (PBY-5A Only)

No.	PART No.	NAME	No.	PART No.	NAME
1	4V4001	Selector Valve	4	41522	Actuating Cylinder
2	523	Down-lock Jack	5	523	Up-lock Jack
3	D8067A	Return Valve			

Item number 1 is an Aerodraulics Co. part number.
Items under 2 and 5 are Weston Aero-Hydraulics Co. part numbers.
Item number 3 is an Adel Precision Products Corp. part number.
Item number 4 is a United Aircraft Products Corp. part number.

acting, single rod type cylinder which actuates the nose wheel door operating mechanism. The piston is two inches in diameter and has a stroke of 4.312 inches. The packing which seals the piston rod to the end cap is of the chevron type. It is retained by a packing nut. The piston is sealed to the barrel by means of a chevron packing. The end caps are threaded onto the barrel and sealed by means of a sealing ring and spanner nuts. The cylinder is mounted on two supports on the floor, aft of bulkhead 2 on the port side.

(b) REMOVAL AND DISASSEMBLY.

1. To remove nose wheel door actuating cylinder: *(See figure 88.)*

a. Check to make certain that all accumulator pressure has been relieved. (See paragraph *b*, (4), *(b)*.)

b. Disconnect the two lines at the fittings.

c. Remove the door torque arm link (4) from the clevis end (6) of the piston by removing the clevis bolt (5).

d. Remove cylinder (8) from the hull structure by removing the two bolts (7).

2. To disassemble the actuating cylinder:

a. Mount cylinder in a jig and unscrew nut and remove clevis end.

b. Remove retainer.

c. Loosen locknut and remove the end cap.

d. Slide the piston out of the cylinder.

e. The packings can now be removed and replaced if necessary.

f. Loosen locknut and remove the end cap.

g. The gaskets can now be removed from barrel and replaced if necessary.

(c) MAINTENANCE.

1. Replace leaking seals if there is evidence of external leakage.

2. Replace seal on piston if the cylinder bypasses fluid.

3. Scores and dents in the piston rod should be lapped out.

(d) ADJUSTMENTS.—To adjust nose door cylinder:

1. Close doors completely.

2. Extend piston rod until bottomed against cylinder end cap.

3. Adjust piston rod clevis to torque arm link and attach.

4. Detach clevis from torque arm link; screw the clevis out of the piston rod one quarter inch; and reattach to the torque arm link.

Note

The stop bolt in port side of cylinder is an adjusting bolt which regulates open travel of nose doors.

5. Open doors to within one half inch of touching outside skin. Clearance between nose gear and nose doors should be at least ¾ in.

(e) ASSEMBLY AND INSTALLATION.—To assemble and install nose door cylinder, reverse procedure outlined in foregoing paragraph *d*, (2), *(b)*.

(3) NOSE WHEEL DOOR MECHANICAL SEQUENCE VALVE.
(See figure 202.)

(a) DESCRIPTION. — Two mechanical sequence valves are installed at the aft end of the starboard nose wheel door torque tube. The flow of hydraulic fluid through each valve is controlled by a spring-loaded plunger which is actuated by the bell crank on the starboard torque arm. The bell crank contacts one valve when the doors are in the open position, and contacts the second valve when the doors are in the closed position.

The sequence valve, which is mounted vertically, is operated only when nose doors are in open position. Its purpose is to provide pressure for lowering the nose gear after nose doors are completely open. The sequence valve which is farthest outboard should not operate until doors are fully closed. Its purpose is to transmit pressure to the door lock and sequence valve.

(b) REMOVAL AND DISASSEMBLY.

1. To remove nose wheel door lock sequence valve: *(See figure 88.)*

a. Check to make certain that all accumulator pressure has been relieved. (See paragraph *b*, (4), *(b)*.)

b. Disconnect the two hydraulic lines at the fittings.

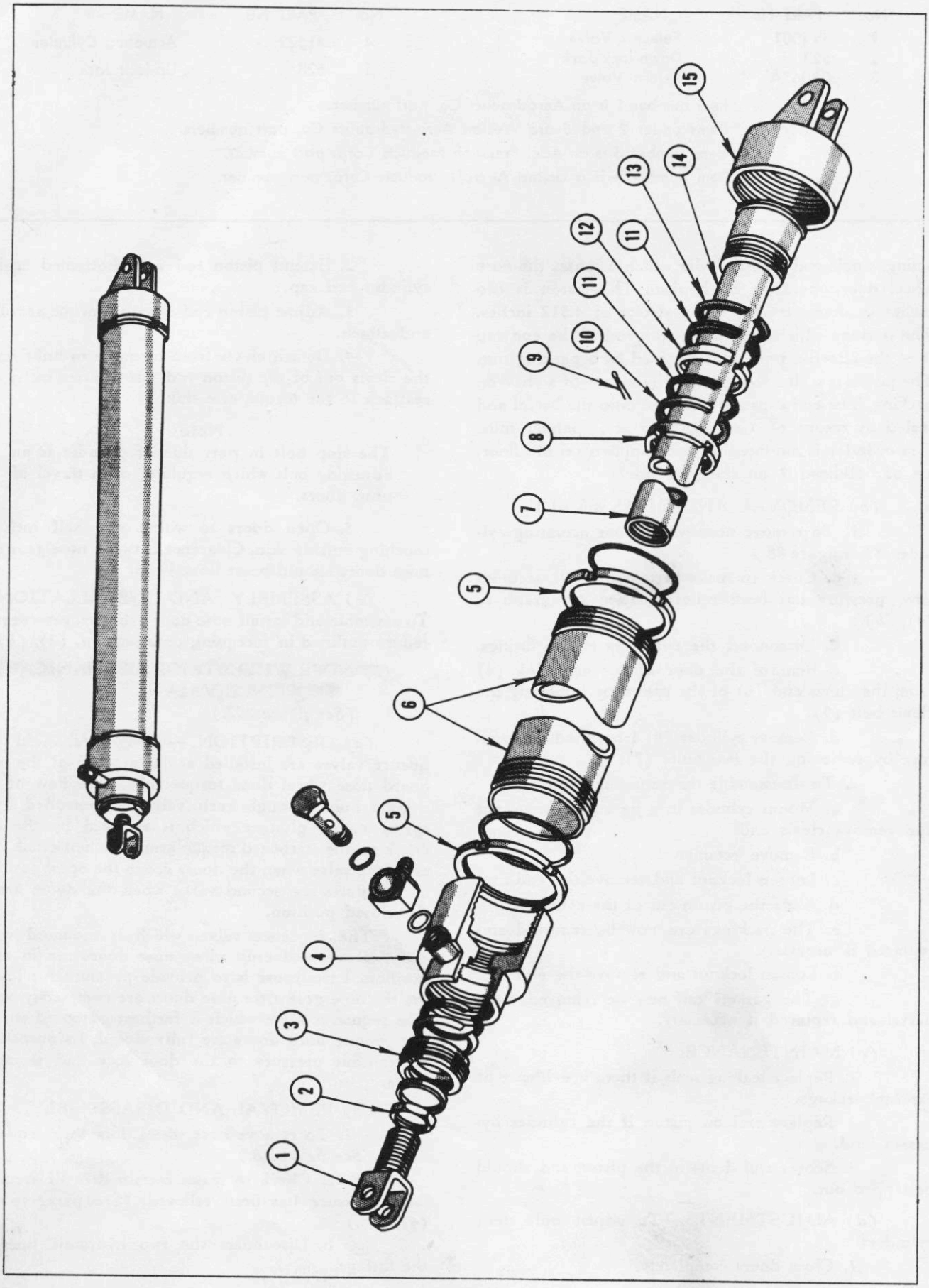

Figure 201—Main Landing Gear Actuating Cylinder (PBY-5A Only)

No.	PART No.	NAME	No.	PART No.	NAME
1	21557	Yoke	10	Hycar 20308 D200-008-004	Piston Ring
2	11556	Locknut			
3	21555	Packing Nut	11	Hycar 20333 4G-H200	Chevron Packing
4	41433	Cylinder Cap			
5	21554	Locknut	12	11559	Spacer
6	41389	Cylinder Barrel	13	Hycar 20308D200-008-001	Piston Ring
7	41574	Piston Rod End			
8	21560	Piston Nut	14	41574	Piston and Rod Assembly
9	AN380-2-2	Cotter Pin	15	41549	Cylinder End

All part numbers except 9, 10, 11 and 13 are United Aircraft Products Co. part numbers.

The part number of the cylinder assembly is 41522.

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c. Remove the three bolts (39) attaching the valve (34) to the mounting bracket (35).

2. The removal of the nose wheel sequence valve is the same as for nose wheel door lock sequence valve as outlined in foregoing paragraph *d*, (3), *(b)*, *1.*

3. To disassemble sequence valve:

a. Unscrew nut and bumper.

b. Remove valve cap.

c. The plunger, spring, washer, retainers, and linear packing can now be removed from the housing, and packing replaced if necessary.

(c) MAINTENANCE.

1. Inspect valve for leaks, and replace packing if necessary.

2. If plunger sticks or fails to move freely, disassemble and clean thoroughly with a good commercial grade of kerosene.

(d) ADJUSTMENTS.

1. To adjust nose wheel door lock sequence valve:

a. Screw adjusting nut on to the shaft of the plunger as far as possible.

b. Close nose doors completely.

c. Adjust cap on plunger so that torque arm crank contacts and operates valve 3/16 inch plus or minus 1/32 inch. Be sure plunger in valve does not bottom.

2. To adjust nose wheel sequence valve:

a. Screw adjusting nut on to the shaft of the plunger as far as possible.

b. Open nose doors to within ½ inch of touching outside skin.

c. Place cap on plunger so that torque arm crank contacts plunger and operates valve 3/16 inch ± 1/32 inch. Be sure plunger in valve does not bottom.

d. Check operation of valve several times by opening and closing doors, using the hand pump.

(e) ASSEMBLY AND INSTALLATION.—To assemble and install mechanical sequence valves, reverse procedure outlined in foregoing paragraph *d*, (3), *(b)*.

(4) NOSE WHEEL DOOR SNAP ACTION SEQUENCE VALVE.

(a) DESCRIPTION.—The snap action sequence valve is located on the starboard side of the auxiliary keel immediately below the copilot's inboard rudder control pedal. The forward port of this valve connects with the nose door cylinder up-line. The aft port connects with the up-line of the selector valve. When the nose wheel is fully retracted, the bell crank, which is attached to the torque arm of the nose wheel, actuates the spring loaded piston of the snap action valve. The piston unseats the ball check and allows the fluid pressure to flow to the nose wheel door actuating cylinder.

(b) REMOVAL. *(See figure 85.)*—To remove the snap action valve from the airplane:

1. Check to make certain that all accumulator pressure has been relieved. (See paragraph *b*, (4), *(b)*.)

2. Disconnect the two hydraulic lines at the fittings.

3. Remove the three bolts (24) attaching the valve to the twin keel.

(c) MAINTENANCE.

1. Inspect the snap action valve for leaks and and replace if necessary.

2. No repair of the snap action valve should be attempted except by specially trained personnel.

(d) ADJUSTMENTS.—This valve has a screw plunger type of adjustment in the forward end of the valve. The plunger is actuated approximately ¾ inch and should be adjusted to operate the last ⅛ inch of travel of plunger when nose gear is moving to the up and locked position. A definite snap can be heard when valve operates.

(e) INSTALLATION.—To install snap action valve, reverse removal procedure outlined in foregoing paragraph *d*, (4), *(b)*.

(5) NOSE WHEEL DOOR LOCK AND SEQUENCE VALVE.

(a) DESCRIPTION. *(See figure 202.)*—The door lock and sequence valve is a combination actuat-

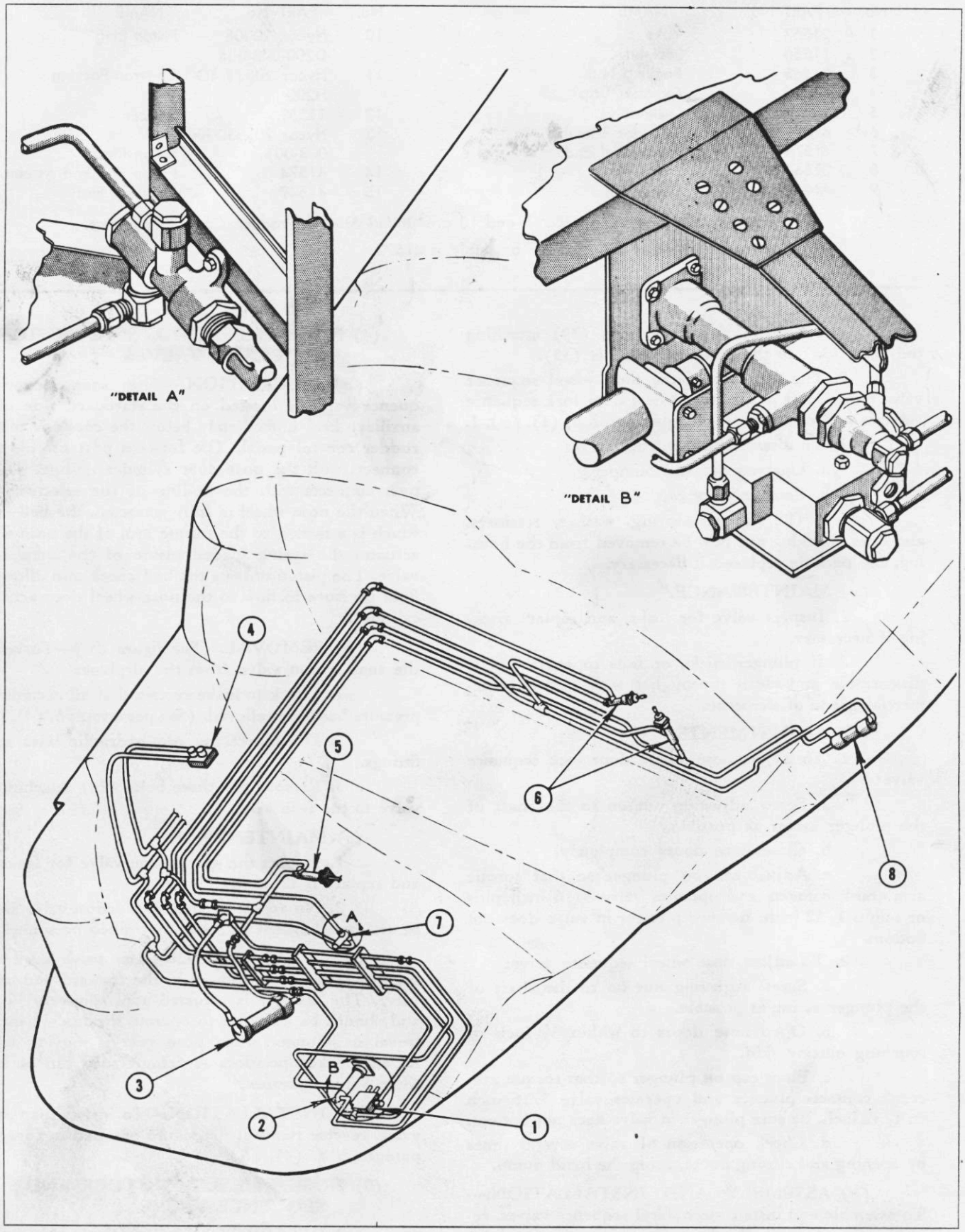


Figure 202—Nose Landing Gear Hydraulic System Diagram (PBY-5A Only)

No.	PART No.	NAME	No.	PART No.	NAME
1	28F6619	Door Lock and Sequence Valve	5	523	Up Lock Jack
2	523A	Down Lock Jack	6	28F6501	Sequence Valve
3	51518	Nose Wheel Actuating Cylinder	7	41531	Snap Action Sequence Valve
4	4V4001	Selector Valve	8	O625H	Nose Wheel Door Cylinder

Items number 2 and 5 are Weston Aero-Hydraulics Co. part numbers.
Items number 3 and 7 are United Aircraft Products Co. part numbers.
Item number 8 is an Interstate Engineering Co. part number.

ing cylinder and sequence valve. The starboard side of the valve is the actuating side and is connected to the door locking pins. The port side is the sequence side of the valve and is operated by the nose wheel door lock pin mechanism. The actuating side of the valve merely locks or unlocks the nose doors. The sequence side of the valve allows the nose wheel doors to open only after the door lock pins have been disengaged from the doors.

On the actuating side of the valve, the piston rod is sealed by two linear packings on the aft end and four linear packings on the forward end. On the sequence side of the valve, the plunger is sealed by three linear packings. The nose wheel door lock and sequence valve is installed on the center line of the plane, immediately forward of station 1.0 and just above the keel.

(b) REMOVAL AND DISASSEMBLY.

1. To remove nose wheel door lock and sequence valve: *(See figure 88.)*

a. Check to make certain that all accumulator pressure has been relieved. (See paragraph *b*, (4), *(b)*.)

b. Disconnect the three hydraulic lines at the fittings.

c. Remove the two bolts (25) attaching the nose wheel lock and sequence valve (24) to bracket.

d. Remove bolt (23) attaching clevis end (26) of actuating valve to door lock link (22).

e. Detach the two lock pin assemblies (19) from lock mechanism assembly (21) by removing clevis bolt (20) attaching each assembly.

f. Remove the lock mechanism assembly (21) from airplane by removing the four attaching bolts (28).

2. To disassemble the nose wheel door lock and sequence valve:

a. On the actuating side of the valve, unscrew the nut and clevis end.

b. Remove plug and then remove the gasket, packing glands, and linear packings. Packings can be replaced if necessary.

c. Remove the plug, gasket, and shaft from the housing.

d. Remove the snap ring from the split collar.

e. Retainers and linear packing can now be removed from piston.

f. On sequence side of valve unscrew the bumper and nut from plunger.

g. Remove plug and plunger.

h. Spring, retainer, and linear packing can now be removed.

i. Remove plug, gasket, spring, and plunger from housing.

(c) MAINTENANCE.

1. Inspect valve for leaks. If valve leaks, replace packing or gaskets.

2. Scores and dents on shaft and plunger should be lapped out.

(d) ADJUSTMENTS.—To adjust door lock and sequence valve:

1. Push emergency door locking arm aft, so that end of door locking pins are $\frac{1}{8}$ inch $\pm$ 1/16 inch forward of rear face of bulkhead 1.

2. Bottom the piston side of valve (starboard side) by pushing piston shaft into valve.

3. Adjust clevis on shaft of piston to align with door locking assembly.

4. Attach and tighten locknut on piston shaft.

CAUTION

In the tightening of bolts on all clevises and linkages, caution should be exercised so that bolts are loose enough to allow mechanism to operate freely.

5. After above adjustment has been made, adjust bumper on sequence side of valve (port side) so that a total travel of 3/16 inch plus zero and minus 1/32 inch is obtained on the plunger.

CAUTION

Be careful that plunger does not bottom.

(e) ASSEMBLY AND INSTALLATION.—To assemble and install nose wheel door lock and sequence valve, reverse procedure outlined in foregoing paragraph *d*, (5), *(b)*.

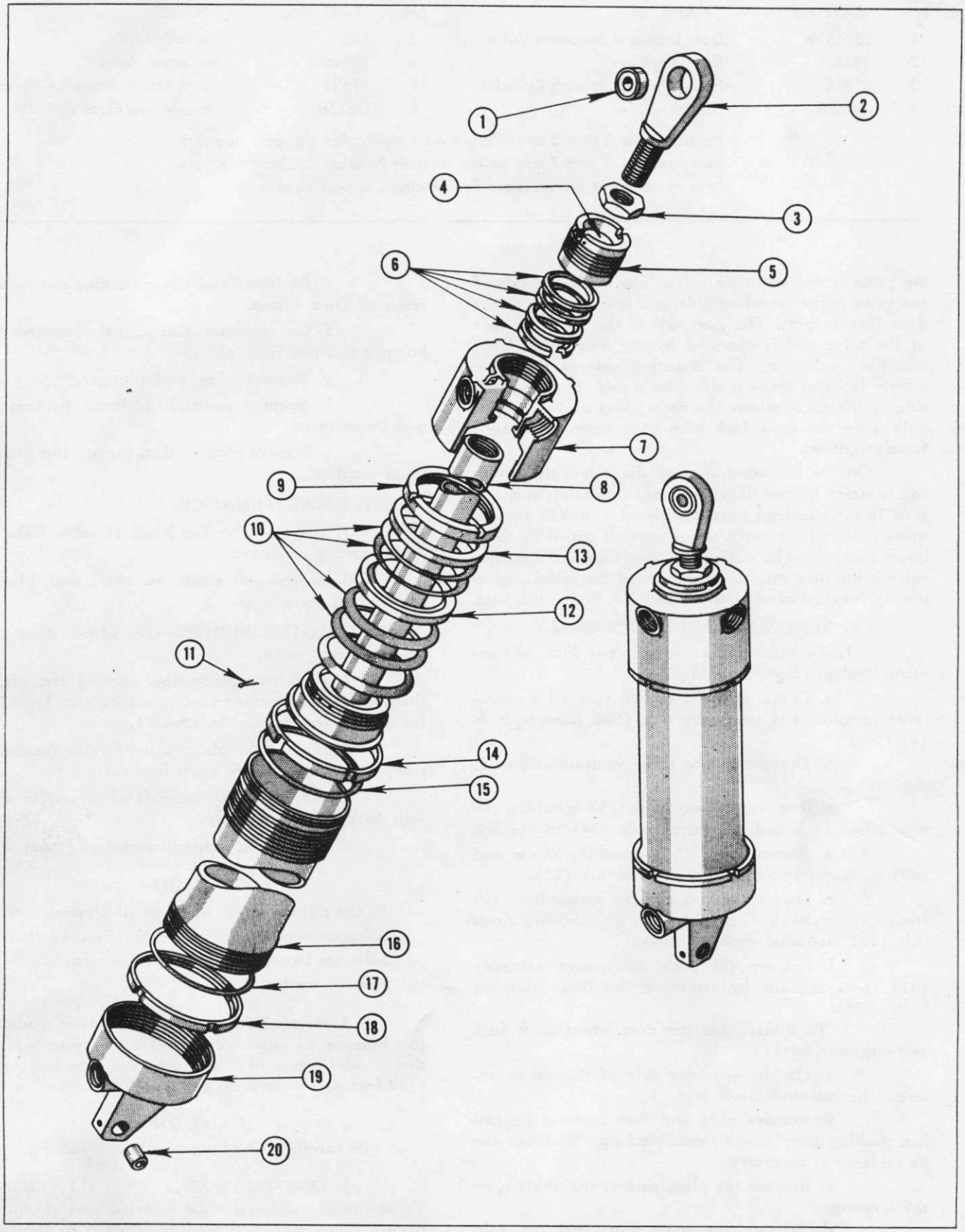


Figure 203—Nose Wheel Actuating Cylinder (PBY-5A Only)

No.	PART No.	NAME	No.	PART No.	NAME
1	RCB5	Bearing	12	11576	Spacer
2	21572	Eye Bolt	13	20308D208-008-001	Ring
3	11575	Nut	14	21566	Nut
4	20300-100F107-125	Washer	15	20312-093-228	Seal Ring
5	21565	Gland Nut	16	21567	Cylinder
6	AN6225-20	Packing	17	20312-093-228	Ring (Synthetic Rubber)
7	21563	End	18		Nut
8	41571	Piston Assembly	19	41562-2	Cap
9	21564	Nut	20	10321-438-5A307-812	Bushing
10	20333-4GH208	Packing—Hycar			
11	AN380-2-2	Cotter			

All items except 6 and 11 are United Aircraft Products Co. part numbers.

e. NOSE LANDING GEAR SYSTEM (PBY-5A Only).
(See figure 202.)

(1) GENERAL DESCRIPTION. — When the landing gear selector valve is rotated to the "DOWN" position and the nose wheel door is opened, a contact arm actuates a sequence valve (7), which releases to allow the pressure to flow to the nose wheel up-lock (5). This up-lock in turn, once actuated, by-passes the fluid pressure to the nose gear actuating cylinder (3). This cylinder (3) retracts to lower the nose landing gear.

When the landing gear selector valve (4) is rotated to the "UP" position, the fluid pressure is transmitted to the nose gear down-lock (2). From the nose gear down-lock, the fluid pressure is routed to the nose wheel actuating cylinder (3), which extends to retract the nose gear.

(2) NOSE WHEEL ACTUATING CYLINDER.

(a) DESCRIPTION. *(See figure 202.)*—The nose wheel actuating cylinder is a single rod, double-acting cylinder. The clevis end of the piston attaches to the nose landing gear. When the piston is extended, the landing gear is retracted; when the piston is retracted, the landing gear is extended. This cylinder contains a steel cylinder and piston rod with chevron type packings used to seal the piston at both ends.

The nose landing gear actuating cylinder is located forward of bulkhead 1, and is suspended between the nose wheel landing gear torque arm and the hull structure.

(b) REMOVAL AND DISASSEMBLY.

1. Remove the nose wheel actuating cylinder from the airplane as follows: *(See figure 85.)*

a. Check to make certain that all accumulator pressure has been relieved. (See paragraph *b*, (4), *(b)*.)

b. Disconnect the two lines at the fittings.

c. Disconnect the clevis end (30) of the cylinder from torque tube arm (22) by removing bolt.

d. Remove cylinder from retracting fitting (31) by removing clevis bolt (19).

2. Disassemble nose wheel cylinder as follows: *(See figure 203.)*

a. Unscrew the nut (3) and clevis end (2).

b. Unscrew gland nut (5), locknut (9) and end (7).

c. Remove piston (8) from cylinder (16).

d. Remove cotter (11), nut (9), and packing (10) from piston (8).

e. Loosen nut (18) and remove cap (19) and ring (17).

(c) MAINTENANCE.

1. Inspect cylinder for leaks.

2. If cylinder leaks at clevis end; loosen gland nut; work piston back and forth a few times; tighten gland nut.

CAUTION

Be careful not to bind piston rod.

3. If cylinder continues to leak after tightening gland nuts (5), replace packings (6).

4. If cylinder leaks at caps, replace seals (15) and (17).

5. See Par. 4, *c*, (3), *(c)* for removing scores, dents, or scratches from the piston rod.

(d) ADJUSTMENTS. — For adjustment of nose landing gear cylinder, see Par. 4, *c*.

(e) ASSEMBLY AND INSTALLATION.—To assemble and install nose landing gear cylinder, reverse procedure outlined in foregoing paragraph *e*, (2), *(b)*.

(3) NOSE WHEEL UP-LOCK JACK.

(a) DESCRIPTION.—The nose wheel up-lock jack (Pesco No. 523 or Weston Aero-Hydraulics No. 523) is similar to the jack used for main wheel up-lock jack (See paragraph *c*, (3).) When this up-lock jack is actuated by the hydraulic fluid, the spring loaded piston contacts the nose wheel up-latch and releases it. The fluid then by-passes to the nose gear actuating cylinder. This nose wheel up-lock jack is located aft of bulkhead 1 and attached to the up-lock bracket.

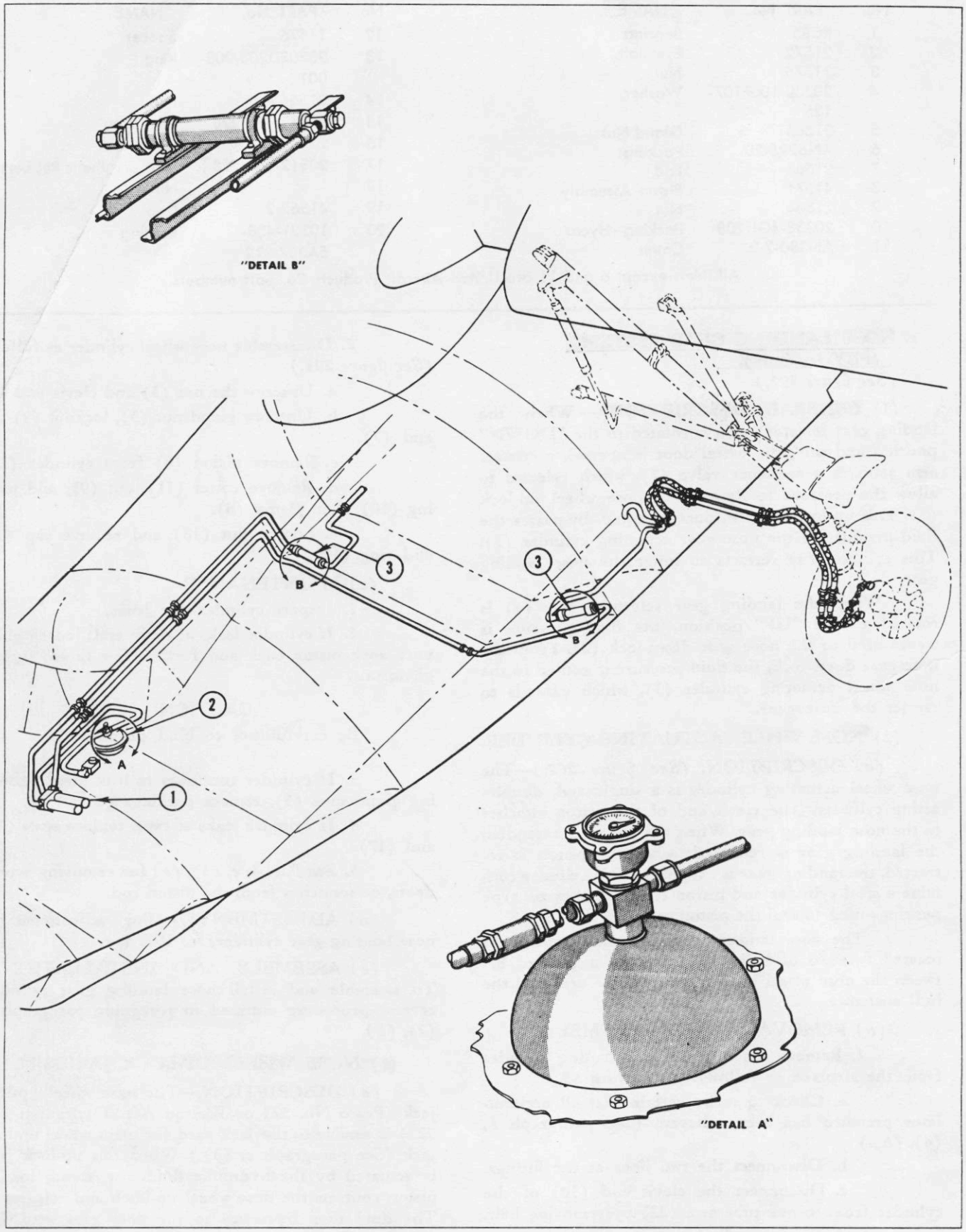


Figure 204—Brake Hydraulic System Diagram (PBY-5A Only)

No.	PART No.	NAME
1	36020A	Brake Valve
2	14005	10 inch Accumulator
3	36021	Brake Debooster

Items number 1 and 3 are Aircraft Accessories Corp. part numbers.
Item number 2 is a Vickers Inc. part number.

(b) REMOVAL.—Remove up-lock jack from airplane as follows: *(See figure 85.)*

1. Check to make certain that all accumulator pressure has been relieved. (See paragraph *b*, (4), *(b).*)

2. Disconnect the two hydraulic lines at the fittings.

3. Remove the four bolts (5) attaching the jack (6) to the up-lock bracket (3).

(c) MAINTENANCE.
(See paragraph *c*, (3), *(c).*)

(d) INSTALLATION. — To install up-lock jack, reverse the procedure outlined in foregoing paragraph *e*, (3), *(b).*

(4) NOSE WHEEL DOWN-LOCK JACK.

(a) DESCRIPTION.—The nose wheel down-lock jack (Pesco 523A or Weston Aero-Hydraulics No. 523A) is similar to the main wheel up-lock jack. (See paragraph *c*, (3).) When the down-lock jack is actuated by the hydraulic fluid, the spring loaded piston contacts the nose wheel down-lock and releases it. The fluid then by-passes to the actuating cylinder. This nose wheel down-lock jack is located forward of bulkhead 1 and is attached to the nose landing gear drag fitting.

(b) REMOVAL.—Remove down-lock jack from the airplane as follows: *(See figure 85.)*

1. Check to make certain that all accumulator pressure has been relieved. (See paragraph *b*, (4), *(b).*)

2. Disconnect the two hydraulic lines at the fittings.

3. Remove the four bolts (42) attaching the jack (41) to the drag fitting (38).

(c) MAINTENANCE.—For maintenance of down-lock jack, see paragraph *c*, (3), *(c).*

(d) INSTALLATION.—To install down-lock jack, reverse the removal procedure outlined in foregoing paragraph *e*, (4), *(b).*

f. BRAKE HYDRAULIC SYSTEM
(PBY-5A Only).
(See figure 204.)

(1) GENERAL DESCRIPTION.—The brake system consists of a 10 inch (inside diameter) accumulator (2), brake control valve (1), and two deboosters (3). When the brake control valve is actuated, the fluid pressure flows by way of the deboosters to the brake cylinders. In response to the brake control valve, these deboosters apply hydraulic fluid pressure to the brake, and deboost or unload the brakes when the actuating pressure is released by the brake control valve. When the brake control valve is released, the low pressure chamber removes the amount of oil used to operate the brakes back into the low pressure chamber of the debooster.

(2) 10-INCH ACCUMULATOR.

(a) DESCRIPTION.—This pressure accumulator (Vickers AA-14005) is a 10 inch unit consisting of two halves which screw together (right-hand thread) clamping a rubber diaphragm in place. The rubber diaphragm completely seals the air chamber from the oil chamber. An air valve leads into the air chamber from the bottom and a hydraulic fluid line leads into the oil chamber from the top. The hydraulic fluid enters the oil chamber and compresses the air chamber until the pressure equalizes. Hence a small quantity of fluid is stored in the accumulator for immediate use. In operation, the air chamber is charged with compressed air to 600 lb/sq in. The 10 inch accumulator is located on the hydraulic platform, which is situated below and outboard of the copilot's seat.

(b) REMOVAL.

1. Drop system pressure completely. (See paragraph *b*, (4), *(b).*)

2. Release air pressure by unscrewing the air valve core slowly until a hissing sound is heard. *(See figure 195.)*

3. Disconnect fluid line at fitting on top of accumulator.

4. Disconnect air pressure line at fitting on bottom of accumulator.

5. Remove accumulator by detaching six bolts (7) from collar.

(c) MAINTENANCE.—If unit does not function properly, it should be sent to nearest repair base.

Note

For hydraulic accumulator air valve cores, use only Dill 302-D or Schrader 2300. These are high pressure cores having neoprene seals and may be identified by a raised letter "H" on the head and by the black neoprene valve seat. In conjunction with these high pressure valve cores, it will be necessary to use valve caps, Schrader 2525 or Dill 637—painted yellow. Any valve core other than approved valve cores will result in loss of air pressure and hydraulic failure.

