ERECTION AND MAINTENANCE

INSTRUCTIONS

GRUMMAN WIDGEON

MODEL G-44A

RANGER 6-440C-5 ENGINE

GRUMMAN AIRCRAFT ENGINEERING CORP.
Bethpage, LONG Island, N. Y.

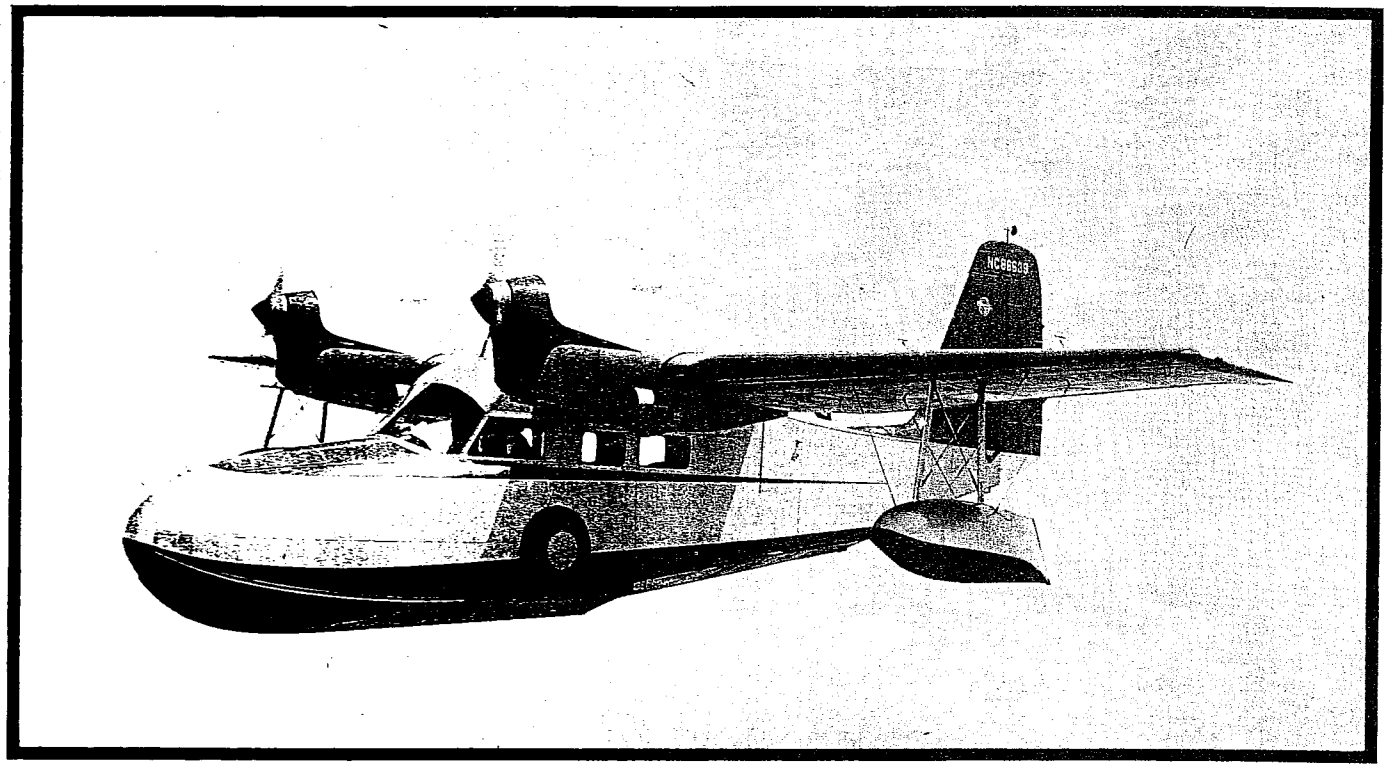
ERECTION AND MAINTENANCE INSTRUCTIONS

SECTION I

GENERAL INDEX

ILLUSTRATIONS

ILLUSTRATIONS (CON'T.)



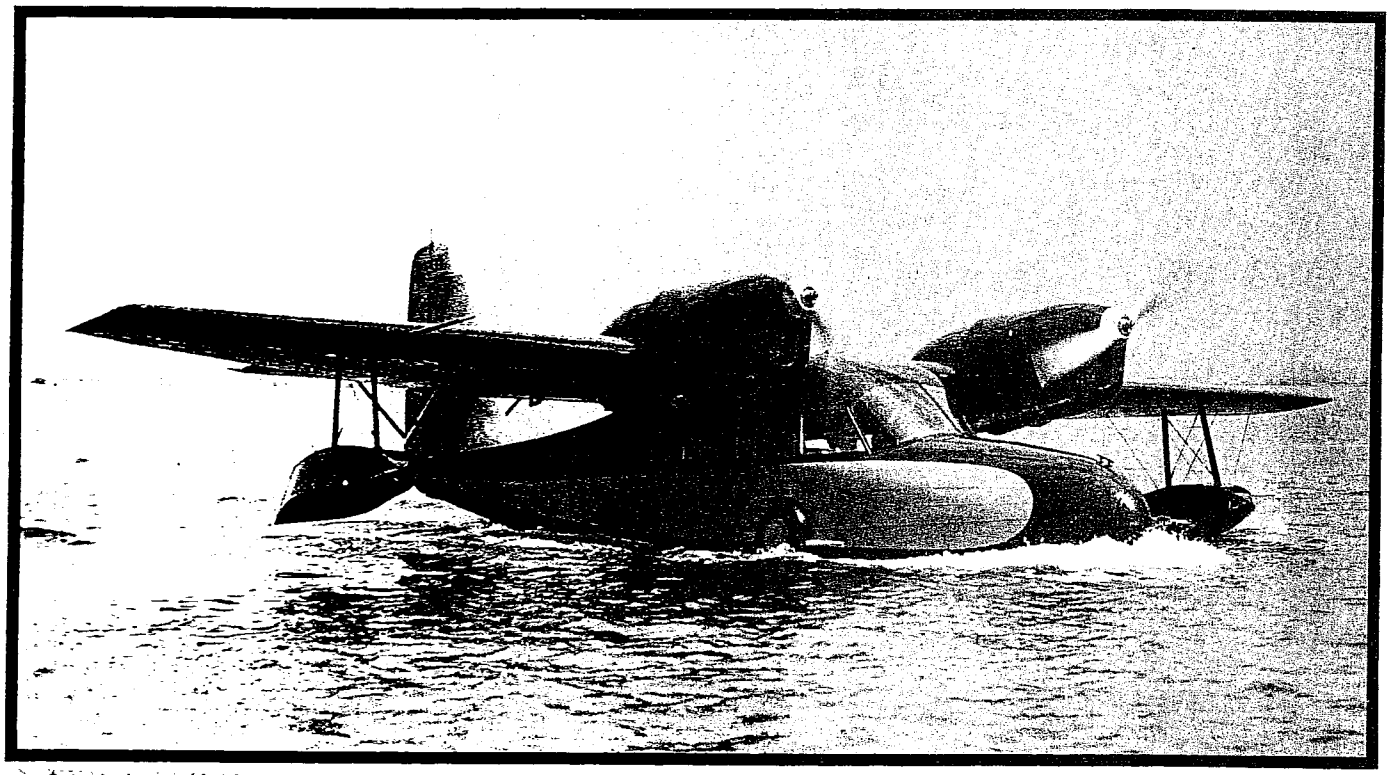
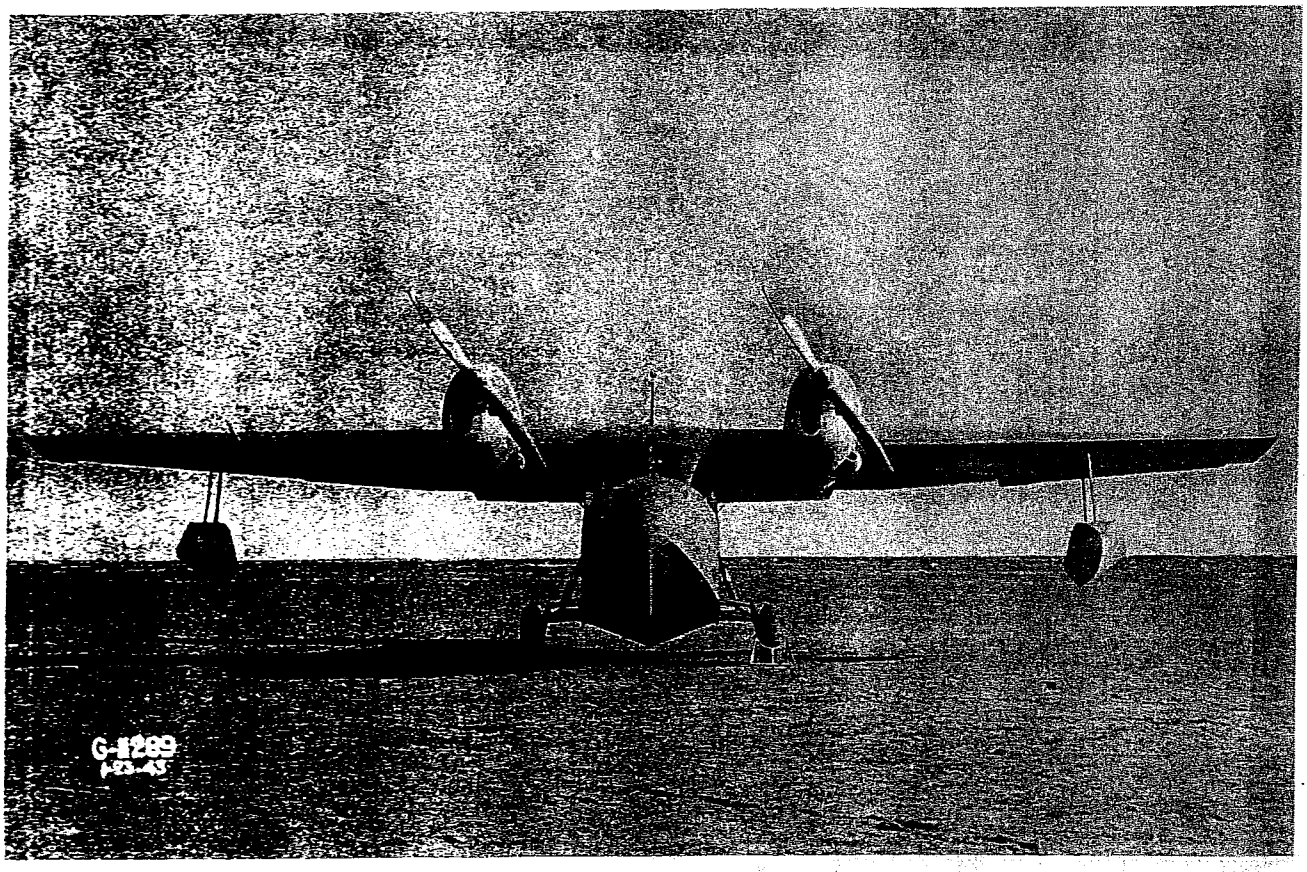


FIGURE I - FRONT & SIDE VIEW OF AIRPLANE

5A



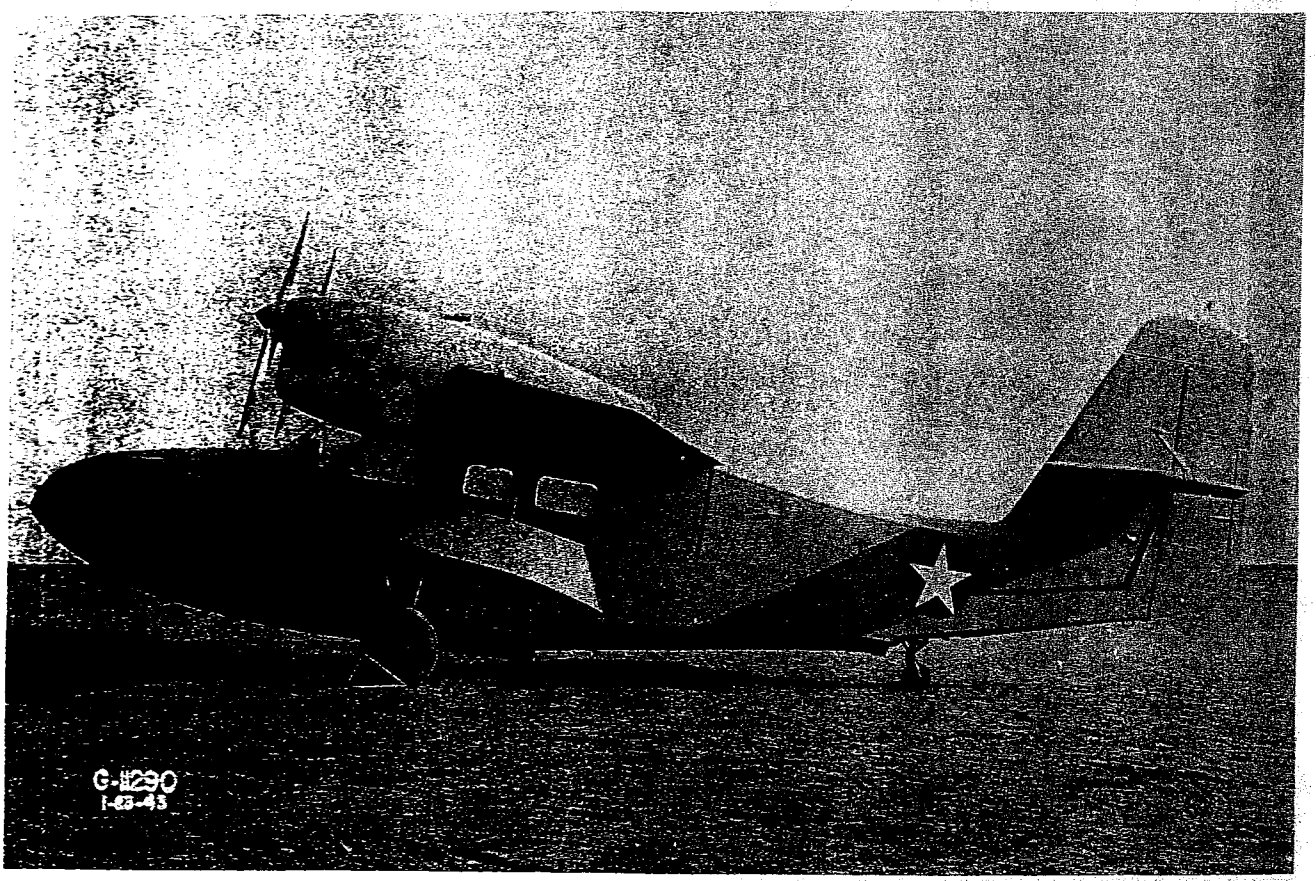
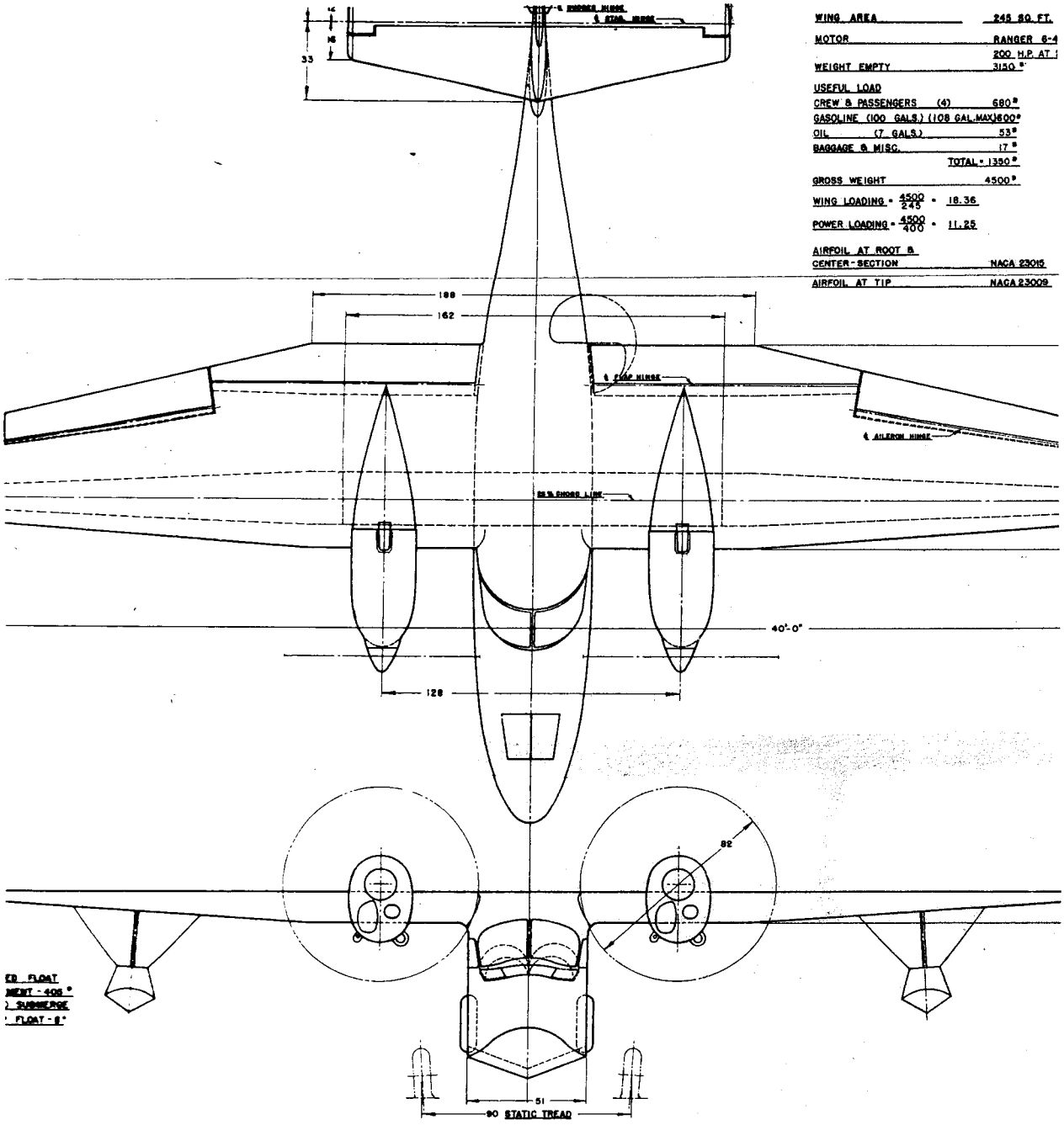


Figure 1 — Front and Side Views



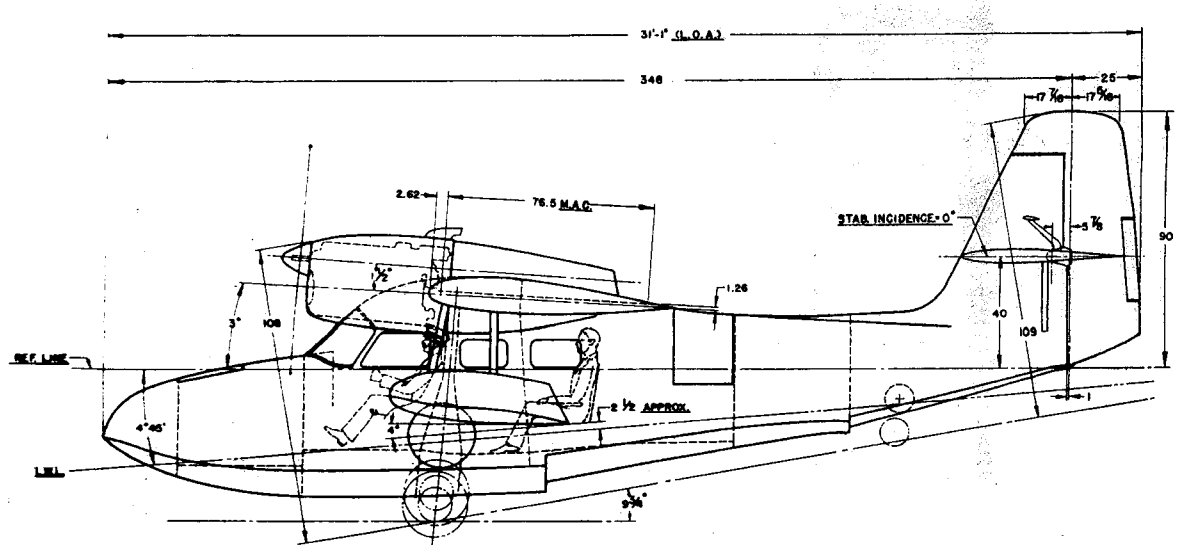


Figure 2 – C l Arrangement

SECTION II

SHIPMENT OF AIRPLANE

A. PREPARATION FOR SHIPMENT

In preparing this airplane for shipment, the following general procedure is recommended. The propellers, radio masts, outer wing panels, rudder and elevators, should be disassembled from the hull, main wheels and tail wheel retracted into the hull, and the units packed in one shipping case. See Section III, ERECTION PROCEDURE.

B. SIZE OF SHIPPING CASE

Double Planked Overseas Box.

Outside Dimensions - 31' x 14'10" x 10'4".

Gross Weight - 15,700 lbs. (Approx.)

C. PACKING

The usual precautions should be observed in packing the various units, such as wing panels, tail surfaces, etc., making sure that surfaces in contact with parts are suitably padded to prevent damage.

In supporting the hull with landing gear retracted, take care to see that special cradles which fit the V bottom are provided in the box to properly support the weight. The cradle should be located at Stas. #7, #15, and #22. See Fuselage Structure Stations Diagram, Fig. #3 and Hull Supports, Fig. #46. The usual precautions, should be taken in lashing down to prevent shifting in the box.

SECTION III

ERECTION PROCEDURE

A. GENERAL INFORMATION

This airplane is a single control, (throw-over wheel) four - five place, all metal, twin engined, high wing amphibian monoplane. The hull is an integral part of the body. The wing center section, which includes the engine nacelles, is permanently bolted to the top of the body.

The landing gear is hydraulically retractable into the hull.

Wing tip floats of standard lines and construction are attached to the outer wing panels.

The Ranger Model 6-440C-5 direct drive, 6 cylinder in line, inverted air-cooled engine is rated at 200 B.H.P. at 2450 RPM for sea level operation, using 87-91 octane fuel.

B. PIPING COLOR CODE

LINE	COLOR BAND
Fuel	Red
Hydraulic Pressure Oil	Light Blue - Yellow - Light Blue
Manifold Pressure	White - Light Blue
Oil	Yellow
Pitot Pressure	Black
Static Pressure	Black - Light Green
Vacuum	White - Light Green
Fuel Vent	Red - Black

The color bands are spaced at frequent intervals to facilitate identification and tracing of lines.

C. HULL

The hull is of metal semi-monocoque construction. The bottom of the water tight area is covered with .040 and .051 24ST aluminum alloy sheet and the deck and sides are .032 24ST. Duprene sealer and tape are used between sheets and members at all water tight joints. Brazier head rivets are used for fastening.

Water tight wells are built into the hull to allow retraction of the main wheels and tail wheel.

The arrangement of the hull interior is as follows: a compartment in the bow of the hull, a compartment for a pilot and co-pilot, and a cabin with two standard seats. The radio equipment is located in the cabin immediately aft of the co-pilot.

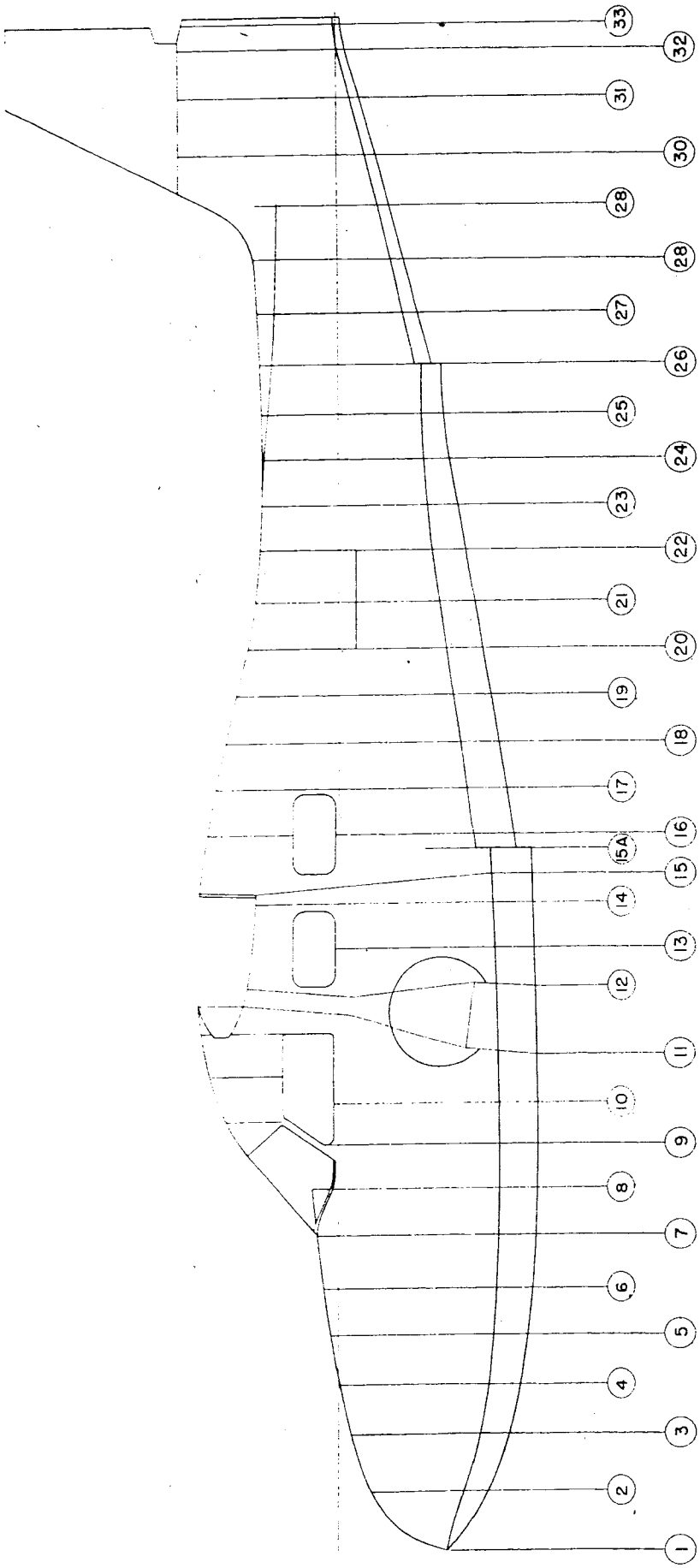


Figure 3 — Fuselage Structure Stations Diagram

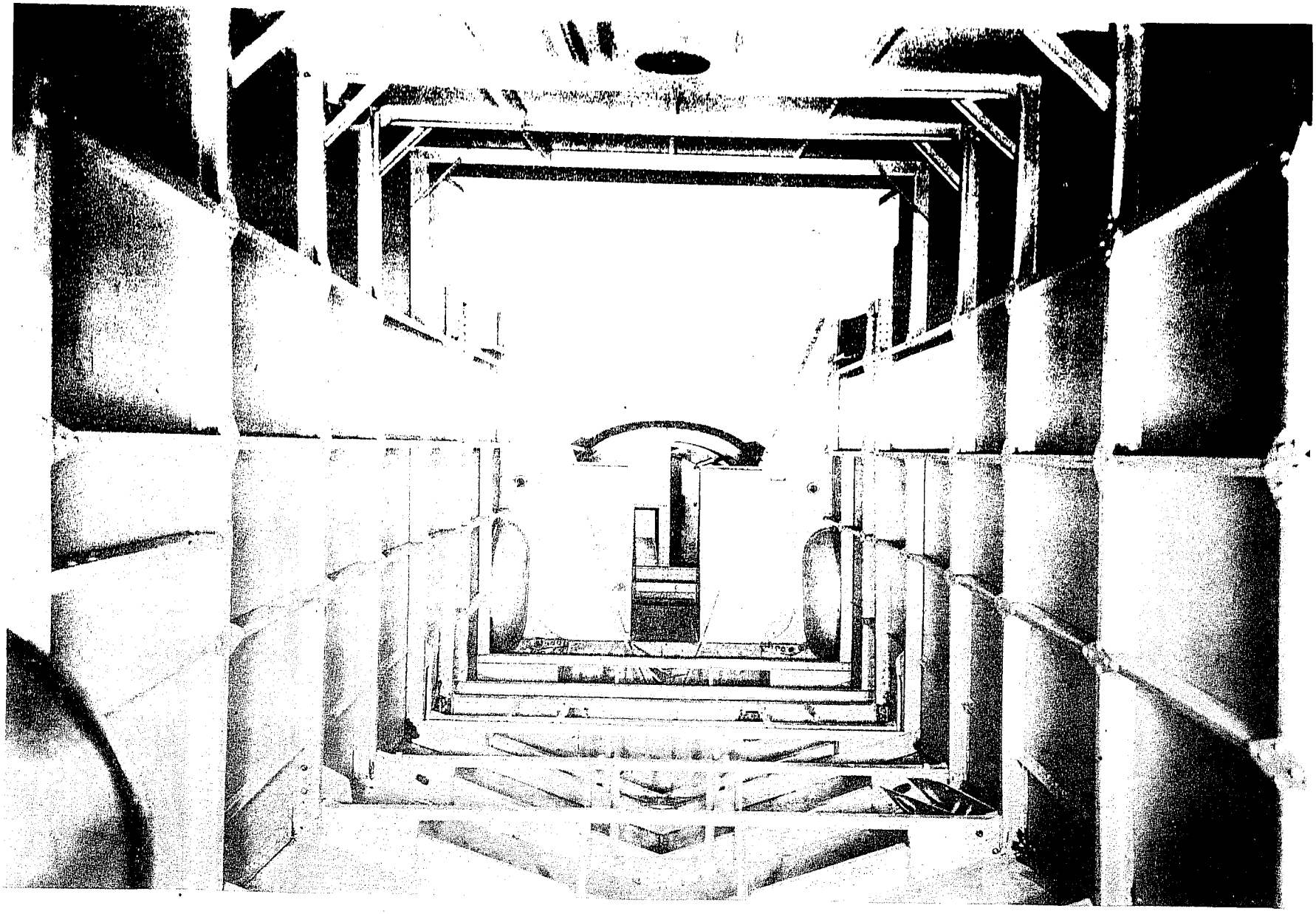


Figure 4 — Hull Structure — Forward View

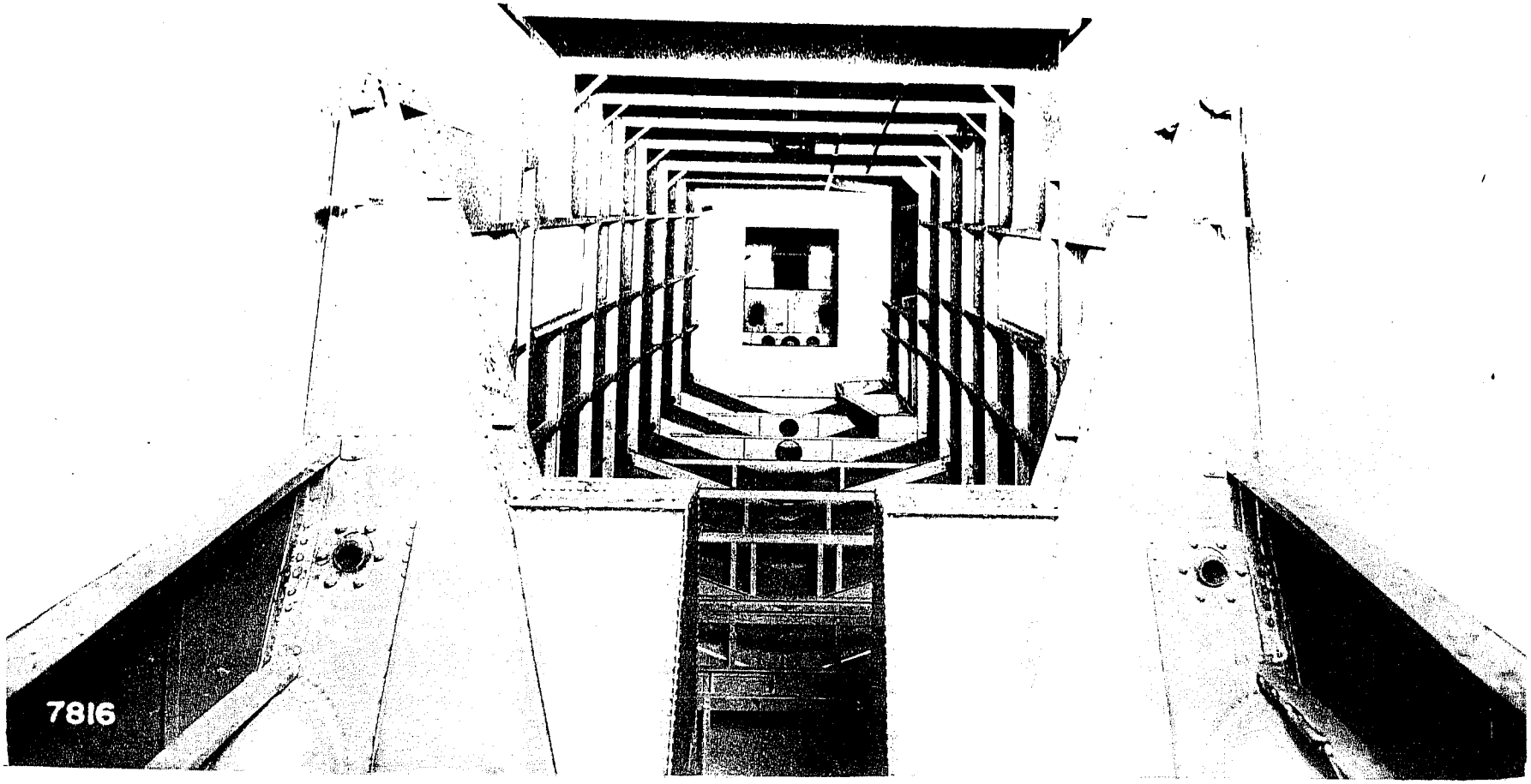


Figure 5 — Hull Structure — Aft View

D. WING STRUCTURE & ATTACHMENT

The wing structure consists of a center section, which carries the engine nacelles and the integral fuel tanks; and the outer wing panels, to which are attached the ailerons, flaps and wing tip floats.