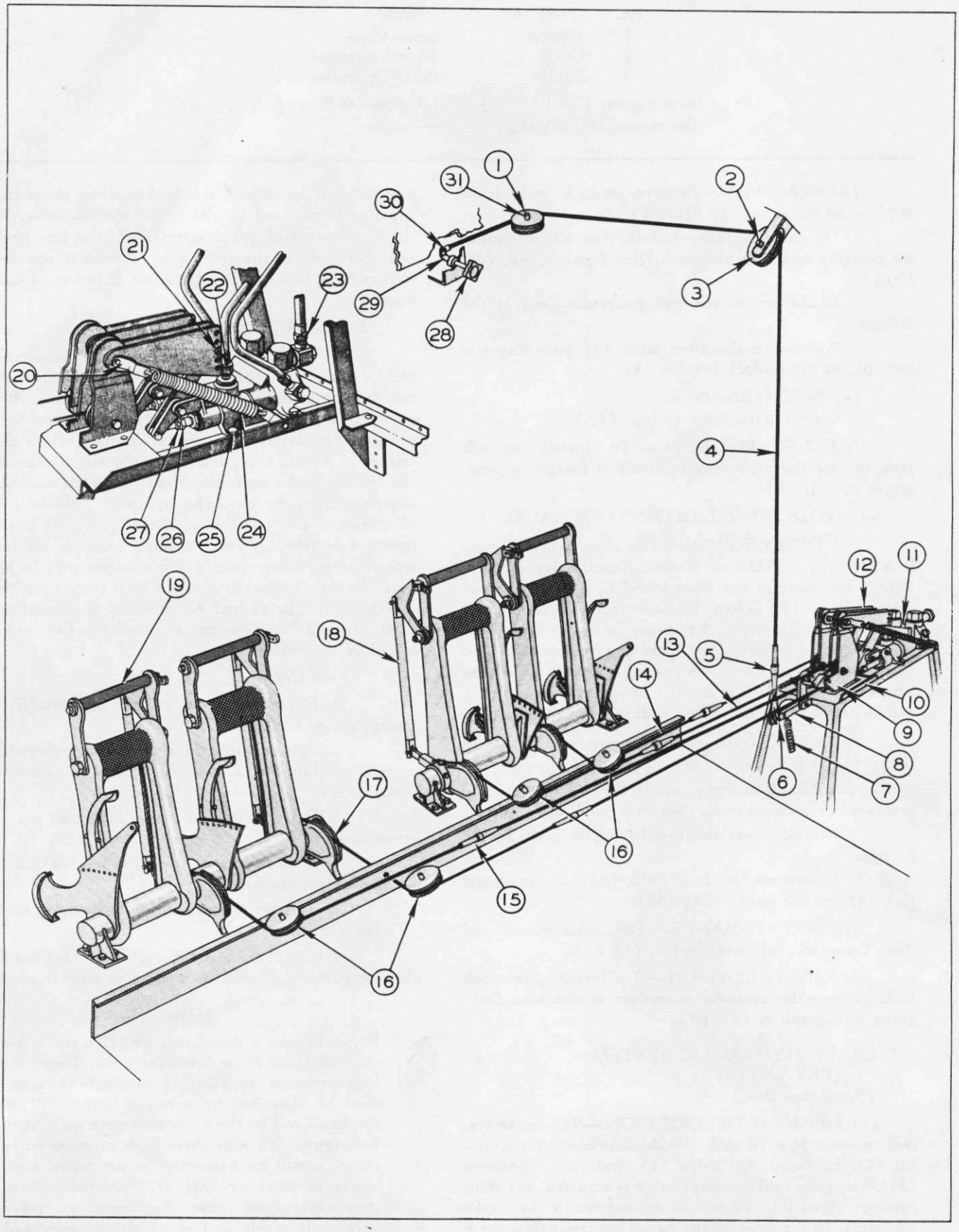


Figure 205—Brake Controls (PBY-5A only)

No.	PART No.	NAME
1	AN210-2A	Pulley
2	AN3-10	Bolt
	AN310-3	Nut
	AN960-AL10	Washer
	Q7020-D8-125	Washer
3	AN210-2A	Pulley
4	28C5732	Cable
5	AN155-16L	Turnbuckle
6	AN3-5	Bolt
	AN310-3	Nut
	AN960-10	Washer
	AN380-C2-2	Cotter
7	28C5727	Spring
8	28C5718	Locking Pawl
9	36148	Lever Arm
10	28C5703	Support
11	36020A	Brake Valve
12	28C5539	Lever Arm
13	28C5728-0	Cable
14	28C5728-2	Cable
15	AN155-16L	Turnbuckle
16	AN210-2A	Pulley
17	28C5701-2	Bell Crank
18	28C5707	Link Arm
19	28C5587	Brake Pedals
20	28C5538	Tab
21	AN4DD-7	Bolt
	AN960A416	Washer
	AN310D-4	Nut
	AN380C2-2	Cotter Pin
22	AC811BT-8D	Fitting
23	AC811BT-8D	Fitting
24	NSC001	Spring
25	AN3-6A	Bolt
	Q7102A10	Washer
	AN365-1032	Nut
26	36436	Locknut
27	AN316-5R	Locknut
28	28C1066	Handwheel
29	28C5713	Bell Crank
30	AN3-5	Bolt
	AN310-3	Nut
	AN380C2-2	Cotter
	AN960-10	Washer
31	AN3-DD21	Bolt
	AN310-3	Nut
	AN960-A10	Washer
	AN380C2-2	Cotter

Items number 9, 11, and 26 are Aircraft Accessories Corp. part numbers.

(d) INSTALLATION.

1. Attach the accumulator to the hydraulic platform by means of the attachment collar and the six collar bolts (7).

2. Connect hydraulic fluid lines to fitting on top of accumulator.

3. Connect air pressure line to fitting on bottom of accumulator.

(3) DEBOOSTER.

(a) DESCRIPTION.—The debooster consists of a steel barrel cylinder fitted with a spring loaded piston that divides the cylinder into two pressure chambers; a high pressure, low volume chamber connecting directly to the brake control valve; and a low pressure, large volume chamber connecting directly to the wheel brakes. The low pressure chamber is approximately three times the area of the high pressure chamber, which gives usable operating pressure for the wheel brakes. Fluid pressure from the control valve acts on the inside of the piston to move the piston against the pressure of the return spring, and force fluid in the low pressure chamber out into the wheel brake. The quantity of fluid forced into the wheel brakes, and consequently the force applied to the brake discs, depends upon the pressure applied by the brake control valve. When the pressure from the brake control valve is diminished or released, the piston return spring drives the piston away from the outlet end and thereby unloads a corresponding amount of fluid from the wheel brake which consequently releases the brake piston. The deboosters are located just forward of bulkhead 4 on hull bottom. The high pressure end (outboard end) may be recognized by noting the breather holes.

(b) REMOVAL.

1. Drop system pressure completely. (See paragraph *b*, (4), *(b)*.)

2. Disconnect hydraulic lines from fittings on outboard and inboard ends of cylinder.

3. Remove two metal clamps which hold the cylinder in place. Remove protecting neoprene strips from beneath clamps.

4. Remove cylinder and micarta blocks.

(c) MAINTENANCE.—If the unit does not function properly, it should be sent to nearest repair base.

(d) INSTALLATION.

1. Install the two micarta blocks.

2. Install debooster cylinder by attaching the two clamps over protecting neoprene strips and tightening four mounting bolts.

3. Connect hydraulic fluid lines.

(4) BRAKE CONTROL VALVE.

(a) DESCRIPTION.—The brake control valve is a right and left brake valve built into one integral unit. The unit consists of an aluminum housing with two barrels, each having same type and number of integral parts. In general each contains a piston, regulator springs, poppet and seat, actuating rod, and seal caps. This unit transmits hydraulic power for actuation of the main landing gear by directing energy stored

at high pressure in the 10 inch hydraulic accumulator to the hydraulic brakes in such a way as to vary the pressure in the brake at the will of the pilot or copilot. It is located outboard of the copilot's right rudder pedal. The power brake control valve (A.A.C. 36020A) is adjustable and is pre-set for a maximum pressure of 600 ± 50 lb/sq in.

(b) REMOVAL.

(See figure 205.)

1. Detach right and left brake line fittings.

2. Detach hydraulic fluid pressure line from top outboard fitting (23).

3. Detach hydraulic line from top inboard fitting (22).

4. Remove the two tension springs (24) from the two tab connections (20).

5. Remove two lever arm bolts (21).

6. Remove four mounting bolts (25) attaching valve to bracket.

(c) MAINTENANCE.—In case of failure, overhaul should be undertaken only at regular repair depots where facilities for overhaul and testing are available.

(d) ADJUSTMENTS.—All valves should be adjusted to regulate within a range of 0 to 600 ± 50 lb/sq in. To adjust, loosen the two locknuts (26) and (27) on valve piston rod and adjust rod travel to give maximum brake pressure with full lever deflection. To decrease pressure, shorten stroke; to increase pressure, lengthen stroke.

(e) INSTALLATION.—Care must be exercised to insure that the installation of the connecting linkage will be such that the loss of motion or "play" is held to a minimum.

1. Attach valve to bracket by installing four mounting bolts (25).

2. Connect the two lever arms (12) by installing two bolts (21).

3. Attach two tension springs (24) to tabs (20).

4. Connect right and left brake fluid lines to fittings located on top, forward, and aft respectively.

5. Connect hydraulic fluid line to fitting on top outboard.

6. Connect hydraulic fluid line to fitting on top inboard.

(5) BRAKE CONTROLS.

(a) GENERAL. *(See figure 205.)*—The brake controls consist of the pilot's and copilot's brake pedals operating a dual parallel linkage and cable system, and the parking brake control operating a single cable system. Motion induced by the brake pedals passes along the connecting cables, over a set of pulleys, and to the power brake valve. The brake pedals, hinged from the tops of the rudder pedals, may be operated by the pilot or copilot.

The parking brake control system has a single cable extending from a handwheel (located below the starboard side of the pilot's instrument panel) to the starboard wall and vertically downward to the locking pawl which is immediately inboard of the control valve lever assembly and held clear of the linkage and cable system by a tension spring connected to the pawl and hull bottom.

(b) BRAKE PEDAL CONTROL SYSTEM.

1. DESCRIPTION. *(See figure 205.)*—When pressure is exerted on the brake pedals (19), the link arm (18) moves the bell crank (17) and the motion passes along the cable (13) around a set of pulleys (16) and to the power brake valve lever arm (12) which actuates the power brake valve.

2. REMOVAL.

a. Break safety wire and remove tension from cables by loosening turnbuckles (15).

b. Remove bolts attaching cables to pilot's and copilot's rudder pedal bell cranks (17).

c. Remove two pulley bolts and two pulleys from control valve lever arm assembly.

d. After detaching pilot's and copilot's footrests, remove pulleys (16) and then withdraw cables (13) and (14).

3. MAINTENANCE.

(Refer to Par. 18, *b*, (3).)

4. INSTALLATION.—Assemble the brake pedal cable system by reversing the procedure for removal as outlined in paragraph *f*, (5), *(b)*, *2.*

(c) PARKING BRAKE CONTROL SYSTEM.

1. DESCRIPTION. *(See figure 202.)*—Controlled by the handwheel (28), this system will engage and lock the brake linkage and cable system and hold the brakes in the "ON" position. When the brake pedals (19) are actuated to the "ON" position, the control valve lever arm (9) is moved into position to become engaged and locked by the locking pawl (8). This locking pawl (8), held clear of the linkage system by its tension spring (7), may be pulled down into position to engage and lock the arm (9) by the vertical connecting cable (4) which is actuated by the control handwheel (28). It is necessary for the brakes to be in the "ON" position before the pawl (8) can engage and lock the arm (9). To release the parking brakes, pressure is exerted on the brake pedals (19) and the cable and linkage system will be moved in such a way that the arm (9) is free of the pawl and the pawl will again be pulled into the unlocked position by its spring (7).

2. REMOVAL.

a. Remove tension from cables (4) by breaking safety wire and loosening turnbuckle (5).

b. Disconnect lower end of cable (4) and spring (7) from locking pawl (8) by removing bolt (6).

c. Detach upper end of cable (4) from bell crank (29) by removing clevis bolt (30).

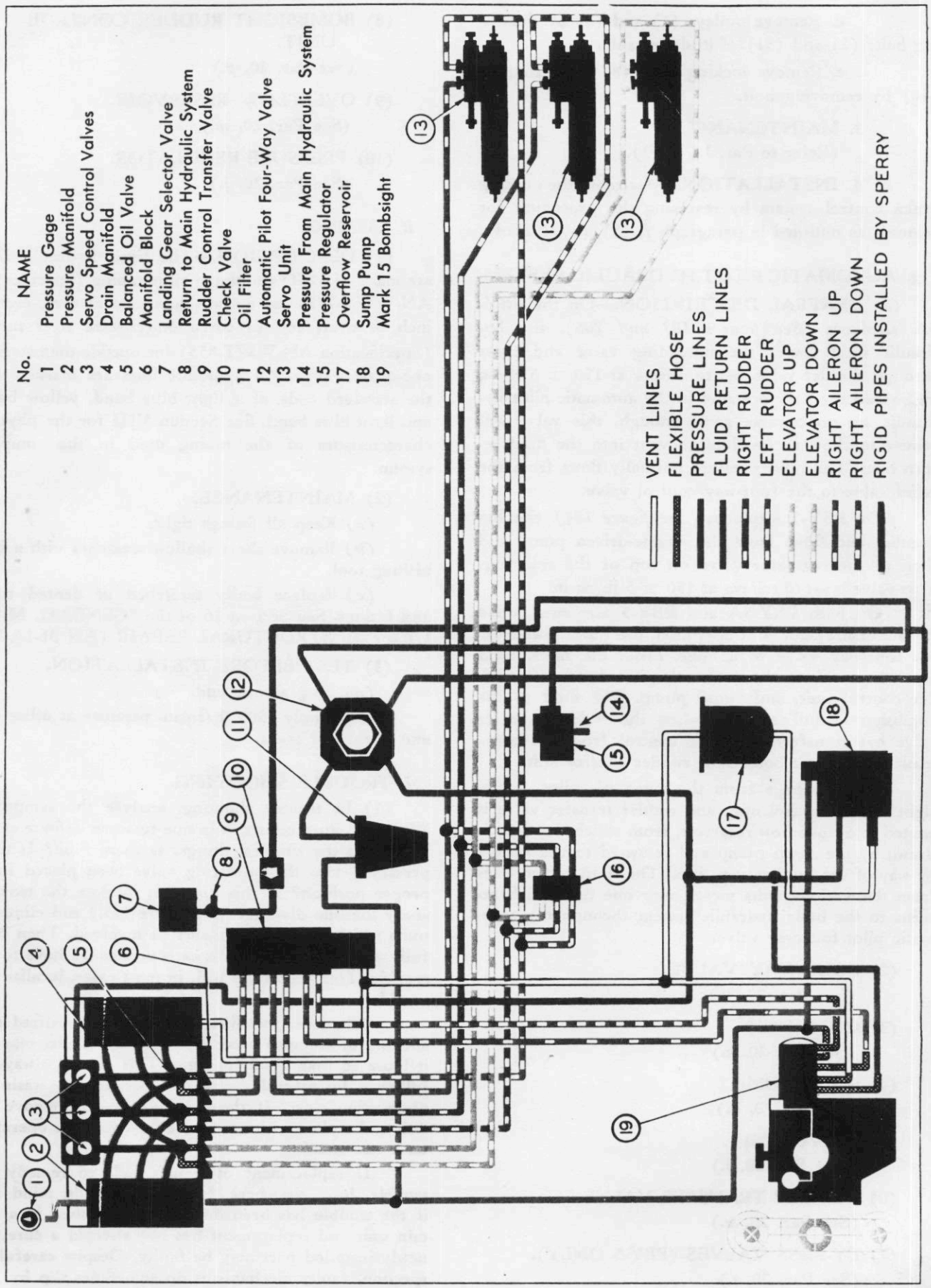


Figure 206—Automatic Pilot Schematic Hydraulic System (PBY-5A Only)

d. Remove pulleys (1) and (3) by detaching bolts (2) and (31). Withdraw cable.

e. Remove locking pawl (8) from support (10) by removing bolt.

3. MAINTENANCE.
(Refer to Par. 18, *b*, (3).)

4. INSTALLATION.—Assemble the parking brake control system by reversing the procedure for removal as outlined in paragraph *f*, (5), *(c)*, *2* above.

g. AUTOMATIC PILOT HYDRAULIC SYSTEM.

(1) GENERAL DESCRIPTION.—On the PBY-5A airplanes *(See figures 183 and 206)*, the hydraulic fluid leaves the unloading valve and flows through a relief valve, set to relieve at 150 ± 5 lb/sq in. Should the back pressure in the automatic pilot hydraulic system become great enough, this valve will relieve to allow excess fluid to vent into the fluid return lines. The fluid pressure normally flows from the relief valve to the four-way control valve.

On PBY-5 airplanes *(See figure 184)*, the hydraulic fluid flows from the engine-driven pump and then to the regulator valve on top of the reservoir. This valve is set to relieve at 150 ± 5 lb/sq in.

On both PBY-5A and PBY-5 airplanes, when the automatic pilot is in operation, the fluid flows from the four-way valve to a filter. From the filter, fluid pressure travels to the automatic pilot, bombsight rudder control unit, and sump pump. The fluid to the bombsight is utilized only when the rudder transfer valve has transferred rudder control from the automatic pilot to the bombsight rudder control unit.

Fluid seepage from the automatic pilot, bombsight rudder control unit, and rudder transfer valve is routed to an overflow reservoir, from which the fluid is drawn by the sump pump and returned to the system by way of the fluid return lines. The fluid return lines from the various units merge into one line which returns to the basic hydraulic system through the automatic pilot four-way valve.

(2) FOUR-WAY VALVE.
(See Par. 20, *v*.)

(3) OIL FILTER.
(See Par. 20, *k*.)

(4) SUMP PUMP.
(See Par. 20, *u*.)

(5) SERVO UNIT.
(See Par. 20, *l*.)

(6) RUDDER TRANSFER VALVE.
(See Par. 20, *w*.)

(7) BY-PASS VALVES (PBY-5 ONLY).
(See Par. 20, *t*.)

(8) BOMBSIGHT RUDDER CONTROL UNIT.
(See Par. 20, *p*.)

(9) OVERFLOW RESERVOIR.
(See Par. 20, *m*.)

(10) PRESSURE REGULATOR.
(See Par. 20, *j*.)

h. TUBING.

(1) DESCRIPTION.—The fixed hydraulic lines are made of 52SO aluminum alloy tubing (Specification AN-WWT-787) for outside diameters of three-eighths inch or over, and of corrosion-resistant steel tubing (Specification AN-WWT-855) for outside diameters of one-quarter inch. All hydraulic lines are marked with the standard code of a light blue band, yellow band, and light blue band. See Section VIII for the physical characteristics of the tubing used in the complete system.

(2) MAINTENANCE.

(a) Keep all fittings tight.

(b) Remove short shallow scratches with a burnishing tool.

(c) Replace badly scratched or dented tubes and fittings. See Section 16 of the "GENERAL MANUAL FOR STRUCTURAL REPAIR (AN 01-1A-1)."

(3) TEST BEFORE INSTALLATION.

(a) Plug at one end.

(b) Apply 1500 lb/sq in. pressure at other end and check for leaks.

i. TROUBLE SHOOTING.

(1) In trouble shooting, analyze the symptoms. When a failure occurs, it is due to some definite cause. Start with the simplest things. Is there fluid? Is there pressure? Has the operating valve been placed in its proper position? If this does not disclose the trouble, study the line diagram *(See figure 193.)* and eliminate units which could not possibly be involved. Then carefully analyze what relation each unit could have to the trouble. This procedure will, in most cases, localize the trouble.

Whenever the difficulty has been localized to a sticking or sluggish valve, a tap with a mallet may jar it loose so that it will operate. This should always be followed by several cycles of operation to wash the obstruction clear. If the trouble persists, remove the unit and replace with a new one, or check the operation on a test stand.

If replacement of a unit fails to remedy the trouble, look elsewhere. However, bear in mind that if the trouble has been definitely established in a certain unit and replacement has not effected a cure, the newly installed part may be faulty. Despite careful inspection, faulty mechanisms do sometimes slip by.

(2) TROUBLE SHOOTING CHART (PBY-5A ONLY).

(a) OPERATIONAL FAILURES AND REMEDIES.

1. LANDING GEAR IN DOWN TO UP POSITION.

TROUBLE	CAUSE	REMEDY
Nose wheel gear will not rise.	Down-lock jack (Pesco 523) is not functioning as a sequence valve.	Check clearance between down-latch and adjustment buttons. Screw adjustment into shaft of jack one or two times. At least 1/32 in. clearance should be maintained.
Nose doors will not close.	Snap action sequence valve adjustment.	Screw out adjustment in shaft of valve until engagement with bell crank is sufficient to operate valve when nose gear is in "up and locked" position.
Nose doors closing or creeping before nose gear is "up and locked."	Snap action valve is by-passing.	Remove valve and replace with new one.
Failure of nose locking pins to lock.	Mechanical sequence valve aft of bulkhead 2 not operating.	Back-off adjusting cap plunger until valve operates, making sure plunger does not bottom in valve.
Erratic action of both door and nose wheel in relation to each other.	The check valve aft of bulkhead 1 on bottom of ship.	The check valve between line from up-lock and down line of selector valve leaks. Replace or service valve.
	Check valve pointing in wrong direction.	
	Arrow on check valve should point starboard.	
Main landing gear fails to rise.	Down-lock jacks (Pesco 523) improperly adjusted.	Adjust button in shaft of jack to 1/8 in. clearance between bell crank and adjusting button. Sometimes a little more clearance is needed to make jack operate properly.
	Return valves are by-passing.	Replace or service valve.

2. OPERATION OF GEAR FROM UP TO DOWN POSITION.

Nose door locking pins will not unlock.	Generally, mechanical linkage.	All moving parts attached to locking mechanism should be free.
Nose door will not open.	Sequence side of door lock and sequence valve is not operating.	Back-off adjustment cap on plunger until sequence valve operates and opens door.
Nose wheel unlocks and starts down before doors open.	Mechanical sequence valve is by-passing or holding open. This valve is the one mounted vertically aft of bulkhead 2.	Replace or service valve.
With doors fully open, nose wheel remains in the "up and locked" position.	Vertically mounted sequence valve aft of bulkhead 2 is not operating.	Unscrew cap on plunger of valve until nose wheel unlocks.
Nose wheel unlatches, but will not go down and lock.	Unlatching jack is not acting as sequence valve.	Check clearance between up-latch and unlatch jack; 1/32 in. clearance should be maintained. In some instances slightly more clearance is necessary for operation of nose gear.
Main landing gear is restricted in its operating to down position.	Return valves are not working properly.	Replace or service.
Main landing gear will not lock down.	Return valves are by-passing through check valve.	Replace or service.

(b) TROUBLES AND REMEDIES PERTAINING TO INDIVIDUAL UNITS.

TROUBLE	CAUSE	REMEDY	EFFECT
		1. GENERAL.	
Engine-driven pump failure in flight.	Engine failure, sheared shaft, or broken part.	Dismantle and replace broken parts; lower landing gear by emergency means or land as boat.	No hydraulic pressure for operation of gear.
Broken pressure or suction line in flight.	Vibration or gun fire.	Same as above.	Loss of fluid from main system, but not pressure for brakes.
Unloading valve sticking on ground.	Foreign material or broken spring.	Remove from airplane and replace.	Properly operating valve will keep accumulator pressure between 800 and 1000 lb/sq in. while operating on engine pump or test stand.
Unloading valve sticking in flight.	Same as above.	If it is desirable to use gear for landing, pump gear down with emergency pump and pump 1000 lb/sq in. in accumulators for use of brakes.	No pressure will show on gage.
Unloading valve leaking.	Loose bolts or bad gaskets.	Tighten bolts on cover plates. Replace gasket.	Reduced pressure and loss of oil.
Erratic action.	No air in accumulators.	Inflate to 600 lb/sq in.	Unloading valve fluctuates constantly.

Note

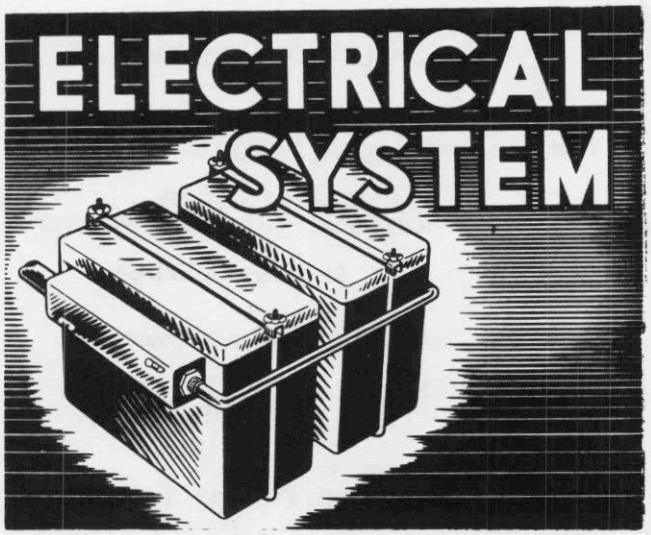
There is no pressure adjustment on the unloading valve. If the operating pressure becomes altered, the unit must be replaced.

TROUBLE	CAUSE	REMEDY
	2. HAND PUMP.	
Will not pump pressure.	No oil in reservoir. Faulty check valve.	Fill reservoir. Dismantle and clean, or replace.
Leakage around piston shaft.	Faulty packing.	Replace packing.
	3. ACCUMULATORS.	
Accumulators will not hold charge of air.	Faulty valve core.	Replace core with Schrader No. 2300 or Dill No. 302D.
Oil leaking around sides of accumulator or oil in air side.	Faulty diaphragm.	Replace accumulator.
	4. RELIEF VALVE.	
By-passing.	Foreign material under check valve seat.	Disassemble and clean thoroughly. Replace if necessary.
Improper setting.	Out of adjustment.	Adjust and set for 1250 lb/sq in. Pressure adjustment is located on top of valve.

TROUBLE	CAUSE	REMEDY
	5. RETURN VALVE.	
Internal leakage or by-passing.	Faulty packing or foreign material under check valve seat.	Replace packing. Clean thoroughly.
	6. SELECTOR VALVE.	
Will not build up pressure. Leaks internally.	Foreign material on valve seat.	Disassemble and clean thoroughly. Replace if necessary.
	7. ACTUATING CYLINDER.	
Leakage around shaft.	Improper adjustment of packing. Faulty packing.	Loosen packing nut; operate several cycles; and tighten packing retaining nut. If leakage still persists, remove old packing. Replace with new.
	8. LATCH RELEASING CYLINDER.	
By-passing.	Foreign material on poppet seat, or mechanical binding.	Dismantle; clean thoroughly; and free binding. Replace if necessary.
Leakage out of bleeder hole.	Faulty packing.	Dismantle and replace packing around piston.
Piston will not operate.	Mechanical restriction or broken spring.	Dismantle free piston. Replace spring.
	9. SEQUENCE VALVES (MECHANICAL).	
By-passing.	Foreign material on poppet seat.	Dismantle and clean. Replace if necessary.
Plunger sticking or holding open.	Mechanical binding.	Dismantle. Use emery cloth to obtain clearance between spool and guide. Clean thoroughly before assembly.
	10. SNAP ACTION SEQUENCE VALVE.	
By-passing.	Piston holding open, or foreign material on ball of valve seat.	Replace valve.
Leakage around plunger.	Faulty packing.	Replace valve.
	11. POWER BRAKE VALVE.	
By-passing.	Poppet valves holding open. Foreign material on bullet valve seat.	Replace brake valve.
Mechanical binding.	Clearance of push rod, or sliding sleeve.	Replace brake valve.
	12. DEBOOSTERS.	
Brakes will not release.	Compensating check valve leaks.	Replace debooster.
Emits air and leaks externally.	Faulty packing.	Replace packing and clean thoroughly.

TROUBLE	CAUSE	REMEDY
	13. FILTERS.	
Handle will not turn.	Clogged with foreign material.	Dismantle and clean plates thoroughly.
External leakage.	Faulty gasket.	Replace gasket.

PARAGRAPH 22



22. ELECTRICAL.

a. GENERAL.—All electrical equipment other than radio and radar and the cooking stove is supplied with 24 volt direct current derived from three generators (one on each engine and the third on the auxiliary power unit) and two 12 volt batteries connected in series. The stove, radio, and radar equipment is provided with 120 volt, 800 cycle alternating current which is also obtained from the above mentioned engine and auxiliary power unit generators. Two additional 12 volt auxiliary batteries are installed in the airplane to supply current to the radio and radar equipment only.

All electrical wiring is protected by conduit.

All circuits are protected by fuses, limiters or either push-button or toggle type manual reset circuit breakers.

All wiring is provided with identifying numbers on each end to aid in tracing circuits and electrical continuity. All wire ends are protected with clear vinolite tubing, except those wires that are soldered in a plug.

To assist in the discussion of each circuit there is shown a wiring diagram, including a sketch showing the relative positions of the equipment, conduit, junction boxes, and wiring. See figure 207 for symbols used in the electrical wiring diagram.

b. GENERATORS.

(1) DESCRIPTION.—Three generators are used in the airplane, one driven by each of the two main engines, and the third driven by the auxiliary power unit. The function of the generators is to supply current for the operation of the various electrical systems of the airplane and to maintain the storage battery in a fully charged condition.

The engine-driven generators on both PBY-5 and PBY-5A airplanes and the auxiliary power unit generator on PBY-5 airplanes are Eclipse Type 716 A.C.-D.C. generators, whose D.C. output is 60 amperes at 28.5 volts and a speed of 2400-3600 rpm, and whose A.C. output is 10 amperes at 120 volts and 800 cycles at a speed of 2400-3600 rpm.

Note

The auxiliary power unit generator on PBY-5A airplanes is an Eclipse Type 638 A.C.-D.C. generator whose D.C. output is 60 amperes at 28.5 volts and whose A.C. output is five to seven amperes at 120 volts and 800 cycles.

The gear ratio between the main engines and the generator is 1 to 1.4 which means that to obtain the operating speed range of the generators, the main engines have to run at speeds of between 1714 and 2571 rpm.

The auxiliary generator, which is driven by the auxiliary power unit by means of a direct drive, is secured directly to the unit. *(See figures 160 and 161.)*

A main engine-driven generator is mounted on the rear of each engine between the two magnetos and under the starter, being attached by six studs and nuts. *(See figure 208.)* To provide a more secure mounting and to decrease vibration, one bracket is clamped near the rear of the generator and extends up and is bolted to the starter mechanism housing. Another bracket is located on the right side of the generator and is bolted to the oil screen housing.

Both A.C. and D.C. electrical connections are made by means of Cannon plugs and flexible conduit to two disconnect receptacles assembled to the middle section of the generator. (The Eclipse Type 638 generator has a terminal junction box mounted on top instead of the disconnect receptacles.)

The auxiliary generator is cooled by means of a fan which is an integral part of the auxiliary power unit. This fan draws air through the generator. The cool air enters the generator through the blast tube, flows through the generator, and exhausts through the ports and screen on the inboard end of the generator.

The main engine-driven generators are cooled by means of a flexible hose, which runs from the small air scoop located on the aft part of the oil cooler housing to the air blast tube on the rear part of the generator. *(See figure 130.)* The cool air enters through the scoop, flows through the flexible hose, and then through the ports and screen on the forward part of the generator.

The wires that attach to the main engine-driven generators run through flexible conduits to a disconnect

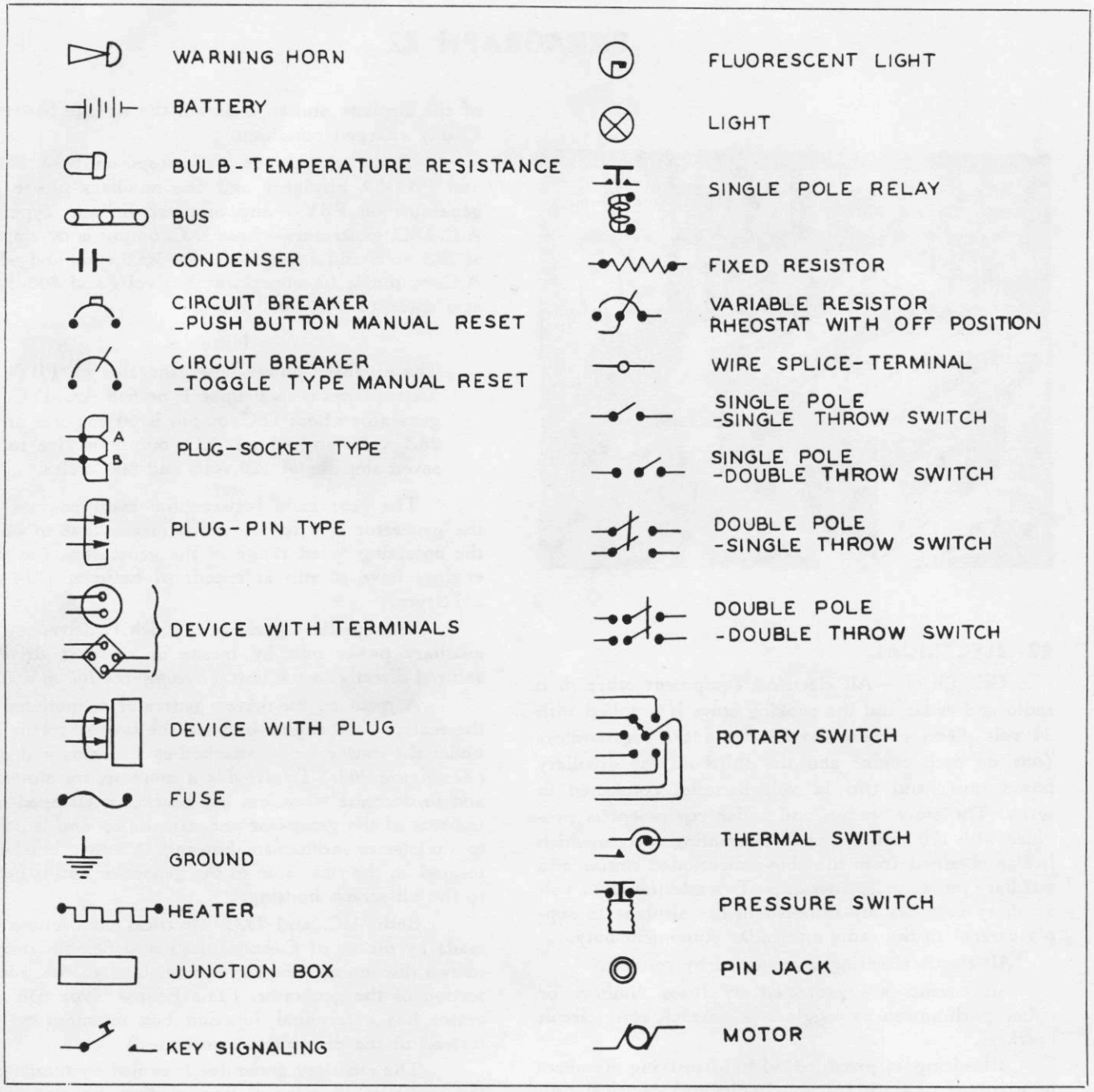


Figure 207—Wiring Diagram Symbols

plug mounted on the inboard side of the engine firewall.

The wires that attach to the auxiliary generator, on PBY-5 airplanes, run through conduit to the auxiliary power unit control panel. This control panel is mounted beneath the starboard food locker. On PBY-5A airplanes the A.C. wires connect to receptacles in the A.C. distribution box on the forward face of bulkhead 4 outboard of the main distribution panel, while the D.C. wires run from the generator to a voltage regulator just above the auxiliary power unit and then to the main distribution panel.

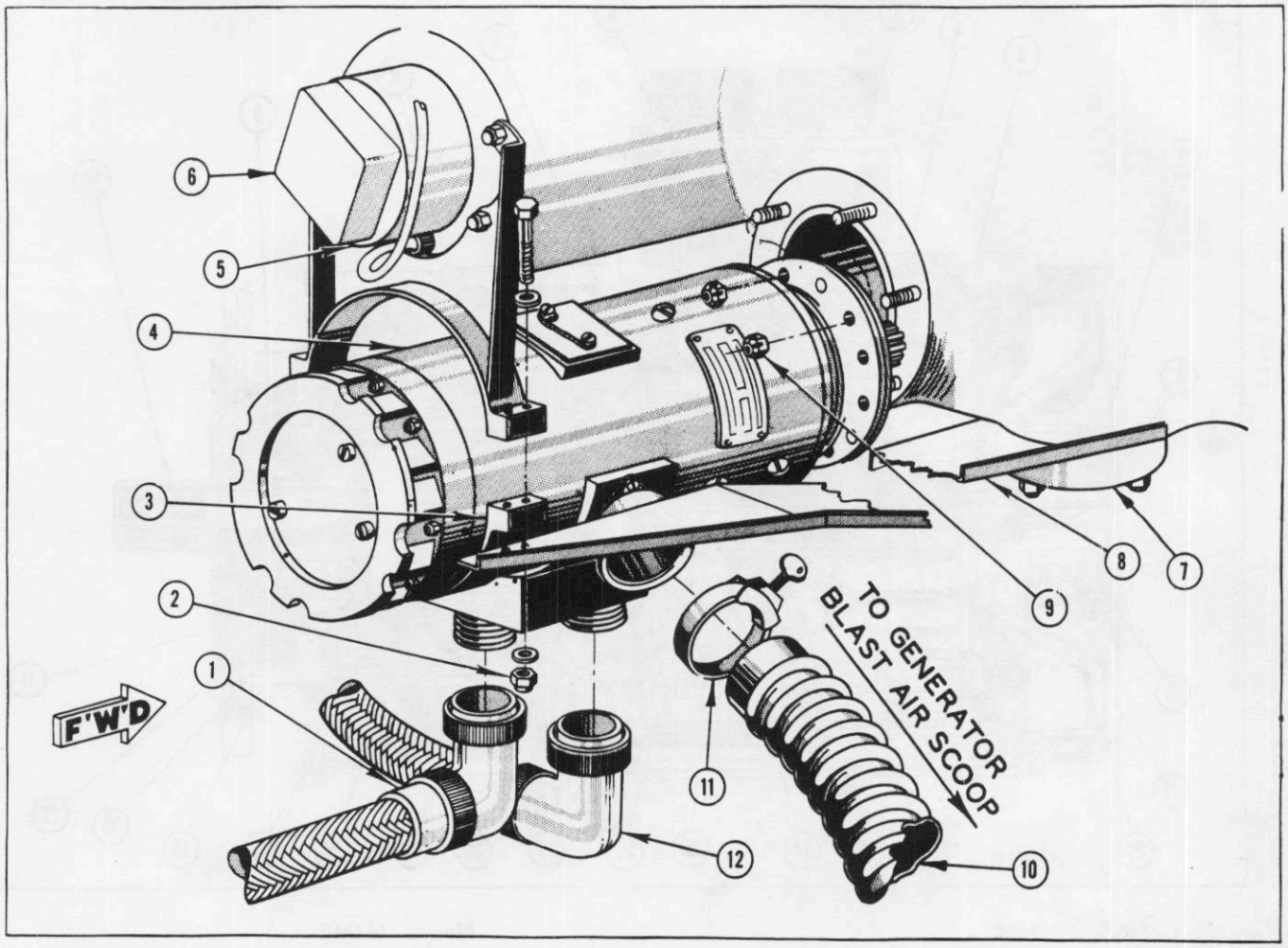
The D.C. output of all generators is controlled by reverse current relays in the main distribution panel, and by voltage regulators. Voltage regulators are also provided to regulate the A. C. voltage of all generators.

(2) REMOVAL AND DISASSEMBLY.

For removal of the auxiliary power unit generator, see Par. 17, *c*.

(a) REMOVAL OF GENERATOR FROM PORT ENGINE.

(See figure 208.)



No.	PART No.	NAME	No.	PART No.	NAME
1		A. C. Conduit and Fitting	6		Starter
2	AN4-22A	Bolt	7		Oil Screen Chamber Cover
	AN365-428	Nut	8	28P5169	Bracket
	AN960-416	Washer	9		Nut
3	28P5529-11	Strap Assembly	10		Generator Blast Tube
4	Type 716 (Eclipse)	Generator	11		Clamp
5	28P5529-6	Strap and Support Assembly	12		D. C. Conduit and Fitting

Figure 208—Generator Installation

1. Raise short wrap cowl on both sides of nacelle. (See Par. 7, *e*, (1), *(b)*.)

2. Shut off oil supply to engine.

3. Shut off fuel supply to engine.

4. Remove engine "oil in" line from crankcase and drain valve.

5. Disconnect "oil return" line from engine.

6. Disconnect cross-feed fuel line from fuel pump.

7. Remove "oil in" and "oil return" flanges from crankcase.

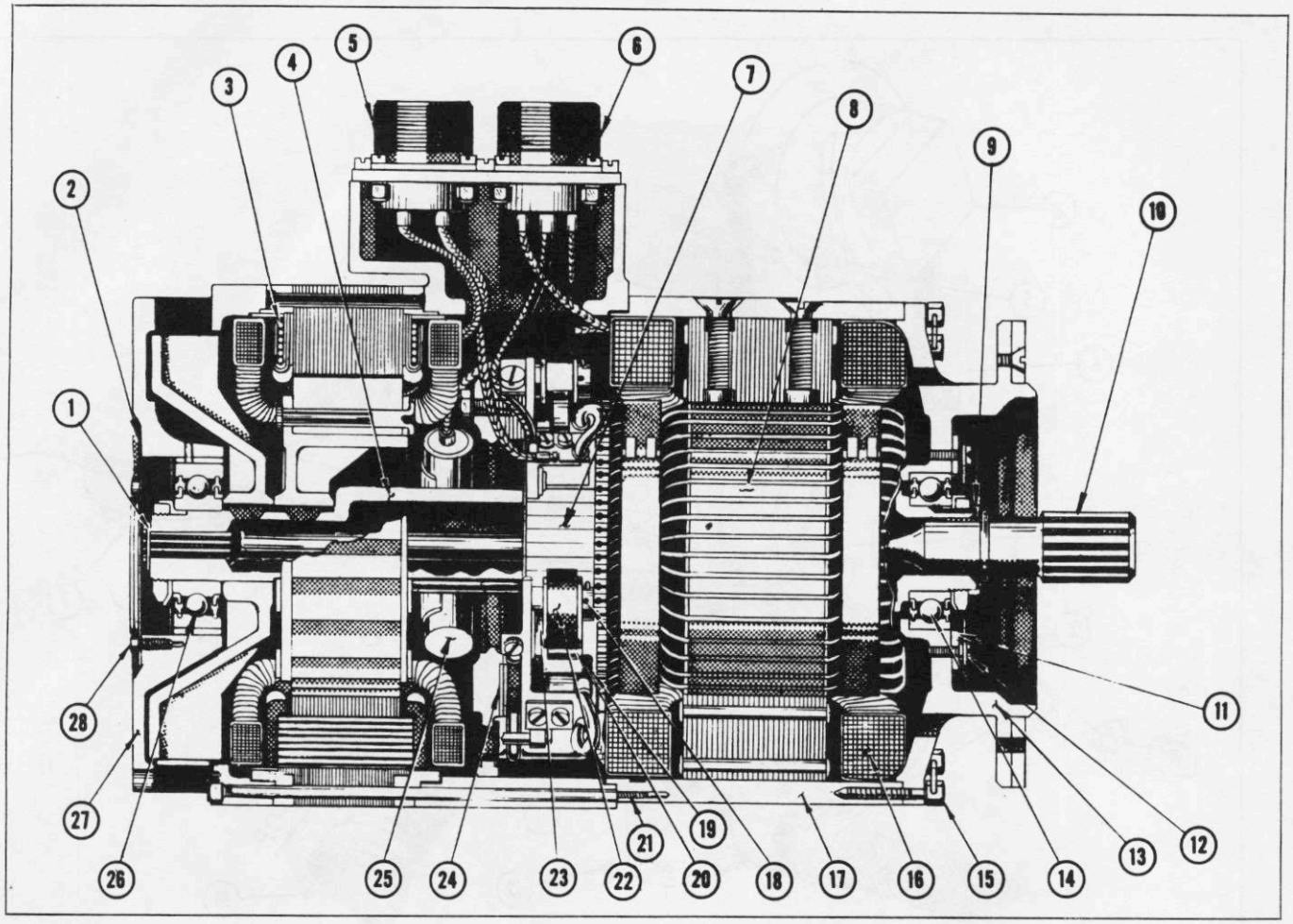
8. Remove starter brace (5) and strap (3) from generator by detaching nuts (2).

9. Disconnect electrical conduit (1) and (12) from generator (4).

10. Remove generator blast tube (10) by detaching clamp (11).

11. Remove top cowl panel (section between short wrap cowl panels).

12. Loop a rope sling or strap over aft end of generator case to support the generator while removing it from the nacelle.



No.	NAME	No.	NAME
1	Cover—End	15	Bolt
2	Ring—Lock	16	Coil Assembly—D-C Shunt Field
3	Coil—A-C	17	Yoke
4	Shaft—Armature	18	Sleeve—Brush Spring Adjusting
5	Receptacle—Disconnect (A-C)	19	Brush
6	Receptacle—Disconnect (D-C)	20	Arm—Brush Spring
7	Commutator	21	Stud
8	Armature	22	Spring—Brush
9	Gasket (Drive Shaft)	23	Box Brush
10	Shaft—Drive	24	Board—Brush
11	Retainer—Bearing	25	Condenser
12	Screw	26	Bearing—Ball (Front Head)
13	Flange—Mounting	27	Head—Front
14	Bearing—Ball (Mounting Head)	28	Screw

The above generator is an Eclipse type 716.

Figure 209—Generator Assembly

13. **Loosen, but do not remove one upper elastic stop nut (9) on generator mounting flange until the other five nuts have been removed, and then only after provision has been made to prevent the generator from falling and causing damage to the spline coupling, the generator, or adjacent parts in the engine mount.**

14. **Support generator and remove remaining nut from mounting flange.**

15. **Lift generator back and out of nacelle on the left side between the fast feathering pump and engine crankcase.**

16. **Install cover over engine mounting pad**

and make provisions to protect the generator spline coupling while it is removed from the engine.

(b) REMOVAL OF GENERATOR FROM STARBOARD ENGINE.—The procedure for the removal of this generator is essentially the same as for the generator removal from the port engine. The following differences, however, should be noted:

1. The generator is removed from the right side of the nacelle.

2. It is not necessary to disconnect the cross-feed fuel line from the fuel pump.

3. It is necessary to remove the cover (7) from the oil screen chamber on the engine crankcase and remove the generator support bracket (8).

(c) The generator should not be disassembled any further than is necessary to remove or replace the brushes (See paragraph *b*, (3),) Further disassembly should be attempted only at major repair bases.

(3) MAINTENANCE. *(See figure 209.)*—Maintenance of the generators consists of inspection of connections for tightness, replacement of brushes, and cleaning. If major repairs are necessary, replace generator with new or reconditioned generator and send old one to repair base for overhaul.

(a) Remove the air blast cover (1) and blow dust out of cover and out of generator with clean, dry, compressed air.

(b) Inspect the brushes (19). If they are oil soaked or are worn down to a length of ½ inch on the short side, replace with new ones.

(c) When replacing the brushes, lift the brush spring (22) with a hook only far enough to remove the brushes. Any further bending of the spring may distort the spring and change the tension.

CAUTION

Do not allow spring to snap down on the brush as it may chip or crack the brush.

When new brushes are installed, the spring tension should be checked with a spring scale. Hook the scale under the brush spring arm (20), and then lift the arm until the bottom surface of that part of the arm which normally rests on top of the brush is 3/16 inch above the top of the brush box (23). The tension should read 28 to 32 ounces. If the tension does not fall within these limits, the position of the adjusting sleeve (18) must be altered to give the correct tension.

(d) New brushes should be seated on the commutator (7) to make sure of the correct brush fit and to eliminate arcing and burning at the commutator. After the new brushes are installed, they should be seated with a seating stone or No. 000 sandpaper to secure the proper fit. With the generator running in its correct direction of rotation, insert the seating stone or sandpaper between the brush holders. Move the seating stone or sandpaper back and forth across the commutator so that an even sanding is obtained without grooving the commutator. Brushes should be seated until at least 80 per cent of their surface is seated to the commutator.

CAUTION

Do not seat brushes more than necessary.

Blow all sand and carbon dust out of the generator. The generator should then be run under load until the brushes contact the commutator over their entire contacting surface.

(e) Wipe away all oil with a clean lintless cloth.

(f) The generators are lubricated at the factory and therefore need no periodic lubrication. Bearings are repacked with grease (Specification AN-G-5) at time of overhaul of generator.

(4) INSTALLATION.—To assemble and install main generators, reverse procedure outlined in paragraph *b*, (2). To install auxiliary power unit generator, see Par. 17, *c*.

(5) OPERATIONAL CHECK.

(a) Run the two main engines within the rated speed of the generators. This is from 1714 to 2571 rpm for the main engines due to the 1 to 1.4 gear ratio between the main engines and the generators. The auxiliary generator operates at the same speed as the auxiliary power unit. The engines are to be run for a period of 15 minutes to warm up the voltage regulators.

(b) Place the voltage selector switch on the main distribution panel to "STB'D. GEN." If the voltage does not read from 28 to 28.5 volts, see paragraph *b*, (6) for locating the cause.

Repeat voltage test for port engine and auxiliary power unit generators. By means of a portable voltmeter, check the A.C. voltage of each generator in the A.C. power junction box. Failure to develop proper voltage does not necessarily mean that the generator is defective as the trouble may lie in the voltage regulator. Before removing generator for repair, carefully check all wiring between the generator and voltmeter to be sure the trouble does not lie in the wiring.

(6) TROUBLE SHOOTING CHART.

TROUBE	CAUSE	REMEDY
(a) Intermittent operation.	*1.* Loose connections (screws, solder lugs, Cannon plugs, etc.)	*1.* Check by twisting and pulling, and repair if necessary.
	2. Faulty adjustment of reverse current relay.	*2.* Check and readjust. (See paragraph *f*, (4).)

TROUBLE	CAUSE	REMEDY
	3. Faulty adjustment of voltage regulator.	3. Replace and return to repair base.
	4. Frayed or worn insulation.	4. Check and repair.
	5. Loose ground connection.	5. Clean and tighten. Replace lug and ground bus, if badly pitted.
	6. Intermitten grounds in wiring of connections.	6. Check and repair.
(b) Generator operates at rated rpm with low voltage output.	1. Defective voltage regulator.	1. Replace and return to base for repair.
	2. Loose or high resistance wiring connections.	2. Check and repair.
	3. Worn brushes.	3. Replace. (See paragraph *b*, (3).)
	4. Dirty, rough or pitted commutator, or slip rings.	4. Clean with No. 00 or finer sandpaper.
	5. Low brush spring tension.	5. Replace spring.
	6. Brushes not moving freely in holders.	6. Remove brushes. Clean brushes and holder with carbon tetrachloride.
	7. Shorted or open armature.	7. Replace generator and return to repair base.
	8. Excessive brush play.	8. Replace brush.
	9. Partial short in power wiring or connections.	9. Check and repair. Replace defective wires or parts.
(c) Generator operating at rated rpm with no voltage.	1. Generator field demagnetized.	1. Replace generator and return to repair base.
	2. Grounded or open field circuit.	2. Replace generator and return to repair base.
	3. Blown fuse.	3. Replace fuse.
(d) Generator operating at normal rpm with reversed D-C voltage.	Generator field magnetized in wrong direction.	Replace generator and return to repair base.
(e) Excessive arcing of generator brushes.	1. Dirty commutator or slip rings.	1. Clean with No. 00 or finer sandpaper.
	2. Worn out brushes.	2. Replace. (See paragraph *b*, (3).)
	3. Brushes stuck in holders.	3. See *(b)*, 6 above.
	4. Short circuit in system.	4. Check connections and insulation and repair.
	5. Open or shorted armature or field coil.	5. Replace generator and return to repair base.
(f) Generator D-C fuse blows during flight.	1. Overload on D-C generator.	1. Reduce load and replace fuse.
	2. Short circuit in main distribution panel.	2. Check and repair.
(g) D-C generator fuse blows on ground.	Reverse current relay stuck.	Open contacts by hand and clean with crocus cloth.

c. BATTERIES.

(1) DESCRIPTION.—The batteries consist of two AN3152, Type S-34 shielded main storage batteries connected in series, and two AN3153-1, Type S-17 auxiliary storage batteries connected in series. The main batteries are rated at 12 volts and 34 ampere hours capacity (based on a five hour discharge rate). Ordinarily, they are maintained in a fully charged condition by the surplus output of the generators.

The main batteries are located in the wing center section leading edge, one inboard of the port nacelle and the other inboard of the starboard nacelle.

The auxiliary batteries are rated at 12 volts and 17 ampere hours capacity. They are located on the floor of the radio compartment under the radio operator's seat.

The main batteries are connected to the ground in the main distribution panel and to the main engine-driven generators and the auxiliary power unit driven generator through busses "A" and "B" in the main distribution panel. The main batteries are connected to several of the more important units of the airplane in the main distribution panel and in other junction boxes in the airplane.

The main batteries are directly connected to the floats and engine starters and should not be used alone to operate these units, as the heavy current drain would discharge the batteries in a very short time. Operate these units only when the auxiliary power unit or main engines are running.

The main batteries are used to operate lights and smaller pieces of equipment for brief periods when the airplane is grounded, and for emergency standby service in the air. The batteries also assist in combating voltage drops when heavy loads are suddenly turned on during flight.

The auxiliary batteries are used for feeding the radio and radar circuits only. For charging, they are connected to busses "A" and "B" in the main distribution panel through a reverse current relay.

(2) REMOVAL. *(See figure 210.)*—Access to main batteries is obtained through access doors (13) *(See figure 20.)* in the wing leading edge. The auxiliary batteries are readily accessible under the radio operator's seat.

(a) Turn main battery switch on main distribution panel to "OFF" position.

(b) Loosen the thumb screws (1) that hold the cross bar (28) on top of the battery.

(c) Push clip (2) up directly under the thumb screw; and then push tie rod (26) to one side to permit removal of the cover (27).

(d) Unscrew wing nuts (16) and then remove conduit terminal box cover (17).

(e) Using special wrench 28U2006 *(See figure 40.)*, remove wing nuts (15) and washers (13) and (14) that hold wire terminals to battery terminal posts (18) and (25). Remove negative or grounded wire first, then the positive wire.

(f) After disconnecting conduits (24) and (10) from the conduit terminal box (11), pull wires out of conduit terminal box and then remove battery from rack.

(3) MAINTENANCE.

(a) CHARGING.—Batteries should be kept in a full state of charge to insure them against freezing at low temperatures and to assure the delivery of their rated voltage and current. A fully charged battery should show the following readings on a hydrometer (specific gravity indicator), at the temperatures indicated. *(See figure 211.)*

TEMPERATURE SPECIFIC GRAVITY

10°C (50°F)—1.285 to 1.310
27°C (80°F)—1.275 to 1.300
43°C (110°F)—1.265 to 1.290

To take a hydrometer reading: remove cover of battery (27); unscrew vent plugs (4) *(See figure 210.)*, and with the hydrometer held vertical, insert the nozzle of the hydrometer syringe into the battery through the vent plug hole; squeeze the bulb of the hydrometer syringe and release slowly until enough electrolyte is drawn up into the tube to float the hydrometer. The correct reading taken is at the level of the liquid on the hydrometer. *(See figure 211.)* Care should be taken to keep the hydrometer float and syringe clean to insure correct readings. The hydrometer must float freely to give correct reading. If the float sticks to the side of the syringe, shake gently to free the float. The electrolyte withdrawn for the test must be returned to the cell from which it was taken.

Note

In case the electrolyte has been permitted to fall below the taps of the plates, the battery may have to be tipped to one side in order to have enough electrolyte reach the nozzle of the syringe to float the hydrometer.

Hydrometer readings should never be taken immediately after adding water or electrolyte to the battery. When the battery is on charge and gassing, a hydrometer reading may be taken an hour after water or electrolyte has been added. When the battery is not being charged, allow 24 hours after adding water or electrolyte before taking a hydrometer reading.

When the specific gravity of any cell of the battery falls below the values given in the table for full charge hydrometer readings, the battery should be put on charge to restore it to a fully charged condition.

To charge a battery, connect the leads of the charging unit to the respective terminals of the battery (positive to positive and negative to negative). The charging voltage should be sufficient to maintain at least 2.33 volts per cell. If the battery is very low

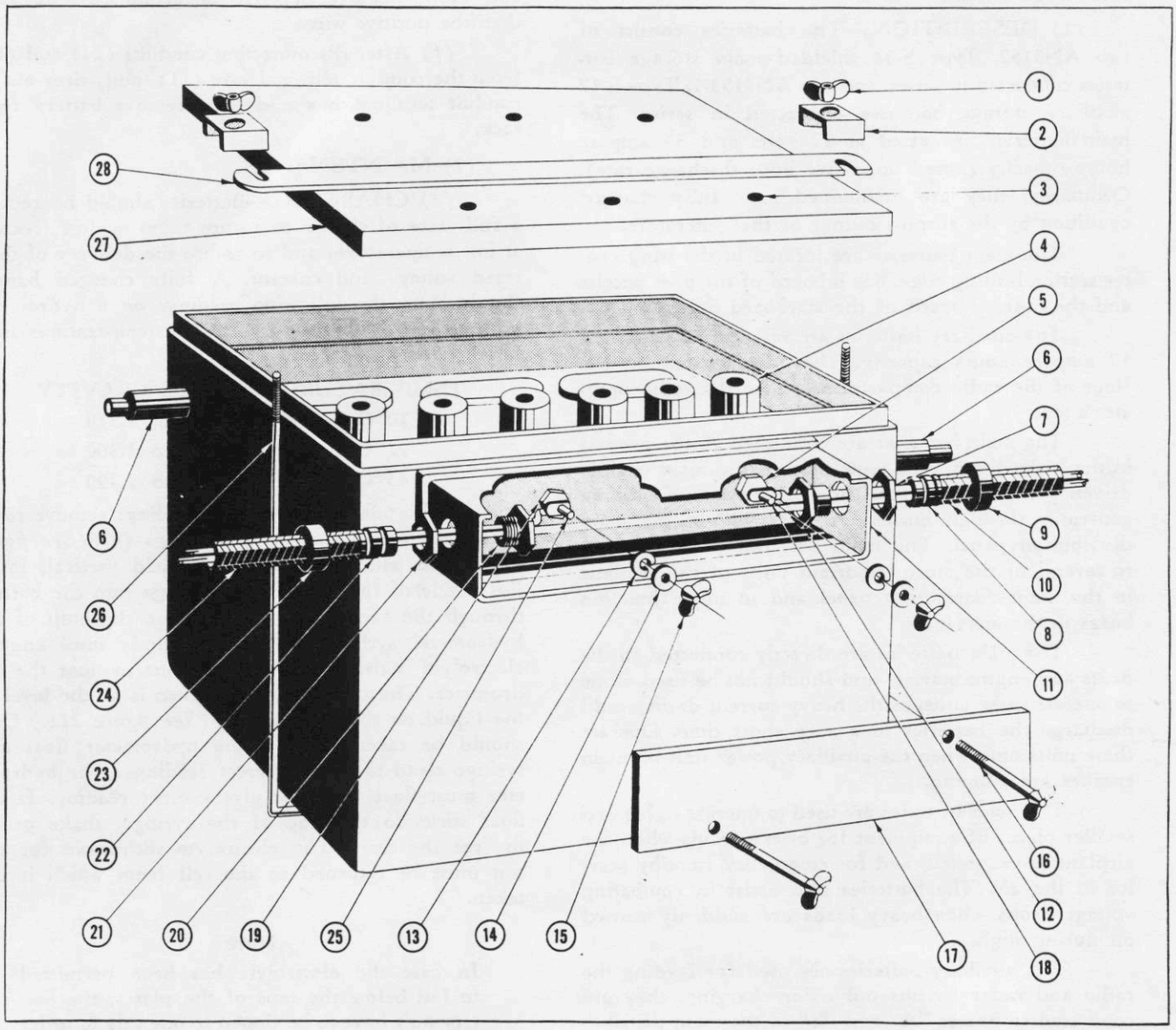


Figure 210—Battery Installation

on charge, a larger current (amperage) may be used until the cells start to gas or the temperature of the electrolyte rises to 43.5°C (110°F). When either of these two occur, reduce the current to 3.5 amperes, and continue charging until all cells gas or bubble freely. When three successive half hour hydrometer readings show no further increase in specific gravity, remove from charging unit.

Specific gravity and temperature readings should be taken every 30 minutes during charging of a battery.

After charging as outlined above, if the cell does not rise to 1.275 to 1.300 specific gravity, remove some of the electrolyte and replace with 1.325 specific gravity electrolyte. Charge for one hour and take reading again; if the cell still has not reached 1.275 to 1.300 specific gravity, repeat process until correct specific gravity is obtained.

Should the cell read too high after charging as outlined above, remove some of the electrolyte and replace with distilled water. Charge battery for one hour and if specific gravity is still too high, repeat this process until correct specific gravity is obtained.

CAUTION

Never adjust the specific gravity of a cell that does not gas or bubble on charge.

Do not remove vent plugs while charging,

No.	PART No.	NAME	No.	PART No.	NAME
1	AN350-1032	Thumb Screw	15		Wing Nut
2	28E2008-3	Clip	16		Wing Nut
3		Vent Hole	17		Conduit Terminal Box Cover
4		Vent Plug	18		Positive Terminal Post
5	Q6211-17	Wire Terminal	19	Q6211-17	Wire Terminal
6		Vent Tube	20	AN3054-16	Conduit Box Connector
7	AN3066-16	Coupling Locknut	21	AN3066-16	Coupling Locknut
8	AN3050-16	Ferrule	22	AN3050-16	Ferrule
9	AN3054-16	Conduit Coupling Nut	23	AN3054-16	Conduit Coupling Nut
10		Flexible Conduit	24		Flexible Conduit
11		Conduit Terminal Box	25		Negative Terminal Post
12	AN3064-16	Conduit Box Connector	26	28E10047	Tie Rod
13		Lock Washer	27		Cover
14		Washer	28		Cross Bar

except for addition of water, or the taking of hydrometer or temperature readings.

If the battery is left in the airplane while being recharged, disconnect the battery switch from the busses in the main distribution panel.

CAUTION

Ventilate battery compartment while charging to remove gases generated by battery. These gases form a combustible mixture and therefore flame, spark, lighted cigars, or cigarettes should not be brought close to the battery when charging or shortly afterward.

Water must be added from time to time to replace that lost by charging and evaporation. Be sure and use only distilled water, (not merely boiled water). The level of the electrolyte should not be lower than the tops of the separators and not higher than ½ inch above the protector on top of the separators. If too much water has been added, immediately withdraw enough solution (by means of a syringe) until proper level is reached.

CAUTION

If electrolyte is spilled on any of the surrounding surfaces, flush all affected areas with water, drain, and sponge with a solution of 0.9 pounds of chromic acid, or 1.32 pounds of potassium dichromate to each U. S. gallon of water. Use hot water if available.

If previous method cannot be used, apply baking soda (sodium bicarbonate) mixed with water to the consistency of a thin paste to the affected area until all bubbling action stops. Then wash with water and dry thoroughly. Do not allow any of the above neutralizing solutions to enter the cells of the battery.

If finish has been removed, paint area affected with clear acid resistant lacquer.

A battery fully charged will freeze at —63°C (—85°F) (1.275 specific gravity or higher), and a battery low on charge will freeze at —7°C (+19°F) (1.100 specific gravity).

CAUTION

In cold climates, add water only before charging as the water will freeze unless mixed with the electrolyte. Failure to do this may result in failure or damage to the battery.

If the electrolyte of a cell is lower than the other cells, inspect that cell for leakage.

A cell that shows a reading of more than 0.2 volts lower than the other cells of the battery should be considered defective and the battery replaced.

If the airplane is to remain idle for more than one week, remove the battery and send it to the battery room for proper maintenance. If the battery is damaged, do not attempt to repair it—replace with a fresh one.

(b) The terminals of the batteries must be kept clean and their connections tight. When dirty, scrape the terminals until clean and wash them and the top of the battery with bicarbonate of soda (one pound of soda to one gallon of water) to neutralize any electrolyte that may have been spilled. Keep vent plugs tight when washing. Rinse with water, dry, and apply a thin coating of "NO-OX-ID" grease or vaseline to the terminals.

(c) It is recommended that a card be kept recording the dates on which water was added, battery recharged, etc. This records a history of the battery and is helpful in analyzing any trouble encountered with the battery.

(4) INSTALLATION.

(See figure 210.)

(a) Place battery on rack.

(b) Place cover (27) over battery.

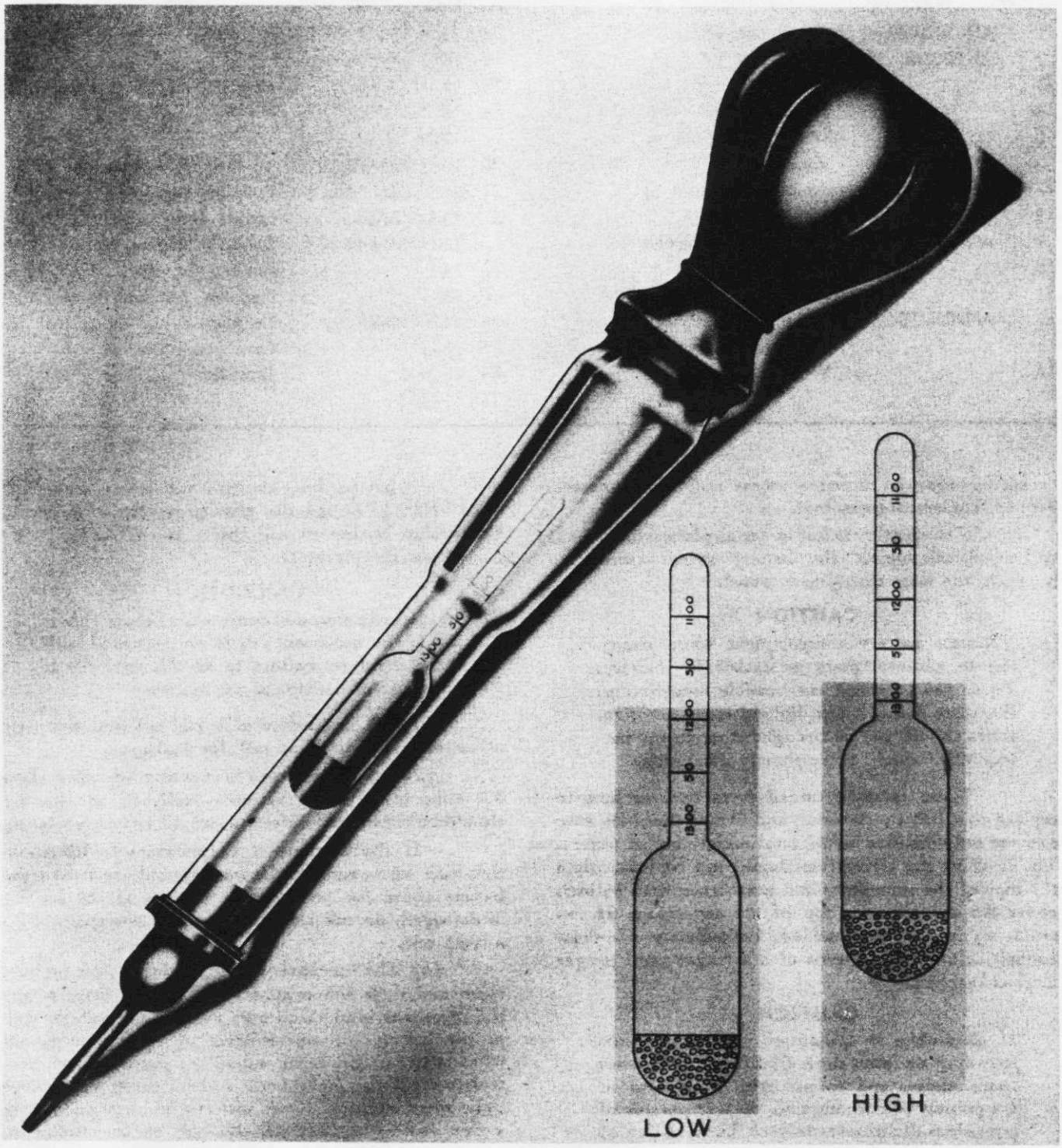


Figure 211—Hydrometer

(c) Engage notches in cross bar (28) with tie down rod (26); place clips (2) over tie rods and cross bar notches; and screw wing nuts (15) on tie down rod to secure cover (27).

(d) Connect conduits to each end of conduit terminal boxes (11) of both batteries.

(e) Connect the positive wire from one battery to the negative pole of the other battery.

(f) Connect the remaining two wires, one to the negative pole of the first battery, and the other to the positive pole of the second battery.

Note

To attach wire terminal to battery terminal post: slip wire terminal over battery terminal post; install lock washer (13) and washer (14); and then tighten with wing nut (15) using special wrench 28U2006. *(See figure 40.)*

(g) Apply a light coating of vaseline to all terminals to prevent corrosion.

(h) Place conduit terminal box cover (17) in position and secure with wing nuts (16).

(5) OPERATIONAL CHECK.—Throw voltmeter switch on main distribution panel to "MAIN BAT" and check voltmeter for 24 volt reading. Turn voltmeter switch to "OFF" and then momentarily operate floats as a further check. Check the auxiliary battery also by means of the voltmeter and the switch on the main distribution panel.

If the above checking procedure is fulfilled, the battery and connections are in serviceable condition.

d. ELECTRICAL POWER DISTRIBUTION.

(1) DESCRIPTION.
(See figures 212 and 213.)

(a) DIRECT CURRENT DISTRIBUTION.—Direct current from each generator is carried in a conduit through the wing center section to a junction box for both conduits at station 0.0 in the leading edge. One conduit carries both lines from this box to a small splice box on the forward face of bulkhead 4, above and slightly inboard of the main distribution panel. Separate flexible conduits connect each line from this box to a voltage regulator and from each regulator to the main distribution panel.

Both positive and negative (ground) wires from the generators run to the main distribution panel. The negative wires are connected directly to a ground bus in the back of the panel. Each positive wire runs through a reverse current relay, fuse, and ammeter, in the order named, to a bus selector switch on the face of the panel. There it may be connected by a switch to either of two buses (bus A or bus B) from which current is distributed throughout the plane by branch circuits.

Direct current from the auxiliary generator is fed through flexible conduit to a D-C voltage regulator on the port side of the galley compartment above the auxiliary power unit. From the voltage regulator, rigid conduit carries the feeders to the back of the float relay box. From this box they feed through the main pull box to the main distribution panel.

Both the negative and positive wires from the main batteries in the wing pass through conduit from the wing to the power junction box on the forward face of bulkhead 4 inboard of the main distribution panel. From here, the wires run through conduit to the main distribution panel. Here, the negative wire connects to a grounded terminal post, while the positive wire connects to either bus "A" or bus "B" through the main battery switch.

Both positive and negative wires from the auxiliary batteries run through conduit to the main distribution panel where the negative wire connects to a grounded terminal post while the positive wire connects to the auxiliary battery reverse current relay and thence to either bus "A" or bus "B" through the auxiliary battery switch.

The system is also provided with a voltmeter and voltmeter selector switch on the main distribution panel.

All other power leads such as lights, outlets, etc., receive their power from one of the buses in the main distribution panel as will be shown on diagrams to follow.

(b) ALTERNATING CURRENT DISTRIBUTION.—Alternating current is carried through the wing in conduits from each engine firewall to the A.C. junction box in the wing leading edge on center line of airplane.

From here (on PBY-5A airplanes) a single conduit carries the wires to the A. C. power distribution panel. The wires pass through this panel and then through conduit to a junction box on the outboard end of the radio locker. From the junction box, the wires pass through flex conduit to the two A.C. voltage regulators on a floor bracket beneath the radio locker. From the voltage regulators, the wires return through two other flex conduits to the junction box and thence through flex conduit to the A.C. power distribution panel on the forward face of bulkhead 4 outboard of the main distribution panel.

On PBY-5 airplanes, a single conduit carries the wires down from the wing to a junction box on the aft face of bulkhead 4, starboard side. From here, the wires pass through two A.C. voltage regulators located outboard of the junction box, and then through conduit to the A.C. power distribution panel on the forward face of bulkhead 4.

On both PBY-5 and PBY-5A airplanes, the wires pass through fuses in the A.C. power distribution panel and then to receptacles on the forward face of the panel.

Alternating current from the auxiliary power unit generator is fed directly from the generator to a fuse in the A.C. power distribution panel and then to a receptacle on the face of the panel.

(2) MAINTENANCE.

(a) Maintenance of the electrical power system consists of a thorough inspection of all the various parts that comprise this system and repairing, adjusting, or replacing the parts found to be defective as described below.

(b) Disconnect the battery leads before making an inspection as this will eliminate any possibility of an accidental short circuit while servicing the equipment.