The wings are of aluminum alloy box beam construction, metal and fabric covered. The center section is covered entirely with metal, and the outer panels are metal covered forward of the rear beam and fabric from the rear beam to the trailing edge.

Wing erection of this airplane is specifically a factory job. The center section is attached at the box beam to strength members in the body by eight vertically installed bolts. The portions fore and aft of the box beam are permanently attached to the hull by extended angular brackets and gap bands.

The outer wing panels are attached to the center section box beam by beam connectors and angle splice plates with a series of vertical clevis bolts and horizontal hex. head bolts. The joint between the outer wing panel and the center section is covered with gap plates fastened with corrosion resistant button head steel screws. See Wing Assembly Diagram, Fig. 6.

Flaps

The N.A.C.A. Standard fabric covered wing flaps facilitate both landing and take-off. These surfaces, which are hydraulically operated to the DOWN position and returned to the UP position by springs within the operating cylinders, extend from the inboard end of the ailerons to the hull. They are attached to the wing at four hinges by hex. head bolts.

The flap actuating cylinders are pivotally attached to the rear face of the box beam and are located just outboard of the hull. They are bolted in position with hex. head bolts. All flap hinges are equipped with grease packed ball bearings.

Ailerons

Each aileron is attached to the outer wing panel by means of hex. head bolts at the three hinges. The control horn is located near the center of the aileron span. The push-pull control tube which mates with the horn extends directly into the wing, being faired at this point by a fabric boot. All aileron hinges are equipped with grease packed ball bearings.

Aileron Tab

If flight testing shows the airplane to be wing-heavy, this condition may be quickly and effectively remedied by bending the fixed aileron tab in the proper direction.

NOTE: Care should be taken not to bend the tab too severely as a slight deflection will compensate for a considerable amount of wing heaviness.

Wing Alignment

Alignment is built into the wings, therefore, no adjustment is necessary or provided.

Wing Connections - Miscellaneous

Wiring

All electrical wiring in the wing is enclosed in solid wall aluminum alloy conduit, flexible conduit being used at light fixtures and panel connections. Wires are individually marked with identification numbers.

The left outer wing panel is fitted with a retractable landing light and motor assembly in the lower surface. Running lights are installed in the left and right wing tips.

Each engine nacelle is fitted with a junction box on the forward side of the firewall. The instrument (main) junction box, is located in the cabin above the pilot's head.

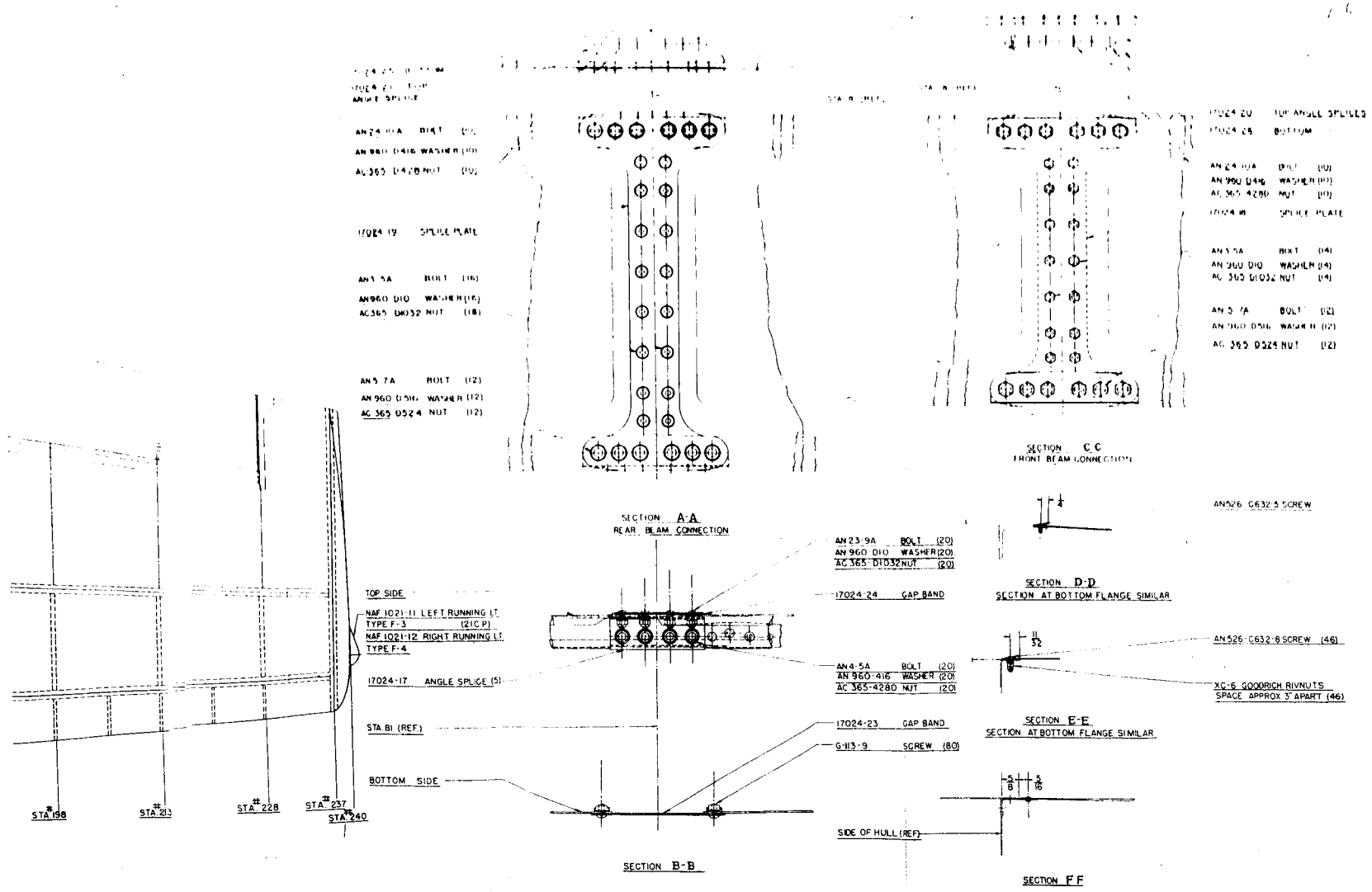
See Electrical Wiring Diagram, herein, for installation of all electrical units.

Aileron Controls in the Wing

The aileron control in the wing consists of push-pull rods and bellcranks which are cable operated from a central bellcrank located in the cabin on the rear face of the wing box beam. All bellcranks are fitted with grease packed ball bearings.

Airspeed Tubing

The airspeed pitot static tube is located on a boom which extends forward from the leading edge of the right wing. The lines in the wing to the pitot static tube are 1/4 ~~3/16~~ dia. 52SO aluminum alloy tubing connected by aluminum alloy compression fittings. They run through the leading edge to the hull. Drain tees are located on the front of the right engine nacelle, just below the master switch.


17024-20 TOP ANGLE SPLICE
17024-25 BOTTOM
AN24-10A BOLT (10)
AN960 D416 WASHER (10)
AC365 D428 NUT (10)
17024-19 SPLICE PLATE
AN3-5A BOLT (16)
AN960 D10 WASHER (16)
AC365 D1032 NUT (16)
AN5-7A BOLT (12)
AN960 D516 WASHER (12)
AC365 D524 NUT (12)
SECTION C-C
FRONT BEAM CONNECTION
AN526-C632-5 SCREW
SECTION A-A
REAR BEAM CONNECTION
AN23-9A BOLT (20)
AN960-D10 WASHER (20)
AC365-D1032 NUT (20)
17024-24 GAP BAND
SECTION D-D
SECTION AT BOTTOM FLANGE SIMILAR
AN526-C632-6 SCREW (46)
XC-6 GOODRICH RIVNUTS
SPACE APPROX 3" APART (46)
TOP SIDE
NAF 1021-11 LEFT RUNNING LT. TYPE F-3 (21C.P.)
NAF 1021-12 RIGHT RUNNING LT. TYPE F-4
17024-17 ANGLE SPLICE (5)
AN4-5A BOLT (20)
AN960-416 WASHER (20)
AC365-4280 NUT (20)
SECTION E-E
SECTION AT BOTTOM FLANGE SIMILAR
STA 81 (REF.)
17024-23 GAP BAND
G-113-9 SCREW (80)
BOTTOM SIDE
STA 198
STA 213
STA 228
STA 237
STA 240
SIDE OF HULL (REF.)
SECTION B-B
SECTION F-F

Assembly

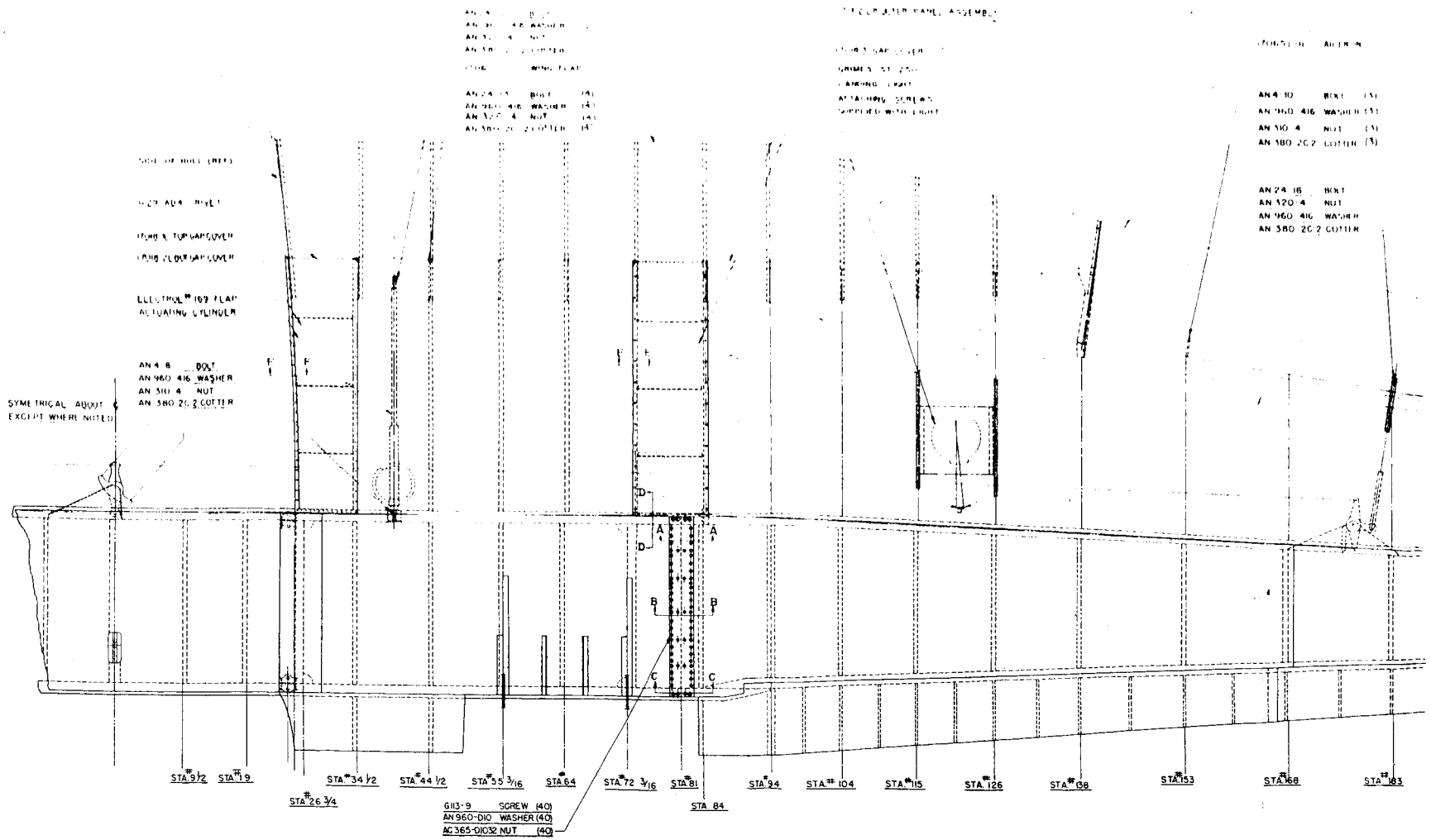

AN 4 B BOLT
AN 960 416 WASHER
AN 310 4 NUT
AN 380 2C 2 COTTER
AN 4 B BOLT
AN 960 416 WASHER
AN 310 4 NUT
AN 380 2C 2 COTTER
ELECTROL 169 FLAP ACTUATING CYLINDER
AN 4 B BOLT
AN 960 416 WASHER
AN 310 4 NUT
AN 380 2C 2 COTTER
SYMETRICAL ABOUT EXCEPT WHERE NOTED
AN 4 10 BOLT (3)
AN 960 416 WASHER (3)
AN 310 4 NUT (3)
AN 380 2C 2 COTTER (3)
AN 24 16 BOLT
AN 320 4 NUT
AN 960 416 WASHER
AN 380 2C 2 COTTER
STA 9 1/2
STA 19
STA 26 3/4
STA 34 1/2
STA 44 1/2
STA 55 3/16
STA 64
STA 72 3/16
STA 81
STA 84
STA 94
STA 104
STA 115
STA 126
STA 138
STA 153
STA 168
STA 183
6113-9 SCREW (40)
AN 960-D10 WASHER (40)
AC 365-D1032 NUT (40)

Figure 6—1

E. WING TIP FLOAT ATTACHMENT

The 405 pound displacement wing tip floats, of standard lines and construction, are attached to the outer wing panels by two vertical struts and streamlined tie-rods. The left and right floats are interchangeable.

To assemble the wing tip float, first attach the struts and the fore and aft tie-rods to the float, then attach the assembly as a unit to the wing panel. Install the transverse tie-rod braces. Adjust the tie-rods as shown on Fig. 7 in order to align the float.

The floats are provided with drain plugs along the keel, one at the center and one at the rear.

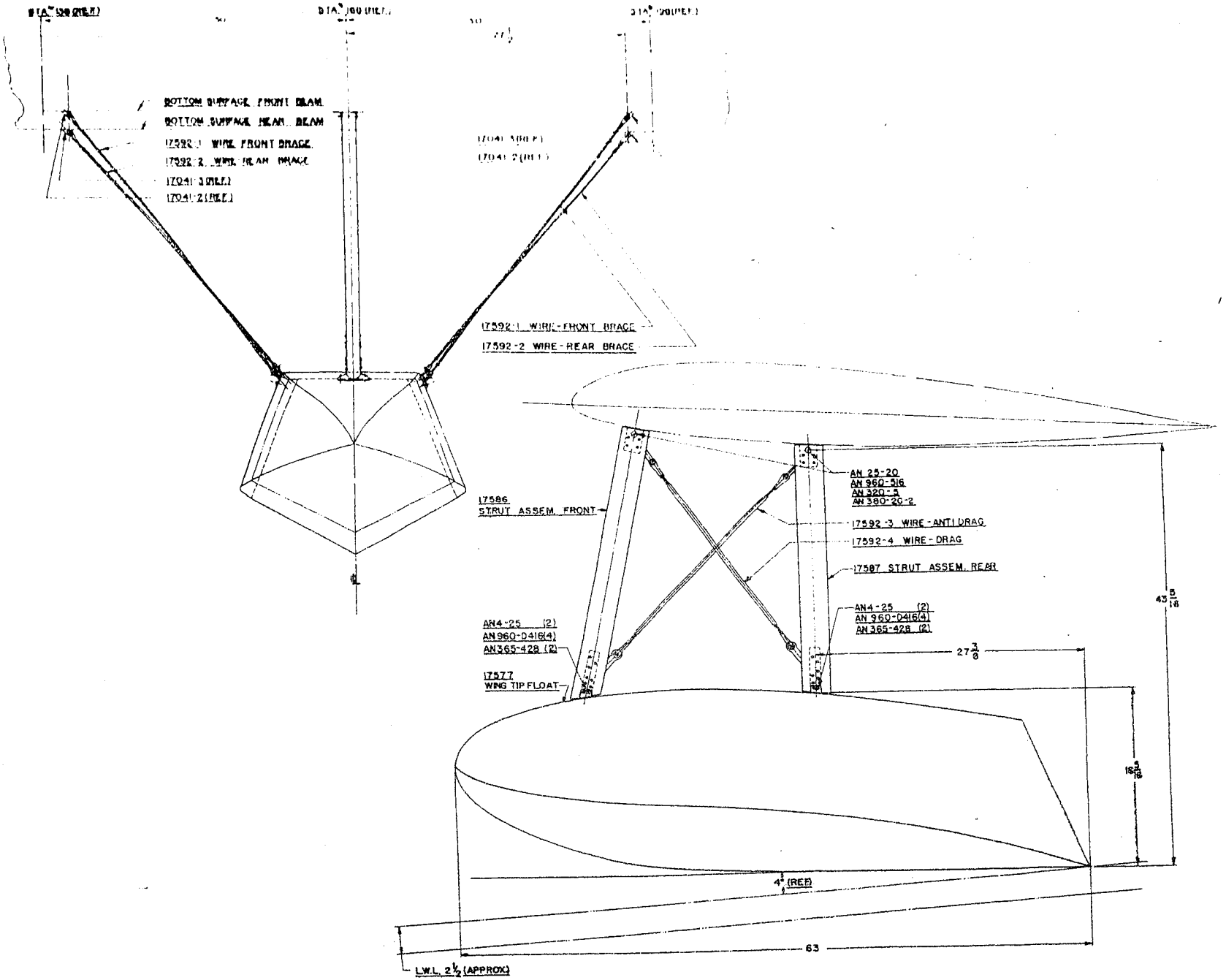


Figure 7 — Wing Tip Float Installation

F. TAIL SURFACES - STRUCTURE AND ATTACHMENT

The tail unit, comprising a cantilever fin with hinged rudder and strut-braced stabilizers with hinged elevators, is supported at the aft end of the hull. The rudder and elevators are readily removable.

Fin

The built-up frame, of stressed skin aluminum alloy, is bolted to the hull.

Rudder

The rudder is a fabric covered internally braced aluminum alloy structure, provided with three hinges fitted with grease packed ball bearings. The upper hinge is bolted to the rear beam of the fin and the two lower hinges are bolted to the stern post.

A fairlead fitting is provided on the top of the rudder for the radio antenna.

The rudder is fitted with electrical conduit and is wired for the anchor and running lights.

The control horn is rigidly attached to the rudder and cannot be disconnected when removing this control surface from the airplane. The control cables, tab control shaft and electric wiring should be disconnected when removing the rudder.

Stabilizers

The stabilizer, which is the same type structure as the fin, is attached to the hull at Sta. #30 and to the stern post by hex. head bolts. The stabilizer brace struts, located below these surfaces, are attached by standard hex. head bolts.

Elevators

The fabric covered, internally braced elevators are provided with four hinges, fitted with grease packed ball bearings, which are bolted to the stabilizer rear beam. The elevators are bolted to the control horn but may be removed individually.

Balances

The rudder and elevators are statically balanced.

Tabs

The rudder and left elevator are fitted with trimming tabs, which are controllable from the cockpit.

The right elevator tab is interconnected with the wing flap control and operates in conjunction with it. This tab is lowered with the wing flaps thus counteracting "nose heaviness" which is consequent to wing flap operation.

Tab Controls - General Notes

Elevator Tab: Handcrank Clockwise - Nose Up

Rudder Tab: Handcrank Clockwise - Nose Right

Radius of Movement - Control Surfaces

Rudder	27° Right	27° Left
Elevator	30° Up	20° Down
Ailerons	20° Up	20° Down
Flaps	0° to	40° Down
Elevator Tab - Left	10° Up	29° Down
Elevator Tab - Right	0° Up	29° Down
Rudder Tab	22° Right	23° Left

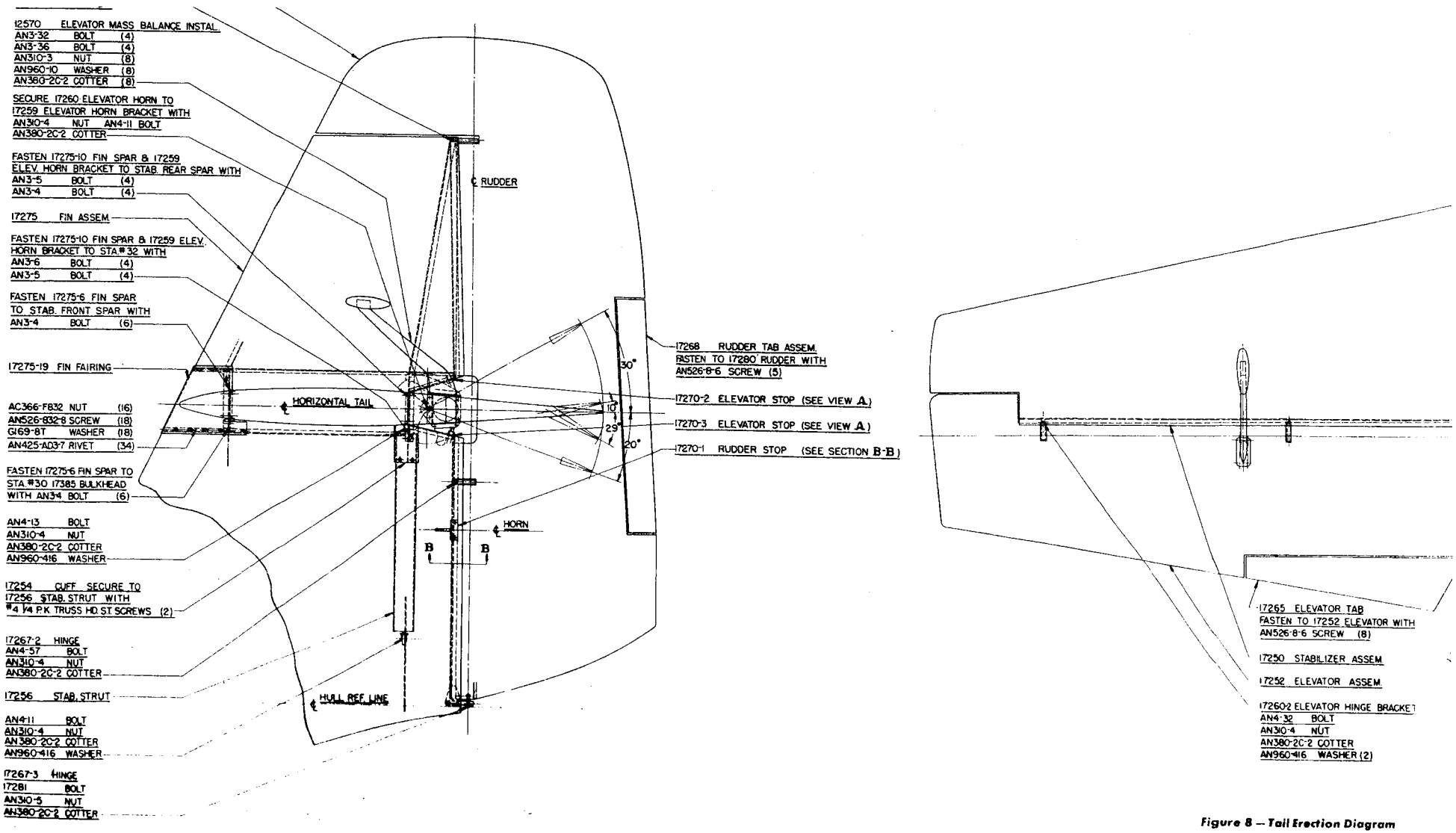


Figure 8 — Tail Erection Diagram

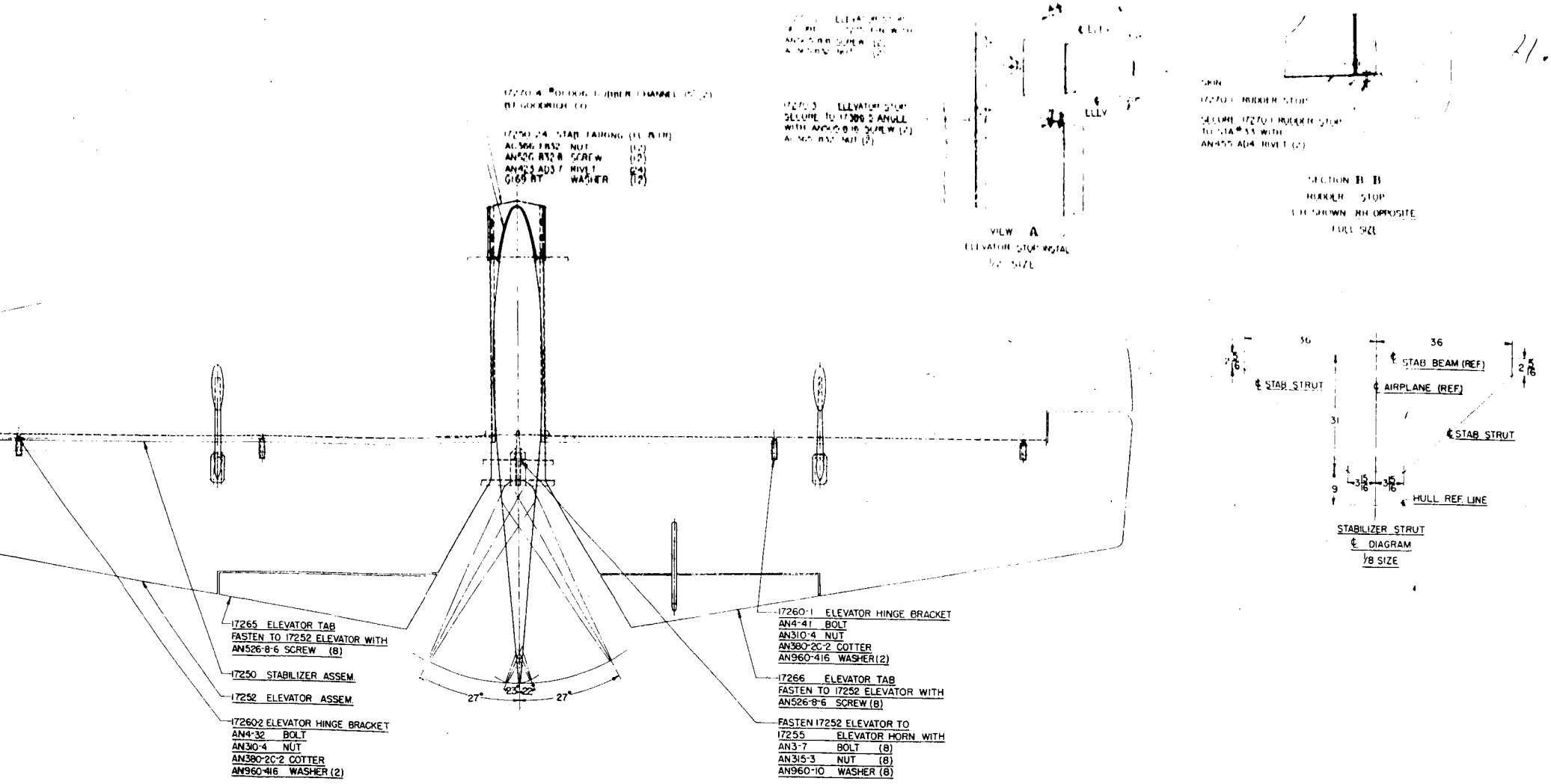


Figure 8 — Tail Erection Diagram

SECTION IV

SERVICE INSTRUCTIONS

A. POWER PLANT

Engine Installation

The Ranger Model 6-440C-5 direct drive, six cylinder, inverted, air cooled engines are rated at 200 B.H.P. at 2450 RPM at sea level and 150 B.H.P. at 2300 RPM from 4000 to 7000 ft., using 87 or 91 octane fuel. The recommended maximum engine speed at cruising, 0 to 4000 ft., is 2150 RPM.