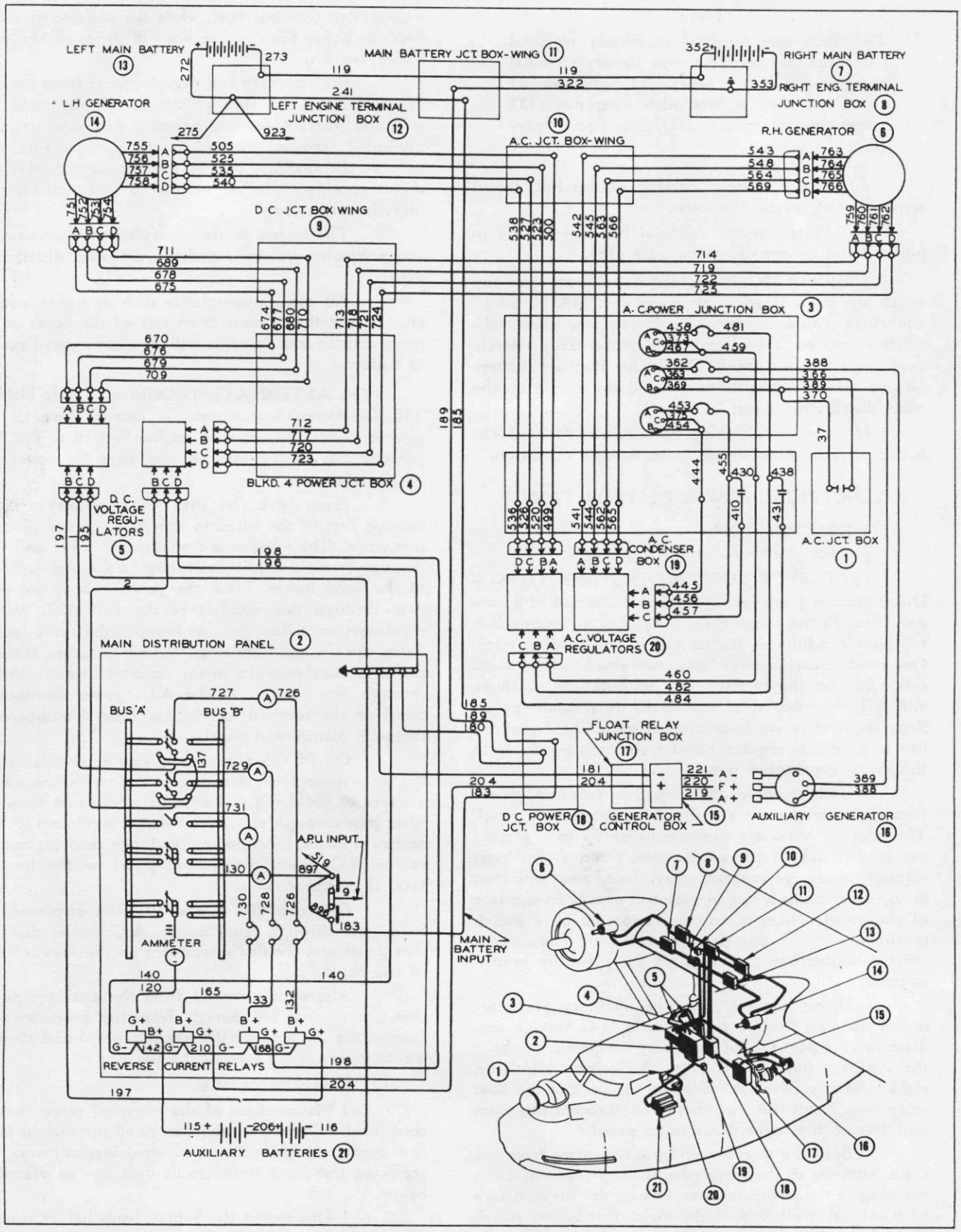


Figure 212—Electrical Power Distribution Circuit (PBY-5A Only)

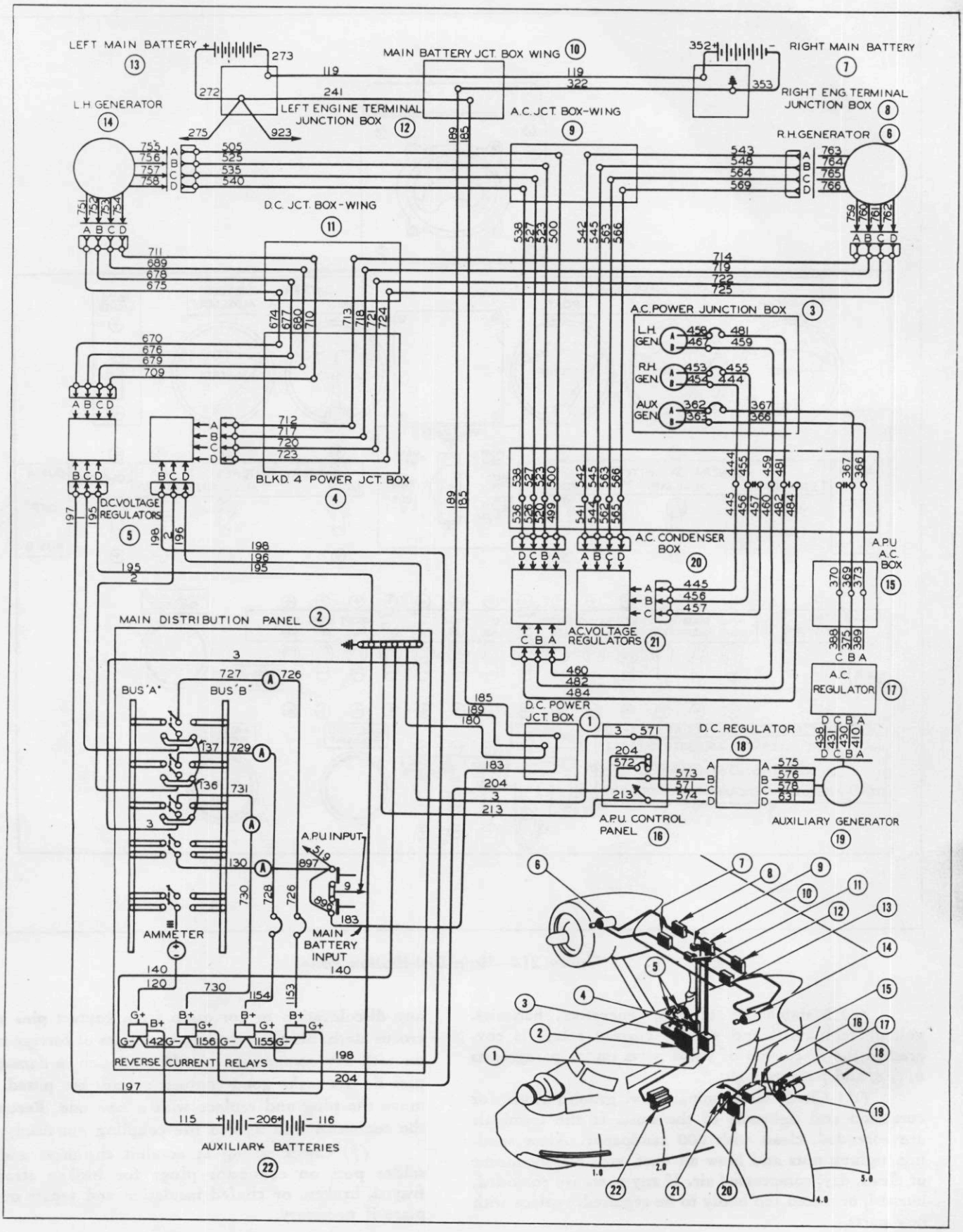


Figure 213—Electrical Power Distribution Circuit (PBY-5 Only)

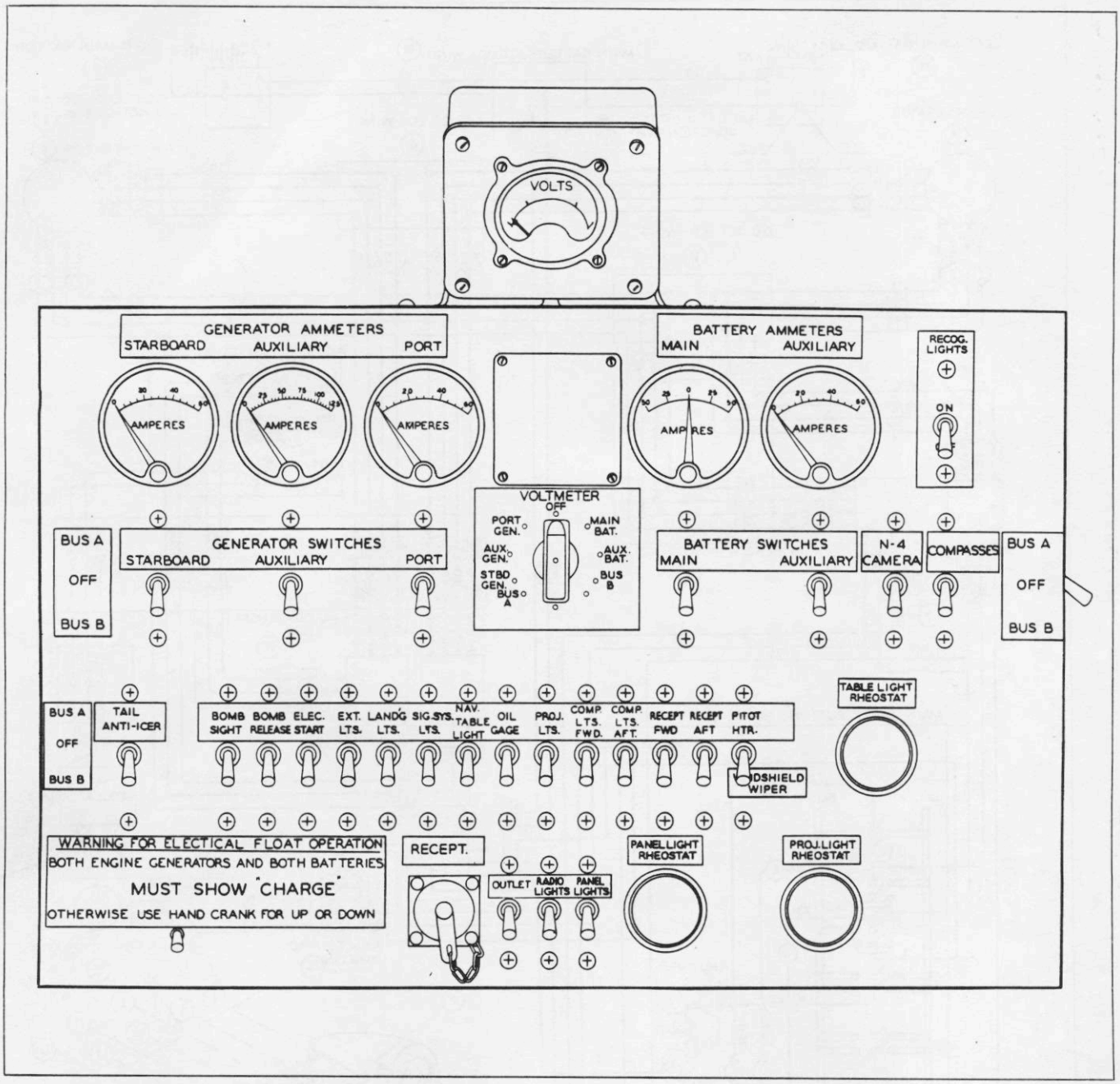


Figure 214—Main Distribution Panel

(c) Maintenance of the generators, batteries, voltage regulators, and reverse current relays is covered in the discussion of these parts under paragraphs *b, c, e,* and *f* respectively.

(d) Check all terminals and ground studs for corrosion and tightness of the nuts. If the terminals are corroded, clean with 000 sandpaper. After sanding, tighten nuts and blow all dust, etc., out by means of clean, dry, compressed air. If any parts are corroded, burned, or pitted too badly to be repaired, replace with new parts.

(e) Uncouple the connector plugs indicated on the wiring diagram. *(See figures 212 and 213.)* Remove any discoloration or corrosion from contact pins with crocus cloth. Blow out dust and particles of foreign matter with dry compressed air. If insulation is damaged, pins do not make good contact, or pins are pitted, remove the plug and replace with a new one. Recouple the connector and tighten the coupling nut firmly.

(f) Check wiring at conduit entrances and at solder pots on connector plugs for broken strands, frayed, broken, or chafed insulation and repair or replace if necessary.

(3) OPERATIONAL CHECK.

(a) On main distribution panel, turn main bat-

tery switch to either bus "A" or "B" and then turn the electric starter switch to the same bus.

(b) Turn either the right or left engine starter switch on the engineer's panel to "START" and hold it there for about five seconds. If the starter motor accelerates normally, it indicates that the main storage battery power circuit is functioning properly. An alternate check may be used as outlined in paragraph *c*, (5).

(c) Operate both main engines at 1800 rpm. Turn the right and left engine generator switches on the main distribution panel to either bus "A" or bus "B" position and the main battery switch to the "OFF" position.

(d) Switch on several circuits to the same bus to provide a load of between 150 amperes and 200 amperes.

(e) Check the right and left engine generator ammeters and the voltmeter located on the main distribution panel.

The voltmeter must read between 28 and 28½ volts. The ammeters will indicate the electrical output of the generators, and should give approximately equal readings.

e. GENERATOR VOLTAGE REGULATOR.

(1) DIRECT CURRENT REGULATORS.

(See figure 215.)

(a) DESCRIPTION.—There are three direct current voltage regulators, one for each engine generator and one for the auxiliary power unit. The engine generator regulators are mounted vertically on the starboard side wall of the radio compartment, forward of bulkhead 4. The forward regulator is for the port generator. The auxiliary power unit regulator is the lower one of two mounted horizontally on the starboard side of the engineer's compartment, forward of the auxiliary power unit on the PBY-5. On the PBY-5A, it is mounted above the auxiliary power unit on the port side aft of bulkhead 4.

Each regulator, except the PBY-5A auxiliary power unit regulator, (which is a Navy type NF-1D regulator) is an Eclipse type 1002, Model 1, and operates on the carbon pile principle. It consists of a stack of carbon discs, a multi-leaved spring and armature assembly, and a solenoid coil with an adjustable core. The carbon discs are compressed by an adjustable screw against the center of the spring. Pressure of the spring is regulated by the attraction of the solenoid coil for the iron armature attached to the spring.

(b) PRINCIPLE OF OPERATION.—The carbon pile resistor is connected in series with the shunt field of the generator. The solenoid coil is connected through a resistor across the output of the generator. Whenever the generator current rises above 28.5 volts, the current in the solenoid increases. This increased current exerts a stronger pull on the armature, and decreases the tension on the attached spring, with a consequent decrease of pressure on the carbon discs. The discs tend to separate, thereby increasing the resistance in the generator shunt field winding, which results in decreased generator voltage. When the generator voltage falls, a reverse action takes place. Resistance of the field circuit is decreased and the generator voltage rises. Proper adjustment of the regulator should hold the generator voltage very close to 28.5 volts at any generator speed above 2400 rpm. Below that speed the generator will not put out 28.5 volts.

The regulator contains an equalizing coil to assist in equalizing the load when the generators are operated in parallel. The action of this coil is to increase the voltage of the generator carrying the heaviest load and decrease that of the one with the least load.

(c) REMOVAL AND DISASSEMBLY.

1. For removal of auxiliary power unit regulator, see Par. 17, *c*.

2. Disconnect Cannon plugs at each end of the main engine generator regulators.

3. Remove four bolts and nuts holding each regulator to the mounting bracket.

4. Do not attempt to disassemble regulators in the field, except to remove the perforated cover from the bottom of the box and the cylinder coil cover from the top, and for inspection and repair of breaks, burned or corroded terminals, or leads. Defective regulators should be returned to an authorized repair base, or to the manufacturer for inspection, repair and test.

(d) MAINTENANCE.

1. Remove the regulator from its mounting in the airplane.

2. Remove the perforated cover (32) from the bottom of the box (31) and the cylindrical cover (27) from the top.

3. Give the box a thorough visual inspection for broken mounting feet, cracked housings, broken spring leaves, loose screws and nuts, broken mica insulators, or burned resistors.

4. Tighten all loose screws or nuts.

5. Replace broken terminals and leads having worn, frayed, broken, or burned insulation.

6. Resolder all loose or corroded connections.

7. Replace any tie wire which has become loose or broken.

8. Replace the covers and remount the regulator. Reconnect the Cannon plugs and make sure they are securely screwed in place, and that the mounting bolts are tight.

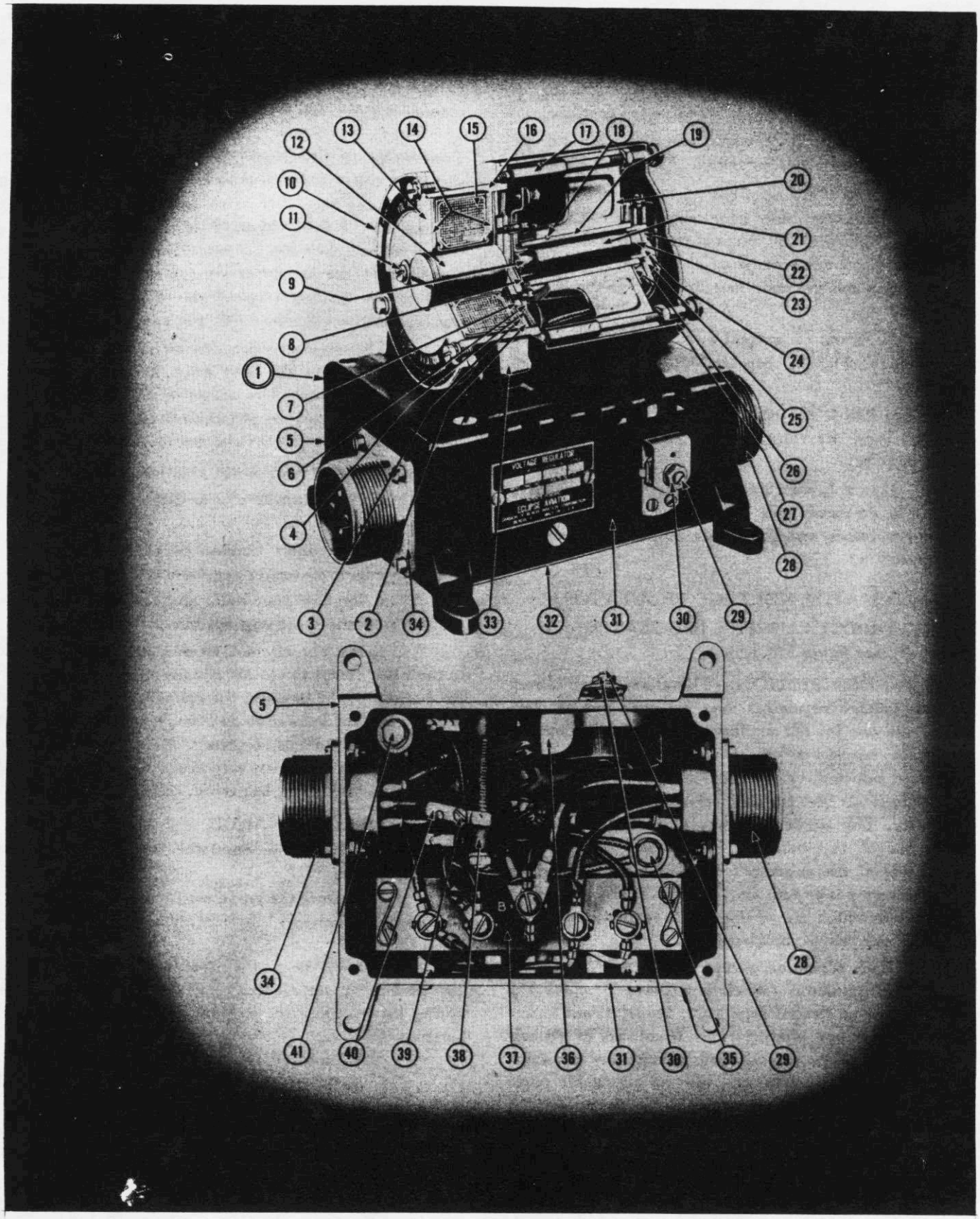


Figure 215—Generator Voltage Regulator (D. C.)

No.	NAME	No.	NAME
1	Regulator Assembly—Carbon Pile	22	Screw—Pile Adjusting
2	Washer	23	Plug—Contact
3	Shim—Armature Stop	24	Ferrule
4	Support—Spring	25	Bracket—Pile Screw
5	Armature Assembly	26	Insulator—Mica
6	Springs	27	Cover—Regulator
7	Armature	28	Receptacle—Disconnect (Output)
8	Ferrule	29	Screw—Rheostat Adjusting
9	Plug—Contact	30	Nut—Rheostat Adjustment Locking
10	Case Assembly—Magnet	31	Box
11	Screw—Core Locking	32	Cover—Bottom
12	Core	33	Strap—Regulator Mounting
13	Plate—End	34	Receptacle—Disconnect (Input)
14	Washer—Paper Packing	35	Resistor
15	Coil—Magnet	36	Rheostat
16	Case—Magnet	37	Board—Terminal
17	Stud	38	Resistor—Equalizer
18	Pin—Cotter	39	Screw—Resistor Slider
19	Tube—Carbon Pile	40	Slider—Equalizer Resistor
20	Support—Pile	41	Resistor
21	Pile—Carbon		

(e) TROUBLES AND REMEDIES.—In all cases of failure or improper operation, investigate the trouble immediately to prevent further damage to the unit. Do not attempt to operate a regulator that does not function properly. A chart of commonly found troubles and suggested remedies follows:

TROUBLE	CAUSE	REMEDY
1. Failure of movement of the adjusting screw to affect voltage.	Connections between generator and regulator are improperly made.	Check wiring for breaks, grounds, shorts or high resistance connections. See schematic power wiring diagram for connections.
	Defective regulator.	Return the regulator to a repair base.
2. Output voltage is zero.	Same causes as for trouble 1. Defective generator.	Same remedies as for trouble 1. Return generator to repair base.
3. Output voltage is about two volts.	Same causes as for trouble 1.	Same remedies as for trouble 1.
4. Output voltage is low.	Same causes as for trouble 1.	Same remedies as for trouble 1.
5. Output voltage is high.	Same causes as for trouble 1.	Same remedies as for trouble 1.
6. Output voltage fluctuates rapidly.	Defective regulator.	Return regulator to a repair base.
7. Output voltage does not stay within proper range when generator is under load.	Defective regulator.	Return regulator to a repair base.
8. Ammeter reads zero when load is applied.	Same as first cause for trouble 1.	Same as first remedy for trouble 1.
	Regulator not grounded properly.	Check ground connection for tightness and correct if necessary.
	Generator fuse blown in main distribution panel.	Replace the fuse.
	Defective reverse current relay.	See paragraph *f*, (6) for tests of the relay.
	Ammeter stuck at zero.	Tap ammeter lightly. Pointer should release and assume correct reading.

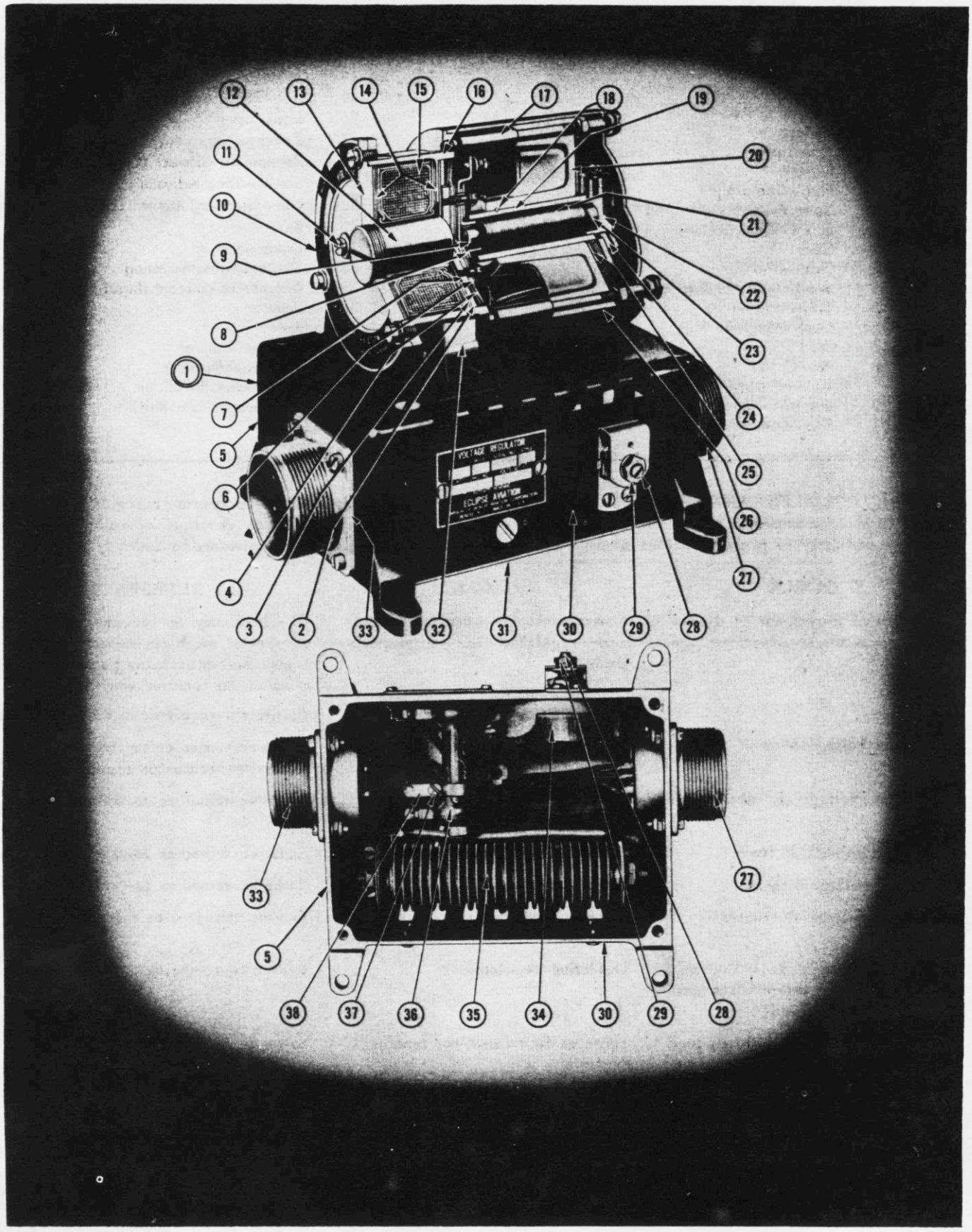


Figure 216—Generator Voltage Regulator (A. C.)

No.	NAME
1	Regulator Assembly—Carbon Pile
2	Washer
3	Shim—Armature Stop
4	Support—Spring
5	Armature Assembly
6	Springs
7	Armature
8	Ferrule—Armature
9	Plug—Contact
10	Magnet Assembly
11	Screw—Core Locking
12	Core
13	Plate—End
14	Washer—Paper Packing
15	Coil—Magnet
16	Case—Magnet
17	Stud
18	Pin—Cotter
19	Tube—Carbon Pile
20	Housing—Pile
21	Pile—Carbon
22	Screw—Pile Adjusting
23	Plug—Contact
24	Bracket—Pile Screw
25	Insulator—Mica
26	Cover Assembly—Regulator
27	Receptacle Assembly—Disconnect (Output)
28	Screw—Rheostat Adjusting
29	Nut—Rheostat Adjustment Locking
30	Box
31	Cover—Bottom
32	Strap—Regulator Mounting
33	Receptacle Assembly—Disconnect (Input)
34	Rheostat
35	Rectifier—Selenium
36	Resistor
37	Screw—Slider Clamping
38	Slider—Resistor

TROUBLE	CAUSE	REMEDY
	Ammeter connections defective.	Check connections and repair if necessary.
	Defective ammeter.	Replace ammeter and return to a repair base.
	Defective generator.	Return generator to a repair base.
	Defective regulator.	Return regulator to a repair base.
9. Adjustment of equalizer resistor produces no division of load when generators are in parallel.	Same as first cause for trouble 1.	Same as first remedy for trouble 1.
	Regulator not grounded properly.	Check ground connection for tightness and correct if necessary.
	Defective regulator.	Return regulator to a repair base.
10. Current does not divide evenly between paralleled generators.	Same as first cause for trouble 1.	Same as first remedy for trouble 1.
	Regulators not grounded properly.	Check ground connection for tightness. Correct if necessary.
	Defective regulator.	Return regulator to a repair base.

(f) INSTALLATION.

1. Install auxiliary power unit generator regulator by reversing removal procedure outlined in Par. 17, *c*.

2. Install main engine generator regulators to mounting brackets on starboard wall forward of bulkhead 4 by means of four bolts and nuts.

3. Connect Cannon plugs at each end of regulator.

(g) TESTS AFTER ASSEMBLY AND INSTALLATION.

(See figure 215.)

1. Connect a precision D.C. voltmeter, known to be in good operating condition, to the G+ terminal of the generator reverse current relay in the main distribution panel and to ground, or between either bus "A" or "B" and ground. If connected to a bus, throw the generator selector switch to the same bus.

2. Throw all other switches on the panel to "OFF" position.

3. Run the engine driving the generator up 1750 rpm. This is the minimum speed for development of rated generator voltage.

Note

As noted before, the speed of the auxiliary power unit generator cannot be changed, so the following described test for its regulator will have to be made at the speed of the power unit.

4. Read the voltage on the precision voltmeter. It should be 28.5 volts. If not 28.5 volts, loosen the locking nut (30) on the rheostat adjusting screw (29) on the side of the control box.

5. Adjust the voltage to exactly 28.5 by turning the adjusting screw. The adjustment should not exceed 0.7 volt.

6. Upon completing the adjustment tighten the locknut (30).

Note

This adjustment is made to compensate for the length of the airplane wiring. Once made, it should not be altered, unless some change which would affect the regulated voltage is made in the wiring.

7. The generators should now be tested for parellel operation. First run both generators for about 15 minutes to warm up the generators and regulators.

8. If only the engine-driven generators are being paralleled, the engines should be run at approximately 1750 rpm. If all three generators are to be paralleled, the engine speed should be increased to approximately 2600 rpm. In either case, when the generators have been brought to speed, connect them and the main battery to the same bus in the same distribution panel.

9. Switch on a D-C load equivalent to the rating of one generator, approximately 60 amperes.

10. Read the generator ammeters on the main distribution panel to determine if each generator is carrying its share of the load ± 10%. If this is not being done, adjust one regulator, if only the engine-driven generators are being tested. Adjust the regulators on the units with the highest and lowest ammeter readings, if all three generators are being tested. Proceed with these adjustments as follows:

a. Dismount the regulator box.

b. Loosen the screw (39), securing the slider (40) on the equalizer resistor (38) which is fastened to the wall of the regulator box.

c. To reduce the load carried by a generator move the slider about ⅛ inch toward the wall upon which the equalizer resistor is mounted.

d. To increase the load move the slider about ⅛ inch from the wall upon which the regulator box is mounted.

e. Test the adjustment and readjust if necessary, until each generator carries its share of the load ± 10%.

11. Switch on a load equal to the full rated load per generator. The generators should divide the load within ± 5%. If they do not, readjust the equalizer resistors as described above, and again test with full load.

12. When adjustment is completed, replace the perforated cover on the bottom of the box and remount the box on the airplane.

(2) ALTERNATING CURRENT REGULATORS.
(See figure 216.)

(a) DESCRIPTION.—On the PBY-5 there are three alternating current voltage regulators, (Eclipse type 1001), one for each engine-driven generator and one for the auxiliary power unit generator. The engine-driven generator regulators are mounted vertically on the aft face of bulkhead 4, starboard of the hatch and the A.C. junction box. Inboard regulator is for the port generator. The generator for the auxiliary power unit is on the starboard side of the engineer's compartment, forward of the auxiliary power unit. It is the upper one of two, mounted horizontally.

On the PBY-5A, there are two main engine generator regulators (Eclipse type 1001) but no auxiliary power unit A.C. voltage regulator. The A.C. voltage regulator from the auxiliary power unit is indirectly regulated by the Eclipse type 673 D.C. voltage regulator. The two engine-driven generator regulators are mounted on a floor bracket beneath the radio operator's locker and are connected to the A.C. power panel through a junction box on the outboard side of the locker.

(b) PRINCIPLE OF OPERATION.—The alternating current regulators operate on the same principle as the direct current regulators, discussed in paragraph *e*, (1), with the following exceptions:

1. The solenoid coil is connected across a rectifier.

2. Voltage regulation is for 115 volts ± three volts.

3. There are no equalizer coils. The alternators are never connected in parallel.

(c) REMOVAL AND DISASSEMBLY.

1. For removal of auxiliary power unit regulator, see Par. 17, *c*.

2. Disconnect Cannon plugs at each end of the main engine generator regulators.

3. Remove four bolts and nuts holding each regulator to the mounting bracket.

4. Do not attempt to disassemble regulators in the field, except to remove the perforated cover from the bottom of the box and the cylinder coil cover from the top, and for inspection and repair of breaks, burned or corroded terminals, or leads. Defective regulators should be returned to an authorized repair base, or to the manufacturer for inspection, repair and test.

(d) MAINTENANCE.—Refer to paragraph *e*, (1), *(d)*.

(e) TROUBLES AND REMEDIES.—In all cases of improper operation, investigate the trouble immediately to prevent further damage to the unit. Do not attempt to operate a unit that does not function properly. Following is a chart of more commonly found troubles and suggested remedies:

TROUBLE	CAUSE	REMEDY
1. Failure of adjusting screw to affect voltage.	Connections between generator and regulator are defective or improperly made.	Check wiring for breaks, shorts, grounds or high resistances, and correct if necessary.
	Defective regulator.	Return regulator to a repair base.
2. Improper operation of A.C. load mechanisms.	A.C.voltage at improper value.	Refer to troubles 3, 4, 5, 6, or 7 of this chart.
	Load mechanisms defective.	Check the connected loads for defects and repair if necessary.
3. A.C. output voltage is zero.	Connections on the output side of the regulator are open circuited.	Same as first remedy for trouble 1.
	Condenser open circuited.	Replace the condenser.
	Generator not in proper working condition.	Refer to generator trouble chart paragraph *b*, (6).)
	Defective regulator.	Return regulator to a repair base.
4. A.C. output voltage low.	Condenser or connections shorted.	Same as first two remedies for trouble 3.
	Generator not in proper operating condition.	Refer to generator trouble chart (paragraph *b*, (6).)
	Defective regulator.	Return the regulator to a repair base.
5. A.C. output voltage too high.	Terminals of disconnect receptacle on output side not properly connected.	Check connections and correct if necessary.
	Defective regulator.	Return regulator to a repair base.
6. A.C. voltage outside range of 112-118 volts under load.	Carbon pile regulator out of adjustment.	Return regulator to a repair base.
7. A.C. voltage fluctuates rapidly.	Carbon pile regulator out of adjustment.	Return regulator to a repair base.
8. Voltage shows a drift upward after 200 hours of operation.	Carbon discs worn.	Return regulator to a repair base.

(f) INSTALLATION.—Reverse removal procedure outlined in paragraph *e*, (2), *(c)*.

(g) TESTS AFTER INSTALLATION.
(See figure 216.)

1. Connect a precision voltmeter, known to be in good condition, across the A.C. output of the regulators on the load side of the condensers. On the PBY-5A airplanes, the voltmeter may be connected in the A.C. junction box outboard of the radio locker. On PBY-5 airplanes, the voltmeter may be connected in the A. C. junction box aft of bulkhead 4 on the port side.

2. Operate the generator at 1750 rpm engine speed, or in the case of the auxiliary power unit at normal operating speed.

3. Be sure no loads are connected to the circuit.

4. Read the A.C. voltage. If it does not fall within the range of 112-118 volts, proceed as follows:

a. Loosen the locking nuts (29) on the adjusting screw (28) on the side of the box (30).

b. Adjust the voltage by turning the adjusting screw. Clockwise rotation increases and counterclockwise decreases voltage. If the required adjustment is more than three volts in either direction, remove and send regulator to a repair base.

c. After adjusting voltage, tighten the locking nut (29).

f. REVERSE CURRENT RELAY.
(See figure 217.)

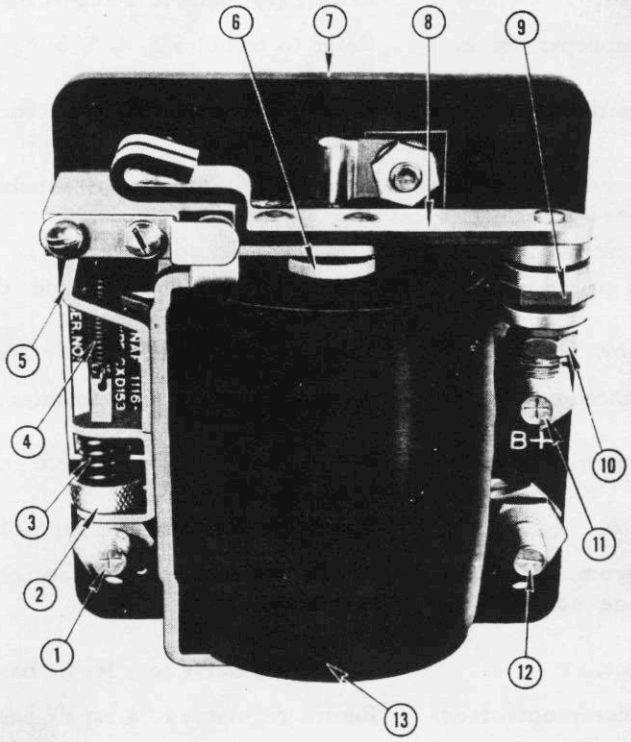
(1) DESCRIPTION.—Four reverse current relays are located in the airplane in the bottom of the main distribution panel. They are arranged from port

to starboard to control the following units respectively: port engine generator, auxiliary generator, starboard engine generator, and auxiliary batteries.

The relays are Struthers-Dunn type CXD 1535, with a rating of 24 volts D.C. and 100 amperes.

The purpose of the relay is to prevent reverse flow of current (from the main battery to a generator) when the generator is at rest or operating at low speed. Whenever generator voltage falls below 26.7 volts, current will flow toward the generator, causing the relay contacts to open and break the circuit. A subsequent rise in voltage to 26.7 or above will close the contacts and restore the circuit.

The auxiliary battery relay operates on the same principle, but for a somewhat different purpose. The battery has only half the capacity of the main batteries and is installed for use only on the radio and radar circuits. It must be connected to the generators for charging, but must not be allowed to discharge into the airplane's power system. Therefore the relay is connected in series between the battery and buses. When tripped, the relay contacts will not close again until reset by pushing the reset button on the lower left corner of the face of the main distribution panel. To prevent possible drain on the battery, it is recommended that this relay be tripped when the plane is grounded, by throwing on the auxiliary battery bus selector switch and turning on a few lights.



No.	PART No.	NAME
1		Terminal
2	4309	Adjusting Bushing
3	4319	Spring
4	4318	Spring
5	4471	Stop
6	2305	Core Assembly
7	2319	Base
8	4374	Yoke
9	3856	Contact Screw
10		Adjusting Screw
11		Terminal
12		Terminal
13	4396-24	Coil Assembly

All items listed are Struthers-Dunn part numbers.

The above assembly is a Struthers-Dunn type CXD 1535 (NAF 1116-4) Cutout.

Figure 217—Reverse Current Relay

(2) REMOVAL AND DISASSEMBLY.

(a) Turn battery and generator switches on main distribution panel to "OFF" position.

(b) Release the three snapslides and then hinge back panel of main distribution panel.

(c) Disconnect all wires from G−, G+ and B+ terminals of relay.

(d) Detach the four mounting screws and remove relay from mounted position.

(3) MAINTENANCE.
(See figure 217.)

(a) Remove the wire terminals from the relay and then inspect them as well as the relay terminals. If they are discolored or corroded, clean them with No. 000 sandpaper.

(b) Inspect the relay contacts; if they are rough, blackened, or pitted, re-surface them with crocus cloth or a small ignition file. After re-surfacing, adjust the gap. (See following paragraph *f*, (4).)