Fuel

87 octane, Spec. AN-F-25

91 octane, Spec. AN-VV-F-776-4

Oil

Grade 1100, Spec. AN-VV-O-446

For all information relative to the care, maintenance, inspection and lubrication of the engines, refer to the Instruction Book for Ranger Aircraft Engines.

Engine Mount

The engine mounts are constructed of chrome molybdenum steel tubing and are connected by six bolts to the wing center section box beam. The mount is provided with four mounting brackets, shock absorber bushings and pressure plates, comprising a resilient mounting for the engine assembly.

All bolts and nuts should be carefully checked for tightness at the standard inspection periods.

Exhaust System

The exhaust system on each engine consists of six short stacks with flanges, leading into the manifold unit and exhausting under the wing to the right of the nacelle. A cowling muff is provided over the exhaust manifold permitting hot air pick-up for carburetor air preheat. A tube is welded to the exhaust mani-

fold for carrying heat to the carburetor hot spot. A heat intensifier tube, in each exhaust manifold, supplies the cabin with heated air through a cockpit control valve unit.

Starting System

The engines are fitted as standard equipment with Type E-80 Eclipse Electric Starters. The starter push buttons are located on the Electrical Panel. For detailed information regarding the care and maintenance of the starters, refer to Eclipse Corporations' Instruction Manual.

An outside power plug is installed inside the cockpit on the bulkhead behind the pilot's head, thus making provision for connecting an external power source for starting the engines and checking electrical equipment.

Engine Controls

The dual throttle control quadrant is located just forward of the Upper Control Panel and the mixture controls are on the Upper Rear Control Panel. These controls are connected to the carburetors by a system of push rods and torque tubes. The torque tubes run inside the leading edge of the wing to the nacelles and the push rods are located in the engine compartments. The adjustable push rods in the nacelles connect the torque tube lever arms with the carburetor levers.

The throttles are arranged so that the engines may be throttled individually or simultaneously. Their movement is conventional; i.e., Forward - OPEN and Aft - CLOSED.

The two wobble pumps, two tank shut-off fuel valves, and the cross flow fuel valve are operated from the Upper Rear Control Panel by torque tubes. The cross flow valve is located in the left engine nacelle; and one wobble pump and shut-off valve are installed in each nacelle.

The carburetor air preheat controls are located on the left hand side of the Upper Rear Control Panel. These controls are connected to the preheat mixing

valves by encased push-pull control wires.

In general, the controls and their operation are indicated by adjacent name-plates.

Idle Cut-Off Unit

This unit provides for stopping the engines by moving the mixture control levers into the topmost section of the control slots, which are marked CUT-OFF and are painted red.

Primers

Priming is accomplished by means of a Priming Pump Control Handle at the lower left hand side of the Main Instrument Panel. Fuel is taken from the system on the carburetor side of the left engine by-pass relief valve and distributed via the pump and tubing to the cylinders. The pump control handle should be rotated to the left to prime the left engine and to the right for the right engine. The left wobble pump must be operated in order to supply fuel for pump priming.

Engine Operation

For engine operating instructions refer to the Pilot's Handbook for this airplane.

Propellers

The two-bladed propellers are fixed pitch Sensenich Model 82-RS-72. They are wooden, with metal leading edges and tips, and are 82 in. in diameter with a 72" pitch at 3/4 radius.

Temperature and humidity conditions affect wooden propellers even after short periods without use. The blades will sometimes warp slightly and not alike on either side thus changing the speed characteristics of their respective engines. This is the probable explanation if one engine does not turn up as fast as the other, and normally does not indicate a power loss. Several hours of running will usually bring the propellers back to their former speed.

It is the usual practice on twin engine airplanes to synchronize the speed of the engines by their sound, even though the tachometer readings may be slightly different.

If the propellers change into steeper pitch (slower speed), the RPM limits shown on the Power Output Table will exceed the Ranger Aircraft Engine Company's maximum and recommended cruising limits, therefore lower RPM's should be used. This condition may be checked by running at full throttle in level flight at 500 ft. for several minutes. If the RPM's are less than 2500, reduce the RPM in the table by the number of revolutions lost.

With manifold pressure gages, it is only necessary to follow the Manifold Pressure column on the following table:

POWER OUTPUT TABLE

CRUISING POWER	LEVEL FLIGHT	ALTITUDE 0	2000	4000	6000	8000
Max. 75%	RPM	2260	2300	2330	2350	2370
	Man. Press.	23.5	23.0	22.5	22.0	21.5
Recom'd 62½%	RPM	2150	2180	2200	2225	2250
	Man. Press.	22.0	21.5	21.0	20.5	20.0
Econ. 50%	RPM	1975	2000	2025	2050	2075
	Man. Press.	19.5	19.0	18.5	18.0	17.5

The seat of the propeller hub on the hub cone should be checked every 100 hours. The tightness of the propeller hub bolts should be checked after the first 25 hours and every 50 hours thereafter.

Pairing of New Propellers

The RPM tolerance of any shipment of wooden propellers is approximately ±40 RPM from the specified static RPM. Thus it would be possible to select a pair that would run 80 revs apart under the same conditions on the same airplane. To prevent this, it is customary to run-up a new shipment of propellers and rate their static RPM's

The propellers should be run-up to maximum RPM on the same engine one after the other, as fast as they can be changed so that the same test conditions will prevail. The plane should be cross-wind to avoid the effect of the wind. The average maximum RPM of all the propellers in the test should be calculated, and the plus or minus revs from this average should be listed for each propeller and painted on the hub for reference. If six or more propellers are used for such a run, the average should be reliable for comparison with other test runs under different barometric and temperature conditions. That is, the ratings above or below the average of one run are comparable with the above or below ratings of another run, even though the averages (due to variable test conditions) are different.

In assigning propellers to an airplane thereafter, they should be matched in pairs with equal ratings as closely as possible. Selections not more than 20, or at the most, 30 revs apart should be made.

If speed is desired, choose propellers with low RPM ratings, and keep the cruising revs lower than shown in the Pilot's Handbook. If quick take-off is desired, choose propellers with high RPM ratings and when cruising, revs may be used slightly above the table values.

Carburetor Air Intake System

The air preheat mixing chamber, mounted below the updraft carburetor, is fitted with a valve arrangement, which consists of a mixing valve and lever. This unit is operated from a push-pull control "T" Handle, located on the Upper

Rear Control Panel. Pull forward for hot air then rotate to lock in position.

The hot air is taken from the exhaust manifold muff and the cold air is supplied from the nose cowling of the nacelle through a large duct to the mixing chamber.

The design is such that hot or cold air or any desired mixture of both may be supplied to the carburetor. An air temperature thermometer bulb is located in the mixing chamber and the gage is on the Main Instrument Panel.

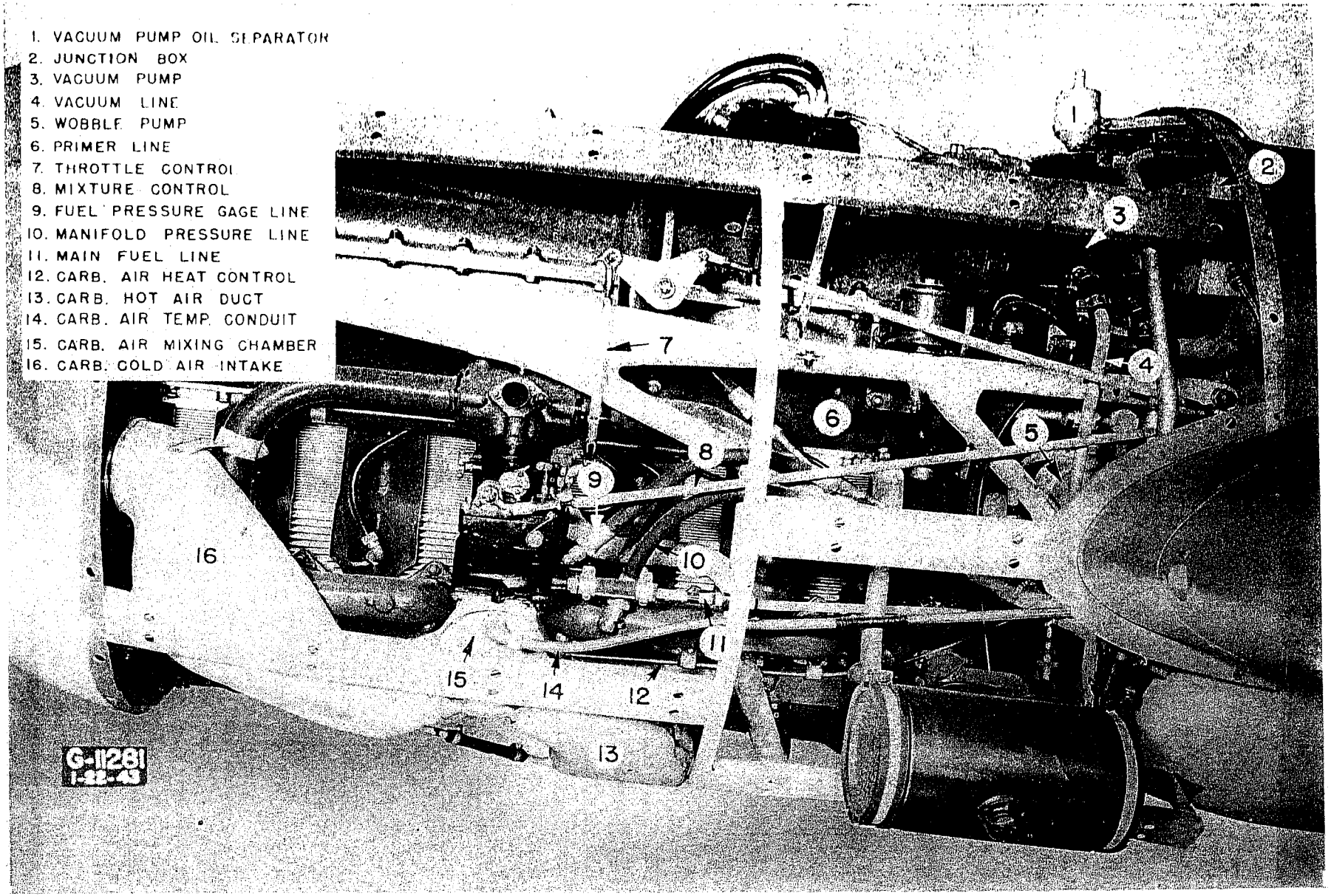


Figure 9 — Left Engine — Left-Hand Side

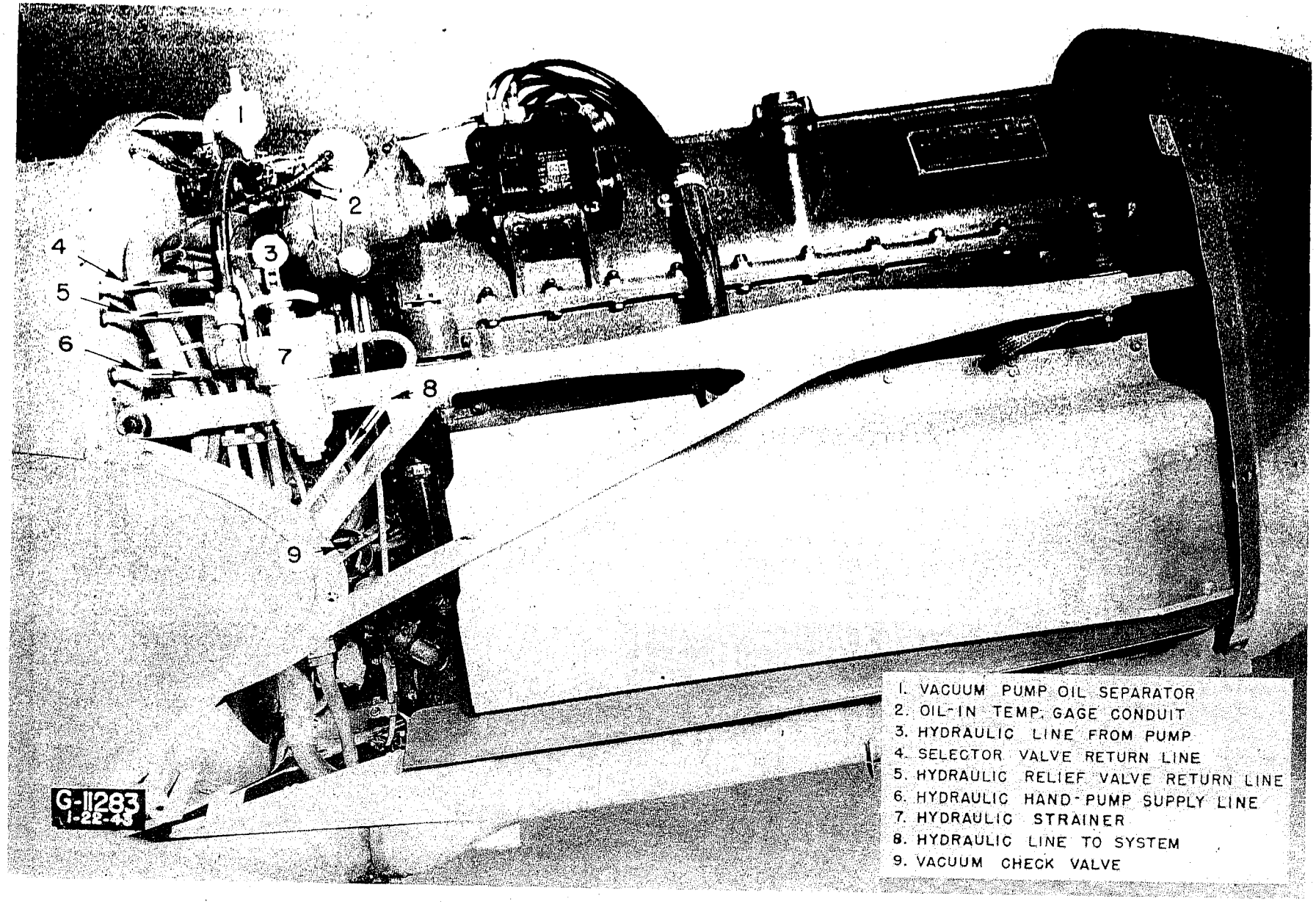


Figure 10 — Left Engine — Right-Hand Side

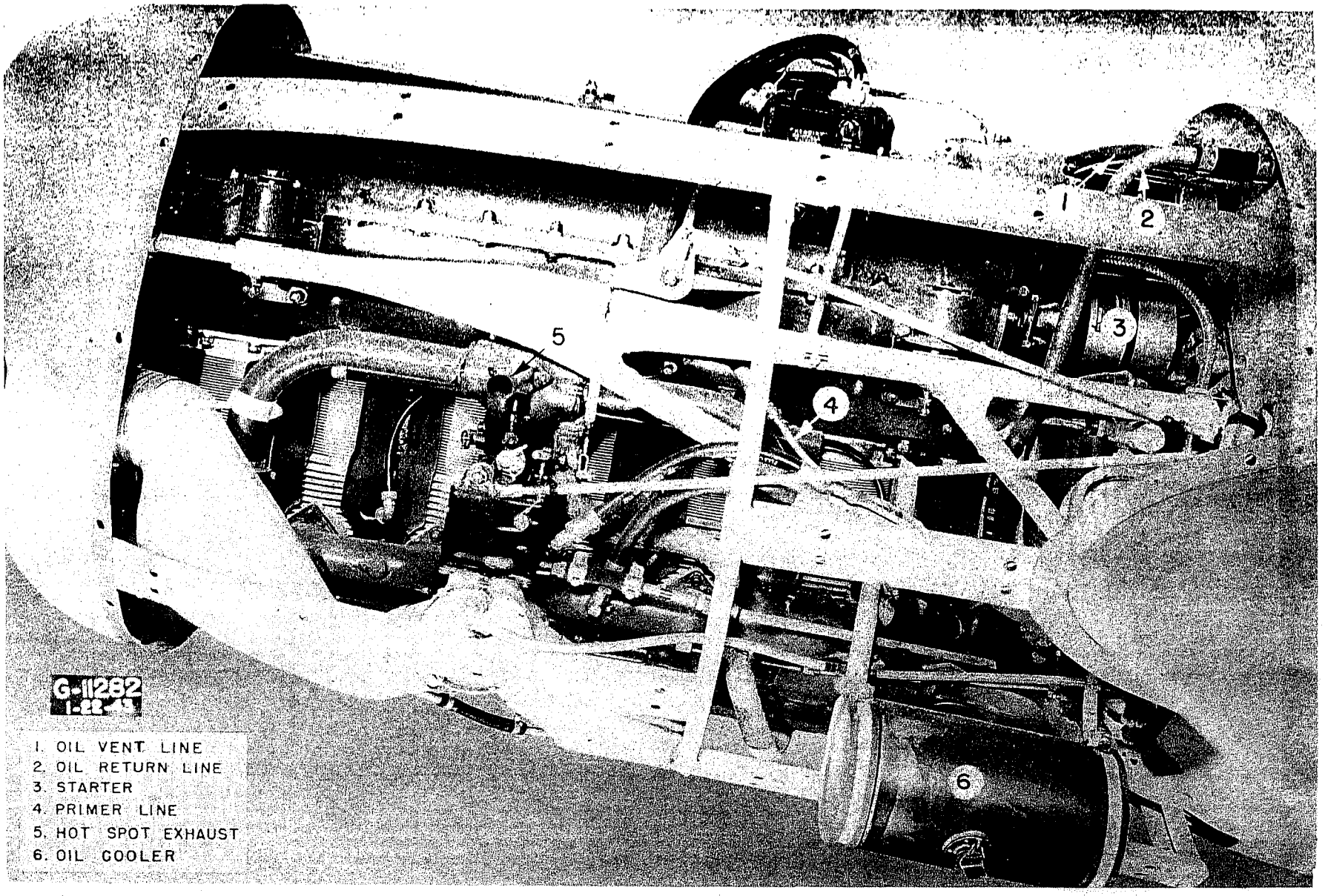


Figure 11 — Right Engine — Left-Hand Side

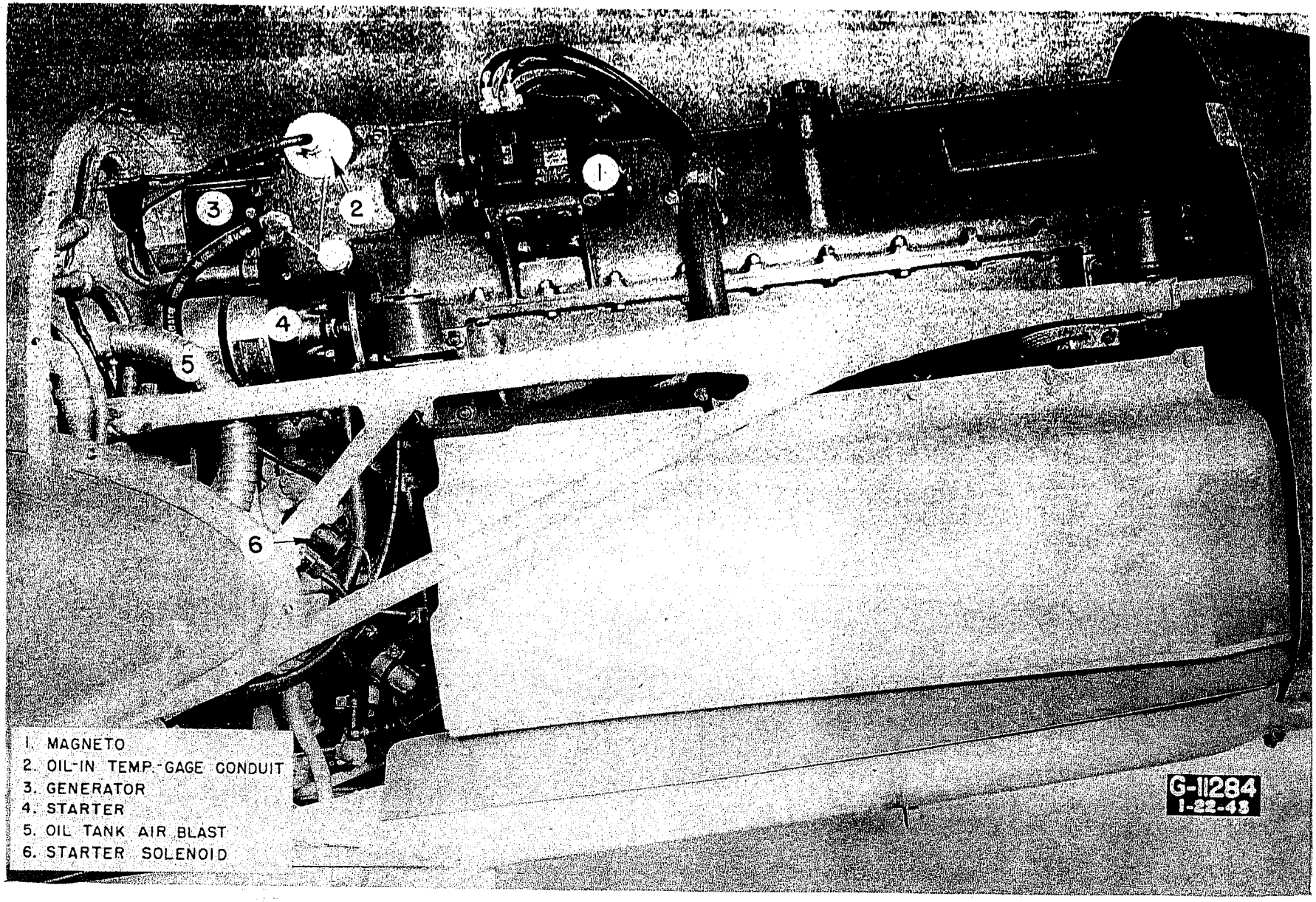
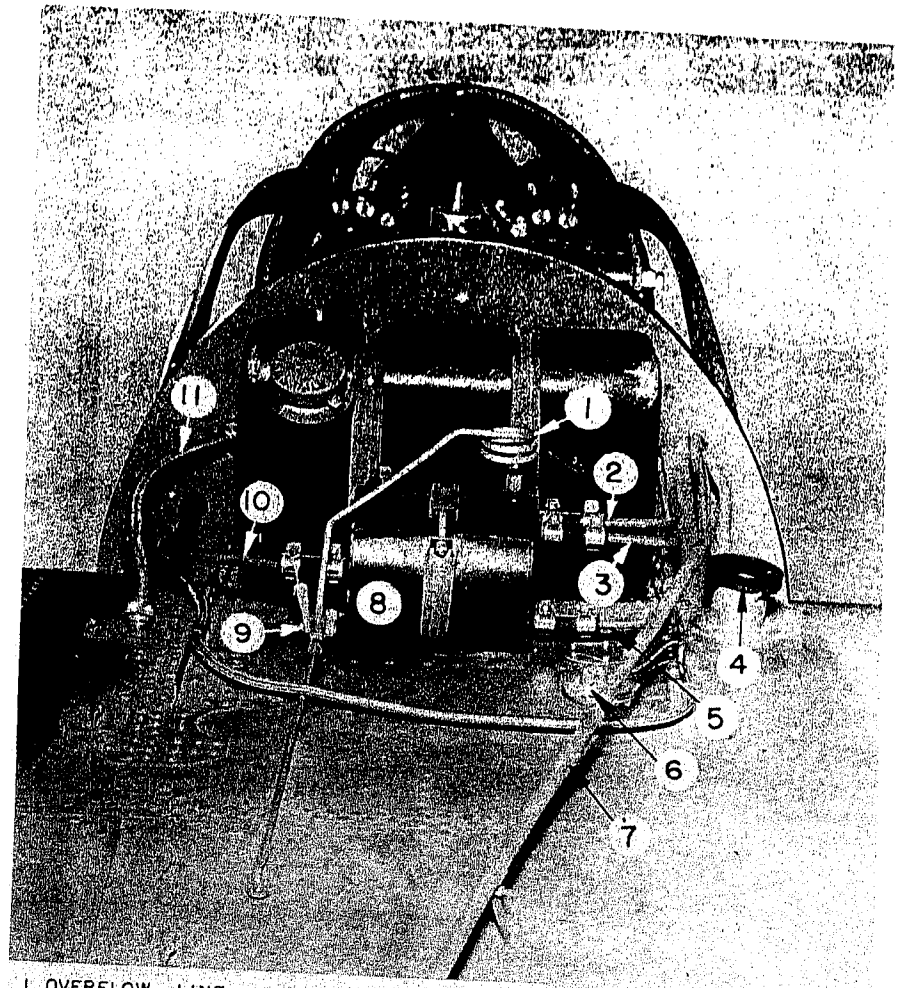
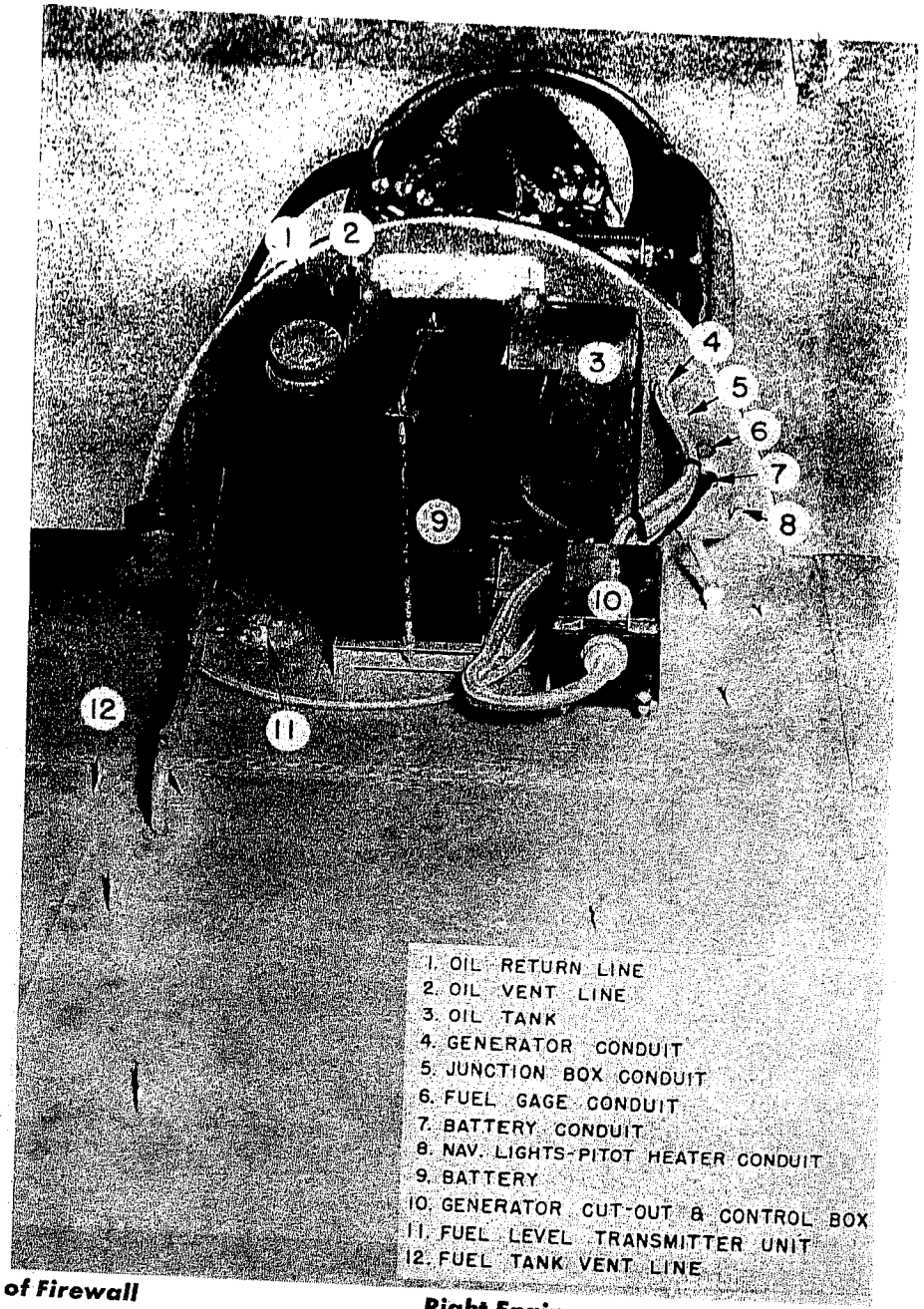


Figure 12 — Right Engine — Right-Hand Side



1. OVERFLOW LINE
2. RETURN LINE FROM FLAP SELECTOR VALVE
3. RETURN LINE FROM RELIEF VALVE
4. FUEL TANK FILLER CAP
5. HAND PUMP SUPPLY LINE
6. FUEL LEVEL TRANSMITTER UNIT
7. FUEL TANK VENT LINE
8. HYDRAULIC FLUID TANK
9. TANK DRAIN VALVE
10. HYDRAULIC PUMP SUCTION LINE
11. ELECTRICAL CONDUIT LANDING & NAV. LIGHTS

Left Engine



1. OIL RETURN LINE
2. OIL VENT LINE
3. OIL TANK
4. GENERATOR CONDUIT
5. JUNCTION BOX CONDUIT
6. FUEL GAGE CONDUIT
7. BATTERY CONDUIT
8. NAV. LIGHTS-PITOT HEATER CONDUIT
9. BATTERY
10. GENERATOR CUT-OUT & CONTROL BOX
11. FUEL LEVEL TRANSMITTER UNIT
12. FUEL TANK VENT LINE

Right Engine

Figure 13 — Aft of Firewall

B. FUEL SYSTEM

Each fuel system consists of an integral wing tank, tank outlet strainer, tank filler, wobble pump and strainer, electric fuel quantity gage, fuel pressure gage, engine driven fuel pump with integral relief and by-pass valve, fuel valve and controls, and vent lines.