(c) If spring (3) or (4) is broken, replace with new one.

(d) If coil assembly (13) becomes inoperative due to overvoltage or any other cause, replace the relay.

(4) ADJUSTMENT.—The contact gap on the relay should be adjusted to give an approximate opening of .025 inches by screwing the adjusting screw (10) in or out. This gap opening allows the contacts to open when five amperes or less reverse current is flowing through the relay.

After adjustment of the contacts, test the voltage setting of the relay. To do this connect a variable resistance, such as a variable rheostat in series with the "G+" terminal. Connect a test lamp between "G+" and "B+," and a 30 volt or larger voltmeter between "G+" and "G−." Starting at a low value, gradually increase the voltage by decreasing the resistance until closing of the contacts is evidenced by lighting of the test lamp. The reading of the voltmeter should be 26.7 ± 0.10.

(5) INSTALLATION.—To install reverse current relay, reverse removal procedure outlined in paragraph *f*, (2) above.

(6) OPERATIONAL CHECK.

(a) With the engine running, turn the battery switches and the generator switches to the same bus ("A" or "B").

(b) Gradually increase the speed of the engine to 1800 rpm and check the relay contacts to see that they are closed.

(c) Gradually decrease the speed of the engine to 500 rpm or stop the engine and check the relay contacts to see that they are open.

g. BOMB AND TORPEDO CIRCUITS.

(1) DESCRIPTION.

(See figures 218, 219, and 220.)

(a) The bomb and torpedo circuits are such that bombs and torpedoes may be released electrically and the bombs armed electrically.

(b) The manual emergency release of bombs and torpedoes is discussed under Section V, Par. 4, *b*, (3), *(c)*.

(c) The bombardier, pilot, or copilot can release the bombs, while only the bombardier can arm the bombs.

(d) The releasing of torpedoes is controlled only by the pilot or copilot, who are provided with a torpedo director.

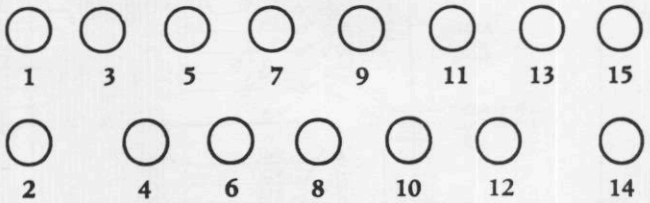
(e) All electrical circuits necessary for electrical release and arming are set up by the bombardier only. The bombardier also controls the selection of bombs to be released.

(f) The bombardier has the choice of two methods of electrical release, automatic and manual electric. In automatic release, the bombsight will initiate the electrical impulse which starts the working of the release system. In addition, the bombsight actuates the pilot's directional indicator (located on the pilot's instrument panel) electrically to provide the pilot with an indication such that he will know the course the bombardier desires that he follow.

(g) The automatic or the manual electric release will release bombs selectively (one bomb or a salvo of several bombs released by one electrical impulse) or in train (a series of bombs released by one electrical impulse which activates the intervalometer).

(h) The bombardier's switch panel, which consists of a front and side panel just forward of the anchor box, contains switches which permit the bombardier to set up the circuit so that one or more bombs may be released by any of the electrical methods described above.

(i) The MK 2-1 intervalometer, which is mounted on the anchor box, provides for the release of bombs in train. Its electrical mechanism is arranged so that the points of impact of successively released bombs will be separated by that number of feet set by the bombardier on the intervalometer panel. Jumper wires with pin plugs attached to each end are provided for the preselection of bomb releases. The red pin jacks on the intervalometer panel are the intervalometer impulse pin jacks. Although they are not numbered, they receive electrical impulses from the intervalometer in the following order:



Thus by connecting one of the jumper wires from the red impulse pin jack number one to the pin jack for any bomb desired to be released, this bomb would be released first. By connecting another jumper wire from red pin jack number two to another pin jack for the bomb desired to be released, this bomb would be released second, etc.

(j) In addition to a bombardier's and a pilot's firing key, which is used for manual electric bomb releasing, there are three indicator lights in the circuit.

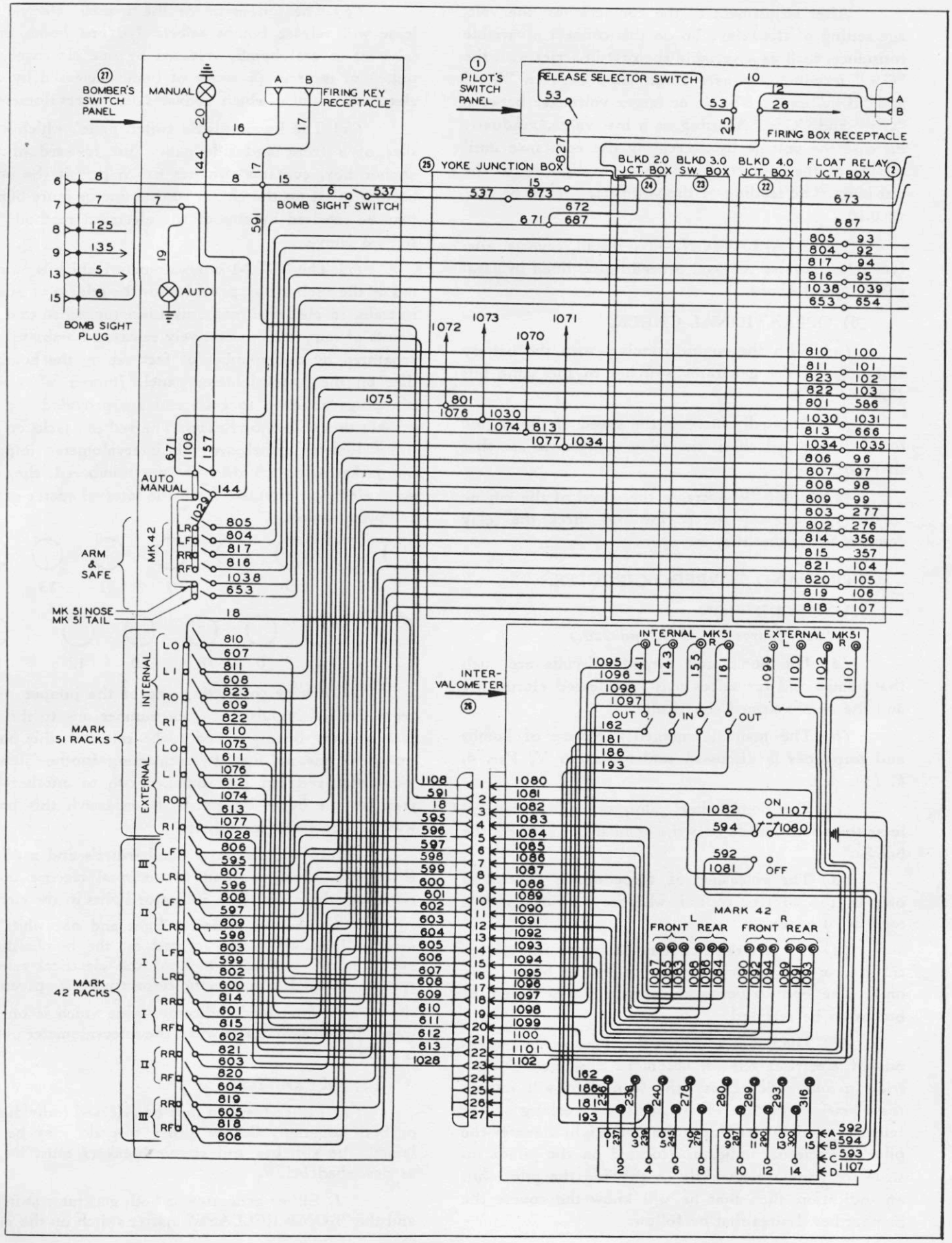
1. One red indicator light and one white indicator light, which are located on the bombardier's switch panel, indicate which of the electrical release systems, manual or automatic respectively, is operating.

2. The third indicator light, which is on the intervalometer, indicates when the intervalometer power is "ON."

(2) OPERATION.

(a) Either torpedo may be released individually or both together. Before either torpedo may be released, the switches and circuit breakers must be set as described below.

1. Either generator or both generator switches and the "BOMB RELEASE" master switch on the main



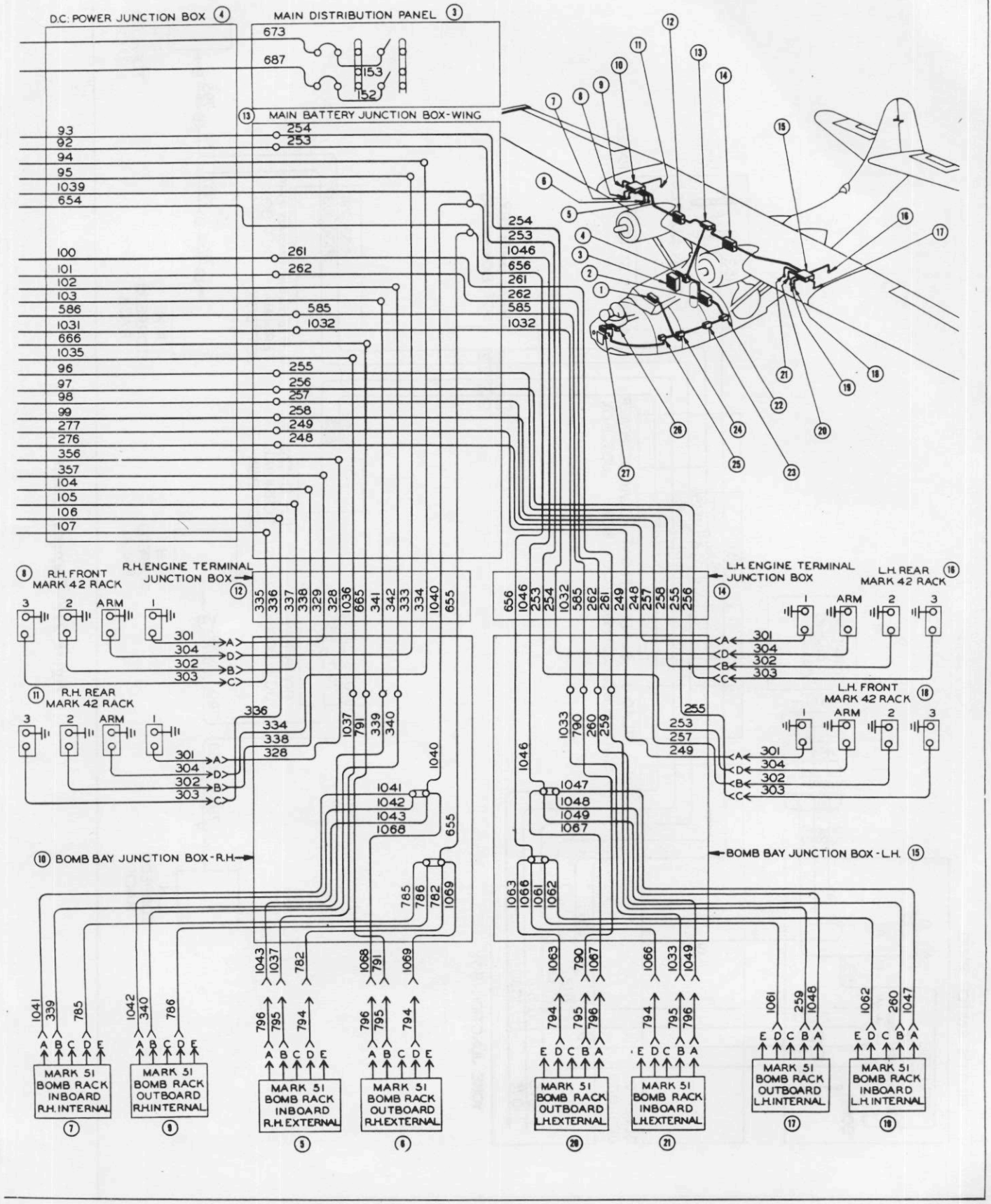


Figure 218—Bomb Circuit

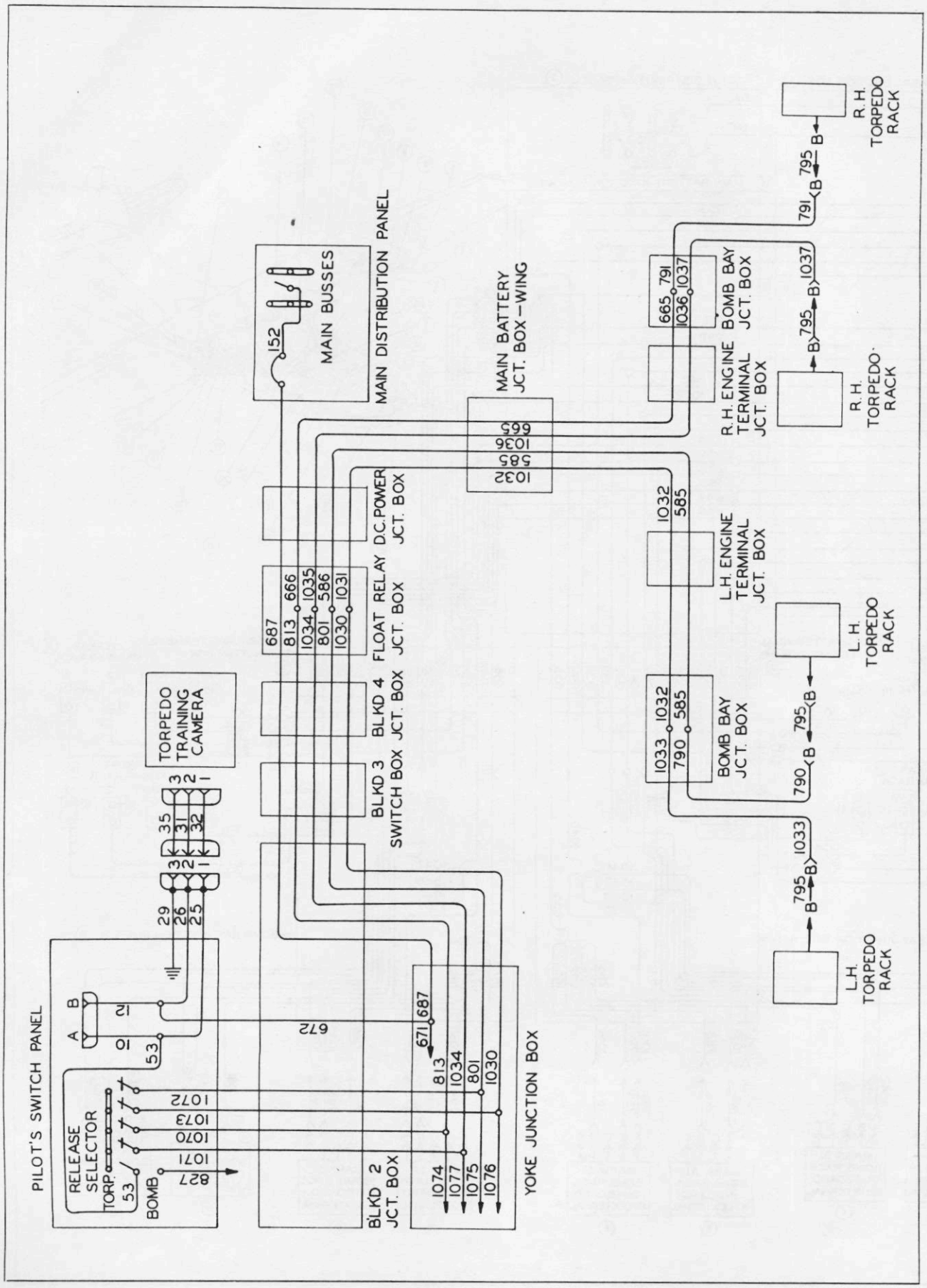


Figure 219—Torpedo Circuit

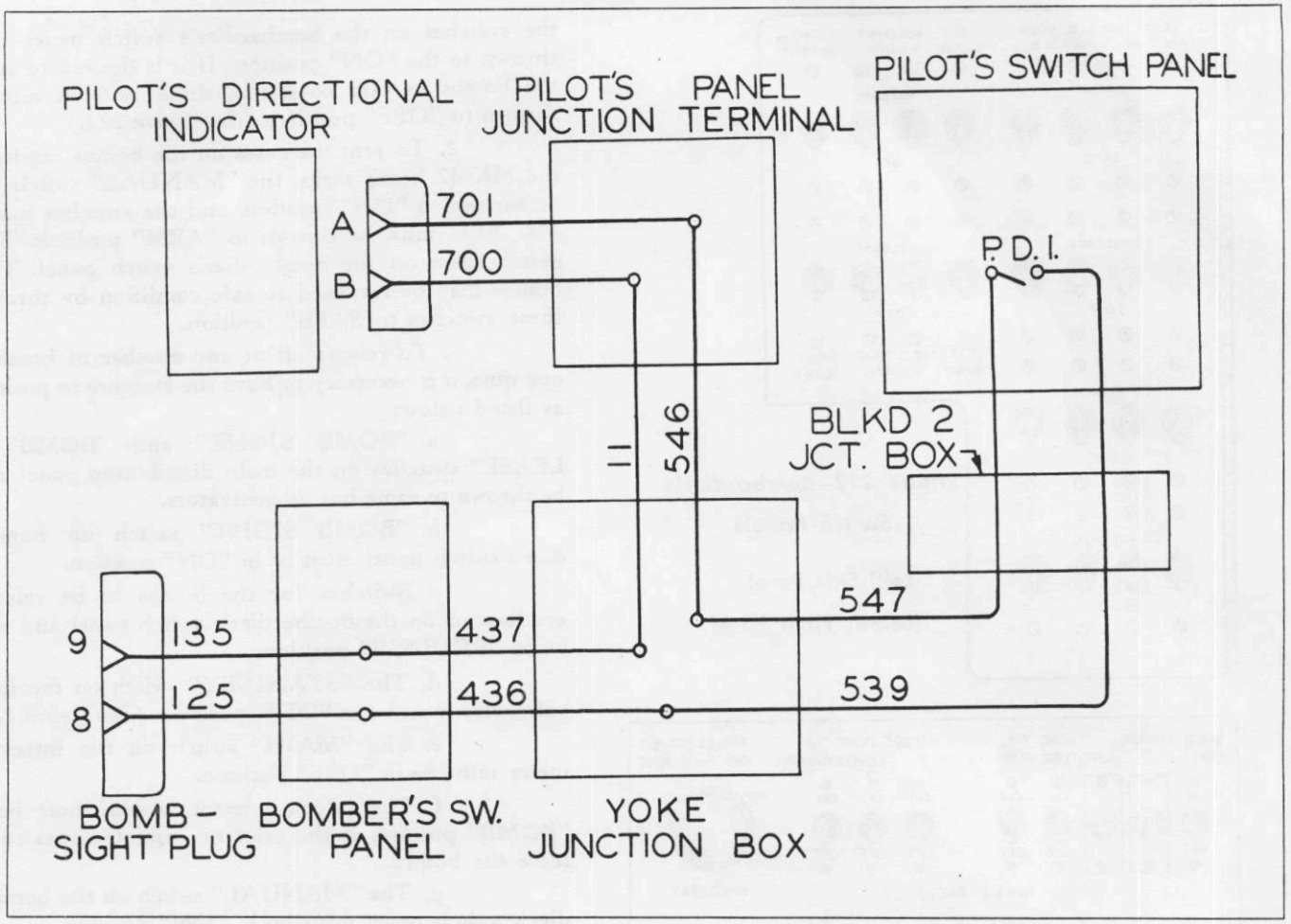


Figure 220—Pilot's Directional Indicator Circuit

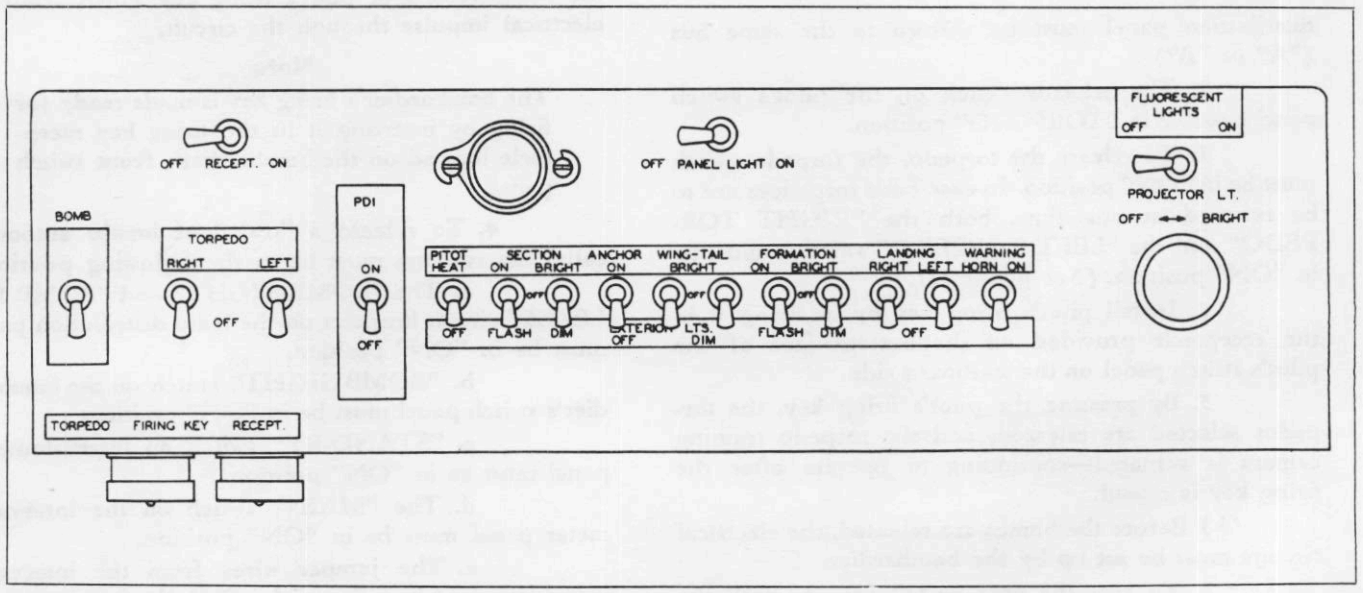
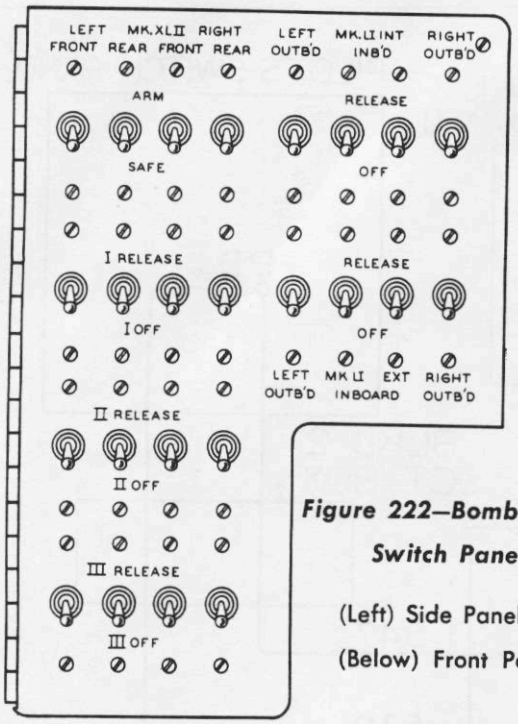


Figure 221—Pilot's Switch Panel



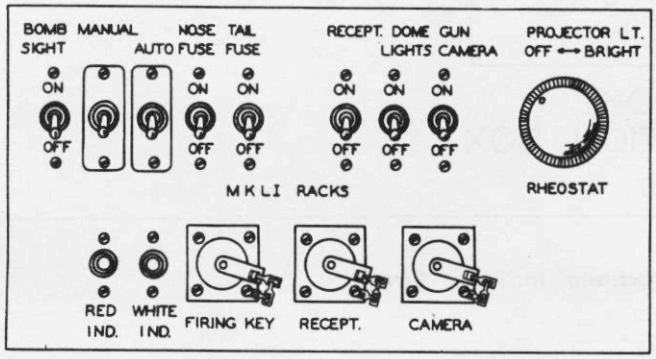


Figure 222—Bombardier's Switch Panels

(Left) Side Panel

(Below) Front Panel

distribution panel must be thrown to the same bus ("A" or "B").

2. The selector switch on the pilot's switch panel must be in "TORPEDO" position.

3. To release the torpedo, the torpedo switch must be in "ON" position. In case both torpedoes are to be released at one time, both the "RIGHT TORPEDO" and the "LEFT TORPEDO" switches must be in "ON" position. *(See figure 221.)*

4. Install pilot's firing key by inserting it in the receptacle provided on the bottom face of the pilot's switch panel on the starboard side.

5. By pressing the pilot's firing key, the torpedos selected are released, and the torpedo training camera is actuated—continuing to operate after the firing key is closed.

(b) Before the bombs are released, the electrical circuits must be set up by the bombardier.

1. To arm the nose or tail fuse or both the nose and tail fuses of the bombs carried on either or both the MK 51 internal bomb racks, it is necessary for the switches on the bombardier's switch panel to be thrown to the "ON" position. If it is desired to return the bombs to safe condition, these switches must be thrown to "OFF" position. *(See figure 222.)*

2. To arm the fuses on the bombs carried on the MK 42 bomb racks, the "MANUAL" switch must be thrown to "ON" position, and the switches marked MK XLII must be thrown to "ARM" position. These switches are on the bombardier's switch panel. These bombs may be returned to safe condition by throwing these switches to"SAFE" position.

3. To release all or any number of bombs at one time, it is necessary to have the switches in positions as listed below:

a. "BOMB SIGHT" and "BOMB RELEASE" switches on the main distribution panel must be thrown to same bus as generators.

b. "BOMB SIGHT" switch on bombardier's switch panel must be in "ON" position.

c. Switches for the bombs to be released are located on the bombardier's switch panel and must be in "RELEASE" position.

d. The "STAND-BY" switch on the intervalometer must be in "OFF" position. *(See figure 223.)*

e. The "MAIN" switch on the intervalometer must be in "OFF" position.

f. The pilot's selector switch must be in "BOMB" position if the pilot or copilot wishes to release the bombs.

g. The "MANUAL" switch on the bombardier's switch panel must be in "ON" position.

h. If the bombsight is to be used to send the electrical impulse through the circuit, the "AUTOMATIC" switch will also have to be in "ON" position.

i. The bombs are then released by closing the bombardier's or pilot's firing key which sends an electrical impulse through the circuit.

Note

The bombardier's firing key is made ready for firing by inserting it in the firing key receptacle located on the bombardier's front switch panel.

4. To release a "train" of bombs automatically, the switches must be in the following positions:

a. The "BOMB SIGHT" and "BOMB RELEASE" circuit breakers on the main distribution panel must be in "ON" position.

b. "BOMB SIGHT" switch on the bombardier's switch panel must be in "ON" position.

c. "STAND-BY" switch on intervalometer panel must be in "ON" position.

d. The "MAIN" switch on the intervalometer panel must be in "ON" position.

e. The jumper wires from the intervalometer impulse pin jacks to the pin jacks for the bombs must be connected.

f. If the bombs are to be released by an

electrical impulse from the bombardier's firing key, the "MANUAL" switch must be in "ON" position.

g. If the bombs are to be released by the pilot's firing key, the selector switch on the pilot's switch panel must be set to "BOMB" and the "MANUAL" switch on the bombardier's switch panel to "ON" position.

h. If the bombs are to be released by an electrical impulse from the bombsight, the "AUTOMATIC" switch must be in "ON" position. For position of "MANUAL" switch, see paragraph *g*, (2), *(b)*, *2*.

i. With the switches set as described, an electrical impulse from either firing key or bombsight will set off the "train" of bombs, as selected by the jumper wires on the intervalometer panel.

5. To release bombs in a preselected order the switches must be set in the same manner as outlined in paragraph *g*, (2), *(b)*, *4* above with the following exceptions:

a. The "AUTOMATIC" switch is to be in "OFF" position.

b. The "STAND-BY" switch on the intervalometer panel is to be in "OFF" position.

c. By momentarily closing either the bombardier's firing key or the pilot's firing key, the first bomb preselected on the intervalometer panel is released. To release the second preselected bomb, the firing key is momentarily closed again, etc. If the firing key is held closed, the intervalometer will continue to operate in exactly the same manner as described in paragraph *g*, (2), *(b)*, *4* above, and the result will be a "train" of bombs.

6. When the MK 51 internal bomb racks are to be connected to the intervalometer impulse pin jacks by jumper wires, the four switches on the upper left-hand corner labeled "MK 51 INTERNAL" must be in "OFF" position.

(3) MAINTENANCE.

(a) Check the disconnect plugs and receptacles shown on schematic diagrams. *(See figures 218, 219, and 220.)*

1. Remove any discoloration or corrosion with crocus cloth.

2. If the insulation is damaged or the pins do not make good contact, replace the plug or receptacle.

(b) Remove bombardier's switch panel from the box and inspect the wiring, terminals, switches, and indicator lights shown on schematic diagrams.

1. Repair or replace any wire having worn or broken insulation.

2. Clean any terminals that are discolored or corroded with No. 000 sandpaper.

3. Make sure switches work properly and if their terminal posts are discolored or corroded, clean with No. 000 sandpaper.

4. Inspect all solder connections. If loose or if strands of wire are broken at joints, repair by resoldering or replace wire and resolder.

5. Remove indicator light lamps and inspect base for discoloration or corrosion; if present, remove with crocus cloth and then reassemble.

6. Be sure all nuts are tightened securely.

(c) Remove the covers from the following junction boxes and switch panels:

1. Bulkhead 2 junction box.

2. Pilot's switch panel.

3. Float relay junction box.

4. Main distribution panel.

5. Center wing junction box.

6. Bomb bay junction box.

Inspect the wiring shown on schematic wiring diagrams *(See figures 218, 219, and 220.)* for worn or broken insulation. Check for broken strands of wire and loose connections. If the wire terminals or terminals on switches or circuit breakers are discolored or corroded, clean with No. 000 sandpaper. Be sure to tighten all nuts securely.

(4) OPERATIONAL CHECK.

(a) TORPEDO RELEASE CIRCUIT.

1. Throw the "MAIN BATTERY" switch and "BOMB RELEASE" master switch on main distribution panel to the same bus ("A" or "B").

2. Throw the selector switch on the pilot's switch panel to "TORPEDO" position.

3. Throw the right-hand torpedo switch and the left-hand torpedo switch to "ON."

4. If the torpedo racks are attached or the external MK 51 racks are attached to the wing, station an assistant to observe the release mechanism.

5. Connect the pilot's firing key to the firing key receptacle on the pilot's switch panel. The release mechanism on the bomb racks should then be actuated when the firing key is pressed.

6. If the torpedo racks or external MK 51 racks are not installed, the circuit may be checked by connecting a test lamp from pin "B" of the external MK 51 bomb rack receptacle to the ship structure (ground) for each rack. When the firing key is pressed the lamps will light if the circuit is operating correctly.

7. Connect a test lamp from pin No. 1 to pin No. 3 of the receptacle for the torpedo training camera. By pressing the firing key, this lamp should light.

(b) SALVO RELEASE.

1. Throw "MAIN BATTERY" switch and "BOMB RELEASE" master switch on main distribution panel to the same bus ("A" or "B").

2. Throw "SELECTOR" switch on pilot's switch panel to "BOMB" position.

3. Throw "MANUAL" switch on bombardier's switch panel to "ON" position.

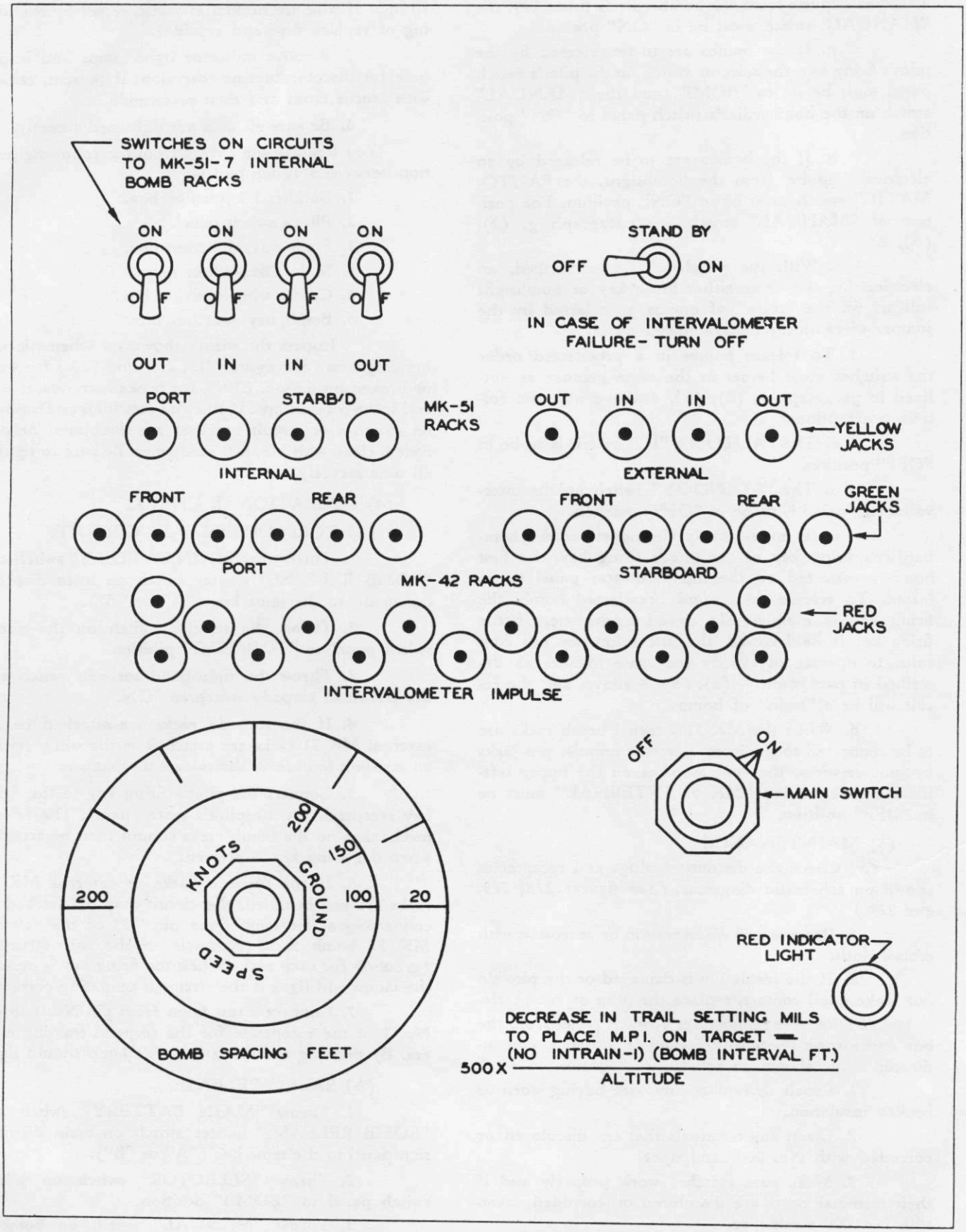


Figure 223—Intervalometer Switch Panel

4. Throw the rack selector switches on the bombardier's switch panel to "RELEASE" position.

5. Be sure the "STAND-BY" switch on the intervalometer panel and the "MAIN" switch on the intervalometer are in "OFF" position.

6. If the external MK 51 and MK 42 bomb racks are installed, station an assistant to observe the release mechanism of the bomb racks.

7. If the external MK 51 and MK 42 racks are not installed, an assistant can observe the action of the internal MK 51 bomb racks and test lamps may be connected to the pins of the other receptacles for the external MK 51 and MK 42 racks.

8. Connect the bombardier's firing key to the firing key receptacle on the bombardier's switch panel and connect the pilot's firing key to the pilot's firing key receptacle.

9. By pressing either the pilot's or bombardier's firing key, all the lamps should light at one time and the release mechanism of the bomb racks should be actuated if the circuit is functioning properly.

10. If test lamps are used, lamps should be connected as follows:

a. Between pin "B" of the external MK 51 rack receptacle and ground.

b. Between pins "A" and ground, "B" and ground, and "C" and ground of each of the receptacles for the MK 42 bomb racks.

(c) AUTOMATIC RELEASE.—With the same setting of switches as outlined in preceding paragraph *g*, (4), *(b)*, except as noted, and same condition of either bomb racks installed or test lamps connected, this circuit may be checked as follows:

1. Throw the "AUTOMATIC" switch on the bombardier's switch panel to "ON" position.

2. Throw the "BOMBSIGHT" switch on the bombardier's switch panel to "ON" position.

3. Throw the "STAND-BY" switch on the intervalometer panel to "ON" position and turn the "MAIN" switch on the intervalometer to "ON" position.

4. Throw the four switches on the top left-hand corner of the intervalometer panel for the MK 51 internal racks to "ON" position.

5. Send an electrical impulse through the circuit by actuating the bombsight. Repeat by using the bombardier's firing key and the pilot's firing key.

6. The release mechanism on the MK 51 internal racks should be actuated in the following order: first, the left-hand outboard; second, the left-hand inboard; third, the right-hand inboard; and fourth, the right-hand outboard.

7. The intervalometer can be heard running through its cycle (15 impulses). Turn the MK 51 internal rack switches on intervalometer panel to "OFF" position.

8. Connect jumper wires from the red intervalometer impulse pin jacks to the green pin jacks for the MK 42 racks.

9. Use red impulse jacks number four through number 15. Connect any three of the four yellow MK 51 external pin jacks to red impulse pin jacks numbered one, two, and three.

10. Send an electrical impulse through the circuit by actuating the bombsight. Repeat by pressing the bombardier's and pilot's firing key.

11. With an impulse from the bombsight or firing key, the intervalometer will automatically complete its cycle (15 impulses) and the release mechanism will be actuated in the same sequence as the sequence that was set up by the jumper wires on the intervalometer panel.

12. Repeat these two checks with different settings of the ground speed dial as a further check on the intervalometer.

(d) ARMING CHECK.

1. Throw the "MAIN BATTERY" switch and the "BOMB RELEASE" switch on the main distribution panel to the same bus ("A" or "B").

2. Throw the MK 51 "NOSE FUSE" and "TAIL FUSE" switches on the bombardier's switch panel to "ON" position.

3. Throw the "MANUAL" switch to "ON" position.

4. Throw the four MK 42 arming switches to "ARM" position.

5. If the circuits are correct, throwing the "BOMB RELEASE" switch on the main distribution panel alternately on the bus and "OFF" will cause the arming mechanism on the bomb racks to be actuated.

6. If the MK 51 external bomb racks or the MK 42 bomb racks are not installed, test lamps may be connected for this check as follows:

a. For the MK 51 racks, connect the test lamp from pin "A" of the MK 51 external receptacle to ground, and pin "D" to ground for each rack.

b. For the MK 42 racks, connect the test lamp from pin No. 4 of each MK 42 receptacle to ground.

7. The lamps should light each time the "BOMB RELEASE" master switch on the main distribution panel is thrown on the bus.

h. ENGINE OIL DILUTION SOLENOID VALVE CIRCUIT.

(1) DESCRIPTION. *(See figure 224.)*—One engine oil dilution solenoid is located on the forward side of each engine firewall. This solenoid opens a valve in a fuel line coming from the carburetor and allows the fuel to enter the oil system. (See Par. 16, *g*.)

The solenoid is actuated by "LH OIL DILUTE" and "RH OIL DILUTE" switches located on the engineer's panel. These two switches are the type

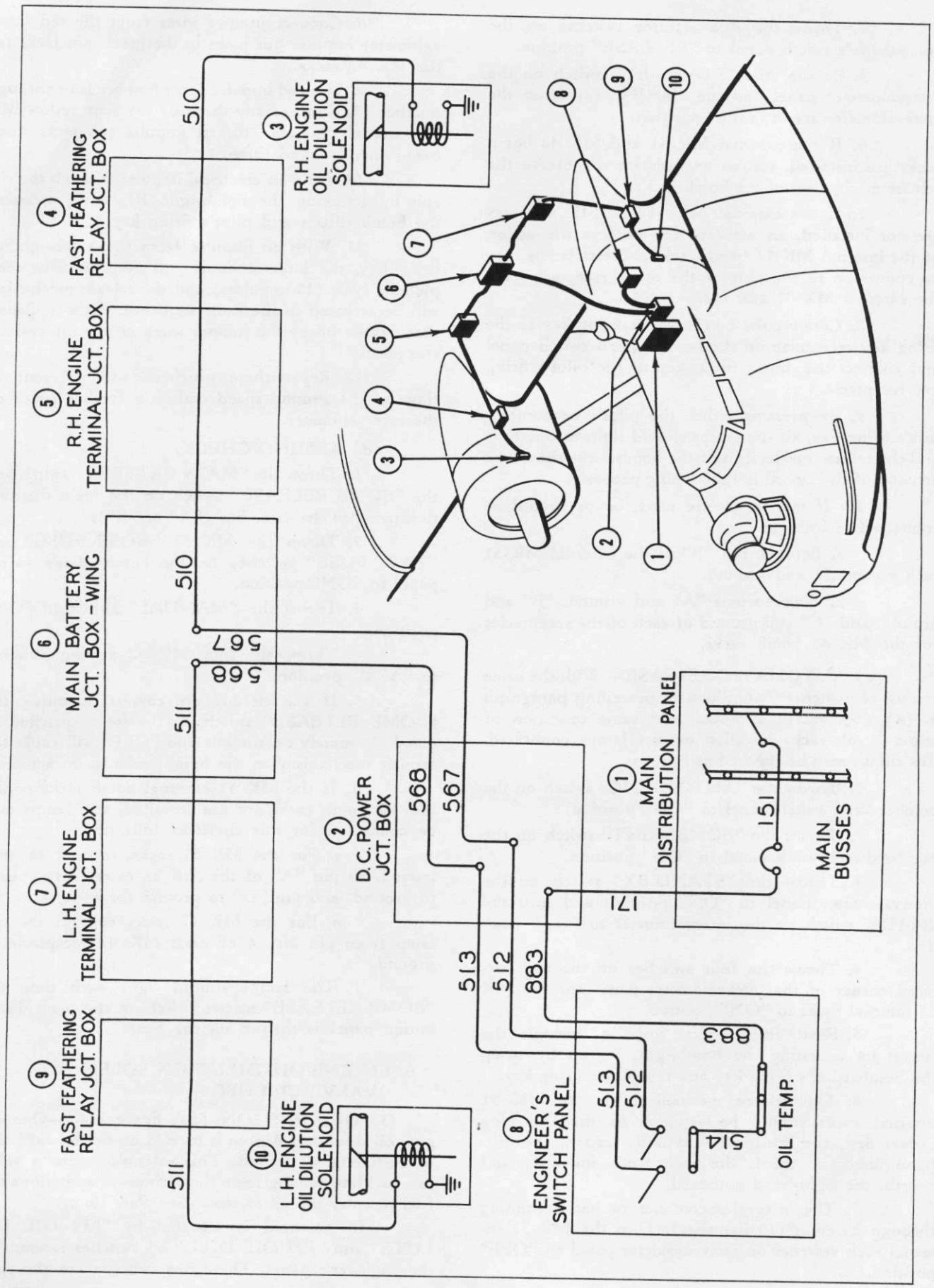


Figure 224—Engine Oil Dilution Solenoid Valve Circuit

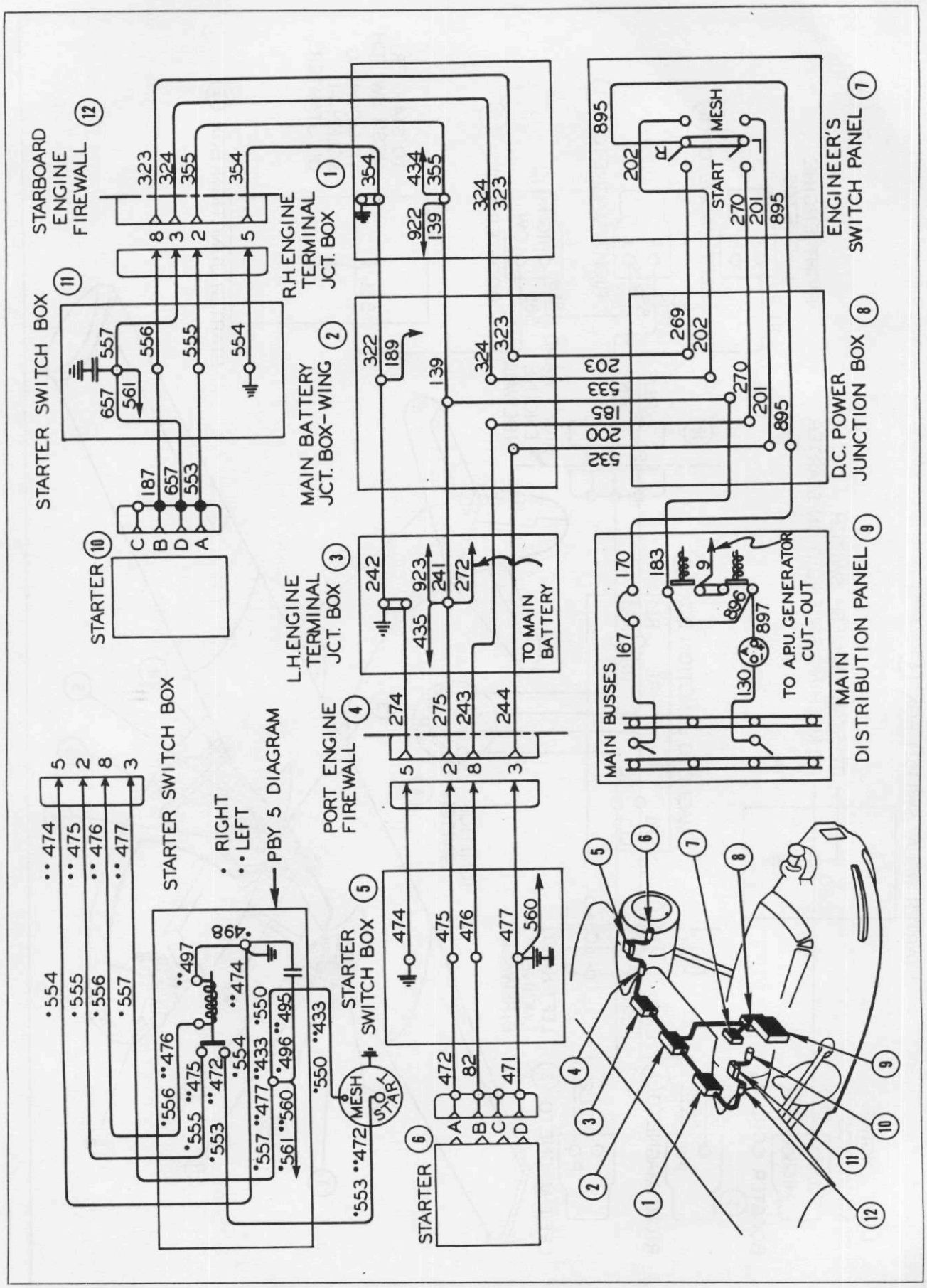


Figure 225—Engine Starter Circuit

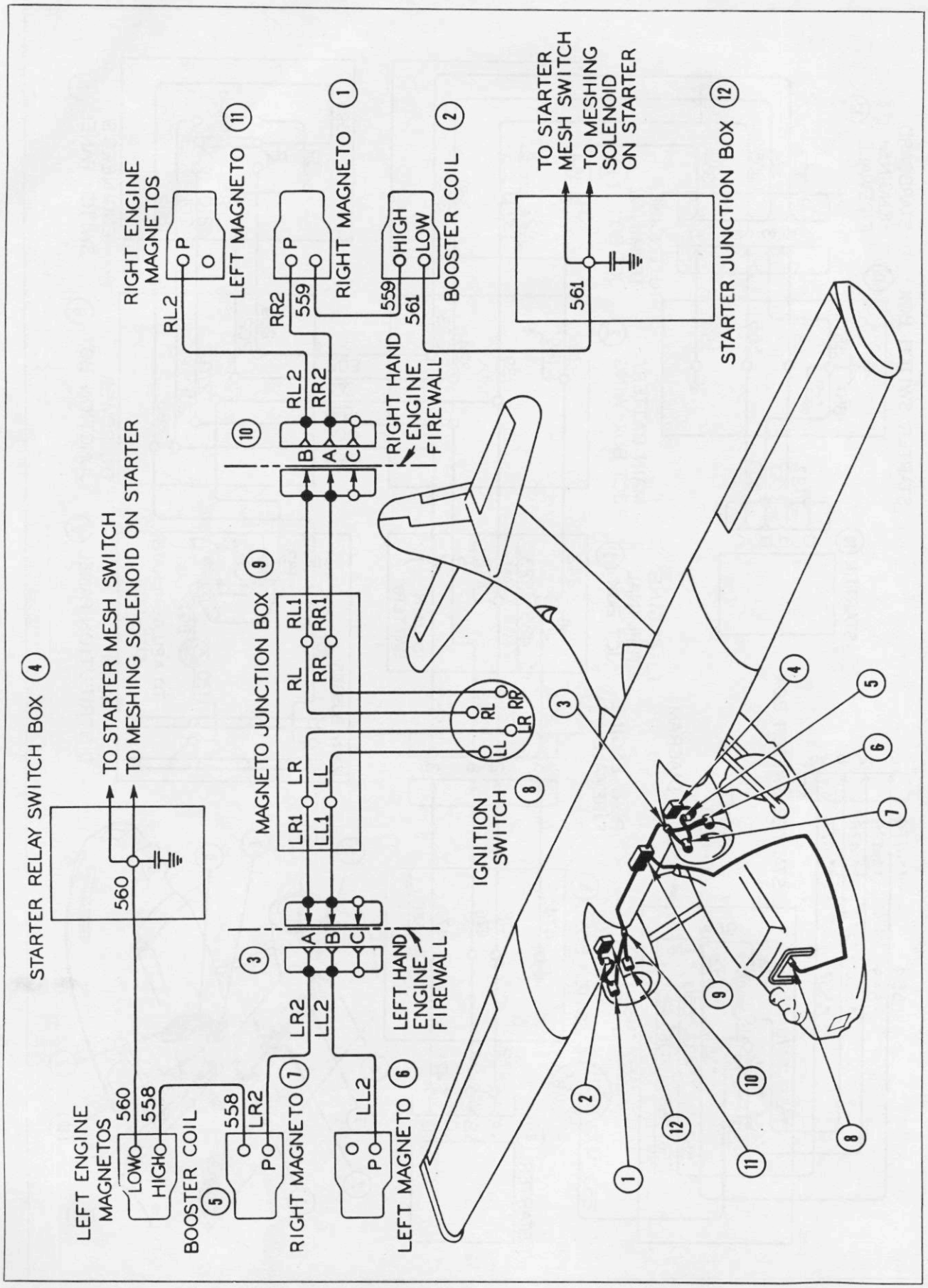


Figure 226—Ignition Circuit

that must be held in "ON" position. Releasing the switch handle opens the circuit.

The energy for the two oil dilute switches is provided by throwing the following switches as follows:

(a) Throw "MAIN BATTERY" switch on the main distribution panel to bus "A" or "B."

(b) Throw "OIL GAGE" switch on main distribution panel to same bus as the "MAIN BATTERY" switch.

(2) REMOVAL.
(See Par. 16, *g*, (2).)

(3) MAINTENANCE.—Inspect wires, terminals, switches and circuit breakers in junction boxes shown on wiring diagram *(See figure 224.)* by following procedure outlined in paragraph *g*, (3).

(a) Remove safety wire from top of solenoid; unscrew wing nut; remove washer; and pull cap and conduit away from solenoid far enough to check the condition of the terminals. If the terminals are discolored or corroded, clean them with No. 000 sandpaper. Reassemble in reverse order of disassembly, being sure to install a new safety wire.

(b) If the solenoid does not function properly electrically, replace the solenoid.

i. ENGINE STARTER CIRCUIT.

(1) DESCRIPTION. *(See figure 225.)*—Each engine is started by an inertia type starter which, after acceleration, is meshed with the engine by a meshing solenoid.

The starting system controls comprise two single pole, three position start and mesh switches (labeled "LEFT ENGINE START" and "RIGHT ENGINE START") on the engineer's switch panel, two solenoid switches in the main distribution panel, and two starting and two meshing solenoids. One starting and one meshing solenoid are a part of each starter mechanism.

(2) OPERATION.—Supply power to the system by starting the auxiliary power unit (See Par. 17, *b*, (1), *(b)*, and 17, *b*, (2), *(b)*.) and turn ignition switch "ON." (See paragraph *j*.)

(a) Throw both the "AUXILIARY GENERATOR" switch and the "ELEC. STARTER" switch on the main distribution panel to either bus "A" or bus "B."

CAUTION

Do not attempt to start engines on batteries alone.

(b) Throw either the "LEFT ENGINE START" or the "RIGHT ENGINE START" switch on the engineer's switch panel to "START."

Note

This causes the solenoid switch in the main distribution panel to connect the auxiliary generator directly to the main battery circuit at the same time that the starter switch on the engineer's switch panel connects the main battery circuit to the starter motor.

(c) Current is sent to the solenoid in the starter which drops the brushes onto the commutator of the motor, thus starting the starter motor and flywheel rotating.

(d) When the starter flywheel has reached its normal operating speed of approximately 22,000 rpm (approximately 12 seconds needed to reach this speed), the starter switch on the engineer's switch panel is thrown from "START" to "MESH." With the switch in this position, the electric circuits of the starter solenoid and motor are disconnected and the meshing solenoid is energized, causing the starter flywheel to mesh with and thus start the engine.

Note

The meshing switch also energizes the booster coil (See paragraph *j*.) thereby boosting the ignition voltage for starting.

CAUTION

Starter disengagement is automatic on firing of the engine. If the engine fails to start and the starter and engine jaws do not disengage, turn the ignition "OFF" and turn propeller by hand about 1/3 or 1/2 of a revolution in its proper direction of rotation, or turn the propeller in opposite direction of rotation for ½ turn. Either operation will release the starter jaw.

Do not operate the starter either manually or electrically while the starter and engine jaws are engaged.

Energize starter not longer than 12 seconds. If a third attempt to start the engine is unsuccessful, allow a five minute period before attempting to start engines again.

(3) MAINTENANCE. — Inspect wiring and terminals in junction boxes shown on wiring diagram *(See figure 225.)* by following procedure outlined in paragraph *g*, (3). Be sure all solenoid contacts are kept clean.

j. IGNITION CIRCUIT.

(1) DESCRIPTION. *(See figure 226.)*—This circuit provides control of the voltage to the engines by grounding the magnetos on each engine when they are not in use and automatically connecting the booster coils into the circuit when starting.

The dual ignition switch, located on the pilot's control yoke, includes the master magneto switch and individual magneto switch for each engine. The master magneto switch grounds all of the magnetos when it is pulled out to "OFF" position, regardless of the positions of the individual switches.

A disconnect plug is provided at each firewall for the quick-disconnect of the conduit.

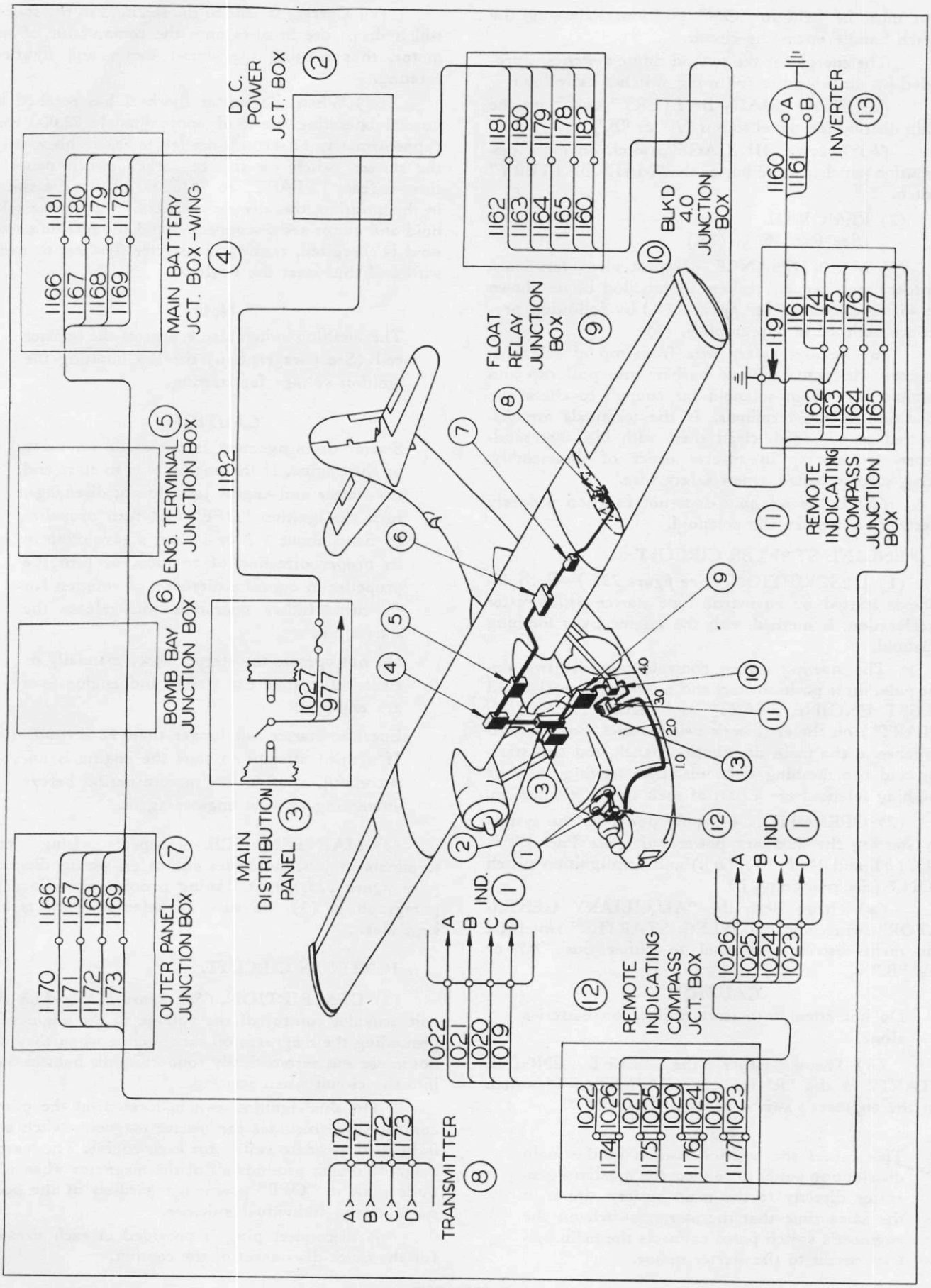


Figure 227—Magnesyn Compass Circuit

WARNING

Do not rotate propellers or engine when this plug is disconnected as the magnetos are not grounded and engine may start.

One magneto is located on the aft port side, and another on the aft starboard side of each engine.

Each magneto connects to a booster coil which is mounted on the under side of the engine starter junction box. The booster coil provides high voltage during starting, when the rpm of the engine is too low for the magnetos to function properly. When the starter switch on the engineer's switch panel is thrown to "MESH" position, current is automatically fed to the booster coil.

(2) MAINTENANCE.

(a) Remove shield from back of ignition switch and inspect wiring and terminals.

1. If terminals are discolored or corroded, clean them with No. 000 sandpaper.

2. If insulation on wires is worn, frayed, or cracked, or the wire strands are broken, repair or replace wire.

(b) Uncouple each ignition disconnect plug on the engine firewalls and inspect the plugs, solder connections, and wires.

1. If the pins on the plugs are discolored or corroded, clean them with crocus cloth. If insulation is cracked or damaged, replace the plug.

2. If the solder connections at the disconnect plug are loose, resolder them.

3. If wires are damaged or insulation is worn or cracked, repair or replace wires.

(c) Remove cover from magneto junction box and inspect wires for worn or cracked insulation or broken wire strands. If any defects are noted, repair or replace the wire. If the terminals are discolored or corroded, clean with No. 000 sandpaper.

k. MAGNESYN COMPASS CIRCUIT.

(1) DESCRIPTION. *(See figure 227.)*—The two remote indicating compasses (F. S. S. C. NO. 88-I-800) on the pilot's instrument panel are actuated by a Magnesyn transmitting unit (F. S. S. C. No. 88-I-1950) located in the port wing outer panel.

Note

The transmitter was formerly located under the port bunk forward of bulkhead 6 but was moved to the wing location by service action. A third remote indicating compass which was located on the aft face of bulkhead 6 was deleted by service action.

24 volt direct current for the operation of the Magnesyn compass system is provided by a 26 volt, 400 cycle inverter (Pioneer type 12117) which is mounted on the port wall of the airplane, above the navigator's table, just aft of the navigator's instrument panel.

The input to the inverter connects to a switch on the main distribution panel which can be thrown to either bus "A" or "B" to obtain 24 volt D.C.

The output of the inverter is connected to the "A" terminals of the transmitter and the indicators. The "B" terminals of the instruments are connected to each other and to a common ground, while the "C" and "D" terminals are connected by the "C" and "D" phase wires, respectively.

(2) MAINTENANCE.

(a) Check wires and terminals shown on wiring diagram. *(See figure 227.)*

1. If wire insulation is worn or broken, replace or repair wire.

2. If wire terminals are discolored or corroded, clean with No. 000 sandpaper.

(b) Inspect disconnect plugs at transmitter and indicators.

1. If insulation is cracked or damaged or pins do not make good contact, replace plug.

2. If pins are discolored or corroded, clean with crocus cloth.

(c) At every overhaul period, remove and check the inverter as follows:

CAUTION

Always break the D.C. supply lead before breaking the ground connection. Failure to do this will result in reduced output voltage.

1. Clean all wiring connections with carbon tetrachloride. Resolder any damaged connections.

2. Unscrew brush caps and remove brush assemblies. If the assemblies are not marked "positive" and "negative," mark them so, in order that they may be replaced in the proper brush guides.

3. Clean brushes with gasoline or Varnalene and dry thoroughly. Do not use carbon tetrachloride.

4. Check length of brushes. If they approach the length of 5/32 inch, replace with new.

5. Insure proper seating of new brushes by inserting a strip of No. 000 sandpaper between brush and commutator, sanded side toward the brush, and pulling in the direction of commutator rotation until the brush is fully seated. Blow out any grit or carbon particles. Do not use emery cloth.

6. Clean dirty commutators with a gasoline or varnalene moistened cloth. If rough, polish with No. 000 sandpaper.

(3) TROUBLES AND REMEDIES.—The accompanying chart lists trouble symptoms characteristic of various wiring faults. All indicator behavior is considered as referred to a transmitter pointed on a North heading. The letters in the chart refer to plug terminal pin markings at any instrument.

TROUBLE	CAUSE	REMEDY
(a) No torque.	"A" shorted to "B."	Check and repair.
	Blown fuse in main distribution panel.	Replace fuse.
	Loose or broken wiring connections between main distribution panel and inverter.	Check and repair.
	Defective inverter.	Replace inverter.
(b) Reverse rotation.	"A" and "B" reversed with "C" and "D" reversed.	Change connections.
(c) Erratic operation in the 90° arc between 300° and 30°.	"D" open.	Check and repair.
(d) Erratic operation in the 120° arc between 300° and 60°.	"C"–"D" phase open in either transmitter or indicator coils.	Replace faulty instrument.
(e) Pointer pulls in at 0° or 180°.	"A" and "C" reversed with "B" and "D" reversed.	Check and correct.
	"A" and "D" reversed with "B" and "C" reversed.	Check and correct.
(f) Pointer pulls in at 30° or 210°.	"A" wire open (power supply reaching one unit).	Check and repair.
	"D" shorted to "A" or "B."	Check and repair.
	"A"–"D" phase open in either transmitter or indicator coils.	Replace faulty instrument.
	"A" and "D" reversed.	Check and correct.
(g) Pointer pulls in at 60° or 240°.	"A" and "C" reversed.	Check and correct.
(h) Pointer pulls in at 90° or 270°.	"C" shorted to "D."	Check and repair.
	"C" and "D" reversed.	Check and correct.
	"A" and "B" reversed.	Check and correct.
(i) Pointer pulls in at 120° or 300°.	"B" and "D" reversed.	Check and correct.
(j) Pointer pulls in at 150° or 330°.	"B" wire open (power supply reaching one unit).	Check and correct.
	"C" shorted to "A" or "B."	Check and repair.
	"B"–"C" phase open in either transmitter or indicator coils.	Replace faulty instrument.
	"B" and "C" reversed.	Check and correct.

(4) ADJUSTMENTS.—Two men are required for the compensation procedure. One adjusts the compensator on the Magnesyn transmitter, the other observes and records the deviation errors of the indicator. The site chosen should be a section of the field completely free of artificial deviation sources such as power lines, steel piping, reinforced concrete structures, other aircraft, etc.

Before "swinging" the Magnesyn, check the power supply to determine that the proper amperage is being delivered to the system. Each unit, counting the transmitter as one, requires 40 to 100 milliamperes of current as measured by an "R.F." milliameter. If the current drawn is not within this range, the voltage and frequency are incorrect and the power supply equipment must be adjusted so that 26 volts, 400 cycles are delivered to the instruments.

While "swinging" the compass, switch on its power only when taking a reading. Always switch off the power before changing the heading of the plane. This avoids transmitter friction. Tap the indicator lightly while taking a reading.

Before "swinging," place the airplane in an attitude that simulates as closely as possible the attitude and conditions of the plane in straight and level flight. It should parallel the plane of level flight, or deviate at an angle not exceeding 5°. This is essential to prevent heeling of the compass card during compensation. To "swing the compass" proceed as follows:

(a) Head the plane due Magnetic North. A pelorus or other suitable instrument is employed to establish Magnetic North. Switch on the Magnesyn compass power. Observe the indicator reading. If it is not on North, turn the "NS" compensating screw (located on the top of the transmitter unit) with the non-magnetic screw driver, supplied with the instru-

ment. Turn until the indicator reads North, then switch off the Magnesyn power.

(b) Head the aircraft due East of Magnetic North. Turn on the Magnesyn switch. If the Magnesyn compass indicator does not show East, turn the "EW" compensating screw of the transmitter unit until the indicator reads East. Once more, switch off the Magnesyn power supply.

(c) Head the plane due South of Magnetic North. Turn on the Magnesyn power supply. If the indicator does not read South, turn the "NS" screw until the error is reduced by one half. For example, if the Magnesyn compass indicates 176° with the aircraft on a southerly heading, turn the "NS" screw until the reading is 178°. Again, turn off the Magnesyn power switch.

(d) Head the aircraft West of Magnetic North. Turn on the Magnesyn power supply. Repeat the operation described immediately preceding, this time turning the "EW" screw until the error is reduced by half. Switch off the Magnesyn power supply.

(e) Head the aircraft Magnetic North once more. Record the error of the northerly heading. Next, record the Magnesyn compass indications for each successive 15° heading around the compass rose. The resulting data are noted on the compass deviation chart and a copy is mounted in the airplane adjacent to each Magnesyn indicator.

(f) If there is an azimuth error, i.e., if the compass deviation error is all minus or all plus, loosen the compass transmitter mounting screws and rotate the unit the necessary number of degrees to distribute the deviation equally on the plus and minus sides.

l. LANDING GEAR POSITION INDICATOR SYSTEM (PBY-5A Only).

(1) DESCRIPTION. *(See figure 228.)*—The landing gear position indicating system is provided for the purpose of giving the pilot or copilot a visual indication of the positions of the main landing gear, the nose wheel, and the nose wheel doors. The indicating portion of the system is protected by a five ampere fuse located on the main distribution panel, and consists of three indicating lights labeled "WHEEL DOOR LOCKED," "WHEELS UP" and "WHEELS DOWN" and also a double throw toggle switch having two positions labeled "INDICATION LIGHTS" and "WARNING LIGHTS." The toggle switch and indicating lights are located on the starboard side of the pilot's instrument panel. The indicator lights and a number of micro-switches, located near the landing gear, are connected to the outer position of the double throw toggle switch as follows:

The "WHEEL DOOR LOCKED" (nose) indicating light is connected in series with a micro-switch located on the keel forward of bulkhead 1. When the nose wheel and the nose wheel door is retracted, the micro-switch is closed and the "WHEEL DOOR LOCKED" indicating light is then illuminated.

The "WHEELS UP" (main landing gear) indicating light is connected in series with two main landing gear "UP" position micro-switches located on the forward upper side of the up-lock structure of each main landing gear. When the main landing gear is locked in the "UP" position, the micro-switches are closed and the "WHEELS UP" indicating light is then illuminated.

The "WHEELS DOWN" (complete landing gear) indicating light is connected in series with the two main landing gear "DOWN" position micro-switches and the nose wheel "DOWN" and "DOWN AND LOCKED" position micro-switches. The main landing gear "DOWN" micro-switch is located a few inches above the hinges on the forward side of the main struts. The nose wheel "DOWN" micro-switch is located on the aft side of bulkhead 1 in front of and below the copilot's right rudder pedal. The "DOWN AND LOCKED" micro-switch is located on the starboard side and forward of bulkhead 1 on the underside of the keel stiffener. When all the landing gear is in the "DOWN AND LOCKED" position, the micro-switches are closed and the "WHEELS DOWN" indicating light is illuminated.

When on the "INDICATION LIGHTS" position, the toggle switch is connected to the hot side of the float control circuit. When the toggle switch is set in this position, any light whose micro-switches are closed will be illuminated.

When on the "WARNING LIGHTS" position, the toggle switch is connected to the "THROTTLE WARNING" switch located under the deck, forward of bulkhead 4 and on center line of airplane. When either throttle is retarded below safe flying speed, the "THROTTLE WARNING" switch is closed and the landing gear position circuit is energized causing an indicator light to be illuminated to indicate the position of the landing gear.

(2) MAINTENANCE.

(a) Check the terminals of the toggle switch on the pilot's instrument panel and the fuse in the main distribution panel; if the terminals are discolored or corroded, clean them with No. 000 sandpaper.

(b) Check the operation of the toggle switch and fuse; if they do not operate correctly, replace them.

(c) Inspect the throttle warning switch; if contacts on terminals are discolored or corroded, clean with No. 000 sandpaper.

(d) If any micro-switches do not operate properly, remove cover from micro-switch housing and replace micro-switch.

CAUTION

Micro-switch housings for the main landing gear "UP" and "DOWN" micro-switches are oil filled and must be held with the cover in an upward position to prevent spilling oil when cover is removed.

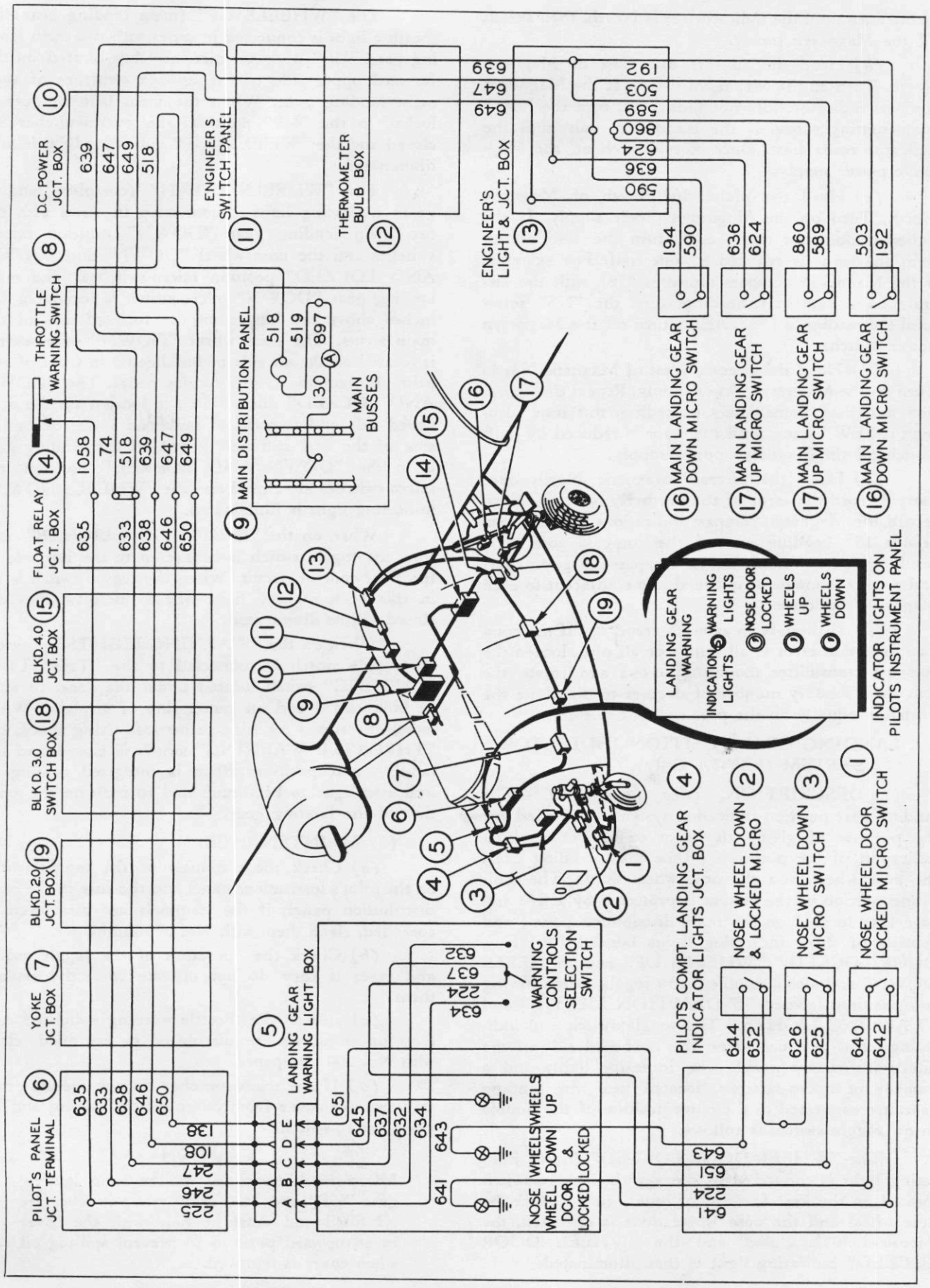


Figure 228—Landing Gear Position Indicator Circuit (PBY-5A Only)

(e) If more oil is needed for housing, fill with "Transyl" oil.