The fuel system is essentially a complete separate unit for each engine, and is normally used as such with each tank feeding its own engine directly. There is, however, a cross-flow connection with a shut-off valve, enabling both engines to be run simultaneously from either tank. To do this, the valve on the tank not being used should be closed. If three valves are open and one of the tanks should run dry, air will enter both systems, resulting in momentary failure of the engines. Closing the valve on the empty tank, thereby cutting it out of the system, will return engine operation to normal.

It should be remembered that for both engines to run two valves must be ON and that three valves should not be ON at once if the fuel is very low.

The fuel pressure relief valve is set to maintain a pressure of 2-1/2 to 3-1/2 p.s.i.

Fuel

Use - 91 octane, Spec. AN-VV-F-776-4

or - 87 octane, Spec. AN-F-25

TANKS

Left Tank	54 U. S. Gals.
Right Tank	54 U. S. Gals.
	108 U. S. Gals.

Fuel Valves

A two-way, ON-OFF, fuel valve is located in each engine nacelle just above the wobble pump. The control handles are located on the Upper Rear Control Panel.

The cross-flow valve is located in the left engine nacelle just outboard of the wobble pump. Its control handle is also located on the Upper Rear Control Panel.

Strainers & Drains

The fuel strainers, located in each engine nacelle, can be drained directly to the ground. These units should be drained every day before flying.

Each tank is drained individually by means of the fuel system drain which is located at the base of the tank sump.

CAUTION: WHEN IT IS NECESSARY TO PRE-HEAT THE ENGINE OR DO ANY FLAME WELDING AROUND THE ENGINE COMPARTMENT, THE ENGINE SHOULD BE RUN DRY AND THE CARBURETOR CHECKED TO SEE THAT IT IS COMPLETELY DRAINED.

Filling Tanks

Fuel tanks should be filled before placing the airplane in the hangar. This has two advantages; the danger of explosion due to vapors in the tank is reduced and the possibility of moisture condensing in the tank is largely eliminated.

The tanks should NOT be filled to capacity in cold weather if the airplane is to be parked in a warm hangar, as the gasoline will expand and overflow through the vents. A fifty degree difference in temperature will cause an expansion of about 2-1/2 gallons per 100 gallons.

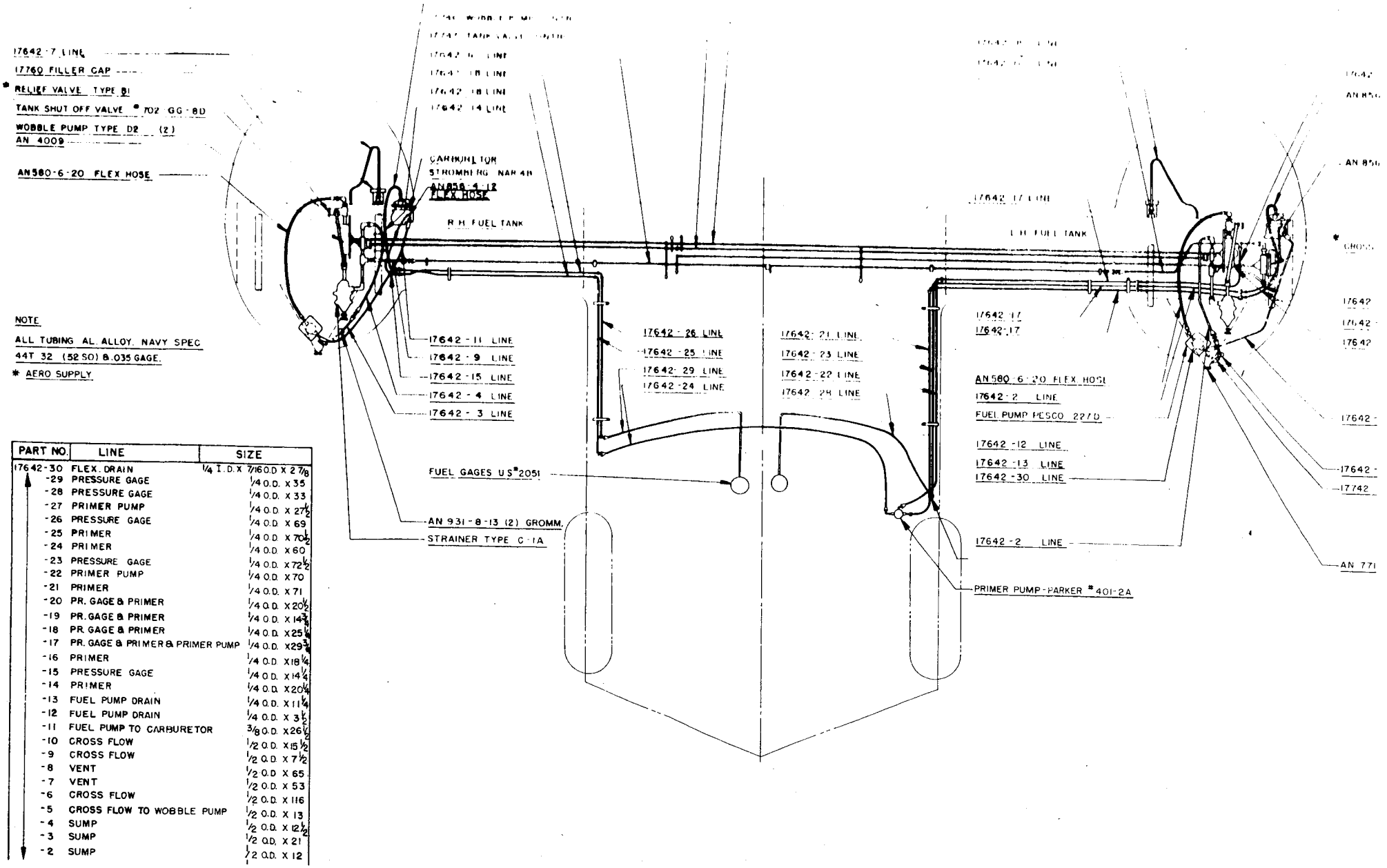
CAUTION: BEFORE FILLING THE TANKS, MAKE CERTAIN THAT THE AIRPLANE IS GROUNDED AND THE HOSE NOZZLE IS BONDED TO THE AIRPLANE. IF THE PLANE IS REFUELED FROM A TRUCK, GROUND THE TRUCK TO THE PLANE. THE BOND BETWEEN THE HOSE NOZZLE AND PLANE MUST BE LEFT CONNECTED UNTIL REFUELING HAS BEEN COMPLETED AND THE TANK COVER CLOSED. DO NOT CHARGE BATTERIES OR TEST THE RADIO TRANSMITTER IN THE PLANE DURING REFUELING.

Fuel and Vent Lines

See Fuel System Diagram for sizes of lines and fittings, unit numbers and general layout. All solid lines are 52SO aluminum alloy tubing.

Hand Pump Units

A Type D-2 wobble pump is located in each nacelle directly ahead of the fire-wall. They are operated by their respective control handles, on the Upper Rear Control Panel.



NOTE

ALL TUBING AL. ALLOY. NAVY SPEC.
44T 32 (52SO) 8.035 GAGE.

* AERO SUPPLY

PART NO.	LINE	SIZE
17642-30	FLEX. DRAIN	1/4 I.D. X 7/16 O.D. X 2 7/8
-29	PRESSURE GAGE	1/4 O.D. X 35
-28	PRESSURE GAGE	1/4 O.D. X 33
-27	PRIMER PUMP	1/4 O.D. X 27 1/2
-26	PRESSURE GAGE	1/4 O.D. X 69
-25	PRIMER	1/4 O.D. X 70 1/2
-24	PRIMER	1/4 O.D. X 60
-23	PRESSURE GAGE	1/4 O.D. X 72 1/2
-22	PRIMER PUMP	1/4 O.D. X 70
-21	PRIMER	1/4 O.D. X 71
-20	PR. GAGE & PRIMER	1/4 O.D. X 20 1/2
-19	PR. GAGE & PRIMER	1/4 O.D. X 14 3/4
-18	PR. GAGE & PRIMER	1/4 O.D. X 25 1/4
-17	PR. GAGE & PRIMER & PRIMER PUMP	1/4 O.D. X 29 3/4
-16	PRIMER	1/4 O.D. X 18 1/4
-15	PRESSURE GAGE	1/4 O.D. X 14 1/4
-14	PRIMER	1/4 O.D. X 20 1/4
-13	FUEL PUMP DRAIN	1/4 O.D. X 11 1/4
-12	FUEL PUMP DRAIN	1/4 O.D. X 3 1/2
-11	FUEL PUMP TO CARBURETOR	3/8 O.D. X 26 1/2
-10	CROSS FLOW	1/2 O.D. X 15 1/2
-9	CROSS FLOW	1/2 O.D. X 7 1/2
-8	VENT	1/2 O.D. X 65
-7	VENT	1/2 O.D. X 53
-6	CROSS FLOW	1/2 O.D. X 116
-5	CROSS FLOW TO WOBBLE PUMP	1/2 O.D. X 13
-4	SUMP	1/2 O.D. X 12 1/2
-3	SUMP	1/2 O.D. X 21
-2	SUMP	1/2 O.D. X 12

C. OIL SYSTEM

The oil system for each engine consists of a single tank, 5" dia. oil cooler with automatic thermostatic control and check valve, system lines with flexible connections where required, drain plug, oil pressure and oil-in temperature gages.

Oil

Use Grade 1100, Spec. AN-VV-O-446

Tanks

The tanks are provided with filler caps equipped with sounding rods and drain plugs with tubes. They are installed on the wings just aft of the firewall.

Capacity of each tank - $3\frac{1}{2}$ U. S. Gal.

Foaming Space of each tank - 1 U. S. Gal.

Oil Cooler

The oil cooler is installed outside of the engine cowling and is attached to the engine mount tubes. Air for the cooler enters through a scoop on the left hand side of each engine cowling and exits at the aft end of the scoop. The thermostatic oil temperature regulator, attached to each cooler, is correctly set at the factory and normally requires no attention.

Pressure Relief Valve

The oil pressure should be maintained within the limits set by the engine manufacturer. It is regulated by adjusting the oil pressure relief valve located on the right rear of the engine crankcase.

Oil Pressures - p.s.i.

Maximum - 70 Minimum Cruising - 50

Desired - 60 Minimum Idling - 15

Drain Plugs

Before filling the tanks, check to see that the drain plugs are lockwired in in the closed position.

Oil Lines

All lines are 5250 aluminum alloy tubing, connected with flexible tubing - AAF Type (Neoprene) and stainless steel clamps.

Oil Gages

The oil-in temperature and oil pressure gages are located on the Main Instrument Panel.

17741-2 OIL IN COOLER LINE
¾ O.D. x .049 x 11
AN 842-12D ELBOW
AN 884-12-12 HOSE CONNECTION
1⅛ IDEAL CLAMP (2)

17741-8 OIL "IN" COOLER LINE
CUT FROM AN 880-12
1⅛ D. IDEAL CLAMP
AN 842-12D ELBOW

50 OIL COOLER * U3150 UNITED AIRCRAFT PRODUCT
THERMOSTATIC RELIEF VALVE * U3255 TYPE D5 U.A.P.

AN 884-8-[illegible] HOSE CONNECTION L.H. ENGINE ONLY
⅞ IDEAL [illegible] AMP (2)

17734-2 L.H. ENGINE ONLY

17741-4 VENT LINE L.H. ENGINE
CUT FROM AN 880-10
17741-5 VENT LINE R.H. ENGINE
CUT FROM AN 880-10
1" D. IDEAL CLAMP (2)
AN 844-10D ELBOW L.H. ENGINE

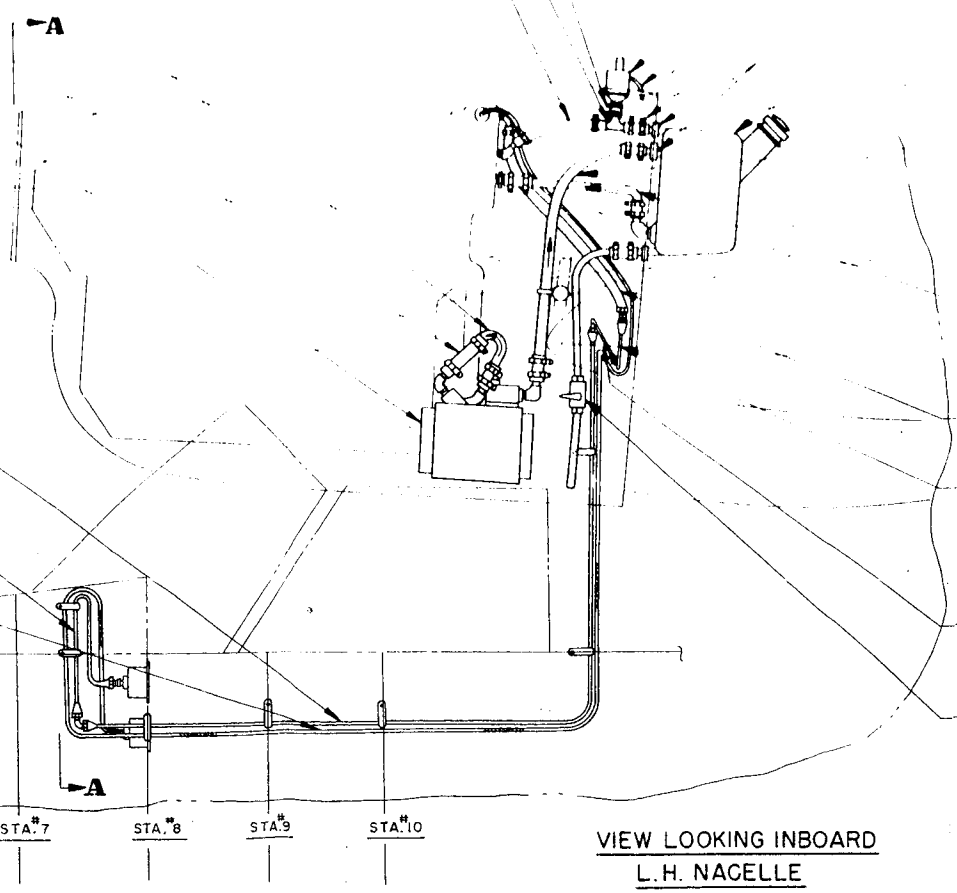
17734-1 SEPARATOR L.H. ENGINE ONLY

[illegible]-A-M PUMP L.H. ENGINE ONLY

AN 880-10-[illegible] HOSE CONNECTION L.H. ENGINE
1" D. IDEAL CLAMP (2)

AN 931-10-14 GROMMET (2)
AN 931-12-20 GROMMET

17605 OIL TANK 5.5 U.S. GALS. CAP



VIEW LOOKING INBOARD
L.H. NACELLE

17741-11 OIL PRESSURE LINE
¼ O.D. X .035 X 71
AN 821-4D ELBOW
AN 817-4D SLEEVE NUT (2)

17741-12 OIL PRESSURE LINE
¼ O.D. X .035 X 34
AN 815-4D UNION
AN 817-4D SLEEVE NUT (2)

OIL TEMPERATURE LINE - FLEXIBLE
* 2001-F X 14" U.S. GAGE CO.

17741-5 OIL "OUT" COOLER LINE - L.H. ENGINE
¾ O.D. x .049 x 29
17741-14 OIL "OUT" COOLER LINE - R.H. ENGINE
¾ O.D. x .049 x 40
1⅛ IDEAL CLAMP (4)
AN 842-12D ELBOW
AN 884-12-12 HOSE CONNECTION (2)

17741-1 OIL "IN" LINE
¾ O.D. X .049 X 16
AN 840-12D NIPPLE
AN 884-12-12 HOSE CONNECTION (2)
1⅛ D. IDEAL CLAMP (4)
AN 842-12D ELBOW

SP 771-10 FLEXO-TUBE
AN 822-4D ELBOW
AN 815-4D UNION

17741-13 OIL PRESSURE LINE - R.H. ENGINE
¼ O.D. X .035 X 28
17741-9 OIL PRESSURE LINE - L.H. ENGINE
¼ O.D. X .035 X 8
AN 817-4D SLEEVE NUT (2)
AN 821-4D ELBOW

17741-10 OIL PRESSURE LINE
¼ O.D. X .035 X 30
AN 817-4D SLEEVE NUT (2)
AN 821-4D ELBOW

PARKER DRAIN VALVE * 702-HB-10D
17741-6 OIL DRAIN LINE
⅝ O.D. X .049 X 13
AN 884-10-12 HOSE CONNECTION
1" D. IDEAL CLAMP (2)
17741-7 OIL DRAIN LINE
⅝ O.D. X .049 X 7

Figure 16—Oil System

AN 815-10-15 HOSE CONNECTION
1" D. IDEAL CLAMP (2)

AN 931-10-14 GROMMET (2)
AN 931-12-20 GROMMET

17603 OIL TANK 5.5 U.S. GALS. CAP

17741-5 OIL "OUT" COOLER LINE - L.H. ENGINE
3/4 O.D. X .049 X 29
17741-14 OIL "OUT" COOLER LINE R.H. ENGIN
3/4 O.D. X .049 X 40
1 1/8 IDEAL CLAMP (4)
AN 842-12D ELBOW
AN 884-12-12 HOSE CONNECTION (2)

17741-1 OIL "IN" LINE
3/4 O.D. X .049 X 16
AN 840-12D NIPPLE
AN 884-12-12 HOSE CONNECTION (2)
1 1/8 D. IDEAL CLAMP (4)
AN 842-12D ELBOW

SP 771-10 FLEXO-TUBE
AN 822-4D ELBOW
AN 815-4D UNION

17741-13 OIL PRESSURE LINE - R.H. ENGINE
1/4 O.D. X .035 X 28
17741-9 OIL PRESSURE LINE - L.H. ENGINE
1/4 O.D. X .035 X 8
AN 817-4D SLEEVE NUT (2)
AN 821-4D ELBOW

17741-10 OIL PRESSURE LINE
1/4 O.D. X .035 X 30
AN 817-4D SLEEVE NUT (2)
AN 821-4D ELBOW

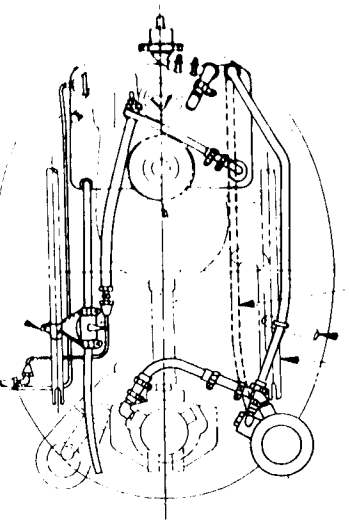
PARKER DRAIN VALVE * 702-HB-100
17741-6 OIL DRAIN LINE
5/8 O.D. X .049 X 13
AN 884-10-12 HOSE CONNECTION
1" D. IDEAL CLAMP (2)
17741-7 OIL DRAIN LINE
5/8 O.D. X .049 X 7

OKING INBOARD
NACELLE

17764 CLAMP

GAGE - OIL PRESSURE

GAGE - OIL TEMPERATURE



SECTION A-A

17741-13 OIL "OUT" COOLER LINE
R.H. ENGINE ONLY
3/4 O.D. X .049 X 40

17814 AIR INTAKE & EXHAUST (RE

17601 MOTOR MOUNT (REF.)

Figure 16—Oil System

D. ELECTRICAL SYSTEM

The electrical system consists of wiring, conduit, junction boxes, battery, generator with cut-out and control box, distribution panel and switch box, switches and lights. The system is a single wire ground return type supplied by a 12 volt battery and maintained by a generator. An outside power plug, for connecting an external power source, is installed on the bulkhead immediately aft of the pilot.

Wiring

All wiring is carried in conduit with junction boxes located at the distribution points thus providing a completely shielded circuit. Solid wall aluminum alloy tubing is used throughout except at light fixtures and special points where of necessity flexible tubing is employed. All connections are made with standard aluminum alloy conduit fittings. Wires are individually marked with identification numbers. Refer to the Electrical Wiring Diagram, herein, for proper connections at the junction box terminals.

Battery

The 12 volt, 34 ampere hour, Type S-34 battery is in a special container in the after section of the right hand engine nacelle. The Master Switch must be ON in order to operate any of the electrical units.

Generator

An Eclipse D-1-309-9 generator is installed on the right engine. The generator control box is installed beside the battery.

Operation of the volt-ammeter switch will show generator output and the condition of the battery.

Distribution Panel and Switch Box

The distribution panel and switch box, located on the lower left hand side of the Main Instrument Panel, contains the following:

Switches	Rheostats
Anchor	Compass
Navigation	Cockpit
Pitot Heat	
Generator	
Fuel Gage	
Landing Light	
Starter	

The panel also provides clearly identified housing for all fuses with their proper amperage plainly marked below each receptacle. Spare fuses and bulbs are stowed in holders fastened to the inner face of the door at the bottom of the switch and fuse box. To gain access to the interior of the box, turn the fasteners which secure the door.

Lights

Interior Lights

The Main Instrument Panel is indirectly illuminated by 2 Griff-Ho lights which are installed on the Upper Control Panel.

Separate lights are provided for the compass and Landing Gear Warning Indicator.

The cabin is illuminated by a dome light.

Exterior Lights

Anchor and Running Lights

The anchor light is installed at the top of the rudder. Wing running lights are installed on the right and left wing tips. A tail light is located on the trailing edge of the rudder.

Landing Light

A Grimes ST-250 motor operated landing light is located in the lower surface of the left outboard wing panel. This light is controlled by a four position switch on the Electrical Panel. The switch positions are OPEN, LIGHT, RETRACT, and OFF.

The gear box and the packing in the two hollow gear shafts should be lubricated with 10-15 drops of Pyroil every 50 flight hours.

The lamp should not be burned continuously for more than ten minutes at any one time. Operation for longer periods may cause the light to smoke the reflector. Replace the lamp after 100 hours total burning time as its efficiency decreases rapidly after this period. The silver reflector should be cleaned only with cotton saturated with kerosene, then dried thoroughly with the same material.

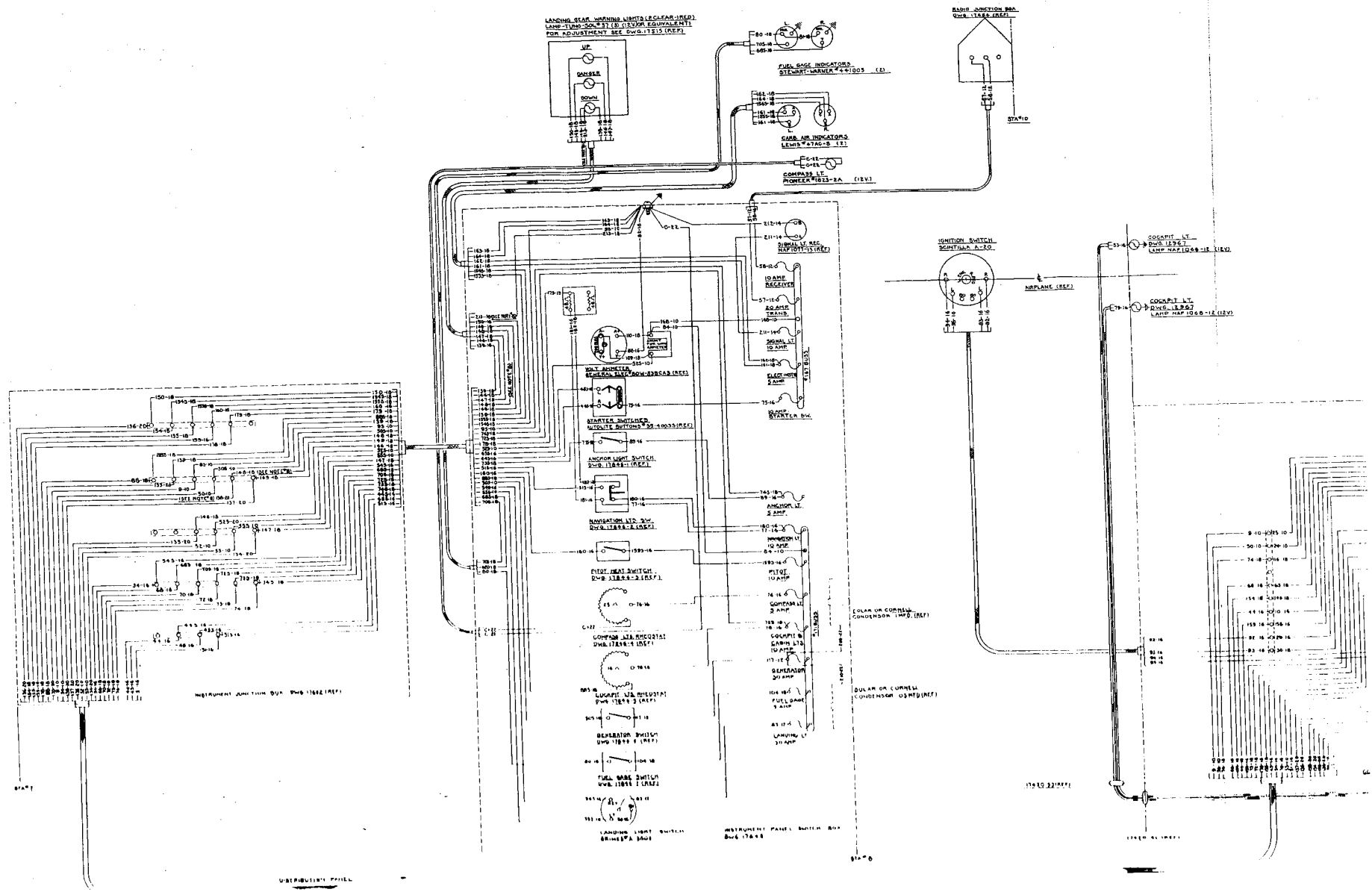
Maintenance

Do not use acid core solder on the system wires or bonding. A rosin core solder should be used under all circumstances. Be sure to replace all bonding wires. Paint or other protective finish should be removed before bonding and soldering.

Keep battery terminals clean and coat with a corrosion resistant grease.

LIGHT BULB CHART

NAME	TYPE	BULB TYPE	VOLTAGE	CANDLE POWER	BASE TYPE	BASE CONTACT	FINISH
Anchor	NAF1068-13	G.E. Mazda #89	12-16	6	Candelabra Bayonet	Single	Clear
Cabin	NAF1068-15	G.E. Mazda #1141	12-16	21	Candelabra Bayonet	Single	Clear
Compass		Kollsman 71A-02	3		Candelabra Bayonet	Single	Clear
Griff-Ho (2)	NAF1068-12	G.E. Mazda #67	12-16	3	Candelabra Bayonet	Single	Clear
Landing Light		Grimes B1171			Candelabra Bayonet	Single	Clear
Tail		G.E. Mazda #93			Candelabra Bayonet	Single	Clear
L.G. Warning Lights (3)		Tung Sol #G-4½		1½	Miniature Bayonet	Single	2 Clear 1 Red
Wing Running Lights (2)		Grimes 1512		21	Candelabra Bayonet	Single	Clear


LANDING GEAR WARNING LIGHTS (2 CLEAR-IRED) LAMP-TUNG-SOL #37 (8 (12) VOLT EQUIVALENT) FOR ADJUSTMENT SEE DWG-17515 (REF)
UP
DANGER
DOWN
FUEL GAGE INDICATORS STEWART-WARNER #44-1005 (2)
CARB AIR INDICATORS LEWIS #47AG-5 (2)
COMPASS LT. PIONEER #823-2A (12V)
RADIO JUNCTION BOX DWG. 17884 (REF)
STA #10
IGNITION SWITCH SCINTILLA A-20
AIRPLANE (REF)
COCKPIT LT. DWG. 12967 LAMP NAF 1068-12 (12V)
COCKPIT LT. DWG. 12967 LAMP NAF 1068-12 (12V)
SIGNAL LT. REC. NAF 1077-15 (REF)
10 AMP RECEIVER
40 AMP TRANS.
SIGNAL LT. 10 AMP
ELECT HORN 5 AMP
10 AMP STARTER SW.
VOLT AMMETER GENERAL ELECT #DW-83BCA3 (REF)
STARTER SWITCH AUTOLITE BUTTON #SB-40033 (REF)
ANCHOR LIGHT SWITCH DWG. 17884-1 (REF)
NAVIGATION LTS. SW. DWG. 17884-2 (REF)
PITOT HEAT SWITCH DWG. 17884-3 (REF)
COMPASS LTS RHEOSTAT DWG. 17884-4 (REF)
COCKPIT LTS RHEOSTAT DWG. 17884-5 (REF)
GENERATOR SWITCH DWG. 17884-6 (REF)
FUEL GAGE SWITCH DWG. 17884-7 (REF)
LANDING LIGHT SWITCH GRIMES #A-8002
ANCHOR LT. 5 AMP
NAVIGATION LT. 10 AMP
PITOT 10 AMP
COMPASS LT. 3 AMP
COCKPIT & CABIN LTS. 10 AMP
GENERATOR 30 AMP
FUEL GAGE 3 AMP
LANDING LT. 30 AMP
SOLAR OR CORNELL CONDENSOR (MFD. (REF)
SOLAR OR CORNELL CONDENSOR (MFD. (REF)
INSTRUMENT JUNCTION BOX DWG 17882 (REF)
INSTRUMENT PANEL SWITCH BOX DWG 17848
DISTRIBUTION PANEL
START

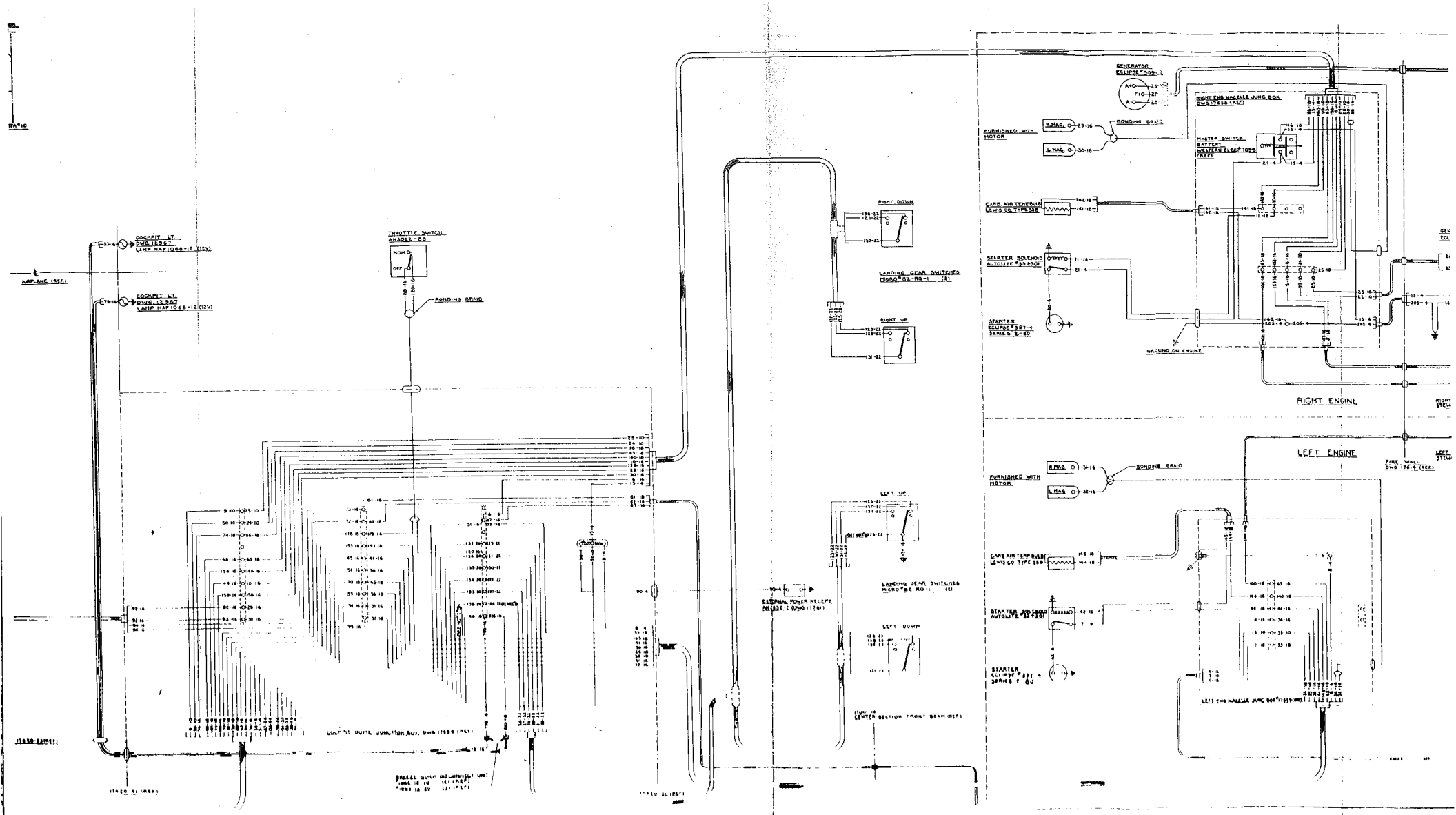


Figure 17 — Electrical Wiring Diagram

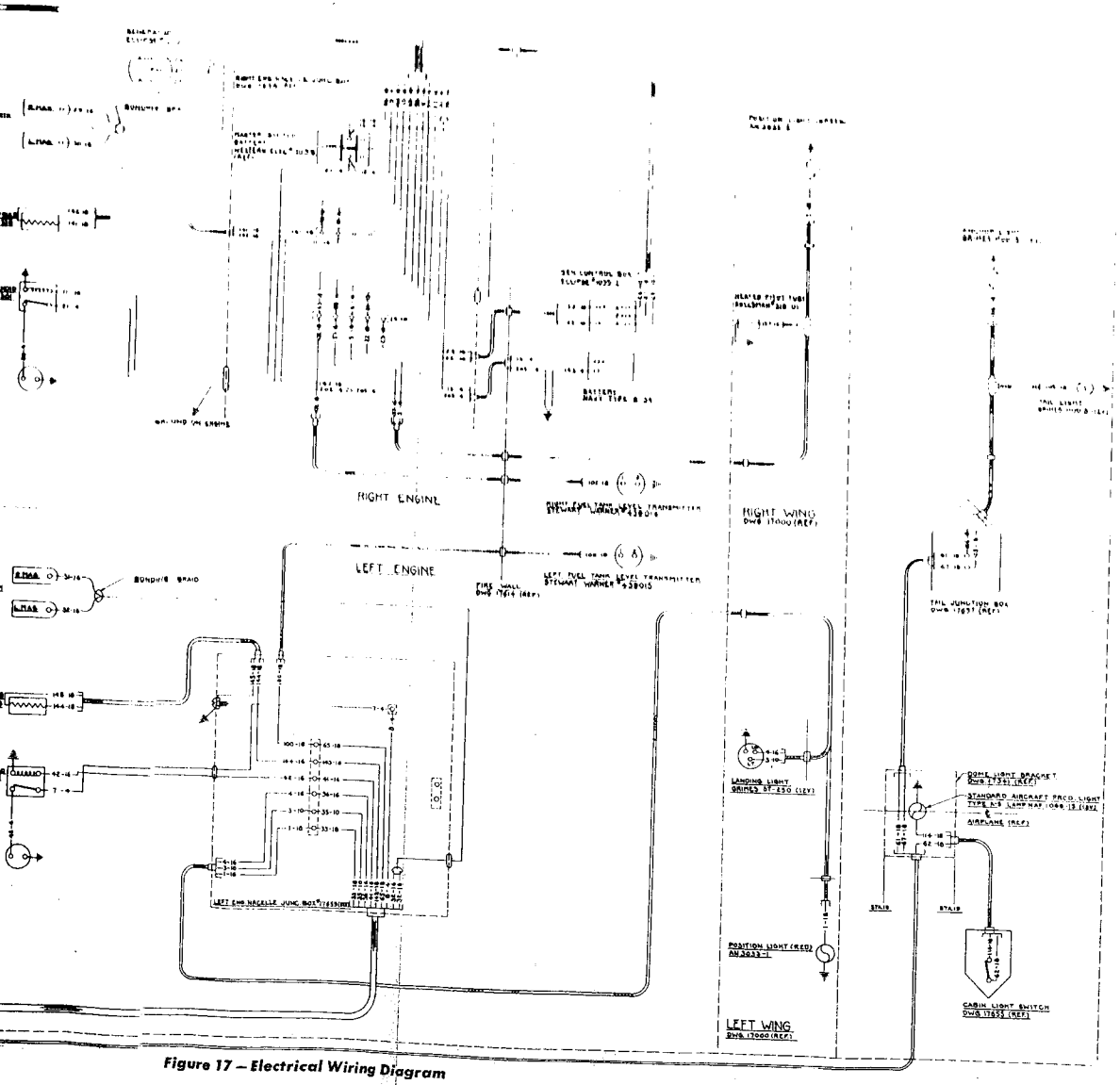
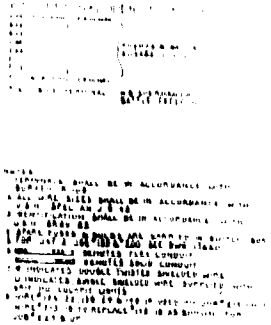
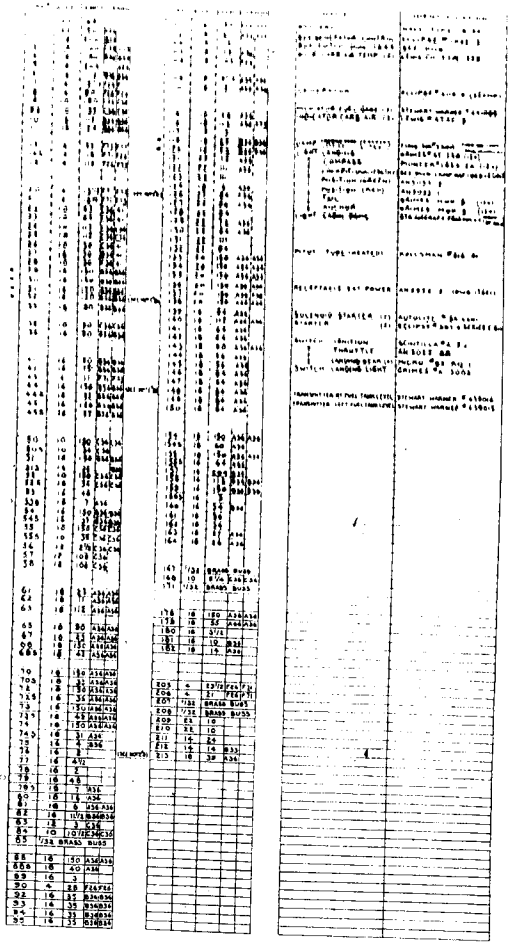


Figure 17 – Electrical Wiring Diagram





WIRING DIAGRAM

E. INSTRUMENTS

The flight and engine instruments, except the hydraulic pressure gage on the Upper Control Panel, are located on the Main Instrument Panel. The following instruments and equipment are installed in the airplane:

Airspeed Indicator	Kollsman	657BK-08
	Pioneer	1426-1AE-A1
Altimeter	Kollsman	K671BK-010
	Pioneer	1555-2J-A
Rate of Climb Indicator	Kollsman	613K-023
	Pioneer	1634-1M-A1
Turn and Bank Indicator	Eclipse	1722-1AR-B1
	Pioneer	1722-2V-A2
Clock	Eclipse	3310-2A-A
	Pioneer	3310-2A-A
Suction Gauge	Kollsman	9702
	U. S. Gauge	AW-1-7/8-21H
Tachometer	Kollsman	218-01
	Pioneer	2000-2B-C1
Manifold Pressure Gauge	Kollsman	788X-02
	U. S. Gauge	AW-2-3/4-14C
Oil Pressure Gauge	Manning, Maxwell & Moore	6711-17
	U. S. Gauge	AW1-7/8-14AX
Fuel Pressure Gauge	Manning, Maxwell & Moore	6711-20
	U. S. Gauge	AW-17/8-15Q
Oil Temperature Gauge	Manning, Maxwell & Moore	6642-30
	U. S. Gauge	AW-1-7/8-20S
Hydraulic Pressure Gauge	Manning, Maxwell & Moore	6930-236
	U. S. Gauge	AW-1-7/8-17BL
Volt-Ammeter	Western	506
Compass	Kollsman	758
Pitot Tube	Kollsman	518B-01

The altimeter and the climb indicator are vented into the airspeed static line.

A non-magnetic srew-driver, for the adjustment of the compass, is mounted on the inner face of the bottom door of the electrical switch and fuse box.

Vacuum System

The engine driven Type B-2A vacuum pump, installed on the left engine, operates the Turn & Bank Indicator. The instrument line is connected to a suction regulating valve located forward of the instrument panel which maintains a constant load of approximately 2" Hg. necessary for the proper functioning of this unit. A check valve is installed in the line, immediately forward of the firewall. The pressure lead from the pump is connected to a centrifugal oil separator mounted above the pump which returns the oil to the engine crankcase and exhausts the air combined with the remaining oil vapor through the louvre at the top of the nacelle.

Maintenance

Remove and clean the oil separator with gasoline every 200 hours. The screen in the Turn and Bank instrument should be kept free of dust to insure proper operation.

Inspect the Lord mounting bushings on the instrument panel periodically and replace before appreciable deterioration has taken place.

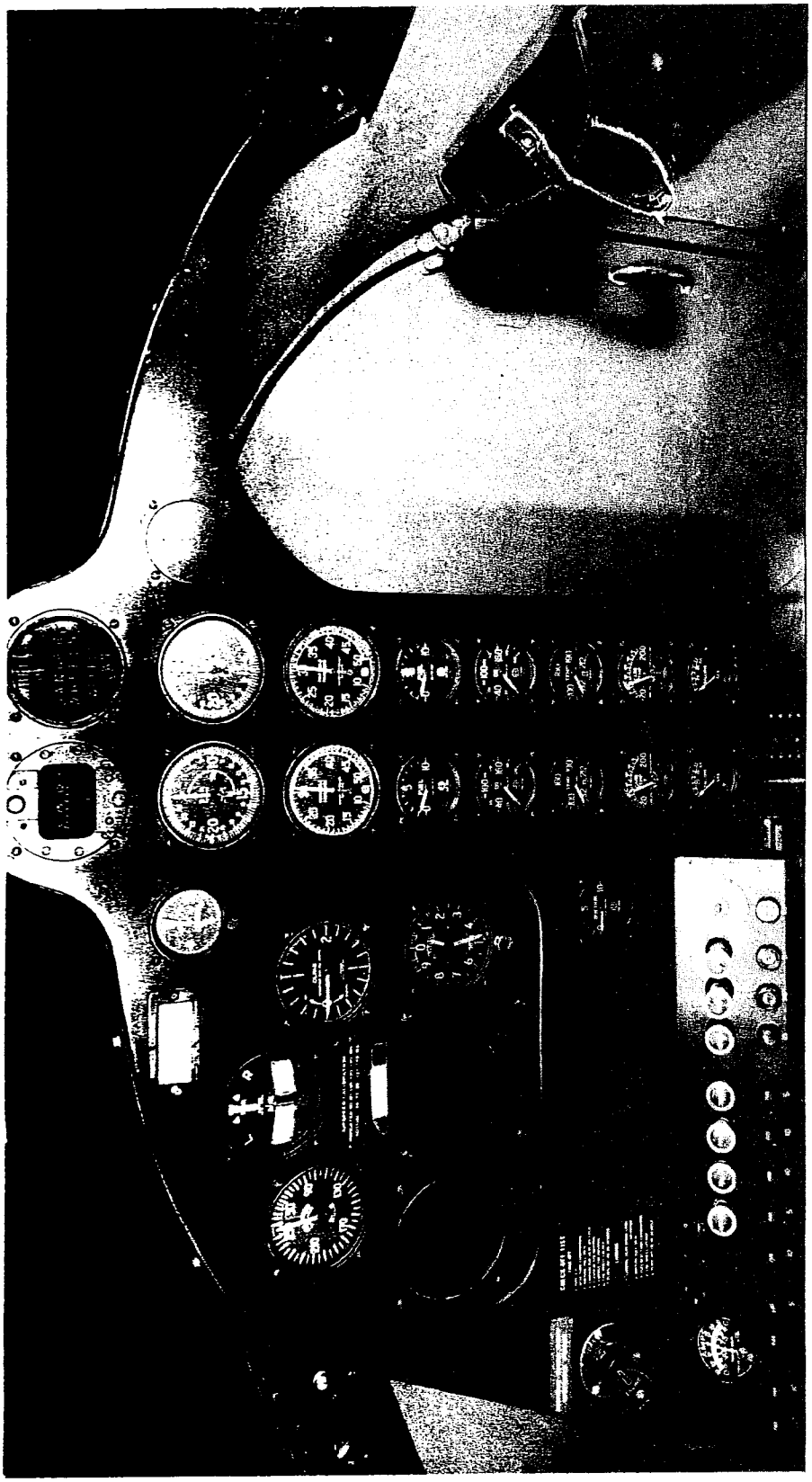


Figure 18 – Main Instrument Panel

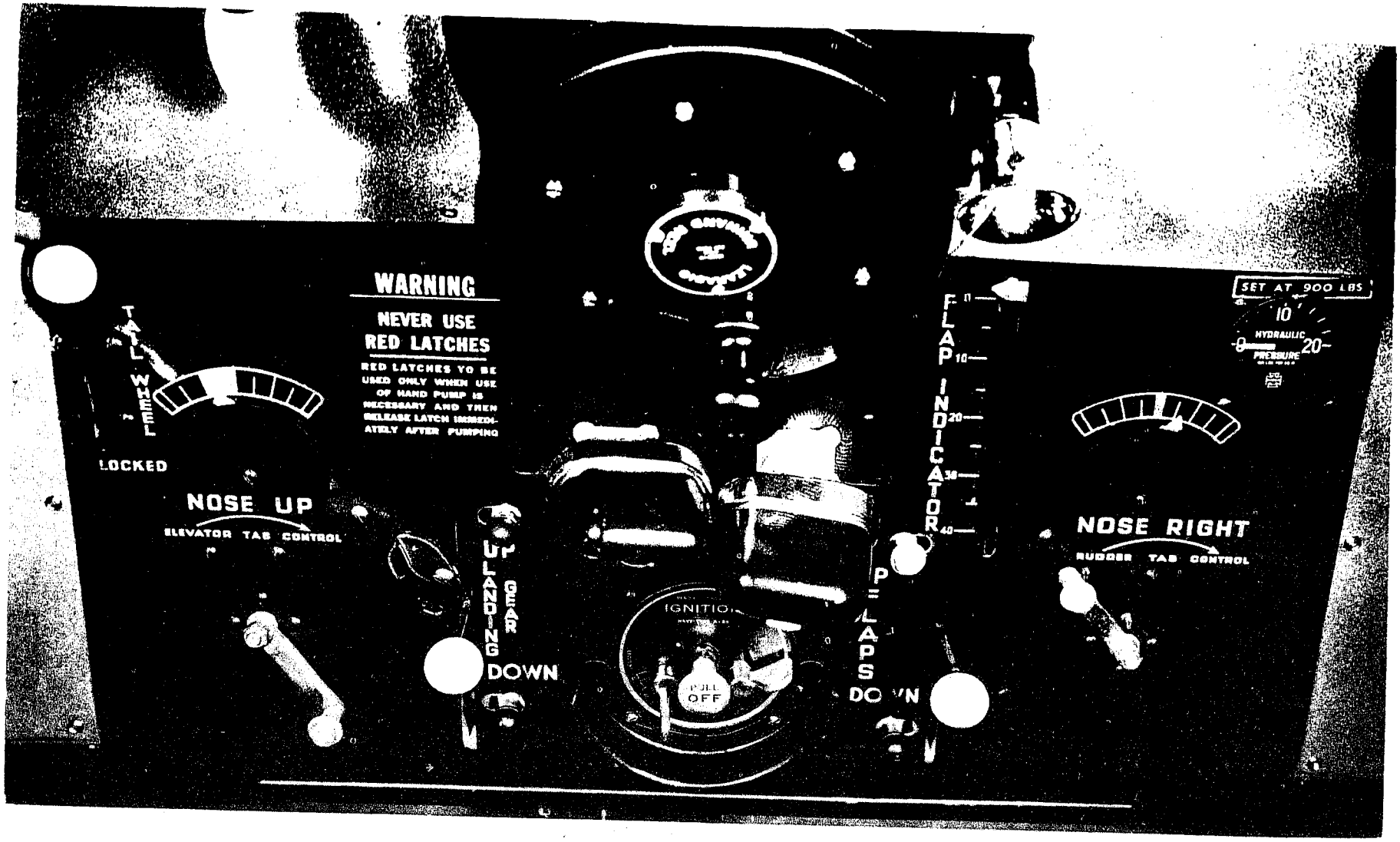


Figure 19 — Upper Control Panel

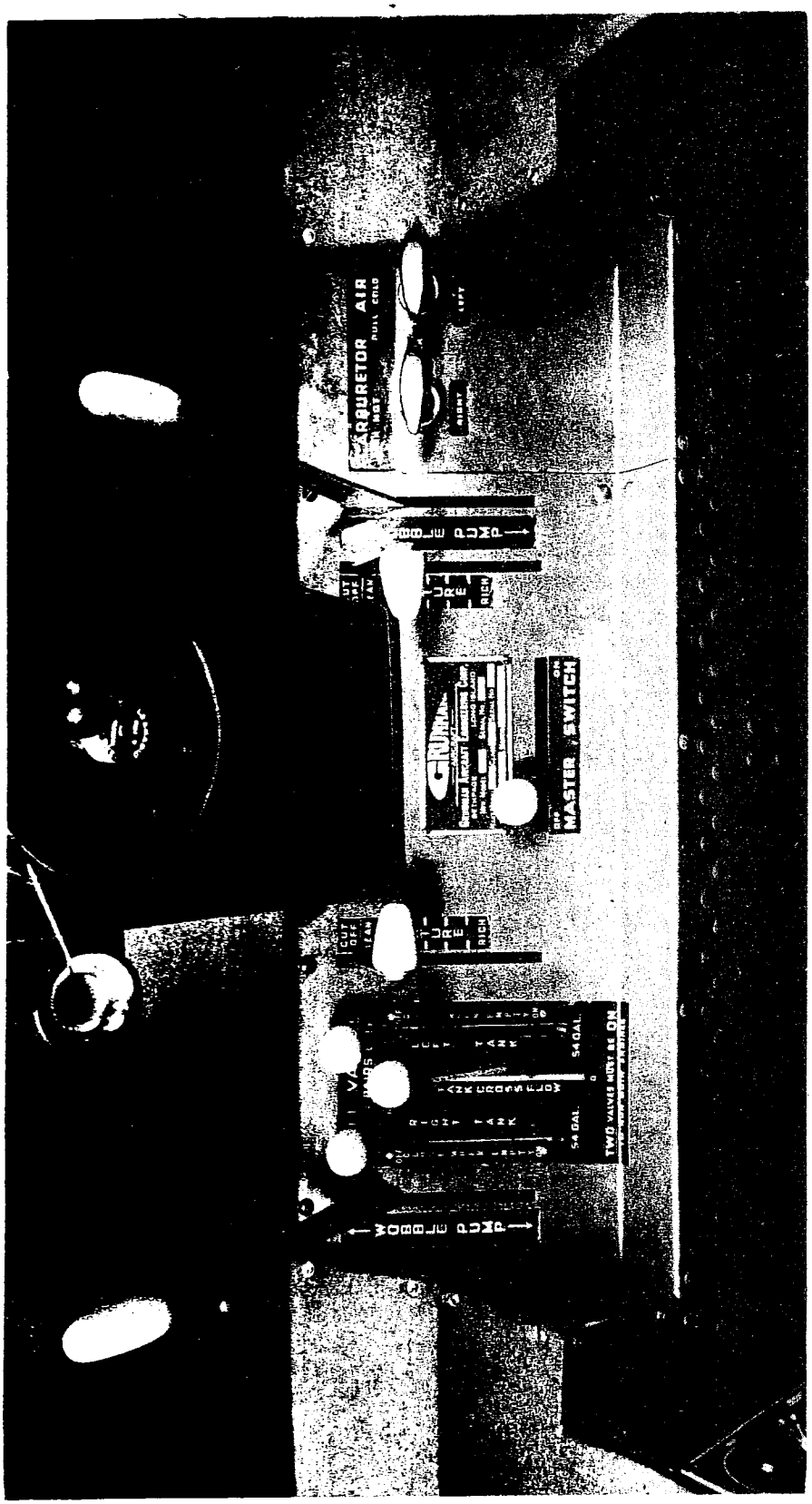


Figure 20 — Upper Rear Control Panel

F. HYDRAULIC SYSTEM

The Hydraulic System consists of fluid, fluid reservoir, an engine driven pressure pump, hand emergency pump, two check valves, relief valve, two selector valves, restrictor, filter, actuating cylinders, solid wall tubing, flexible hose assemblies and a pressure gage.

Fluid

The fluid used in this system is MINERAL OIL (red color), Spec. M-339. The fluid reservoir is located in the left engine nacelle aft of the firewall and the capacity is approximately 3/4 U. S. gal.

Pump

The fluid is circulated steadily by the Pesco engine driven pump which is attached to the generator drive of the left engine. Should the pump fail or if the engine is not operating, the emergency hand pump, located on the floor at the left of the pilot's seat, is used to supply pressure when operating the various actuating cylinders. Approximately twenty-four (24) cycles of the hand pump are required to operate the landing gear.

Pressure Relief By-Pass Valve

The system pressure relief by-pass valve, located behind the Upper Control Panel, is set to open at approximately 950 p.s.i.

Selector Valves

These units are directional valves which determine the end of the particular cylinder which shall receive pressure, and that which shall be exhausted; i.e., in which direction the piston will be moved. The wing flap control valve is mounted at the right hand side of the Upper Control Panel and the landing gear control valve on the left hand side. These valves are connected in series with the main hydraulic line.

The landing gear valve is a four port, two-way unit operating the main wheels and tail wheel actuating cylinders. In the NEUTRAL position, there is free flow

through the valve. In the DOWN position, the pressure is directed to actuate the cylinders; the oil from the free side of the actuating piston being returned to the hydraulic fluid reservoir. In the UP position, the pressure is directed to raise the landing gear, again returning the oil on the non-pressure side of the piston to the fluid reservoir.

The flap valve is a three port, one-way unit. In the NEUTRAL position, there is free flow through the valve. In the DOWN position, the pressure is directed to lower the flaps; and since these actuating cylinders are single acting, there is no oil return to the reservoir during this action. In the UP position, there is again free flow through the valve, and the flap cylinder port is open thus permitting the spring return action of the actuating cylinders to return the oil to the reservoir as the flaps retract.

In order to prevent too rapid retraction of the flaps, there is a restricting orifice installed in the flap port; however, under pressure during the lowering of the flaps, the action is rapid.

In normal operation, the time to complete the raising or lowering of either flaps or landing gear is so short that there is no need to latch the valve handles in the operating position; however, latches are provided to retain the handles when emergency conditions require use of the hand pump, thus freeing the pilot's hand. These latches should NOT be left on after the completion of the operation or while the engine pump is running. In the case of the landing gear valve, this would prevent flow to the flap valve thus making it inoperative. In the case of the flap valve, this would throw back pressure to the landing gear valve resulting in uncertain and erratic operation of both main wheels and tail wheel.

The exception to the above statements is the UP latch on the flap valve handle. This is normally used when retracting the flaps on the ground and does not subject the system to pressure.

Check Valves

Two check valves are installed in the system; one, located in the ceiling at the rear of the pilot's compartment, isolates the engine driven pump in case it becomes inoperative; and the second, located under the cockpit flooring at the hand pump, isolates the pump.

Filter

A Puralator strainer, located in the left engine nacelle near the engine driven hydraulic pump, is connected into the pressure line between the pump and the pump check valve.

The filter is cleaned by turning the handle thus removing sludge and dirty oil from the strainer without allowing air to enter the hydraulic system. Two complete turns should be made every twenty hours.

Lines

The lines throughout the system are solid wall aluminum alloy tubing except at the actuating cylinders and the engine driven pump, where flexible hose assemblies are used to allow for movement of the units. The screw thread on all fittings is AC standard.

Pressure Gage

The hydraulic system gage is located on the right hand side of the Upper Control Panel. The gage registers the system pressure, 950 p.s.i.

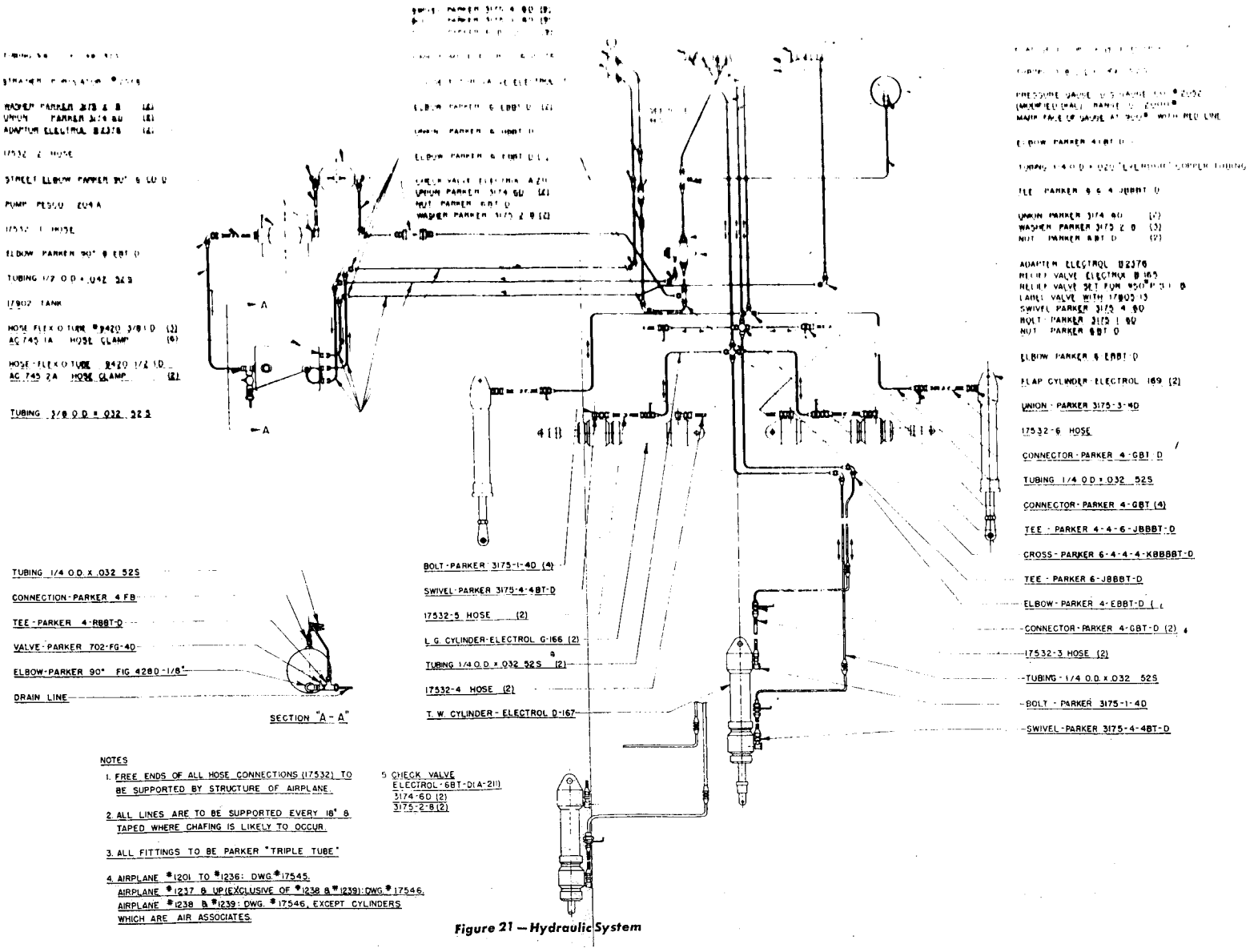
Actuating Cylinders

The actuating cylinders are of the single and double acting types as follows:

	Electrol Part No.	Quantity	Type
Landing Gear	166	(2)	Double Acting
Tail Wheel	167	(1)	Double Acting
Wing Flaps	169	(2)	Single Acting
			Single Acting (Flap returned to UP position by a spring within the operating cylinders.)