(f) Inspect the lamp in the indicator lights.

1. If the glass is fumed or darkened by use, replace the lamp.

2. If the base is discolored or corroded, clean with crocus cloth.

(g) Inspect disconnect plug on landing gear warning light box, which is located on forward side of pilot's instrument panel.

1. If insulation is cracked or damaged, replace plug.

2. If pins are discolored or corroded, clean with crocus cloth.

3. If pins do not make good contact, replace plug.

4. Remove knurled nut from rear of plug and inspect solder connections, making sure all connections are tight and wires are not broken.

(h) Inspect wires and wire terminals in junction boxes shown on wiring diagram. *(See figure 228.)*

1. If insulation is worn or broken, repair or replace wire.

2. If wire terminals are corroded or discolored, clean with No. 000 sandpaper.

(i) Be sure that all terminals, plugs, and conduit fittings are tight.

(3) TROUBLES AND REMEDIES.—Investigate and correct failure of any unit of the system. Following is a list of more common troubles and suggested remedies:

TROUBLE	CAUSE	REMEDY
(a) Failure of all lights with control switch in either position.	Blown fuse.	Replace fuse.
	Defective or loose wiring connections between main distribution panel and float relay box.	Check and repair.
(b) Failure of all lights with control switch in "WARNING LIGHTS" position.	Defective throttle warning switch.	Repair or replace switch.
	Dirty contacts on throttle warning switch.	Clean contacts.
	Contacts on throttle cables out of adjustment.	Adjust contacts.
	Defective control switch.	Replace control switch.
	Defective or loose wiring connections between throttle switch and control switch.	Check and correct.
(c) Failure of all lights with control switch in "INDICATION LIGHTS" position.	Defective control switch.	Replace switch.
	Defective wiring connections between float relay box and control switch.	Check and repair.
(d) Failure of main landing gear "WHEELS UP" light.	Burned out bulb.	Replace bulb.
	Defective lamp socket.	Repair or replace socket.
	Defective "UP" micro-switch on main landing gear.	Replace switch.
	Defective or loose wiring connections in landing gear "UP" circuit.	Check and correct. *(See figure 228.)*
(e) Failure of landing gear "WHEELS DOWN" indicator light.	Same as first and second causes for trouble *(d)*.	Same remedies as for first and second causes for trouble *(d)*.
	Defective main gear "DOWN," nose gear "DOWN," or nose gear "DOWN AND LOCKED" micro-switch.	Replace defective switch or switches.

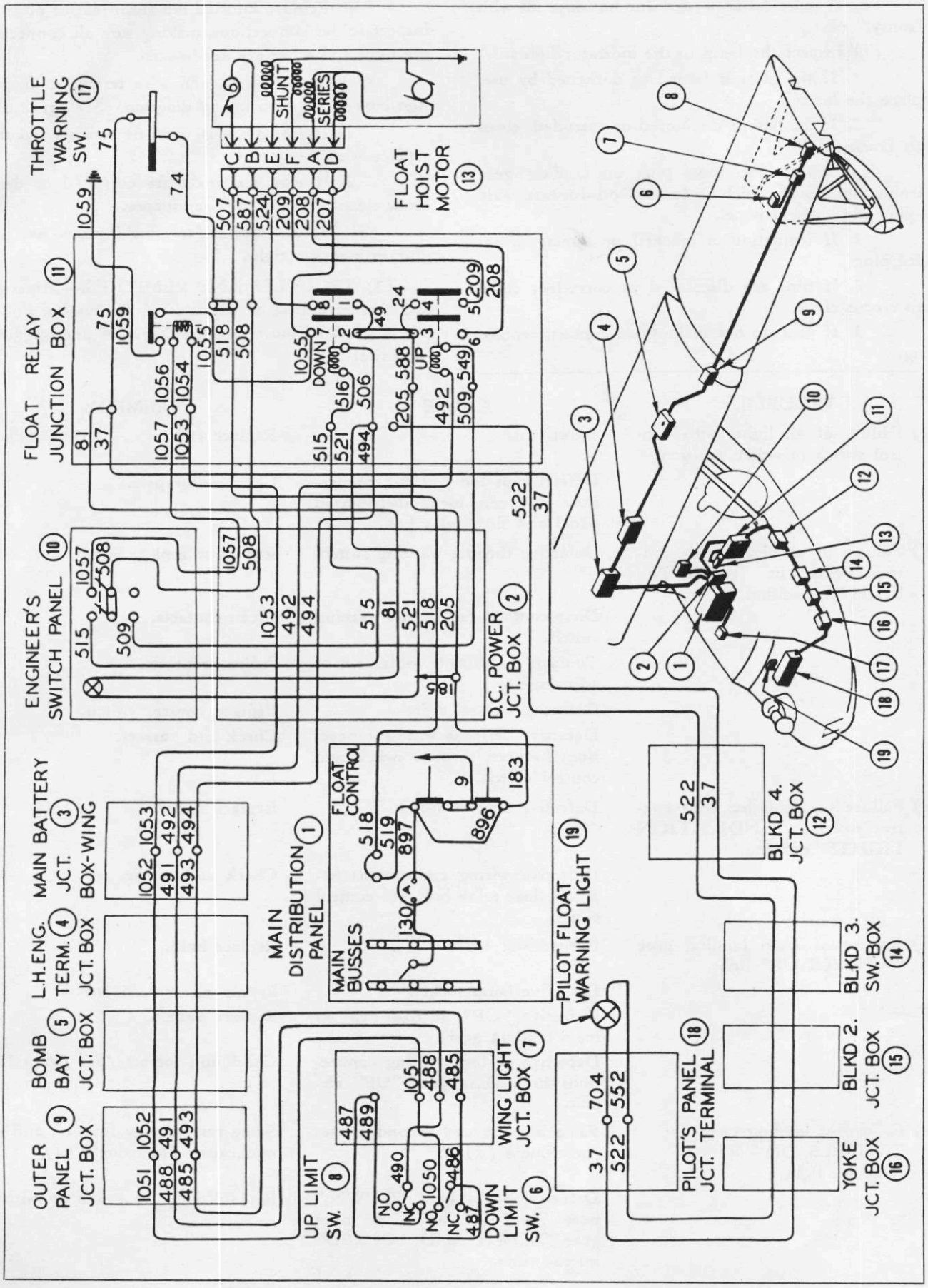


Figure 229—Float Operating and Indicating Circuit

TROUBLE	CAUSE	REMEDY
	Defective or loose wiring connections in landing gear "DOWN" circuit.	Check and correct. *(See figure 228.)*
(f) Failure of nose "WHEEL DOOR LOCKED" indicator light.	Same as first and second causes for trouble *(d)*.	Same remedies as for first and second causes for trouble *(d)*.
	Defective nose wheel door "LOCKED" micro-switch.	Replace switch.
(g) Intermittent or flickering operation of all lights.	Intermittent ground between main distribution panel and control switch.	Check and correct.
	Loose or defective wiring connections in above line.	Check and correct.
	Defective control switch.	Replace switch.
(h) Intermittent or flickering operation of any one light.	Bulb loose in socket.	Check and correct.
	Defective wiring or loose connections in circuit of lamp affected.	Check and correct.
	Intermittent ground in circuit of lamp affected.	Check and correct.
	Defective micro-switch in circuit of lamp affected.	Replace switch.

(4) OPERATIONAL CHECK.

(a) This may be accomplished during flight, on the water, or when the airplane is in any position such that the landing gear is free to operate.

(b) The starboard engine must be running to build up enough pressure in the hydraulic system to operate the landing gear.

(c) Throw the selector switch on the pilot's instrument panel to "INDICATION LIGHTS" and then operate landing gear. (See Par. 4.) If the system is functioning correctly, the indicator light marked "WHEEL DOOR LOCKED" will light when the nose wheel is in "UP" position. The indicator light marked "WHEELS UP" will light when the main landing gear is up. The indicator light marked "WHEELS DOWN" will light when the nose wheel and main landing gear are in "DOWN" position.

(d) Throw the selector switch to "WARNING LIGHTS" and with the throttle in a position that would produce a speed so low as to be unsafe for flying, operate the landing gear.

The indicator lights should operate as outlined in paragraph *l*, (4), *(c) above*.

m. FLOAT OPERATING AND INDICATING CIRCUIT.

(1) DESCRIPTION. *(See figure 229.)*—This circuit provides electrical control for raising and lowering the floats as well as a warning light system for giving the pilot and engineer an indication of the position of the floats.

An electric motor containing a thermal cut-out switch provides the necessary power for raising and lowering the floats. The motor is mounted on the forward face of bulkhead 4 between the main distribution panel and the float relay junction box. Current for the motor is taken from a connection to the main batteries in the D.C. power junction box located between the main distribution panel and the float relay junction box.

Power for the circuit is obtained through a connection to the main battery circuit in the main distribution panel and is protected by a five ampere fuse in the panel and the thermal cut-out switch which, in case the motor becomes overheated, breaks the control circuit and thus shuts off the motor.

An "UP" and "DOWN" relay and a "BRAKING" relay are provided in the circuit to control the flow of current to the motor. These relays are located in the float relay junction box which is mounted on the forward face of bulkhead 4 on the port side.

Two limit micro-switches are located in the port wing. The "UP" micro-switch is mounted in the forward float strut slot slightly inboard of the wing end. The "DOWN" micro-switch is mounted on the under side of the wing forward and adjacent to the trough that contains the screw jack, approximately five feet from the wing end. These switches are closed by the float when in the extended and retracted positions.

A control switch to raise and lower the floats completes the units in the control circuit. It is located on the upper part of the engineer's panel.

The indicating circuit consists of two "FLOAT WARNING" lights and the throttle warning switch.

One of the two "FLOAT WARNING" lights is located on the upper central portion of the pilot's

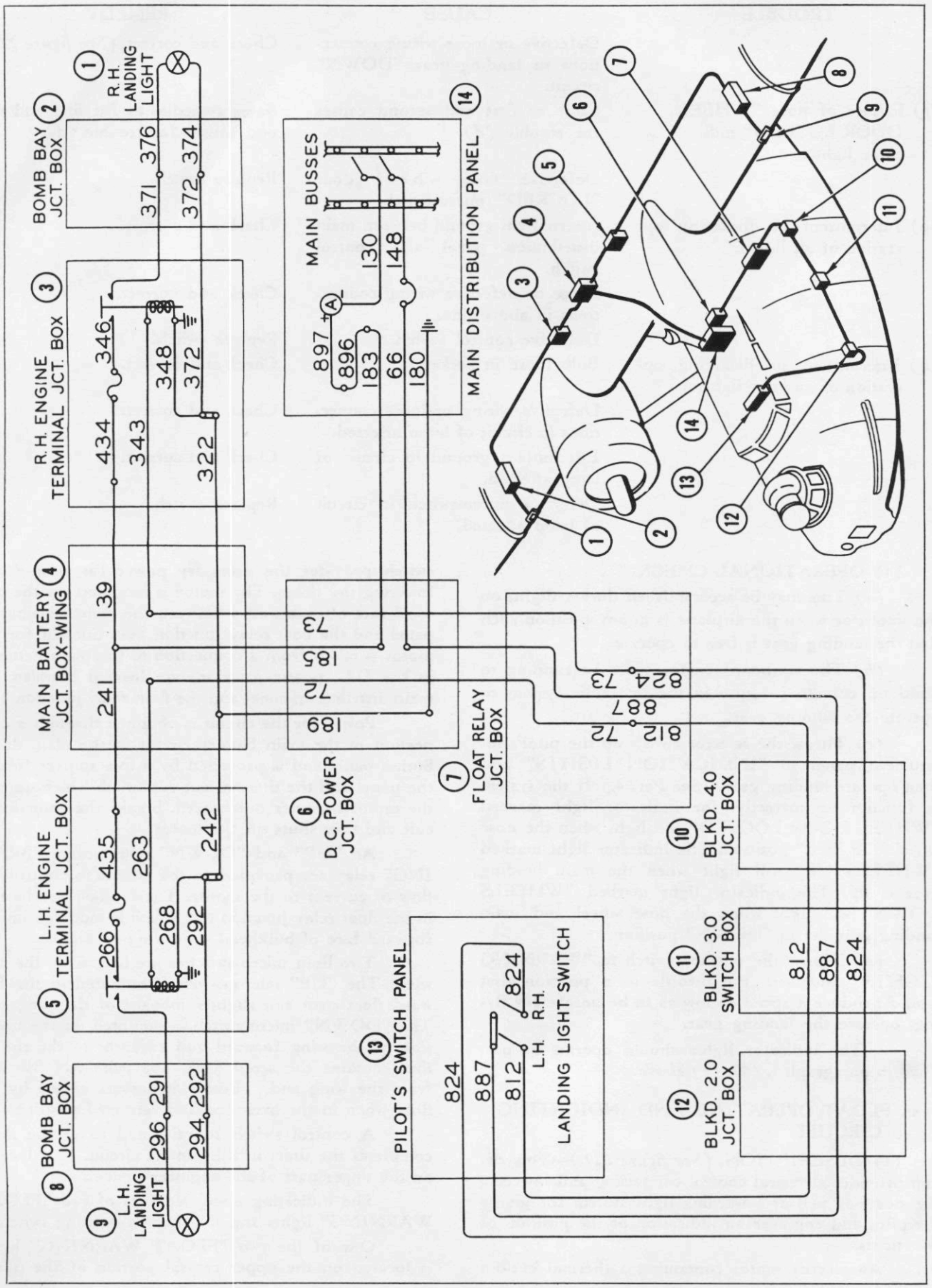


Figure 230—Landing Light Circuit

instrument panel, while the other indicating light is located on the engineer's instrument panel.

The throttle warning switch completes the indicating circuit. It is located just forward of bulkhead 4 on center line under the deck. Whenever the pilot retards either throttle below safe flying speed, the throttle warning switch is closed and if the floats are not latched down, the "FLOAT WARNING" lights will be illuminated.

To raise the floats from a "DOWN" position, proceed as follows:

Throw the control switch on the engineer's panel labeled "FLOATS" to the "UP" position.

When this switch is thrown, the "UP" coil of the "UP" and "DOWN" relay is energized. This closes its contacts and the power flows to two windings of the motor. The motor runs in the proper direction to raise the floats by means of the operating mechanism. (See Par. 6, *d*, (1).) As the port float latches in the upper position, it makes mechanical contact with the "UP" limit switch. This switch opens and breaks the "UP" coil circuit in the "UP" and "DOWN" relay; the coil is de-energized; and the contacts open thus stopping the motor.

To lower the floats, proceed as follows:

Throw the engineer's control switch to the "DOWN" position.

The "DOWN" coil of the "UP" and "DOWN" relay is thereby energized. The contacts are closed and the power flows to the "DOWN" winding of the motor. The motor runs in a reversed direction to what it ran to raise the floats, and lowers the floats by means of the operating mechanism. As the port float latches, it makes mechanical contact with the "DOWN" limit switch. The "DOWN" limit switch is a single pole, double throw switch normally closed and in series with the "DOWN" coil of the "UP" and "DOWN" relay and the throttle warning light circuits. When mechanically tripped, it opens these two circuits and closes the "BRAKING" relay coil circuit. The "DOWN" coil of the "UP" and "DOWN" relay is de-energized and the relay contacts open. The "BRAKING" relay grounds the "UP" series windings of the motor thus causing the motor to operate as a short circuited generator. Consequently, grounding the windings acts as a brake to stop the motor and to combat the floats while latching.

(2) MAINTENANCE.

(a) Inspect wires in junction boxes indicated on wiring diagram. *(See figure 229.)*

1. If wire insulation is worn or broken, replace or repair wire.

2. If wire strands are broken, replace wire.

(b) Inspect all wire terminals.

1. If discolored or corroded, clean with No. 000 sandpaper.

2. Make sure all terminal connections are tight.

(c) Inspect fuse and switches.

1. If terminals are discolored or corroded, clean with No. 000 sandpaper.

2. If switches do not operate properly, replace with new ones.

(d) Inspect disconnect plug at motor.

1. Uncouple plug and inspect insulation. If cracked or damaged, replace plug.

2. If pins are discolored or corroded, clean with crocus cloth.

3. Make sure pins make good contact; if they do not, replace the plug with a new one.

4. Inspect the solder connections on rear of plug; if loose, resolder.

(e) If any micro-switches are defective, remove cover of micro-switch housing and replace switch.

(f) Remove lamps from indicator lights and inspect them.

1. If base is discolored or corroded, clean with crocus cloth.

2. If glass is discolored or darkened by use, replace lamp.

(g) Inspect the contact points on "UP" and "DOWN" relay and the "BRAKING" relay. Access to the contact points on the "UP" and "DOWN" relay is gained by removing the four nuts and lock washers from the black plastic caps on the lower side of the relay and then removing the caps. The contact points on the "BRAKING" relay are visible after the cover of the float relay junction box has been removed.

1. If the points are discolored or corroded, clean with crocus cloth.

2. If the points are pitted slightly, clean them lightly with No. 000 sandpaper.

3. If the points are badly pitted or burned, replace the relay.

4. If the armature sticks or the relay does not function properly, replace the relay.

(h) For maintenance of float motor, see paragraph *v*, (3).

(3) OPERATIONAL CHECK.

(a) Throw the engineer's "FLOAT" switch to "DOWN" position.

(b) Place either throttle in "CLOSED" position.

(c) If the system is operating properly, the floats will swing downward and the warning lights will be lighted until the floats reach the "DOWN" latch position.

When the floats hit the "DOWN" limit switch the lights will go "OUT" and the float motor will stop. There should be no back-lash of the floats as they reach their lower limit.

(d) Throw the engineer's "FLOAT" switch to "UP" position.

(e) If the system is operating correctly, the floats will swing upward and the warning lights will again light. When the floats hit the "UP" limit switch, the float motor will stop running.

(f) Advance the "Retarded" throttle. The warning light should then go out.

n. EXTERIOR LIGHTS AND CIRCUITS.

(1) LANDING LIGHTS.

(a) CIRCUIT.

1. DESCRIPTION. *(See figure 230.)*—Current for the port and starboard landing lights is provided by the main batteries in the wing. Before reaching the landing lights, the current passes through 35 ampere fuses and landing light relays located in each engine terminal junction box. The ground return is carried through to the main distribution panel where it is connected to a ground stud.

The controlling part of the circuit operates the landing light relays and is protected by a five ampere fuse located on the main distribution panel. The current for the controlling part of the circuit, taken from either bus "A" or "B" in the main distribution panel, passes through the "LANDING LIGHTS" master control switch and the fuse on the main distribution panel and feeds the bus for the landing light switches on the pilot's switch panel. When these switches are thrown to the "ON" position, current flows to the coils of the landing light relays which are energized; the relay contacts then closes, thus closing the main part of this circuit and lighting the landing lights.

To operate landing lights, throw "MAIN BATTERY" switch and "LANDING LIGHTS" master control switch on the main distribution panel to the same bus ("A" or "B") and then throw "LANDING LIGHT" switches on pilot's switch panel to "ON" position.

2. MAINTENANCE.

a. Check wires in junction boxes shown on wiring diagram. *(See figure 230.)*

(1) If insulation is worn or broken, replace or repair wire.

(2) If wire strands are broken, replace wire.

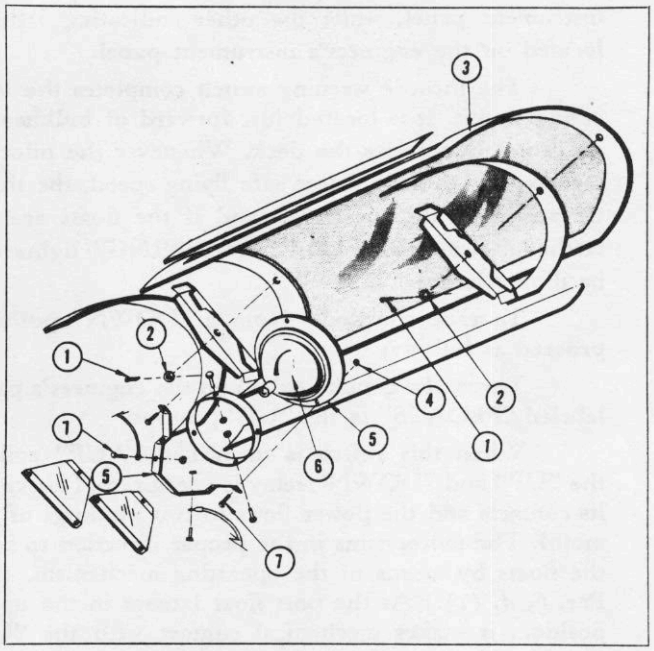
b. Check wire terminals and terminals of switches and fuse.

(1) If terminals are discolored or corroded, clean with No. 000 sandpaper.

(2) Make sure all connections are tight.

c. If switches do not operate properly, replace with new ones.

d. Inspect terminals of fuse and fuse holder in engine terminal junction boxes; if discolored or corroded, clean with No. 000 sandpaper.



No.	PART No.	NAME
1	AN380-2-3	Cotter Pin
2	AN310-4	Nut
3	28E043	Cover Assembly
4	No. 10-24	Nut
5	K8279351-PT. 1	Clamp
	K8242399-PT.1	Adapter
6	4541	Lamp Assembly
7	No. 8-32 x 7/8 in.	Screw

Items number 5 and 6 are General Electric part numbers.

Figure 231—Landing Light

e. Inspect contact points of landing light relays in engine terminal junction boxes.

(1) If discolored or corroded, clean with crocus cloth.

(2) If slightly pitted or burned, clean lightly with No. 000 sandpaper.

(3) If badly burned or pitted, replace relay with new one.

Note

Bomb bay junction box may be reached for inspection only through the manhole (22) in the outer wing panel. *(See figure 20.)* The engine terminal junction boxes and the center wing junction boxes may be reached through access doors on the top side of the leading edge.

(b) LANDING LIGHTS.

1. DESCRIPTION.—Landing lights are the

sealed beam type, rated at 450 watts and manufactured by General Electric, and designed to operate on a 24 volt system. Two of these lights are mounted in wells in the center section leading edge, one outboard of each nacelle. A frame containing a Plexiglas window fits over the well and seals the light assembly from the weather.

2. REMOVAL.

(See figure 231.)

a. Remove the cotter pins (1) and nuts (2) from the outside of the cover that holds the Plexiglas to the leading edge and then remove the cover and Plexiglas (3).

b. Remove four nuts (4) (two on top and two on bottom) on the front of the fixture and carefully pull out the lamp assembly holder (5) and lamp assembly (6).

c. Disconnect the wires from the terminals on the back of the lamp assembly.

d. Remove three screws (7) from the lamp assembly holder and remove the lamp assembly.

e. The lamp assembly, consisting of a bulb reflector and lens, must be replaced as a unit as the bulb cannot be removed.

CAUTION

Do not attempt to remove the fixture bracket from its supports unless necessary for emergency repairs. It is set at installation at the correct angle and any loosening of the holding nuts will disturb the setting.

3. MAINTENANCE.

a. Inspect wires and terminals on the rear landing light; if they are corroded or discolored, clean with No. 000 sandpaper.

b. If wire insulation is worn or broken or wire stands are broken, repair or replace wire.

c. Make sure all connections are tight.

d. Clean Plexiglas cover.

e. If sealed beam unit does not operate properly, replace unit as it is not meant to be disassembled.

4. INSTALLATION.

a. Install landing lights by reversing removal procedure outlined in paragraph *n*, (1), *(b)*, *2* above.

b. If the fixture bracket has been removed, it must be installed before the lamp assembly and also adjusted in such a manner that the lamp assembly faces 25° outboard and 24° downward, measured from the face of the shield located behind the landing light assembly and bracket.

5. OPERATIONAL CHECK.

a. Throw "MAIN BATTERY" switch and "LANDING LIGHTS" master control switch on main distribution panel to same bus ("A" or "B").

b. Throw "LANDING LIGHTS" switch on pilot's switch panel to "ON" position.

c. If system is operating correctly, the landing lights will light to full brilliancy when these switches are thrown to "ON" position.

CAUTION

When testing landing lights on the ground, do not have them on for a longer period than necessary to assure satisfactory operation. Because of lack of adequate cooling, they will become extremely hot in a few seconds, with resultant danger of warping the Plexiglas shield and shortening the life of the lamp.

(2) RECOGNITION LIGHTS.

(a) CIRCUIT.

1. DESCRIPTION. *(See figure 232.)*—This circuit provides current for the operation of four recognition lights. The circuit, which is protected by a 10 ampere circuit breaker located on the main distribution panel, is controlled by individual switches or a keying switch located on the recognition light switch box. The recognition light switch box is located on the pilot's signal panel on the control yoke.

The switch circuits are so arranged that one, all, or any combination of lights may be switched on and left on until turned off. This is done by throwing the desired combination of switches to the "STEADY" position. To switch lights off, throw switch to neutral position. The switch circuits are also arranged so that one, all, or any combination of lights may be switched on temporarily by throwing the desired combination of switches to the "KEY" position. At this position, the lights are turned on or off by depressing or releasing the keying switch.

The current to operate the lights passes from the main battery lead in the main distribution panel through the circuit breaker, and feeds the bus in the recognition light switch box. From the bus, the current passes through the switches and either directly to the lights or through the keying switch and then to the lights, depending upon the position of the switches.

2. MAINTENANCE.

a. Inspect wires and terminals in junction boxes shown on wiring diagram. *(See figure 232.)*

(1) If wire insulation is worn or broken, replace or repair wire.

(2) If wire strands are broken, replace wire.

(3) If terminals are discolored or corroded, clean with No. 000 sandpaper.

(4) Be sure all connections are tight.

b. Inspect circuit breaker and switches.

(1) If terminals are discolored or corroded, clean with No. 000 sandpaper.

(2) If circuit breaker or switches do not operate properly, replace with new ones.

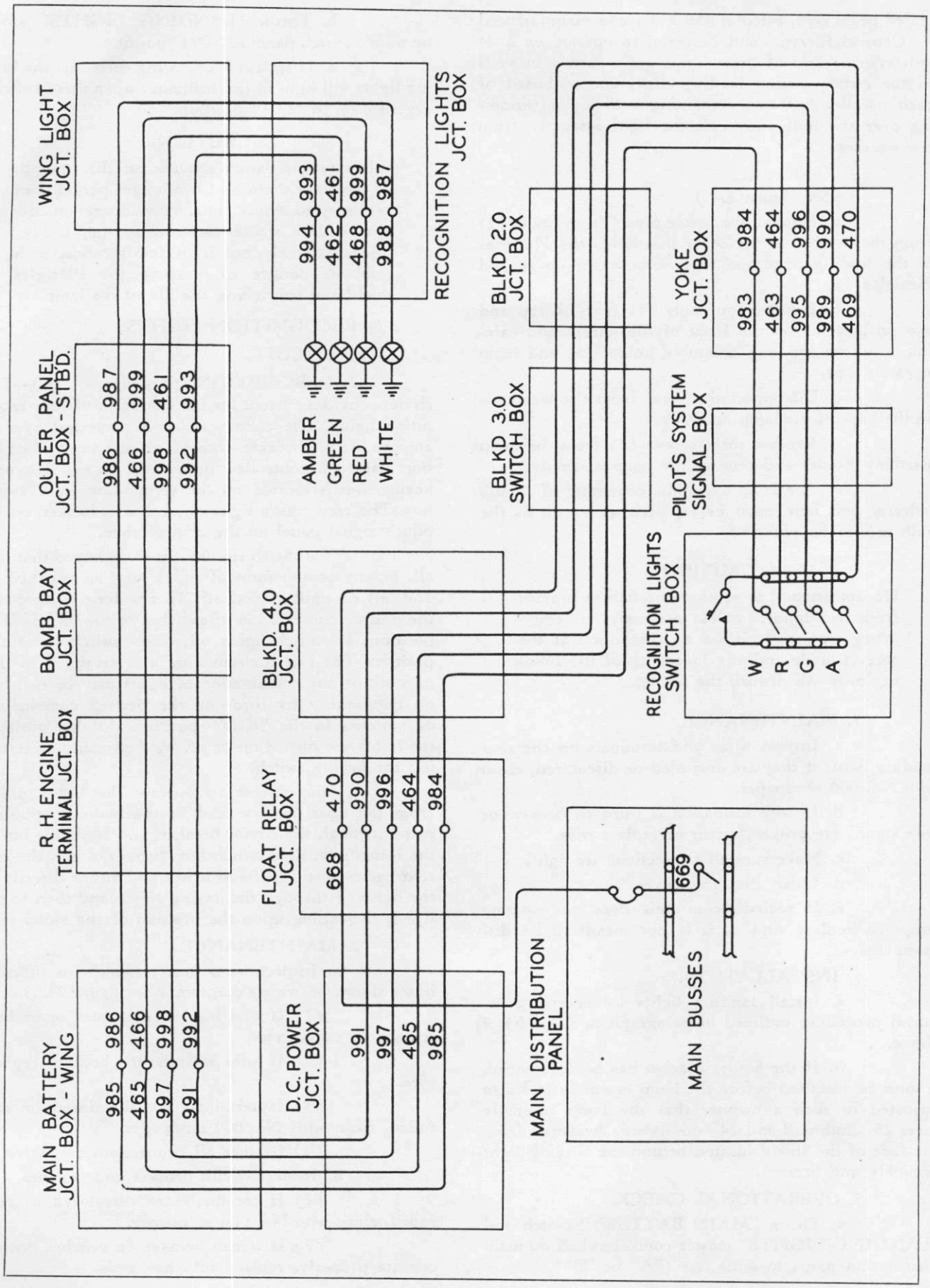


Figure 232—Recognition Lights Circuit

(b) RECOGNITION LIGHTS.

1. DESCRIPTION.—Three of the recognition lights, colored red, green, and amber respectively, (GRIMES MFG. CO. No. B2389) are located on the lower surface of the starboard wing near the wing tip. The fourth light, colored white (GRIMES MFG. CO. No. B2115), is located on the upper surface of the starboard wing near the tip.

2. REMOVAL.

a. Remove six screws from the outer ring of the light, and then detach light assembly and gasket from wing.

b. Disconnect the electrical connection after unscrewing the knurled nut.

c. Disassemble light assembly as follows:

(1) Remove six screws from inner ring that holds the glass lens.

(2) Remove ring, lens, and gasket.

(3) Push bulb in and turn counterclockwise to remove bulb.

(4) Remove three screws from bottom of the reflector and remove the circular plate through which the socket projects.

3. MAINTENANCE.

a. Inspect the bulb; if the base is discolored or corroded, clean with No. 000 sandpaper; if the glass is darkened, discolored or loose, replace the bulb.

b. Inspect the socket contacts; if the contacts are discolored or corroded, clean with No. 000 sandpaper; if contacts have lost their spring such that they cannot be adjusted, replace the light.

c. Clean the lens if dirty.

d. If gasket is not in good condition, replace with new one as a gasket that is not tight will allow moisture to enter light causing damage.

4. ASSEMBLY AND INSTALLATION.—Assemble and install lights by reversing removal procedure outlined in paragraph *n*, (2), *(b)*, *2* above.

5. OPERATIONAL CHECK.

a. Throw the switches on the recognition light switch box to "STEADY" position. If the circuit is functioning properly, the recognition lights will be illuminated.

b. Throw the switches on the recognition light switch box to "KEY" position, and then observe the lights as the "KEYING" switch is pressed.

The lights should light each time the "KEYING" switch is closed.

WARNING

The operation of the recognition lights should be checked before any flight that will be concluded after dark. These lights identify the plane when flying over or landing on friendly territory. Failure of these lights to operate may result in destruction of airplane.

CAUTION

When the plane is not in flight, do not leave the recognition lights burning continuously. The busses may be damaged if subjected to continuous heat of bulbs.

(3) RUNNING, FORMATION, ANCHOR, AND SECTION LIGHTS.

(a) CIRCUIT.

1. DESCRIPTION. *(See figure 233.)*—Current for the circuit passes from the main bus ("A" or "B") through the "EXTERIOR LIGHTS" master control switch and then through a five ampere fuse in the main distribution panel to the lights.

Except for the exterior anchor light switch, which is located on the port side of the airplane just forward of station 1.66 and below the pilot's enclosure, the control switches for the lights are located on the pilot's switch panel. *(See figure 221.)* Resistors are located in the pilot's switch panel to provide for dimming the wing and tail running lights, section lights, and formation lights. By throwing switches on the pilot's switch panel to "FLASH" or "ON," the formation and section lights may be illuminated momentarily or continuously.

Turning the exterior anchor light switch to "ON" position or the switch labeled "ANCHOR LIGHT" on the pilot's switch panel to "ON" position, sends current to the two anchor lights.

By throwing the "FORMATION" and "SECTION" light switches (on the pilot's switch panel) to "ON" position or holding them in "FLASH" position and throwing "FORMATION" and "SECTION" lights switches to "BRIGHT" positions, the current is sent from the bus through the switches to the two formation lights and the section light. When the switches are thrown to "DIM" position, the current follows the same route with the exception that it passes through the resistors and then to the formation and section lights.

By throwing the running lights switches, labeled "WING-TAIL," to "BRIGHT" positions, the current is sent from the bus through the switches and then to the running lights. When the switches are thrown to "DIM" position, the current follows the same path with the exception that it passes through the resistors before it reaches the lights.

2. MAINTENANCE.

a. Check wires in junction boxes shown on wiring diagram. *(See figure 233.)*

(1) If insulation is worn or broken, repair or replace wire.

(2) If wire strands are broken, replace wire.

b. Check wire terminals in junction boxes shown on wiring diagram.

(1) If terminals are discolored or corroded, clean with No. 000 sandpaper.

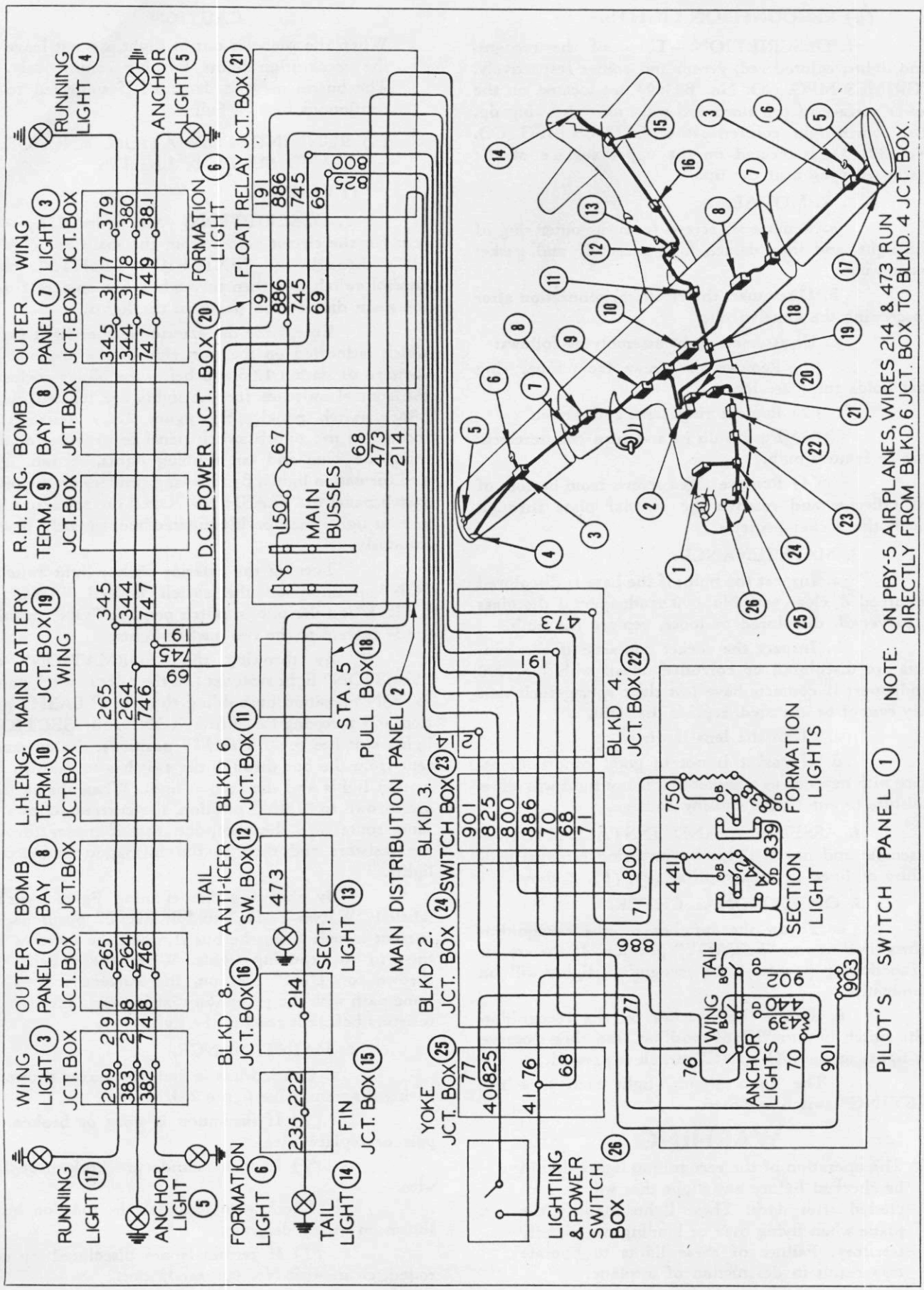


Figure 233—Running, Formation, Anchor, and Section Lights Circuit

(2) Be sure all connections are tight.

c. Inspect fuse and switches.