Seals and Packings

Item	Electrol Part No.	Quantity	Seal or Packing
Main Wheels Cylinder	166	4	Seal ELB50-6
		4	Packing ELB6-16A
		4	Packing ELB6-10A
Tail Wheel Cylinder	167	2	Seal ELB50-6
		2	Packing ELB6-16A
		3	Packing ELB6-10A
Wing Flap Cylinder	169	2	Seal ELB14-21
		4	Packing ELB6-12A
Pressure Relief Valve	165	1	Seal ELB14-21
		1	Packing ELB14-11
		1	Seal ELB50-12
Landing Gear Selector Valve	171	3	Seal A-2514
		5	Seal A-2250
		5	Seal ELB14-13
		5	Seal A-2482
Wing Flap Selector Valve	170	2	Seal A-2514
		2	Seal ELB14-13
		2	Seal A-2482
		2	Seal A-2250
Hand Pump	176	1	Seal A-2496
		1	Packing AN6227-15



NOTES

1. FREE ENDS OF ALL HOSE CONNECTIONS (17532) TO BE SUPPORTED BY STRUCTURE OF AIRPLANE.
2. ALL LINES ARE TO BE SUPPORTED EVERY 18" & TAPED WHERE CHAFING IS LIKELY TO OCCUR.
3. ALL FITTINGS TO BE PARKER "TRIPLE TUBE"
4. AIRPLANE #1201 TO #1236: DWG. #17545.
   AIRPLANE #1237 & UP (EXCLUSIVE OF #1238 & #1239): DWG. #17546.
   AIRPLANE #1238 & #1239: DWG. #17546, EXCEPT CYLINDERS WHICH ARE AIR ASSOCIATES.
5. CHECK VALVE ELECTROL-6BT-D(A-211) 3174-6D (2) 3175-2-8 (2)

Figure 21 — Hydraulic System

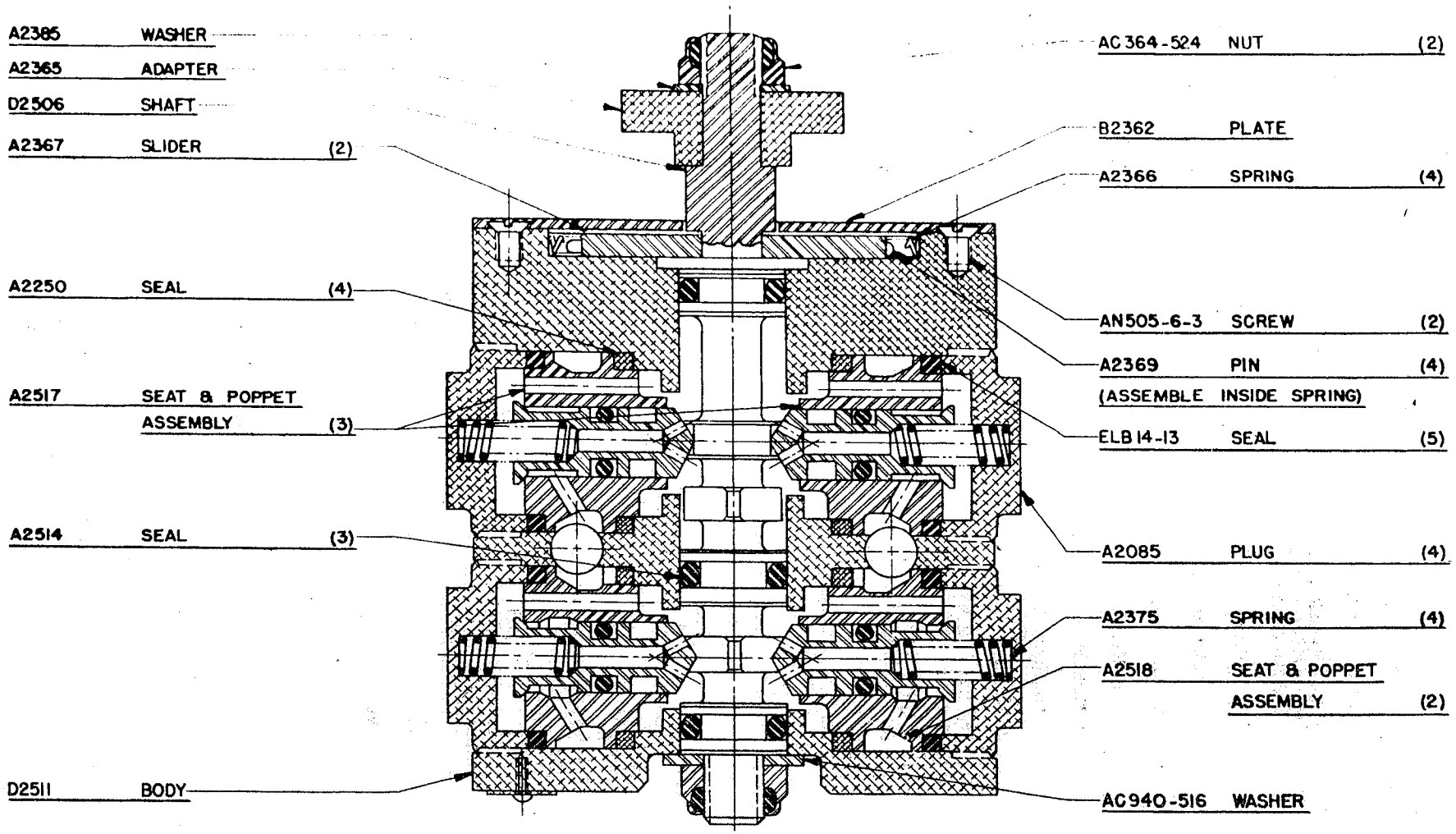


Figure 22 — Landing Gear Selector Valve

56.

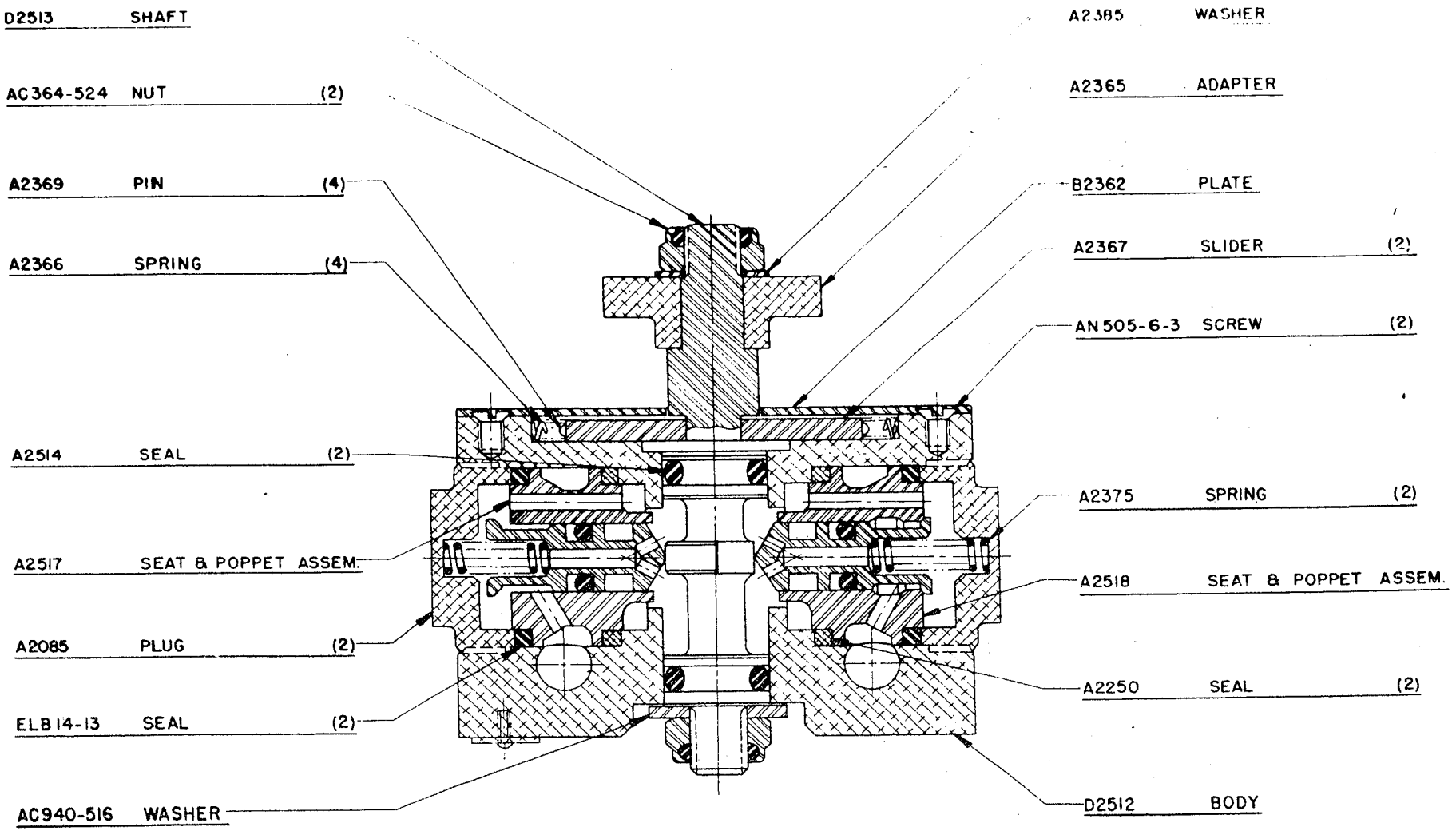
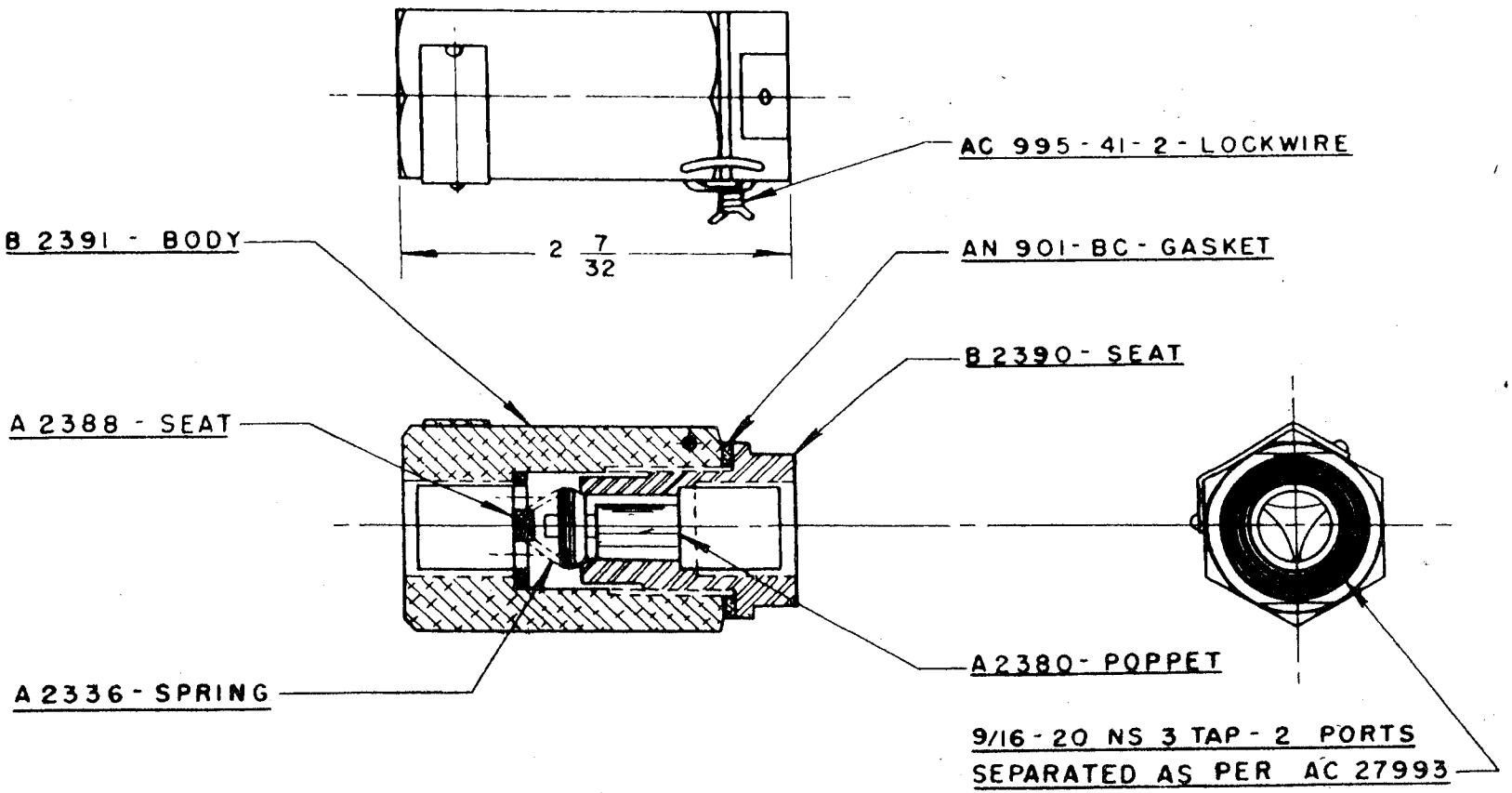
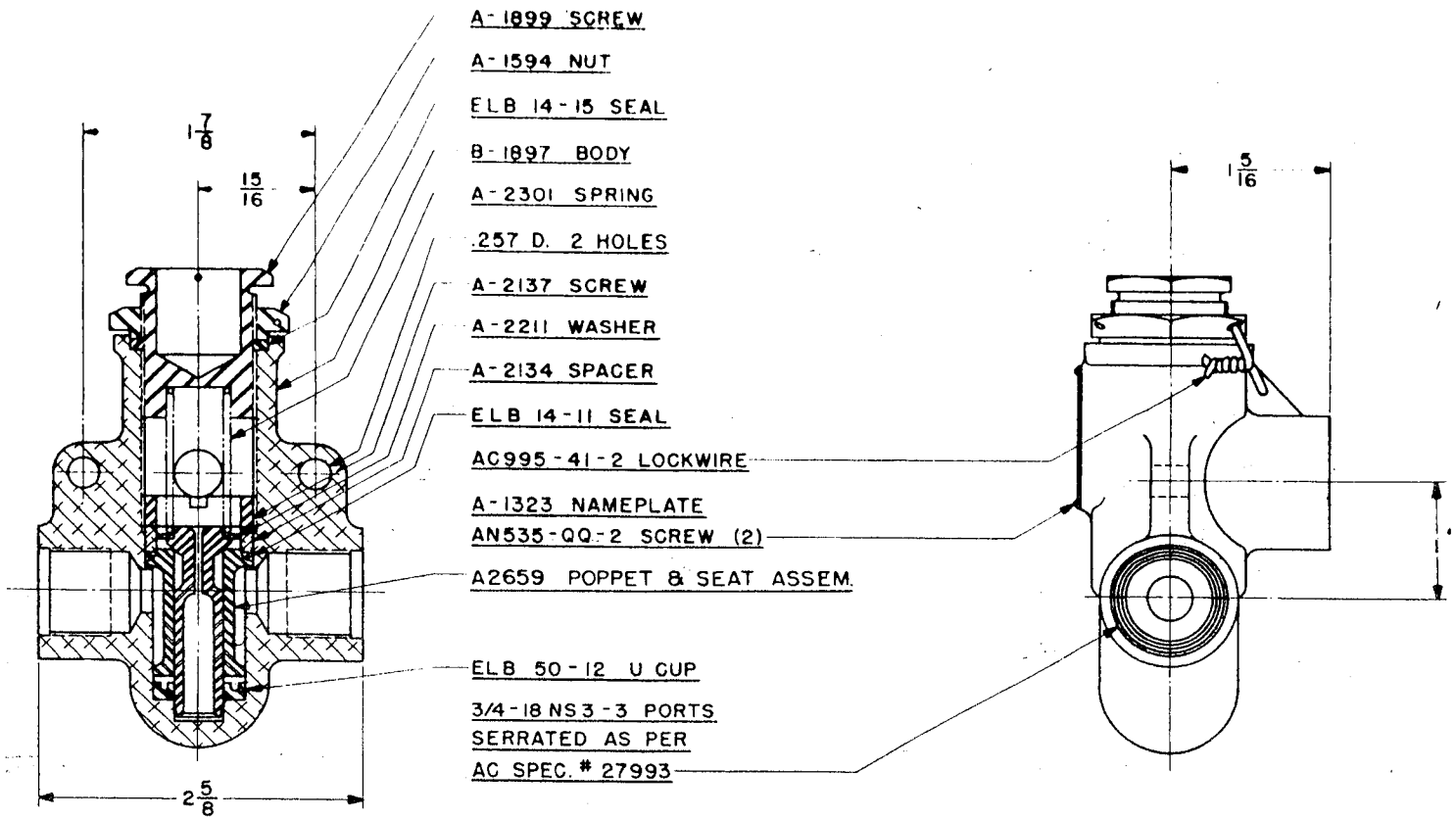


Figure 23 — Wing Flap Selector Valve



NOTE:
PROOF PRESSURE 2250 P.S.I.
BURST PRESSURE TO EXCEED 3,750 P.S.I.

Figure 24 — Check Valve

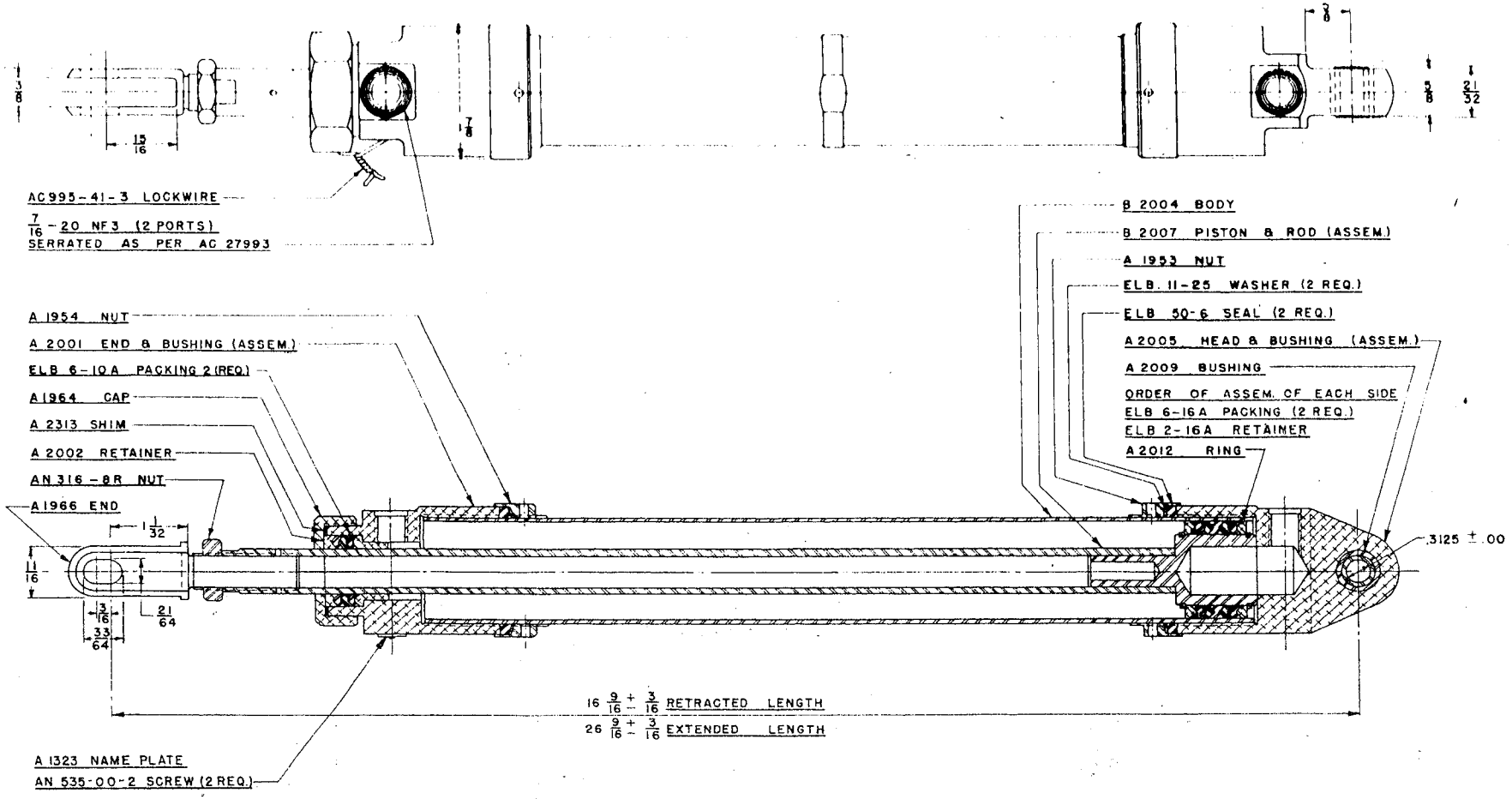


NOTE:

OPERATING PRESSURE = 1000 P.S.I.
PROOF PRESSURE = 1500 P.S.I.
BURST PRESSURE TO EXCEED 2500 P.S.I.
PRESSURE RELIEF SET AT 950 P.S.I.

REFERENCE ELECTROL DRAWING NO. 165
REFERENCE GRUMMAN DRAWING NO. 17805-13

Figure 25 — Main Pressure Relief Valve



NOTE:

STROKE - 10 1/16
OPERATING PRESS. = 1000 P.S.I.
PROOF PRESS. = 1500 P.S.I.
MADE BY ELECTROL, NO. 166

Figure 26 — Main Wheels Actuating Cylinders

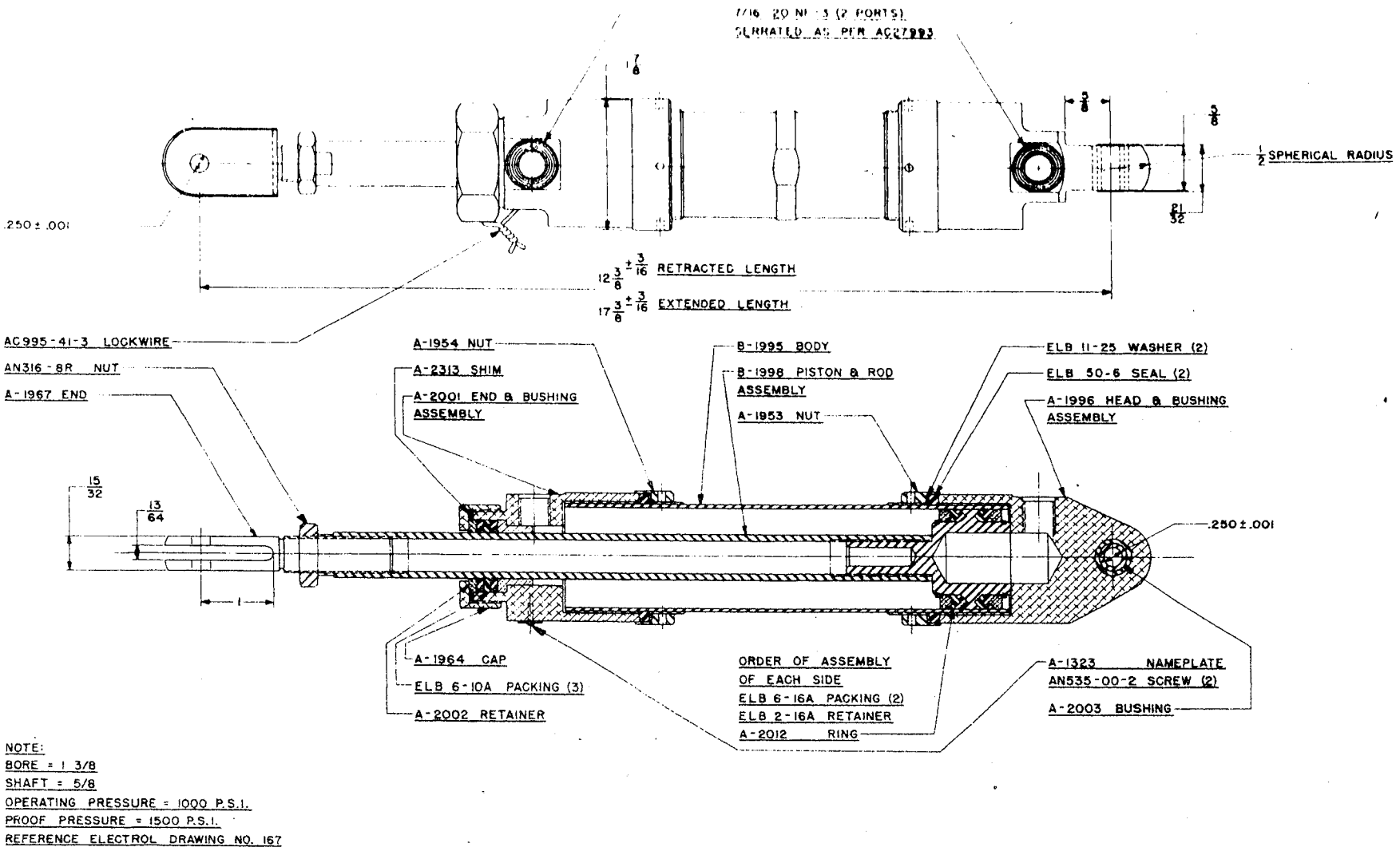
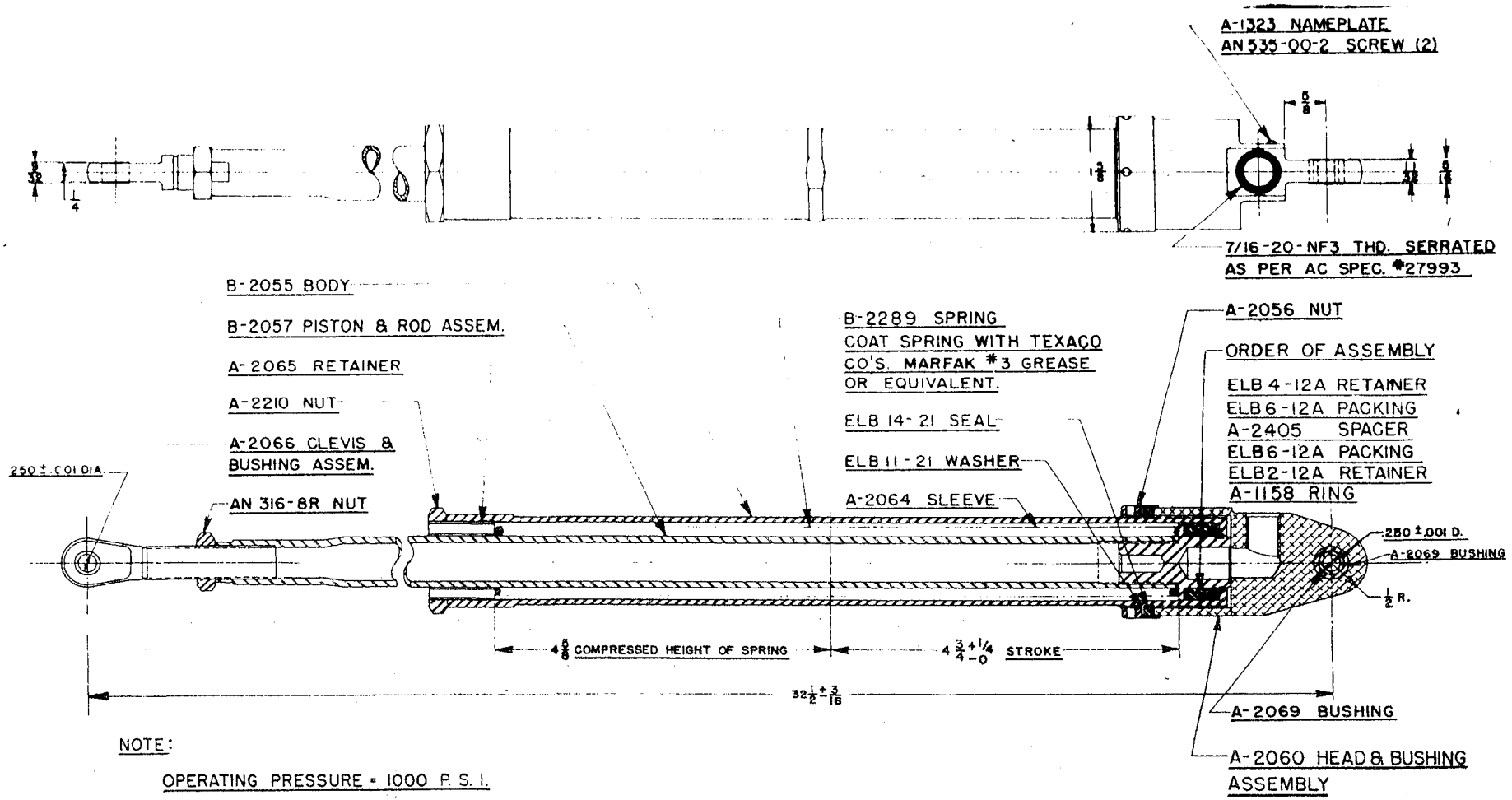


Figure 27 — Tail Wheel Retracting Cylinder



NOTE:

OPERATING PRESSURE = 1000 P. S. I.

PROOF TEST PRESSURE = 1500 P. S. I.

ELECTROL REF. NO. 169.

Figure 28 — Wing Flap Cylinder

G. LANDING GEAR

This airplane is equipped with hydraulically operated Main and Tail Wheels which are retracted or extended simultaneously by double acting hydraulic cylinders. The operating pressure is supplied normally by the engine driven hydraulic pump or by the hydraulic hand pump for emergency operation. The landing gear consists of the main wheels, tail wheel, shock struts, actuating cylinders and cockpit controls.

1. Main Wheels

Normal Operation

The Main and Tail Wheels are retracted or extended by manual operation of the control lever on the Upper Control Panel.

LEVER UP - WHEELS RETRACT

LEVER CENTER - NEUTRAL

LEVER DOWN - WHEELS EXTEND

Time Required to Raise - approx. 6 sec. (at flight RPM)

Time Required to Lower - approx. 6 sec. (at flight RPM)

Emergency Operation

In the event that the engine driven pump is not operating, the Main and Tail Wheels may be raised or lowered by operating the hydraulic hand pump - approximately 24 strokes are required to retract or extend the landing gear. Two red thumb latches are provided at the right of the lever slot to lock the landing gear control lever in the desired operating position, enabling the pilot to have one hand free if hand pump operation is needed.

CAUTION: THE RED LATCHES SHOULD BE USED ONLY WHEN OPERATING THE HAND PUMP AND RELEASED IMMEDIATELY AFTER PUMPING, OTHERWISE, THERE IS NO FLOW THROUGH THE VALVES AND UNRELIABLE OPERATION OCCURS.

Time Required to Raise Wheels - Approx. 30 Sec.

Time Required to Lower Wheels - Approx. 30 Sec.

Safety Devices

Inspection Windows

Located at the top of each wheel pocket. The hinged covers of the wheel pockets may be raised for complete inspection.

Warning Instrument

This instrument, designed to help prevent inadvertent landings with the Landing Gear in the incorrect position, is located at the top center of the Main Instrument Panel. The signal lights when the right engine is throttled below 1550 RPM. In the event that the wheels are neither completely UP or DOWN - DANGER WHEELS is lighted; if the wheels are in the retracted position - WHEELS UP is lighted, and if they are DOWN - WHEELS DOWN is lighted.

Landing Gear Latches

Spring actuated latches are installed on the main wheels and tail wheel assemblies as a precaution against their inadvertent retraction while on the ground. Inspect the latches frequently to make sure that they are functioning properly and are protected by a coating of corrosion resistant grease. The latter is very important in salt water operation because of the corrosive action of the salt.

Wheels, Tires and Brakes

The main wheels are 7.5" x 10" Hayes #G-3-45A, the tires are 7.5" x 10" - 6 ply, heavy duty and the brakes Hayes #G-2-201 Expander Tube.

Warning Light Adjustment

The Landing Gear Position Indicator Lights are operated by a micro-switch and cable system located under the upholstery on the aft side of each wheel pocket.

The micro-switches should be set by their adjusting nuts so that the Wheels Up or Wheels Down Light comes on just as the landing gear latches close. Note that during retraction the cable will travel approximately one-half inch before the latches open. It is permissible that the Wheels Down Light may continue to show during the first one-eighth inch (1/8") of this motion provided that, while the wheels are lowering, it does not come on before the latches snap shut.

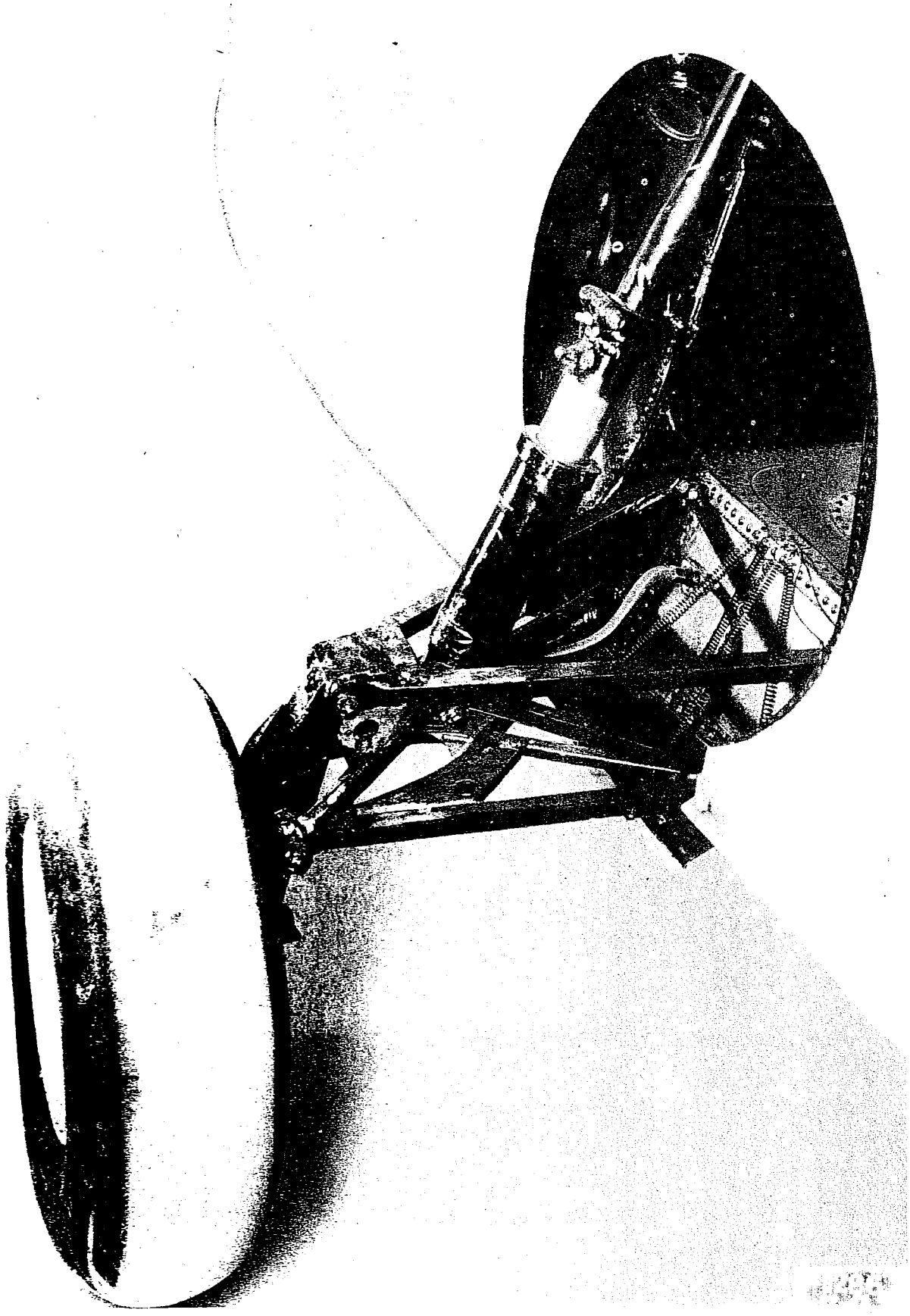


Figure 29 — Main Wheels — Fully Extended

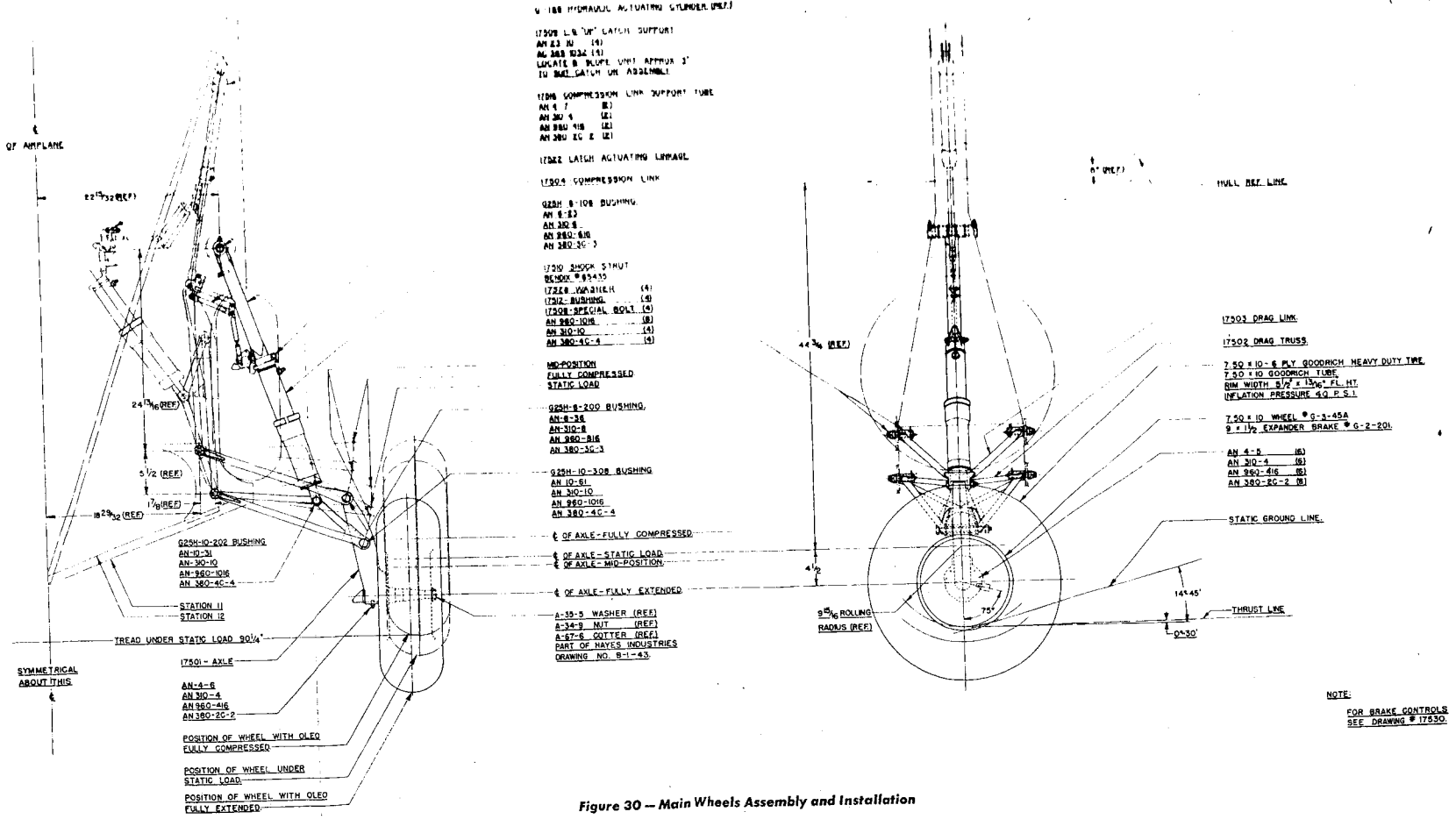


Figure 30 — Main Wheels Assembly and Installation

2. Tail Wheel

The tail wheel is the self-aligning full swivel type, fitted with a controllable caster lock mechanism, a Bendix Pneudraulic Shock Strut and a Goodrich 10" - 6 ply pneumatic tire on a Hayes #B-3-127 wheel.

The tail wheel assembly is installed as a unit to the fittings provided. To perform this operation the tail of the airplane should be supported at the rear hull bulkhead, Station #22.

Operation

The tail wheel unit is retracted or extended simultaneously with the main wheels by the double-acting hydraulic cylinder which is controlled by the landing gear selector valve. This motion is accomplished by means of a chain which runs over a sprocket fitted to a compression link and attaches at both ends to a bellcrank. The bellcrank is actuated by the hydraulic cylinder.

An automatic spring loaded hook type latch locks the strut when closed thus preventing the possibility of wheel retraction during landing or take-off. No separate control is required for the latch, as it automatically disengages during the initial movement of the retracting mechanism.

Caster Lock

The tail wheel drag link is equipped with a lockpin which locks the 360° swivel type caster in the trailing position. The lockpin is controlled by a cable from the lever at the left hand side of the Upper Control Panel.

LEVER UP - CASTER UNLOCKED

LEVER DOWN - CASTER LOCKED

The primary purpose of the lock is to reduce the possibility of ground looping in landing. The lock also assists in taxiing cross-wind and up and down steep ramps.

Lubrication

Refer to the Lubrication Chart, herein, for points of lubrication and lubricants to be used.

A plate covered opening in the upper forward section of the tail wheel pocket affords access for inspection and lubrication.

Adjustment

After installing the tail wheel assembly in the hull and/or after changing the operating chain, the following adjustment is recommended:

1. Disconnect piston rod from bellcrank and push FULL IN, bottoming in the cylinder.
2. Rotate bellcrank until tail wheel is locked FULL DOWN.
3. Adjust the chain turnbuckles until the bellcrank bolt hole is 1/16" forward of the bolt hole in the piston rod.
4. Pull piston rod forward 1/16" and insert bolt through bellcrank and piston rod.
5. With tail wheel in mid-position have chain adjusted until just snug.

NOTE: This 1/16" cylinder adjustment permits the tail wheel to lock in the FULL DOWN position while the piston still has 1/16" movement.

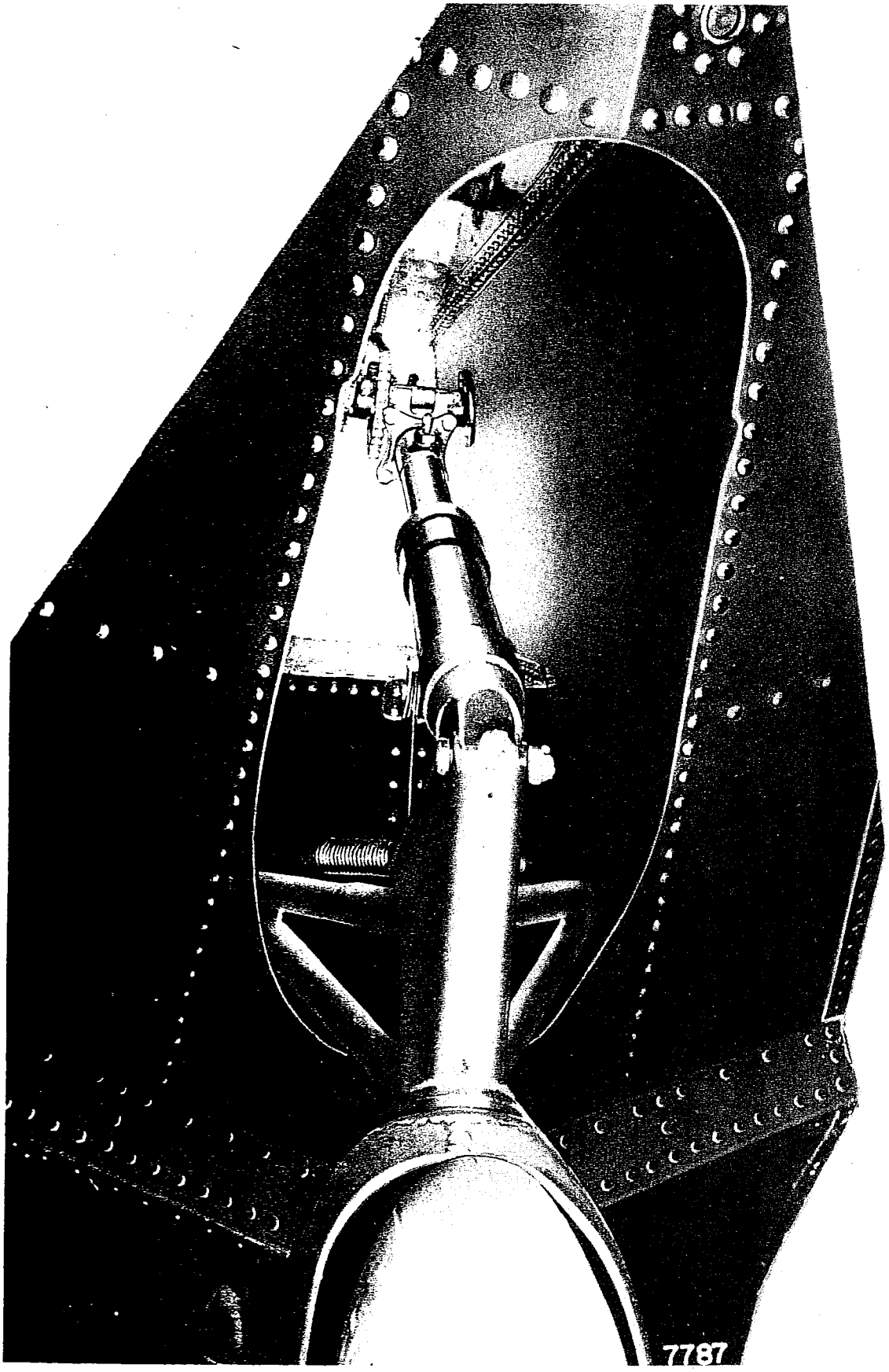


Figure 31 — Tail Wheel Extended

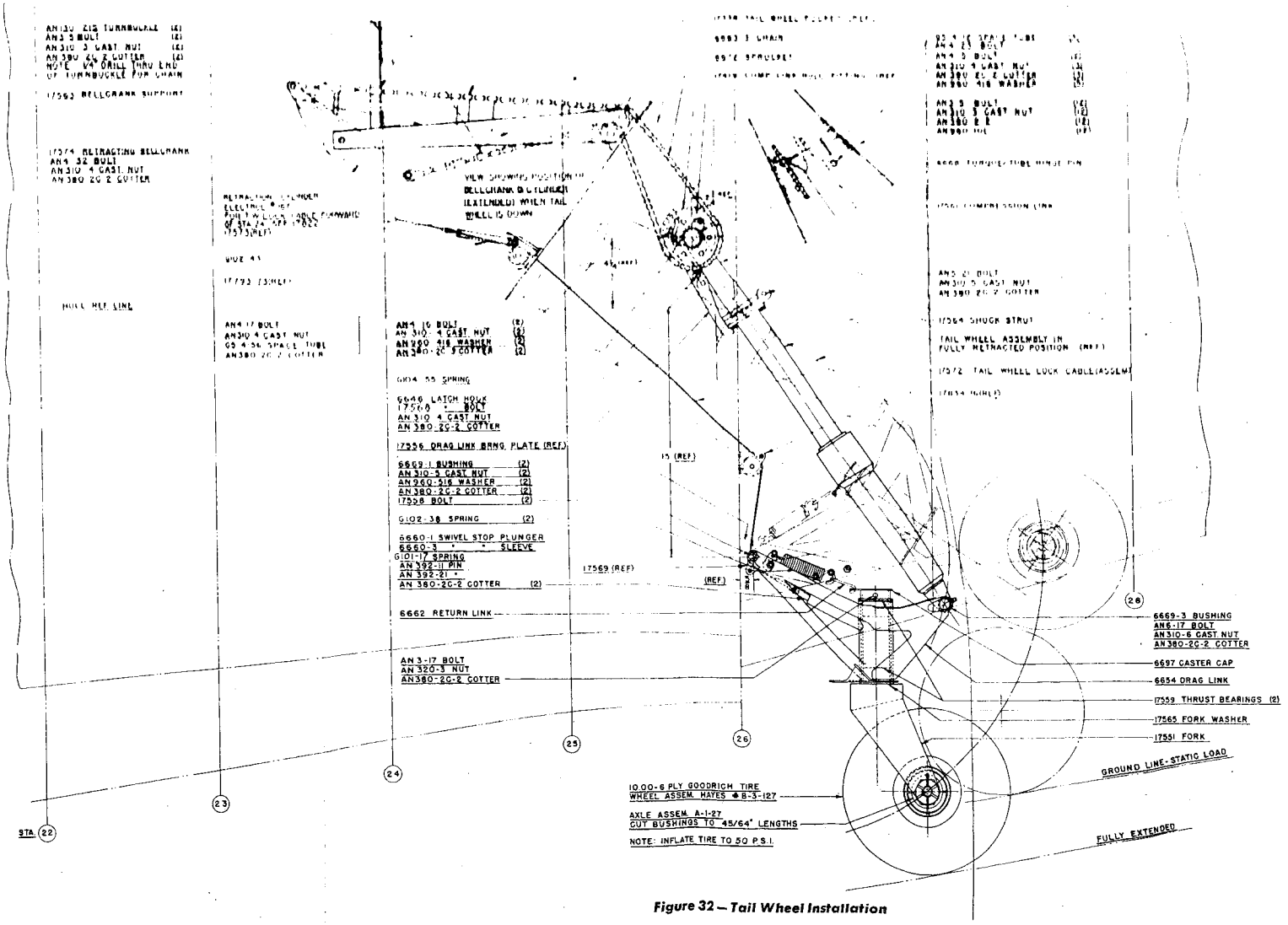


Figure 32 — Tail Wheel Installation

3. Shock Struts

Bendix Pneudraulic shock absorber struts are of the combined hydraulic and pneumatic type. Impact loads are dissipated mainly through the hydraulic unit by forcing fluid through the annular orifice, the size of which is controlled by the position of the metering pin in the orifice. Taxiing loads are carried mainly by the compressed air.

When the load is applied to the strut and compression starts, the piston forces fluid through the orifice into the upper chamber where the rising fluid level compresses the air above it. When the strut has made a stroke sufficient to absorb the energy of the impact, the air at the top expands and forces the fluid back. On the return stroke a valve, which is open on the compression stroke, is closed; and the fluid is forced back from one chamber to another through small holes. This acts as a snubber preventing quick rebounds.

Fluid 3580

Use Mineral Oil M-339, (Red Color), in the struts. The filler plug boss is located on the (side view) centerline of the strut in such a position that when fluid is just level with the hole in the boss and the strut is in the fully compressed position, the correct amount is indicated. A certain amount of fluid loss, due to seepage past the packing rings, is to be expected and the fluid level in the strut will vary according to the amount of seepage, which may not be the same for both struts. In general, however, the fluid level should be checked whenever the strut strikes bottom or top with ordinary usage when inflated to the proper extension. This indicates that the proportion of fluid to air has been decreased to a point where the air does not build up sufficient pressure to prevent bottoming. To check the fluid level, deflate the strut by depressing the valve core, then back off the filler plug one turn until all the fizzing of air and fluid stops. Remove the filler plug and check the fluid

level. This level should be flush with the filler plug hole when the strut is fully compressed.

When an empty strut is filled, care should be taken to completely extend and compress the strut at least two times to make sure that all air pockets are eliminated before the final fluid check is made. This is unnecessary when fluid is added after the strut has been in service. If the strut is not in place on the airplane when it is filled, care must be taken to place it under the same angular conditions as on the airplane when final level is checked.

Inflation

Due to the small quantity of air in the strut and the relatively high pressure required, it is not advisable to attempt to measure the pressure with a gauge. This is not necessary as the correct pressure is indicated when the specified extension of the strut is obtained under the full load. If it is more convenient to check pressures under a light load, the actual extension under this load should be noted after the strut has been properly inflated under the full load. The correct extension under full load is specified on the Instruction Plate.

Either a Bendix Booster Pump or High Pressure Air Bottle may be used for inflating struts. For first inflation, the distance should be approximately 1/4" greater than specified as moving the airplane around will cause some absorption of the air by the fluid. A variation of 1/4" either way for final reading should not be considered of importance. Adjustment should be made with the airplane out of the wind; without the slip-stream from the propellers; and after the airplane has been moving forward, tail on the ground. The airplane should also be rocked occasionally while inflating to overcome packing friction, thus preventing inadvertent over-inflation.

After the struts are once correctly adjusted, readjustments should not be

made for minor changes, as this may be due to change in position of airplane, change of load, wind action, packing friction, rolling the airplane backward, etc. Always check only after the airplane has been correctly loaded and has been rolled forward with tail down. Do not over-inflate, as hard taxiing and bouncing on contact will result.

The filler plug, which also contains the air valve, is provided with an annular ring on the under side of the hex. A soft copper gasket is provided between this ring and the plug seat on the strut. These seats must be free from dirt and marks, and the plug must be seated snugly to prevent air leaks at this point. If needed, a new gasket should be used each time the plug is replaced.

Air Valves

Two types of air valves are suitable for use in these struts. Both are special types, developed for this purpose, one by Schrader's Sons and the other by Dill Mfg. Co. These valves function like those in an automobile tire. The hex cap provided with this type of valve has a soft metal seat to furnish a secondary seal. It should be screwed down tightly, but not so tight that the tin seat in the cap is forced inward, thereby depressing the valve core stem. The cores are replaceable.

The valve core and the seat around the filler plug should be tested for leaks by putting a little oil on these joints to show the presence of air bubbles.

If the air pressure is especially high, it is desirable to not over-inflate struts as experience shows the valve cores are more easily damaged by the releasing of high pressure air through them than in any other way. Under the pressure ordinarily used, no difficulty results from this condition.

Packing

The packing used in the pneudraulic strut is a special aircraft packing, designed especially for this work. Two moulded composition rings separated by aluminum alloy spacer rings are used. One type of design of the packing box requires rings with inside flexible sealing lips, and the other type requires rings with the flexible lips on the outside.

Sealing on the lip side of the packing is accomplished automatically by the hydraulic pressure; hence, any leakage on this side of the packing cannot be remedied by tightening down on the packing nuts. However, leakage past the fixed side of the packing can usually be eliminated by tightening down on the packing nut as the heel of the ring is thus forced firmly against the packing gland wall.

Packing rings, which will, of course, wear out in service, may be replaced as follows:

1. Release all air from the strut by depressing valve core stem.
2. Remove filler plug and pour out fluid.
3. Unscrew nut at end of cylinder.
4. Pull out piston tube assembly using a slight bumping action to break rings loose, if necessary.
5. Remove old rings and replace with new ones.
6. After the rings are installed, tighten packing nut down firmly to provide seal at heel of ring on side opposite lip. The packing nut is tightened down as the last assembly operation.

Storage

Struts should be kept in storage in the deflated condition, except for short periods or when desired for immediate replacement, as the packing deteriorates as much when under air pressure in storage as in service. When

struts are to be stored for long periods as spare parts, it is recommended that the inside be coated with a rust preventative and that the struts be assembled without packing or fluid.

It is very important that the rust preventative be thoroughly cleaned out before the strut is provided with new packing, filled and reassembled for service.

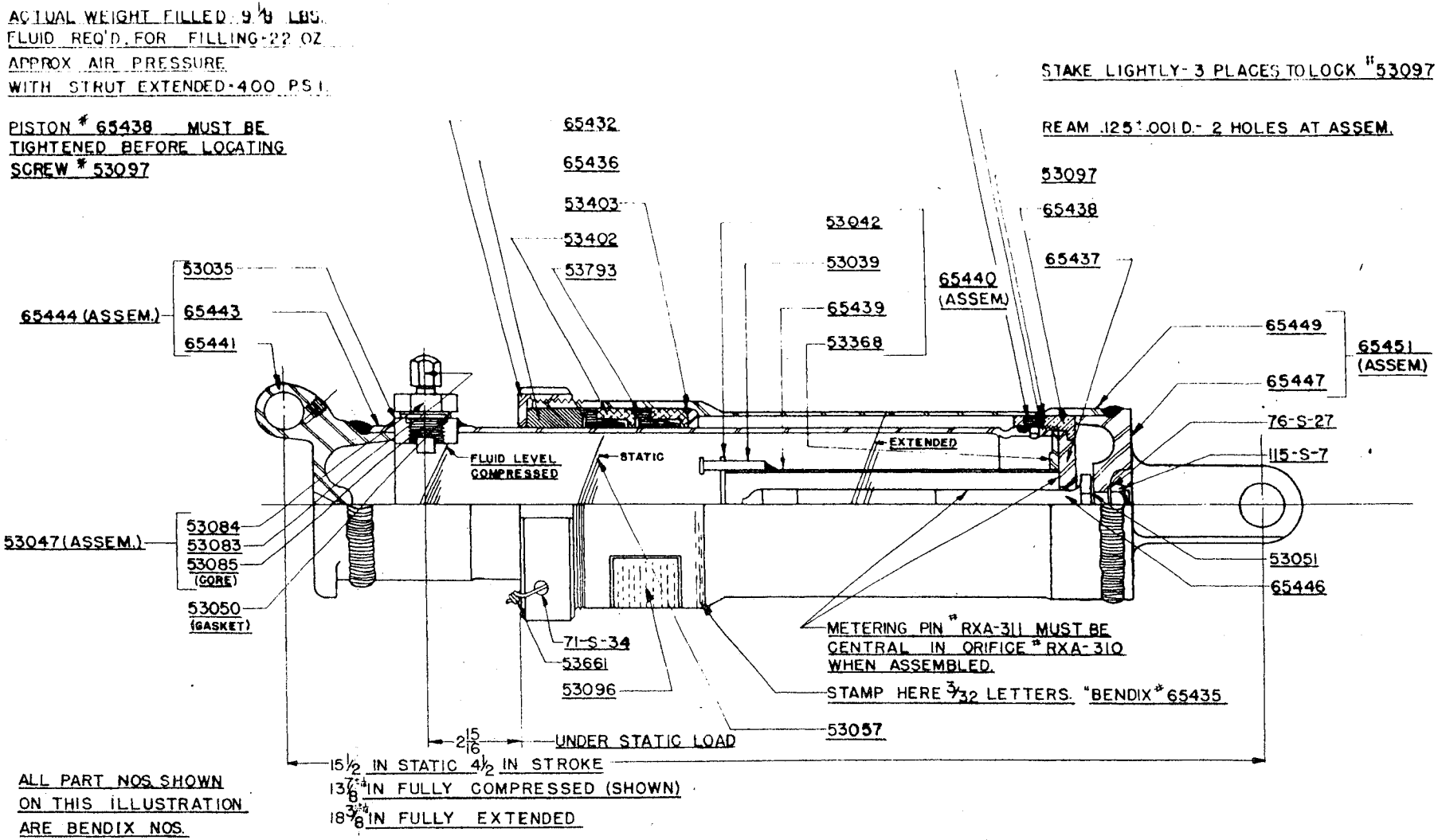


Figure 33 — Shock Strut Main Wheels

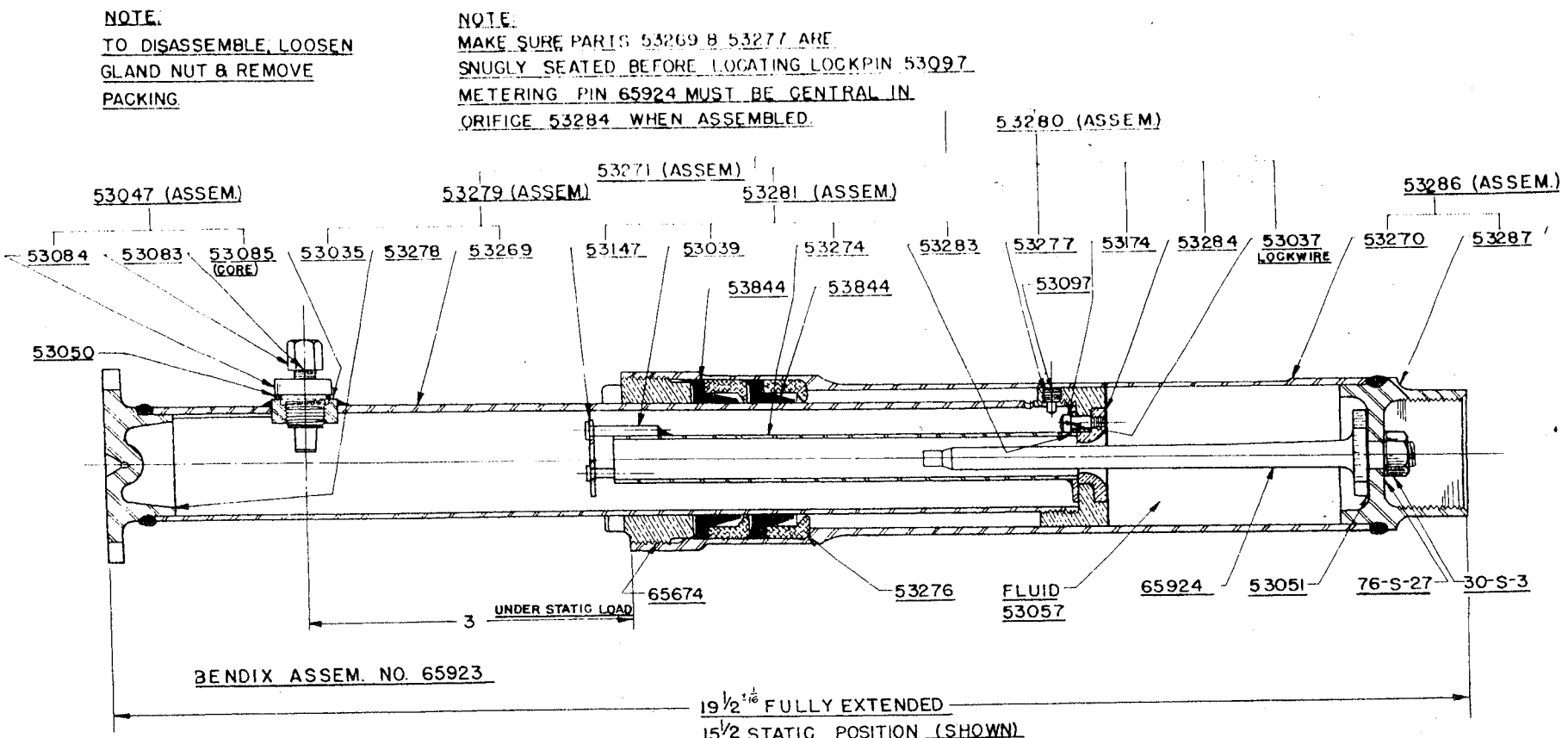


Figure 34 — Shock Strut Tail Wheel

4. Brake Control System

Standard Hayes #G-3-45A wheels and #G-2-201 hydraulic brakes are installed.