(1) If terminals are discolored or corroded, clean with No. 000 sandpaper.

(2) If switches do not function properly, replace with new ones.

d. Inspect disconnect plug at tail post forward of rudder.

Note

The aft fairing must be removed on the port side under the horizontal stabilizer in order to reach this plug. See Par. 2 for removal of fairing.

(1) If plug insulation is cracked or damaged or pins do not make good contact, replace plug.

(2) If contacts are discolored or corroded, clean with crocus cloth.

3. OPERATIONAL CHECK.

a. Throw the "MAIN BATTERY" and the "EXTERIOR LIGHTS" master control switch in the main distribution panel to the same bus ("A" or "B") and then from outside the ship turn the exterior "ANCHOR LIGHT" switch to "ON" position. If this part of the circuit is functioning correctly, the two anchor lights will be illuminated to full brilliancy.

b. Turn the exterior "ANCHOR LIGHT" switch to "OFF" position and then throw the "ANCHOR LIGHT" switch on the pilot's switch panel to "ON" position. If the anchor lights again light, this circuit is functioning properly.

c. With the "MAIN BATTERY" switch and the "EXTERIOR LIGHTS" master control switch still thrown to the same bus, throw the running lights switches labeled "WING-TAIL" to "BRIGHT" position. If the system is operating correctly, the running lights on the wing and tail will be illuminated to full brilliancy.

d. Throw above switches to "DIM" position. If the running lights are lighted but dimmer than when turned to "BRIGHT," this part of the system is also functioning correctly.

e. Next, throw the "FORMATION" and "SECTION" lights switches to "ON" position. If the two formation and one section lights are illuminated to full brilliancy when the "FORMATION" and "SEC TION" lights control switches are thrown to "BRIGHT" position, this part of the system is functioning properly.

f. Throw the "FORMATION" and "SECTION" lights control switches from "BRIGHT" to "DIM" position. The lights should light as before except that they should be dimmer than they were when in "BRIGHT" position.

g. Repeat procedure outlined in paragraph *n*, (3), *(a)*, *3*, e and *n*, (3), *(a)*, *3*, f with the "FORMATION" and "SECTION" lights control switch held in "FLASH" position. If this circuit is operating correctly, the lights should be illuminated according to the settings of the "FORMATION" and "SECTION" lights control switches each time the control switch is pressed to "FLASH" position.

(b) RUNNING LIGHTS.

1. DESCRIPTION.—The airplane is equipped with three running lights; one white light (NAF 1023-13) located in the rudder; one red light (NAF 1021-11) located on the leading edge at the tip of the port wing; and one green light (NAF 1021-12) located on the leading edge at the tip of the starboard wing.

2. REMOVAL.

a. The running light in the rudder can only be removed by tearing the tail covering fabric around the light and drilling out the rivets that mount the light.

b. Disconnect the electrical connection after loosening coupling nut on back of light.

c. Remove globe and bulb by unscrewing globe and pressing in and turning counterclockwise to remove bulb.

d. Remove the wing running lights as follows:

(1) Remove outboard part of fairing around the light by removing four screws on top of and four screws on bottom of light. Inboard part of light fairing is riveted to leading edge and can only be removed by drilling the rivets out.

(2) Remove screw from center of lens retainer. This allows both lens and retainer to be removed.

(3) Remove bulb by pressing in and turning counterclockwise.

(4) Remove the three screws holding light to fairing and pull light out of fairing as far as possible.

(5) Disconnect electrical connections after unscrewing coupling nut on back of light.

3. MAINTENANCE.

a. Inspect bulbs; if base is discolored or corroded, clean with No. 000 sandpaper; if glass is darkened, discolored, or loose, replace bulb.

b. Inspect spring and socket contact. Make sure the spring is resilient enough to make a good contact. If the socket is corroded, clean with No. 000 sandpaper.

c. Clean lens, if dirty; if damaged, replace with new ones.

d. If socket of light is discolored or corroded, clean with No. 000 sandpaper.

4. INSTALLATION.—Install wing running light and tail lights in reverse order of removal described in paragraph *n*, (3), *(b)*, *2*. See General Man-

ual for Structural Repair (AN 01-1A-1) for repair of fabric.

(c) FORMATION LIGHTS.

1. DESCRIPTION. — The airplane is equipped with two formation lights, one located on each wing approximately five feet from each wing tip. The formation lights are NAF 1023-15 type with NAF 1023-16 reflector and NAF 1023-26 Lunor white lens.

2. REMOVAL.

a. Remove access door directly below formation light on underside of wing. This access door may be reached when floats are in down position.

b. Remove three nuts, screws, and washers that hold light in position.

c. Remove light through access door.

d. Disconnect electrical connections after unscrewing coupling nut on back of light.

e. To remove bulb proceed as follows:

(1) Remove the lens by unscrewing it from the light.

(2) Remove the gasket.

(3) Remove the bulb by pressing in and turning in a counterclockwise direction.

3. MAINTENANCE.

Same as for running lights. (See paragraph *n*, (3), *(b)*, *3.*)

4. INSTALLATION.

a. Install lights by reversing removal procedure outlined in paragraph *n*, (3), *(c)*, *2* above.

b. Apply zinc chromate paste between light flange and upper wing skin when installing light flange.

c. Install reflector so that opening faces aft.

(d) ANCHOR LIGHTS.

1. DESCRIPTION. — The airplane is equipped with two anchor lights, one mounted on the upper surface of the wing near each wing tip. These lights are NAF 1023-15 type lights and contain NAF 1023-19 white glass lenses.

2. REMOVAL.—The anchor lights are located in the forward float strut slots and are readily accessible when the floats are in down position.

a. Remove the three screws, nuts, and washers to remove the light assembly.

b. Disconnect the electrical connections after unscrewing the connector nut on the back of the light.

c. To remove bulb, proceed as follows:

(1) Remove lens by unscrewing it from light.

(2) Remove bulb by pressing in and turning counterclockwise.

3. MAINTENANCE.—Same as for running lights. (See paragraph *n*, (3), *(b)*, *3.*)

4. INSTALLATION.

a. Install lights by reversing removal procedure outlined in paragraph *n*, (3), *(d)*, *2* above.

b. Apply zinc chromate between light flange and upper wing skin when installing light flange.

(e) SECTION LIGHT.

1. DESCRIPTION. — The airplane is equipped with one section light which is located on the upper skin surface just aft of bulkhead 7. The section light is a NAF 1023-15 type light containing a NAF 1023-26 Lunor white lens.

2. REMOVAL.—Two men will be required to remove light; one located outside with a screw driver; and one inside to remove the three nuts.

a. Remove the light and gasket by detaching the three screws.

b. Disconnect the electrical connection by unscrewing the connector nut on the bottom of the light.

c. To remove bulb proceed as follows:

(1) Remove lens by unscrewing it from the light.

(2) Remove bulb by pressing in and turning in a counterclockwise direction.

3. MAINTENANCE.—Same as for running light. (See paragraph *n*, (3), *(b)*, *3.*)

4. INSTALLATION.—Install lights by reversing removal procedure outlined in paragraph *n*, (3), *(e)*, *2* above.

o. INTERIOR LIGHTS AND UTILITY OUTLETS CIRCUITS.

(1) CIRCUITS.

(a) DESCRIPTION. *(See figure 234.)*—This circuit provides for control and protection of the compartment lights, projector lights, table lights, fluorescent lights, panel lights, MK 8 compass light, and utility outlet receptacles.

All the lights and receptacles draw their current through fuses and master control switches in the main distribution panel. Secondary control switches are provided in the compartments in which the various lights are located.

Brightness of the projector lights is controlled by rheostats which also serve as "ON-OFF" switches.

Brightness of the navigator's and radio operator's table lights is also controlled by rheostats. However these lights are operated by separate "ON-OFF" switches.

The bombardier's and pilot's fluorescent lights are furnished alternating current by a vibrator inverter which converts 28 volt direct current to alternating current. The inverter is located under the pilot's seat.

(b) MAINTENANCE.

1. Check wires and terminals in junction boxes shown on wiring diagram. *(See figure 234.)*

a. If wire insulation is worn or broken, repair or replace wire.

b. If wire strands are broken, replace wire.

c. If terminals are discolored or corroded, clean with No. 000 sandpaper.

2. Inspect switches, fuses, rheostats and busses shown on wiring diagram.

a. If buses or terminals of switches, fuses, or rheostats are discolored or corroded, clean with No. 000 sandpaper.

b. If switches do not work properly, replace with new ones.

c. If exposed section of wire core on rheostat has become discolored or corroded, clean with crocus cloth.

d. If enamel is cracked or rheostat does not work properly, replace rheostat with new one.

3. Inspect utility receptacles shown on wiring diagram.

a. Make sure dust caps can be removed and screwed back on easily.

b. If pins are discolored or corroded, clean with crocus cloth.

c. If insulation is cracked or damaged, replace receptacle with new one.

d. Make sure pins make good contact with portable equipment plugs; if they do not, replace receptacle with new one.

e. Inspect solder connections on receptacles; if loose, resolder them.

4. Inspect disconnect plug on pilot's stand-by compass.

a. If pins are discolored or corroded, clean them with crocus cloth.

b. If pins do not make good contact or insulation is cracked or damaged, replace plug with new one.

c. Inspect solder connections on back of plug; if loose, resolder them.

(c) OPERATIONAL CHECK.

1. FLUORESCENT AND PROJECTOR LIGHTS.

a. Throw "MAIN BATTERY" switch, "PROJ. LIGHTS" switch, and "COMP. LTS. FWD." switch on main distribution panel to same bus ("A" or "B").

b. Throw the "RADIO LIGHTS" and "PANEL LIGHT" switches on the main distribution panel to "ON." If the projector light for the main distribution panel alternately grows "BRIGHT" and "DIM," and then is extinguished when the "PANEL LIGHT RHEOSTAT" is rotated from "OFF" position to "ON" position and back to "OFF" position, this part of the circuit functions correctly.

c. If the radio operator's projector light alternately grows "BRIGHT" and "DIM" and then is extinguished when the "PROJ. LIGHT RHEOSTAT" located on the main distribution panel is rotated from "OFF" position to "ON" position, and then back to "OFF" position, this part of the circuit functions correctly.

d. If the pilot's and copilot's projector lights alternately grow "BRIGHT" and "DIM" and then are extinguished when the "PROJECTOR LT." rheostat on the pilot's switch panel is rotated from "OFF" position to "BRIGHT" position, and then back to "OFF" position, this part of the circuit functions properly.

e. If the engineer's projector light alternately grows "BRIGHT" and "DIM," and then is extinguished when the "PROJ. LT." rheostat on the engineer's switch panel is rotated from "OFF" position to "BRIGHT" position and then back to "OFF" position, this part of the circuit works correctly.

f. If the bombardier's projector light alternately grows "BRIGHT" and "DIM," and then is extinguished when the "PROJECTOR LT." rheostat located on the bombardier's switch panel is turned from "OFF" position to "BRIGHT" position and then back to "OFF" position, this part of the circuit functions properly.

g. Throw "FLUORESCENT LIGHTS" switch on pilot's switch panel to "ON" position. Test each fluorescent light separately by rotating the knurled knob on the light to vary the brilliancy. If the markings on the instruments and the panel glow when the control switch is in "ON" position and cease to glow shortly after the control switch is turned to "OFF" position, this part of the circuit functions correctly.

Note

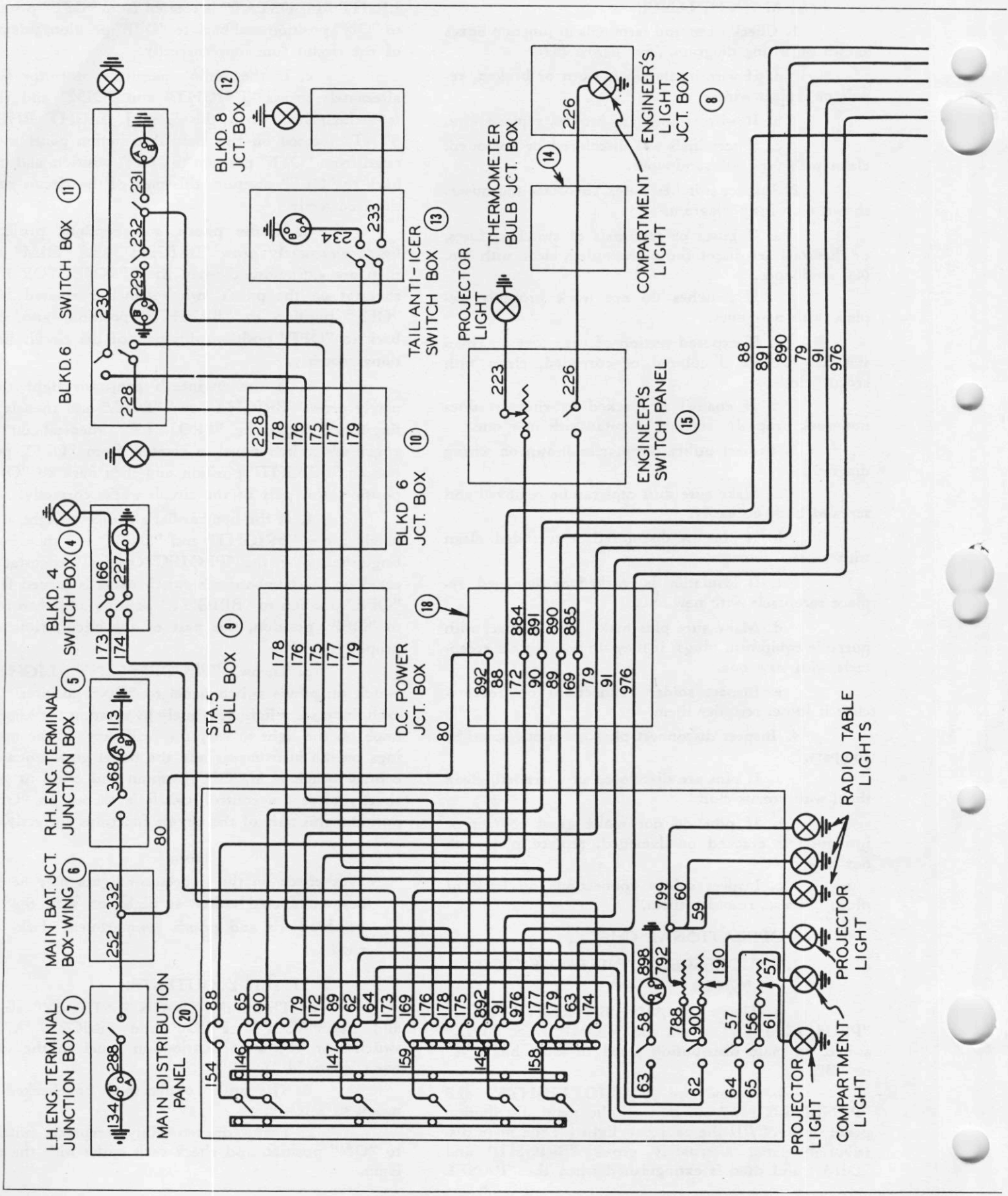
This check on the fluorescent lights may be best conducted either at night or with the bombardier's and pilot's compartment darkened .

2. UTILITY OUTLETS.

a. Throw the "MAIN BATTERY" switch and the "RECPT. FWD." and "RECPT. AFT." switches on the main distribution panel to the same bus ("A" or "B").

b. The utility outlets may be checked by means of a test lamp.

c. Throw the ten utility receptacle switches to "ON" position and check each outlet with the test lamp.



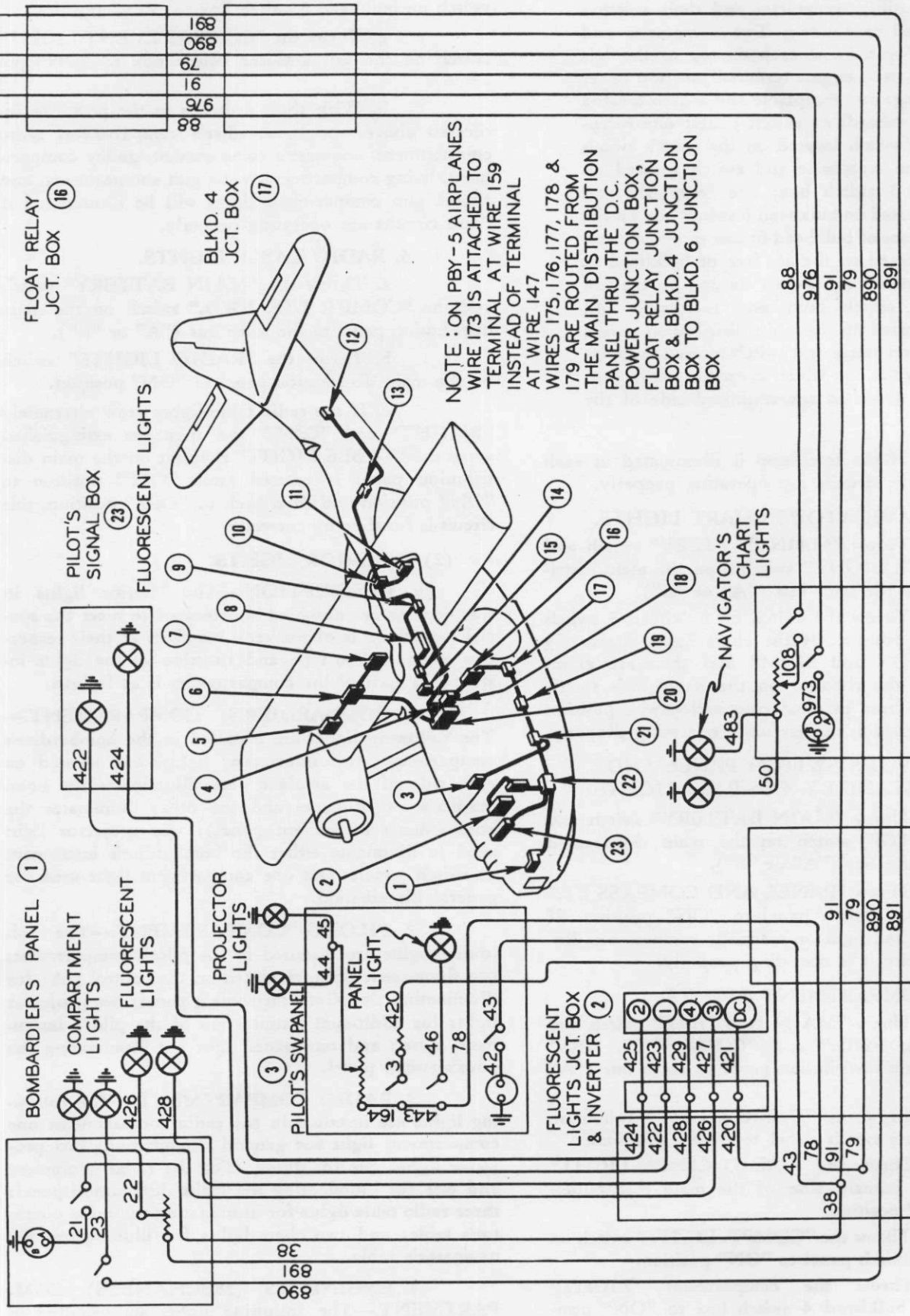


Figure 234—Interior Lights and Utility Outlets Circuit

Note

The ten utility receptacles and their switches are located as follows: Two receptacles and switches located one each on top of the left and right-hand engine terminal junction boxes in the wing; one receptacle and switch located on the bombardier's switch panel; one receptacle and switch located on the pilot's switch panel; one receptacle and switch located on bulkhead 3 switch box; one receptacle and switch located on bulkhead 6 switch box on the forward face of bulkhead 6; one receptacle and switch located on the aft face of bulkhead 6; one receptacle and switch located on the tail anti-icing switch box; one receptacle and switch located on the main distribution panel; and one receptacle and switch located on bulkhead 4 switch box which is on the aft face of bulkhead 4 and to the starboard side of the doorway.

d. If the test lamp is illuminated at each receptacle, these circuits are operating properly.

3. NAVIGATOR'S CHART LIGHTS.

a. Throw "MAIN BATTERY" switch and "NAV. TABLE LIGHT" switches on the main distribution panel to the same bus ("A" or "B").

b. Throw the switch on bulkhead 3 switch box to "ON" position. If the chart lights alternately grow "BRIGHT" and "DIM" and then are extinguished when the rheostat on the navigator's switch box is rotated from extreme counterclockwise position and then back again, this circuit is operating properly.

4. PILOT'S SWITCH PANEL AND STAND-BY COMPASS LIGHTS.

a. Throw "MAIN BATTERY" switch and "PROJ. LIGHTS" switch on the main distribution panel to the same bus ("A" or "B").

b. Throw "PANEL AND COMPASS LT." switch on pilot's switch panel to "ON" position. If light on panel and light on magnetic compass are illuminated, this circuit is operating properly.

5. COMPARTMENT LIGHTS.

a. Throw "MAIN BATTERY" switch and "COMP. LTS. FWD." and "COMP. LTS. AFT" switches on main distribution panel to same bus ("A" or"B").

b.Throw the "DOME LIGHT" switch on the bombardier's switch panel to "ON" position.

c. Throw the "RADIO COMP. LIGHT" switch on the inboard side of the main distribution panel to "ON" position.

d. Throw the "COMPT. LIGHT" switch on the engineer's switch panel to "ON" position.

e. Throw the compartment "LIGHT" switch on the bulkhead 4 switch box to "ON" position.

f. Throw the compartment "LIGHT" switch on bulkhead 6 switch box to "ON" position.

g. Throw the "COMPARTMENT LIGHT" switch on the tail anti-icer switch box to "ON" position.

h. With these switches in the positions indicated above, the bombardier's compartment, radio compartment, engineer's compartment, galley compartment, living compartment, waist gun compartment, and tunnel gun compartment lights will be illuminated if these circuits are operating properly.

6. RADIO TABLE LIGHTS.

a. Throw the "MAIN BATTERY" switch and the "COMPT. LTS. FWD." switch on the main distribution panel to the same bus ("A" or "B").

b. Throw the "RADIO LIGHTS" switch on the main distribution panel to "ON" position.

c. If the radio table lights grow alternately "BRIGHT" and "DIM," and then are extinguished when the "TABLE LIGHT" rheostat on the main distribution panel is rotated from "OFF" position to "ON" position and then back to "OFF" position, this circuit is functioning correctly.

(2) INTERIOR LIGHTS.

(a) DESCRIPTION.—The interior lights in the airplane are designed and located to meet the special requirements of the crew members at their respective stations. The type and function of the lights installed in each of the compartments is as follows:

1. BOMBARDIER'S COMPARTMENT.—The following lights are installed in the bombardier's compartment: two fluorescent lights, one located on each side of the airplane (one illuminates the bombardier's switch panel and the other illuminates the bombardier's instrument panel); one projector light used to illuminate either the bombardier's instrument or switch panels; and one compartment light used for general illumination.

2. PILOT'S COMPARTMENT.—The following lights are installed in the pilot's compartment: two fluorescent lights mounted on the control yoke for illuminating the pilot's instrument panel; two projector lights for additional illumination of the pilot's instrument panel; and one panel light for illuminating the pilot's switch panel.

3. RADIO COMPARTMENT.—The following lights are installed in the radio compartment: one compartment light for general illumination; two projector lights, one for illuminating the radar equipment and one for illuminating the main distribution panel; three radio table lights for illuminating the radio operator's table; and two chart lights for illuminating the navigator's table.

4. ENGINEER'S (MECHANIC'S) COMPARTMENT.—The following lights are installed in the engineer's compartment: one compartment light

for general illumination; and one projector light for illumination of the engineer's instrument panel.

5. GALLEY COMPARTMENT.—One compartment light is provided for general illumination.

6. LIVING COMPARTMENT.—One compartment light is provided for general illumination.

7. WAIST GUN COMPARTMENT.—One compartment light is provided for general illumination.

8. TUNNEL GUN COMPARTMENT.—One compartment light is provided for general illumination.

(b) REMOVAL.

1. COMPARTMENT LIGHTS.

a. Loosen the mounting screws in the base.

b. Turn the reflector in a counterclockwise direction and pull away from base.

c. Remove bulb by pushing in and turning in a counterclockwise direction.

d. Detach the mounting screws in the base and then remove the light and reflector retaining ring.

e. The electrical connections may be disconnected by loosening the coupling nut on the back of the light.

2. PROJECTOR LIGHTS.

a. Remove shield by rotating and pulling.

b. Remove bulb by pushing in and turning counterclockwise.

c. The electrical connections may be disconnected by loosening the coupling nut on the back of the light.

d. Detach the mounting screws, washers, and nuts from mounting base and then remove light.

3. FLUORESCENT LIGHTS.

a. Remove lens housing by detaching knurled knob and small screws on either side of housing and pulling housing straight off.

b. Remove bulb by pressing in and turning counterclockwise.

c. Remove housing base by detaching the four screws that secure it to the signal box on the control yoke.

4. PANEL LIGHT AND RADIO OPERATOR'S TABLE LIGHTS.

a. Loosen mounting screws and turn reflector clockwise to remove.

b. Remove bulb by pressing in and turning counterclockwise.

c. Detach mounting screws and remove light.

d. Electrical connections may be disconnected by removing connector nut on back of light.

5. CHART LIGHTS.

a. Remove bulbs by pressing in and turning in a counterclockwise direction.

b. Loosen screw at top of reflector and remove reflector.

c. Disconnect electrical connections by loosening and removing coupling nut on back of light fixture.

d. Remove light fixture by removing mounting screws and nuts.

(c) MAINTENANCE.

1. COMPARTMENT LIGHTS.

a. If a bulb is darkened or discolored, replace it.

b. If the base of the bulb is discolored or corroded, clean with No. 000 sandpaper.

c. If the socket of the light is discolored or corroded, clean with No. 000 sandpaper.

d. If the plunger contactor is corroded or discolored, clean with No. 000 sandpaper.

2. PROJECTOR LIGHTS.—Same maintenance as for compartment lights.

3. FLUORESCENT LIGHTS.

a. If bulbs do not light properly, replace bulbs.

b. If base of bulb is discolored or corroded, clean with No. 000 sandpaper.

c. If socket or light is discolored or corroded, clean with No. 000 sandpaper.

d. If contacts on lights are discolored or corroded, clean with No. 000 sandpaper.

4. PANEL LIGHTS.—Same maintenance as for compartment lights.

5. CHART LIGHTS.—Same as for compartment lights.

(d) INSTALLATION.—Interior lights are installed by reversing order of removal procedure. (See paragraph *o*, (2), *(b)*.)

p. PITOT HEAD HEATING CIRCUIT.

(1) DESCRIPTION. *(See figure 235.)*—This circuit supplies current to energize the heating unit in the pitot head to prevent icing. The circuit is protected by a 10 ampere fuse which also protects the anti-icer motor.

The circuit is controlled by the "PITOT HTR." switch on the main distribution panel and the "PITOT HEAT" switch on the pilot's switch panel. A small disconnect plug near the pitot head in the pitot mast is provided for a quick disconnect when removing the pitot head.

(2) MAINTENANCE.

(a) Inspect wires in junction boxes shown on wiring diagram. *(See figure 235.)*

1. If insulation is worn or broken, repair or replace wire.

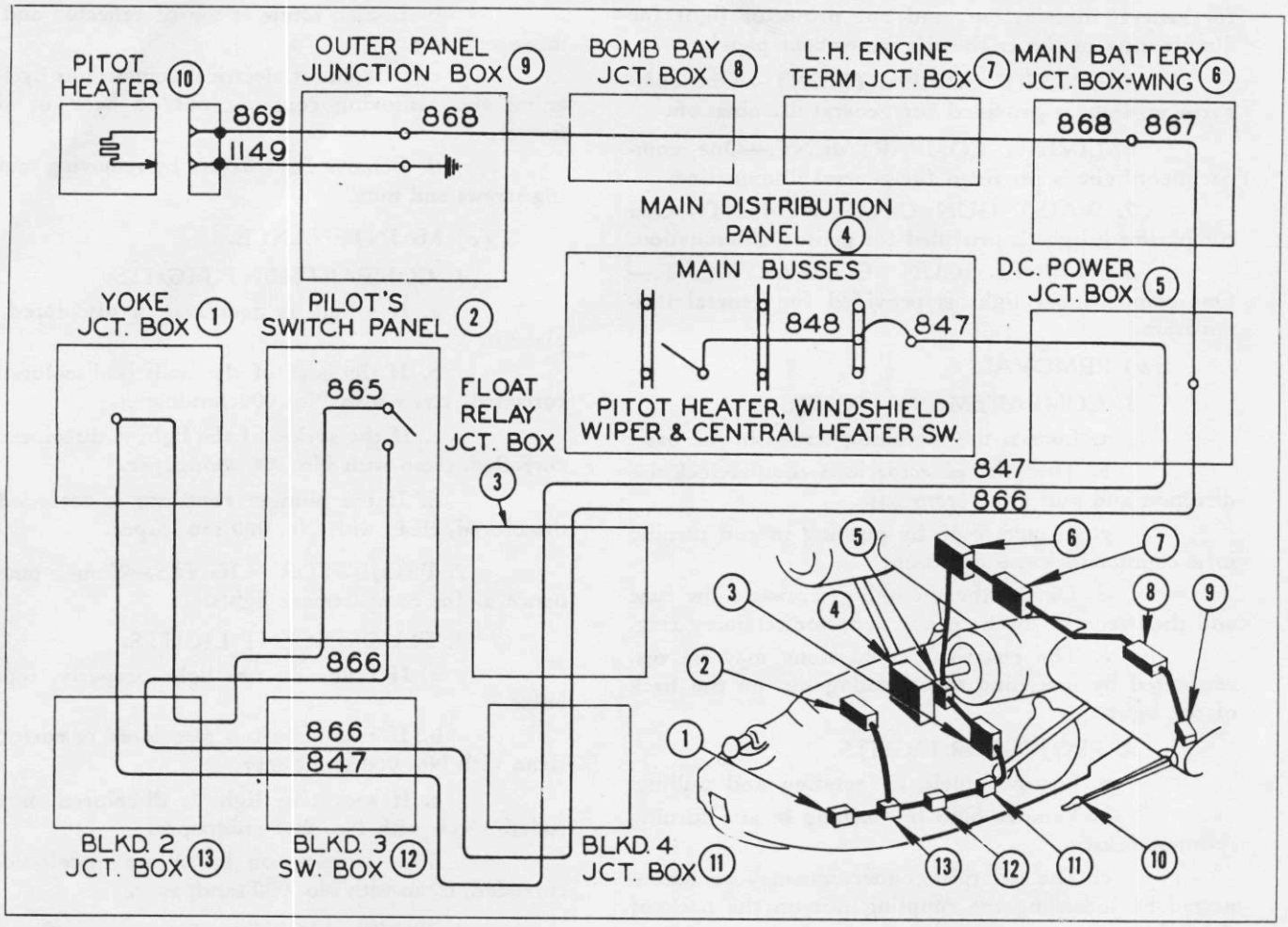


Figure 235—Pitot Head Heating Circuit

2. If wire strands are broken, replace wire.

(b) Inspect wire terminals in junction boxes; if terminals are discolored or corroded, clean with No. 000 sandpaper.

(c) Inspect switches and the fuse.

1. If terminals are discolored or corroded, clean with No. 000 sandpaper.

2. If switches do not operate properly, replace with new ones.

(3) OPERATIONAL CHECK.

(a) Throw "MAIN BATTERY" switch and "PITOT HTR." switch on the main distribution panel to the same bus ("A" or "B").

(b) Throw "PITOT HEAT" switch on pilot's switch panel to "ON" position.

(c) Place hand on pitot head; if rapid increase in temperature is noted, the heater unit is functioning.

CAUTION

The pitot head heater must not be turned on for periods longer than necessary to check its operation while airplane is not in flight, or the unit will be damaged by overheating.

q. PROPELLER FEATHERING AND CONTROL CIRCUITS.

(1) CIRCUIT.

(a) DESCRIPTION. *(See figure 236.)*—This circuit supplies current to operate the port and starboard propeller feathering pump motors, which are located on the forward face and port side of each firewall. Each motor is controlled by a control switch, relay, and pressure switch system.

The control switch which is located on the ceiling of the pilot's cockpit forward of the throttle control, is a combination switch and relay. It contains a solenoid coil which is energized by pushing the switch button manually. Once energized, the coil holds the switch contacts closed until its circuit is broken.

In series with the coil are the pressure switch contacts, located adjacent to the propeller. They are normally closed, but will open when the oil pressure in the pressure switch which is located in a junction box on the forward face of each firewall builds up to sufficient pressure to open the switch. The motor relay coil is in series with the control switch contacts while

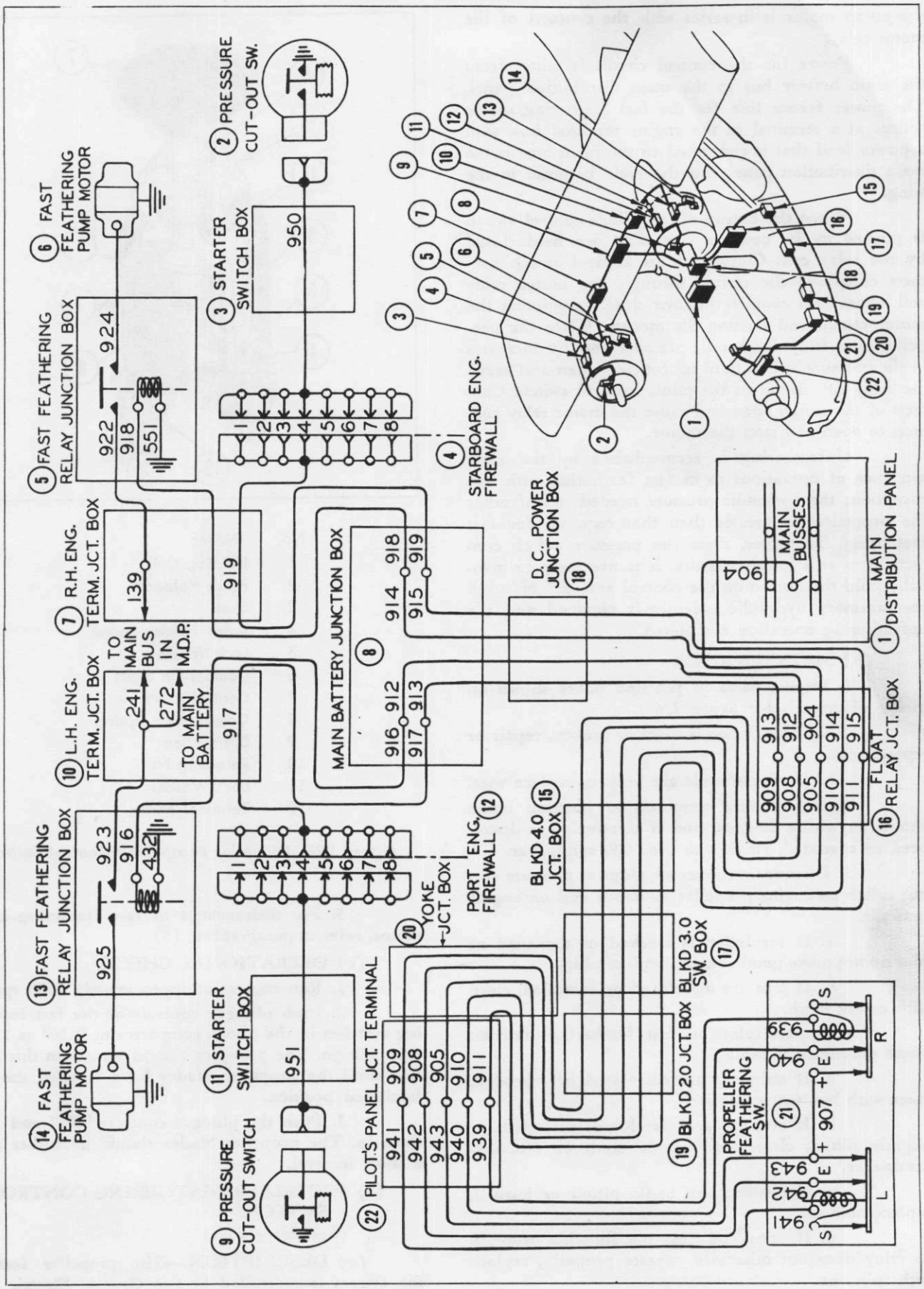


Figure 236—Propeller Feathering Control Circuit