The brake toe-bars, mounted above the pilot's rudder pedals, may be adjusted relative to the rudder pedals by altering the length of the brake pedal connecting rods.

Operating and Parking

The brake on each landing gear wheel may be applied individually or, they may be applied simultaneously by pressing on the toe-bars. For parking, either brake or both can be locked ON by raising the knob located between the rudder pedals, then operating the brakes.

Fluid

The fluid used in this system must conform with Spec. M-339 which is a Mineral Oil and is easily identified by its Red Color.

Master Cylinder (Hayes #D-87-33)

The piston is completely immersed in fluid as the integral supply reservoir is connected by ports to the cylinder proper. This prevents the entrance of air into the line under any condition. The high pressure line is connected to the head end of the cylinder. There is a small port just in front of the piston cup in the OFF position which connects the brake line to the reservoir whenever the brake is in the OFF position; thus allowing the high pressure line to accommodate itself to changes in volume of fluid due to temperature changes and slight seepage of fluid.

Any air trapped in the hydraulic line is very detrimental to brake operation because its volume will reduce under increased pressure, and thus result in excessive pedal travel during brake operation.

Flexible lines with neoprene lining, are used at the wheels. Solid lines are constructed of 5280, 1/4" O.D. x .032" wall aluminum alloy tubing. The

Parker triple compression flared type fittings are so designed that a sleeve is between the tubing flare and the nut.

Bleeding the Brakes

After the brake is installed and securely bolted to the torque flange on the main wheel, all air should be removed from the brake system by removing screw "43" (See Figure 35) and screwing a bleeder hose into place. After loosening the bleeder screw and connecting the hose, the brake pedal should be put full on, after which the bleeder screw should be tightened and the brake released. This operation should be repeated, noting that the reservoir in the master cylinder is kept full, because if it is allowed to become low, air will be sucked into the system. When clear fluid comes out of the bleeder hose thus showing that no air is in the system close the bleeder screw "42" and apply the brakes. Then with the brakes applied, open the bleeder screw about one turn, which will allow any air to be forced out of the expander tube or nozzle connection. After all air is bled out of the brake system, securely tighten the bleeder fitting "42" and install the screw "43" to keep dirt out. When installing a brake, it is necessary to see that copper gaskets "40" and "41" are between the line connection fitting "37", connection bolt "39" and connector "27". After installing the brake, inspect around the nozzle packing for leaks. This can be accomplished by looking thru the spokes of the wheel with the brake full on. If a leak should appear at the nozzle packing, remove the wheel and tighten packing nut "30".

CAUTION: DO NOT APPLY THE BRAKES UNLESS THE BRAKE IS IN THE BRAKE DRUM. IF THE BRAKE IS NOT IN THE DRUM, THE BLOCKS WILL BE BLOWN OUT AND THE EXPANDER TUBE AND BLOCKS DAMAGED. DO NOT GET BRAKE FLUID OR OIL ON THE BRAKE LINING.

Wheels

A Hayes Wheel and Expander Tube Brake is shown in Figure35 mounted on a standard stub axle. This figure shows the wheel and the sleeve type brake drum

construction used in this installation.

The wheels covered by this description are of the drop center rim type, made of a one-piece aluminum alloy casting. The wheel casting consists of the rim supported on the outer side by six spokes running in radially to the center hub; six spokes running in radially from the rim rear near the inner face of the brake drum, and six ribs between the inside and outside spokes. There are also small intermediate ribs between the main ribs under the outer bead seat. The hub cast thru the wheel between the bearings serves to take the compression loads of the bearings as well as to keep dirt out of them. On the outboard side, there is a hub cap "13" protecting the outboard bearing held in place by the outer fairing "14", which is held in place by Dzus fasteners, hooking onto the springs "16" which are hooked around the outer spokes. The inboard bearing is protected against entrance of dirt and escape of grease by grease seal "5" or washers "7", felt "6", and the lock ring "8", which can be removed for replacing the felts. The wheels are equipped with Timken tapered roller bearings.

Maintenance

Occasional inspection should be made to see that the protective coating of paint is not chipped off the wheel, and if it is, the wheel should be repainted to protect the metal against corrosion. The wheels should be removed from the axles every fifty hours and the bearings cleaned and lubricated. The Timken bearings require only a small quantity of grease; and if excess grease is used, it may leak by the grease seal, getting on the brake drum, which will adversely affect the brake performance.

If it is necessary, due to wear, to remove the bearing cups "19" and "21" from the wheel, the wheel should be submerged in boiling water which will cause it to expand and the cups can then be driven out with a brass rod. Take care to drive them out uniformly.

To install new bearings, submerge the wheel in boiling water until it reaches the same temperature as the water. At the same time, the bearing cups should be put in dry ice and left long enough to become thoroughly cooled and to shrink. The bearing cups can then be dropped into the bearing bore in the wheel. When the wheel cools and the bearing cups warm up to normal temperature, they will be tight in the bearing bore. It is very important that the bearing cups be dropped in squarely and not allowed to heat up before they are all the way in the bearing bore.

To Remove and Install Brake Drums

It will be necessary from time to time to replace the brake drum due to wear, deformation, growth or heat checking due to excessive use.

The sleeve type steel drum, shown in Figure 35, is chrome plated and should be replaced when the chrome plating wears through. This state of wear is easily determined since the chrome plating will remain bright until worn through, whereupon rusting will be evident.

In order to replace the sleeve type drum, heat the wheel in boiling water, after which the drums can be removed by prying out by the inner flange. If this fails, the drums may be cut with a cold chisel, taking care not to damage the wheel around the brake drum.

To replace the drum, repeat the process by keeping the drum cool and heating the wheel in boiling water, after which the new drum can be dropped in, making sure that the bolt holes line up if the brake drum is already drilled. In most cases, however, the drums are sent out without the bolt holes so that they may be drilled after installing them in the wheel, using the wheel as a jig to drill the holes. It will be necessary to use an extension on the standard length drill in order to reach through the wheel.

Since the wheel and tire are balanced, if necessary, by means of balance weights, located under the brake drum bolt nuts, these weights should either be replaced in the same location or the wheels should be balanced and the necessary weights added after a new drum is installed. All wheels are balanced before leaving the factory, but it may be necessary to rebalance the wheel assembly after the tire and tube has been mounted on the wheel. This can be accomplished by adding or removing the balance weights.

Installation & Maintenance

The brake blocks "34" are ground to size at the factory, and there is no adjustment provided to change the radial clearance between the brake lining and the brake drum. The radial clearance should be .015" and must not be allowed to become less than .010". If the clearance becomes too great, the brake pedal travel will increase, which will clearly indicate the necessity of relining the brake.

A decrease in clearance may be caused either by inward growth of the brake drum or swelling of the expander tube. With normal operation, however, the wear on the brake linings offsets the growth of the expander tube, and the brake clearance remains constant.

Relining Brakes

The brakes can be relined quickly with the following procedure, using only standard wrenches and screwdrivers. Dismount the wheel and take off the brake assembly as it cannot be disassembled on the landing gear. After the brake assembly is removed take out screws and nuts "32" and "33" which hold the two halves together. Loosen the nut "26" on the tube nozzle and the packing nut "30" where the nozzle is inserted into the fluid connections. Drain the fluid from the brake. Care should be taken to see that no brake fluid gets on the lining blocks at any time as it causes extreme gripping when the brakes are applied.

After removing the screws, the frame halves can be separated and the brake blocks taken out. Then remove the expander tube for inspection and replacement; it is advisable to install a new expander tube when the brake is relined.

After removing the brake blocks the retractor springs will remain in the slots in the ends of the blocks and should be removed and cleaned. If any of these springs show signs of cracking or if they have lost their tension, they should be replaced.

To reassemble the brake, use the following procedure:

The new brake blocks, which should be obtained only from the manufacturer, should have one retractor spring inserted in the slot in one end of each block. These retractor springs should be installed with the spring arched inward (opposite to curve of block) so that when the ends of the springs are located in the spring grooves in the brake frame, the spring will force the block inward. The brake expander tube should be checked to see that the nut which holds the nozzle is tight; and in tightening this nut, the brake expander nozzle should be held with a wrench. Install the expander tube by first putting the nozzle into the fluid connection, which should be put in its slot in the inner half of the frame, with the nuts and packing in proper position, after which the tube can be stretched on this half of the stamped frame. After the expander tube has been stretched over one half of the frame, the other half should then be pressed down in the expander tube, leaving a distance approximately 1/4" greater than the width of the blocks between the edges of the brake frame.

The blocks can now be installed by locating the end of the retractor spring in the proper grooves in the inner brake frame, installing each block successively until all are installed, sliding the last block down the retractor spring of the first block installed. Place a rubber band around the brake to hold the blocks which have already been installed. After this is done, check to see that all retractor springs are in their slots in the inner frame as far as they can go. Now, push the other half of the brake frame in the tube and put in one bolt to

hold the brake frame against the end of the retractor springs. With a screwdriver, start at one point and push one of the retractor springs in radially until its end is caught in the spring notch in the outer half of the frame. Hold the brake frame down at this point and proceed around the brake frame in both directions, pushing in the retractor springs and clamping the frame together tightly until all retractor springs are located in their slots. All screws may now be tightened up, making sure before doing this, that all of the retractor springs are in their slots. Make sure that the nut, which holds the expander tube nozzle in place, is tightened and the packing nut should then be tightened sufficiently to eliminate any chance of leakage. Be sure the fluid connector is at the bottom of its socket before tightening the packing nut. If the fluid connection is not at the bottom of the socket, it will not line up properly with the hole in the inner fairing. The brake is now ready for installation on the airplane.

If for any reason, there appears to be a high spot in the brake lining, this should be investigated. Check to see if the lining is in the proper position and that there is no dirt between the lining and the expander tube. If the lining is too thick, it can be reduced in diameter by filing or sanding off the high spot. If it is desired to check the clearance around the entire brake, it is suggested that the brake be put on the axle and held in position with one or two bolts without the fairing assembly. In this manner, clearance of all the blocks can be checked, although this procedure should not be necessary.

Be sure when ordering service parts to give full information, such as the wheel size, assembly number and serial number; also the brake size, assembly number and serial number. It is also well to give the serial number of the airplane for which the parts are required.

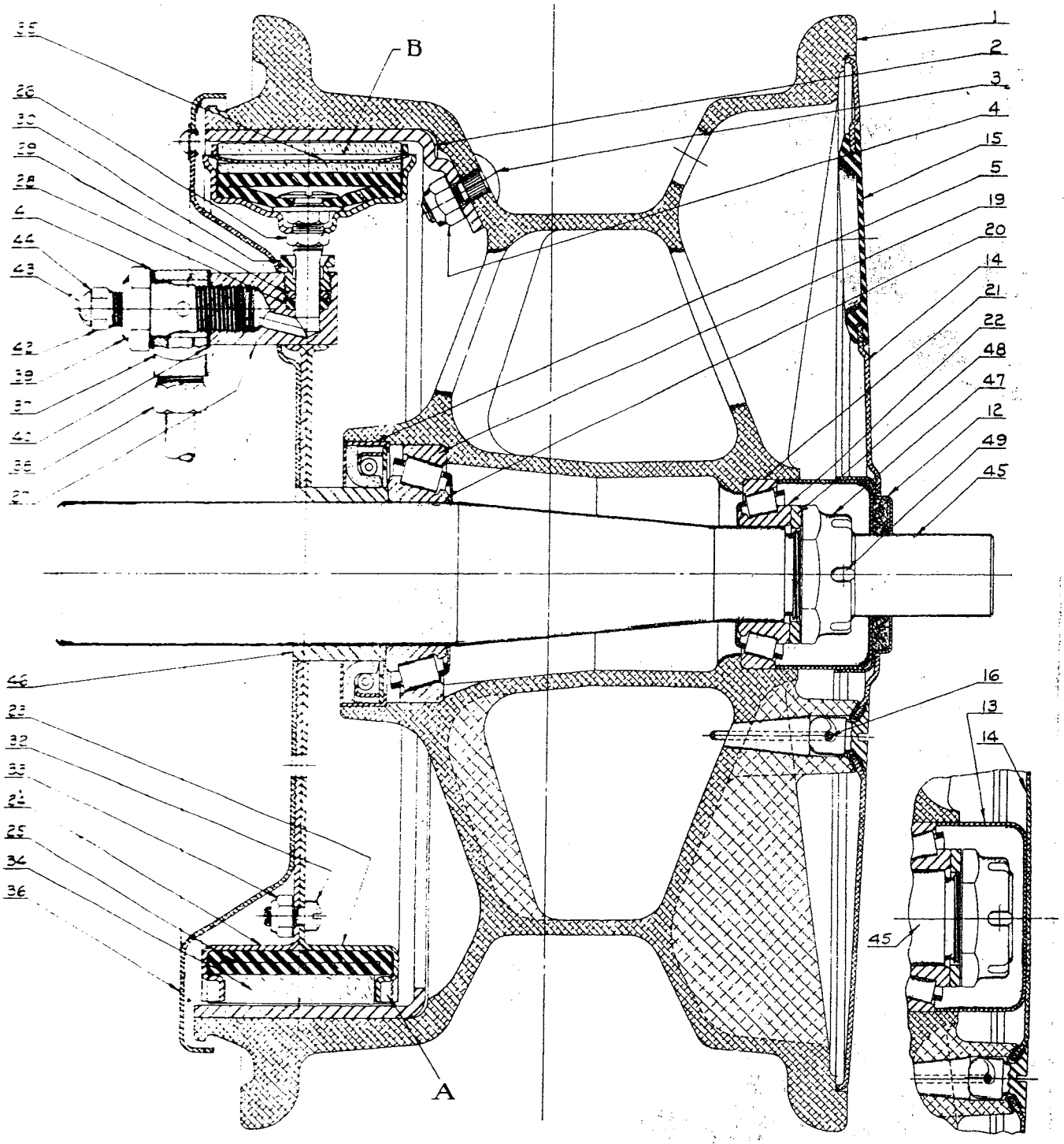


Figure 35 — Wheel and Expander Tube Brake

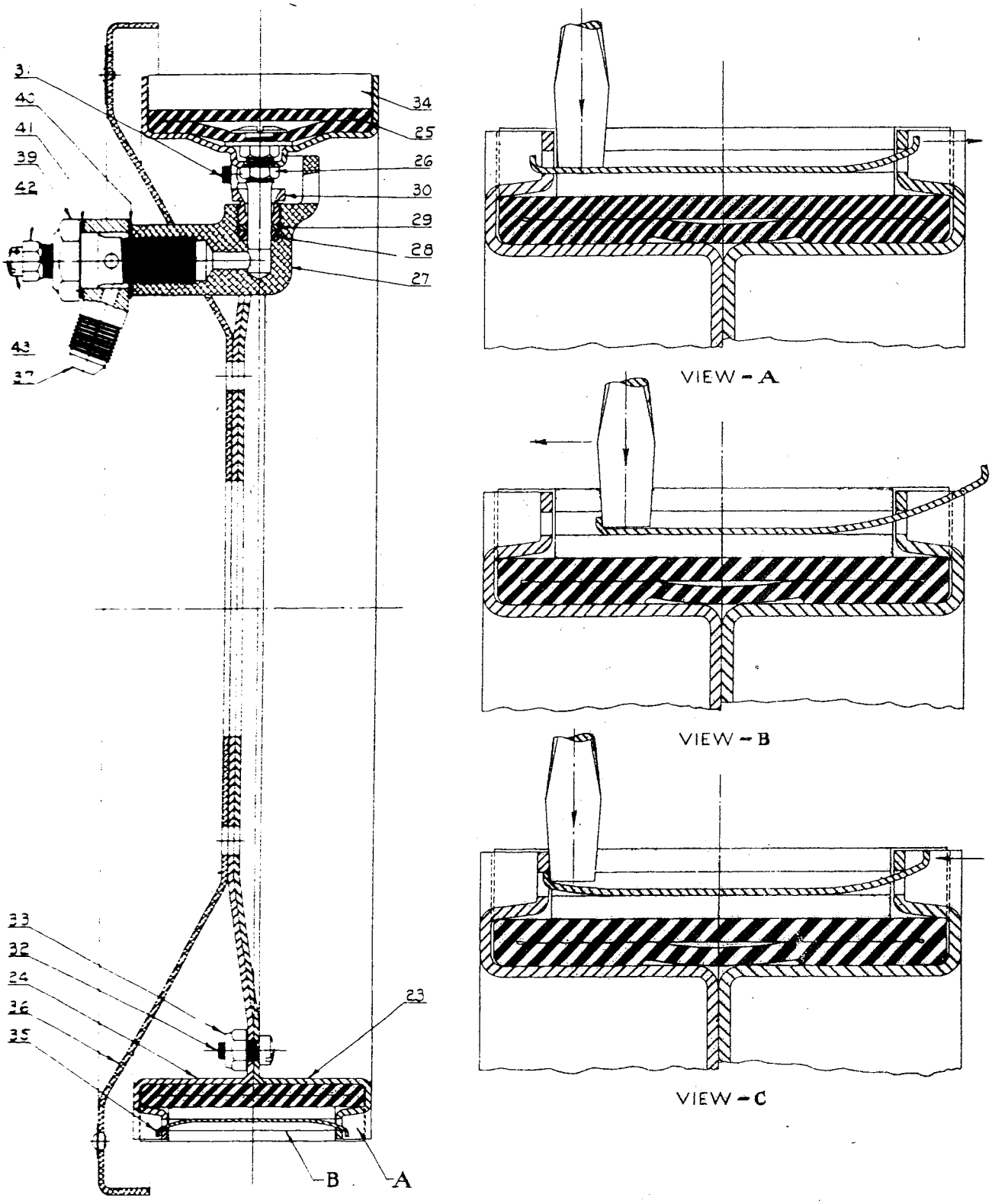


Figure 36 – Expander Tube Brake

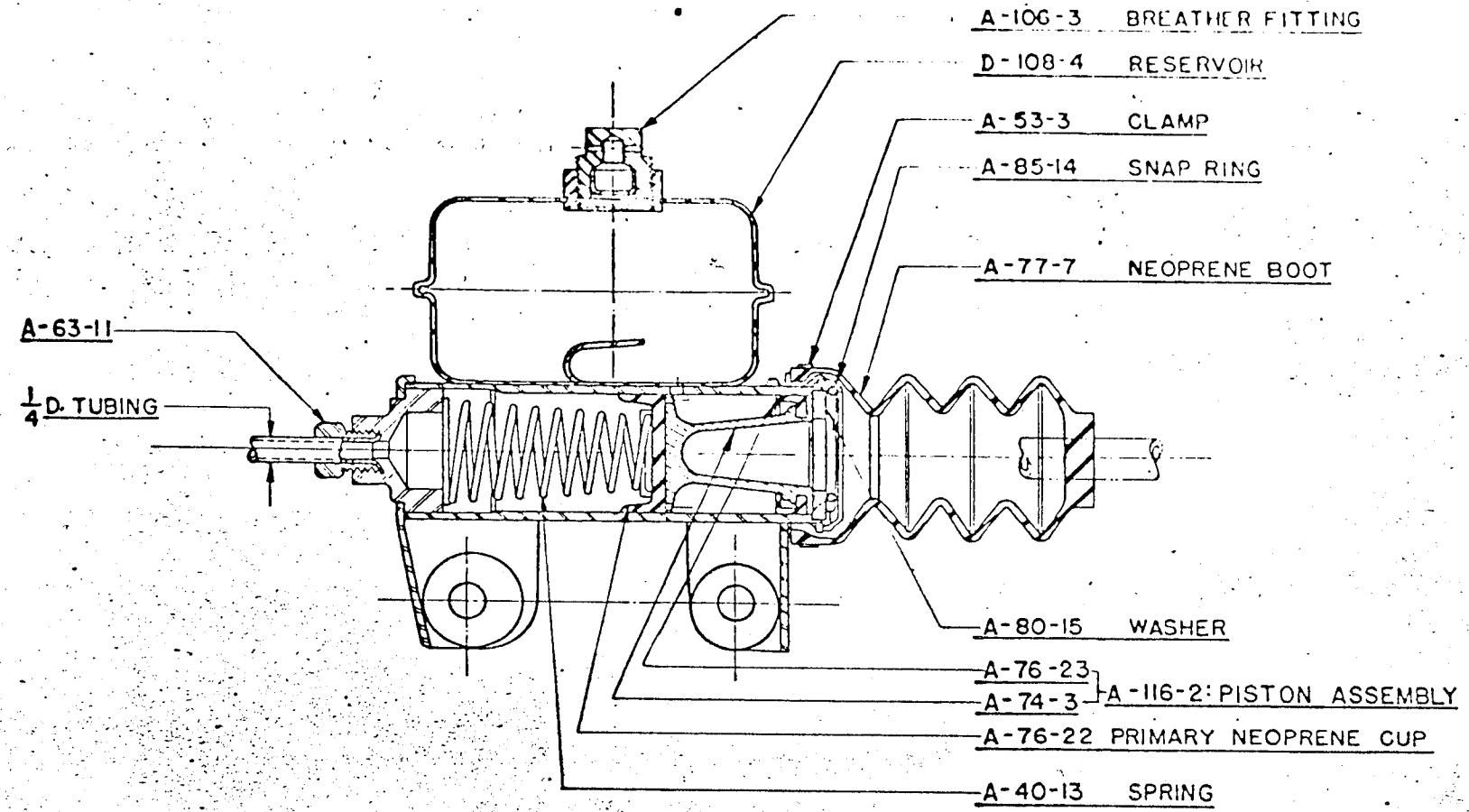
Brake Master Cylinder Maintenance

The master cylinders normally require little service and the primary neoprene cup and secondary neoprene seal which serve to keep the cylinder from leaking are the parts most likely to need replacement. The lips of these cups sometimes become worn or scratched and thus develop leaks. In order to replace these parts, it is only necessary to remove the clamp A-53-3 and the boot A-77-7 after which the lock ring A-85-14 can be removed and the cylinder parts pulled out of the cylinder bore. The cylinder should then be thoroughly cleaned and inspected, and before reassembling, should be lubricated with a small amount of brake fluid.

In reassembling, first install the spring A-40-13, after which the primary cup can be put into the bore and the piston, with the secondary seal assembled on it, can be forced in by a rod. Hold the piston in the cylinder, drop washer A-80-15 over the rod and hook the snap ring A-85-14 in place. This will hold the assembly together. The boot can then be reinstalled on the cylinder.

After the cylinder is reassembled in the airplane, the fit at the end of the piston rod (Grumman #17883) should be such that there is a slight amount of play between the piston rod and the piston. If the piston rod is too long and does not let the piston come back against the washer A-80-15, the primary cup will project over the hole (in the cylinder wall) and if there is any expansion of the brake fluid after the brake is released, it may cause the brakes to lock and drag.

The following is an additional contributing cause of brake dragging and locking. The assembly is so designed that some fluid is added to the pressure side of the piston during the return stroke. Hence, if the relief port is not opened by the complete return of the piston when the brake is released - pressure is apt to be built up in the system, with consequent drag or locking.



BRAKE MASTER CYLINDER

FIG-37

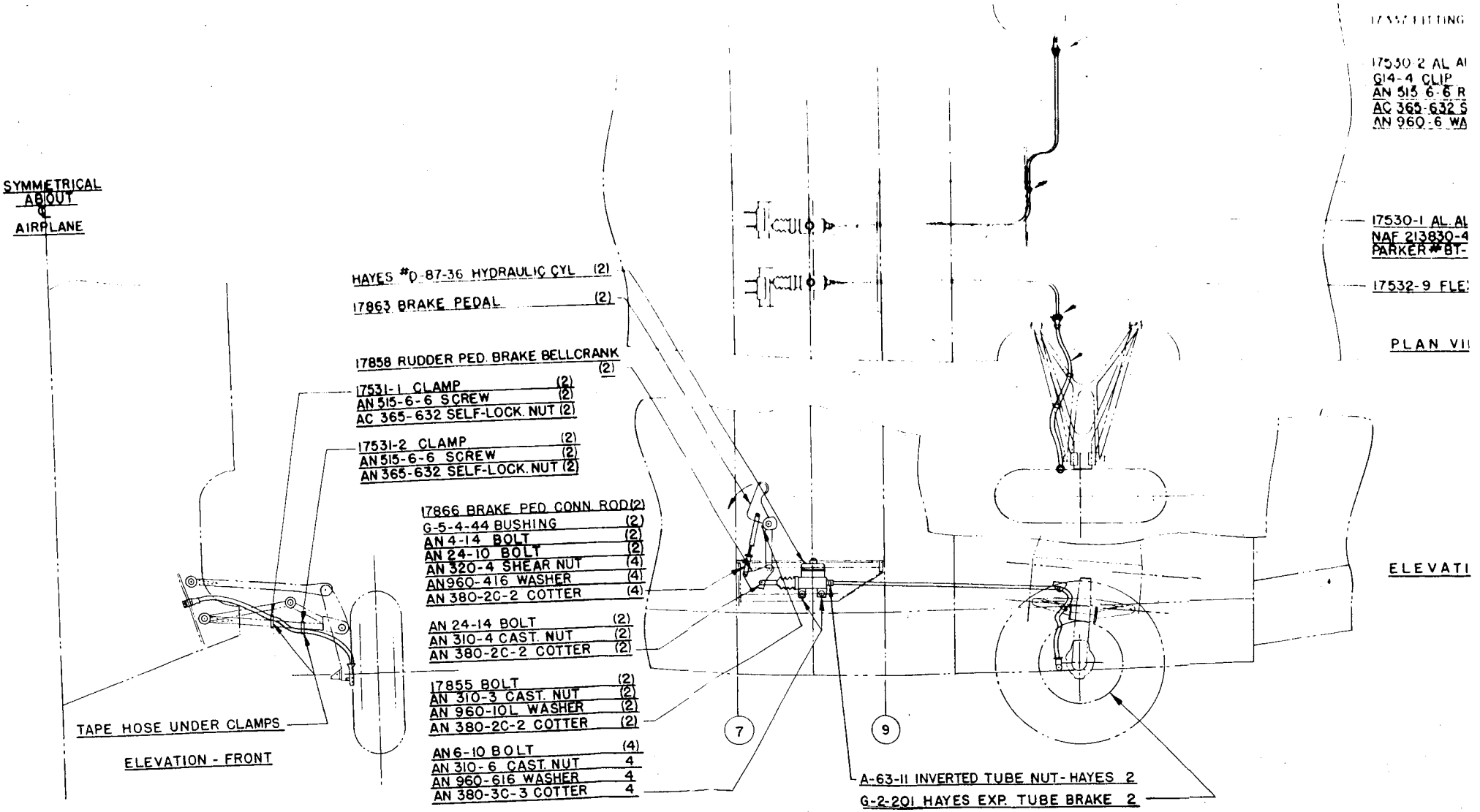


Figure 38 — Brake Control System

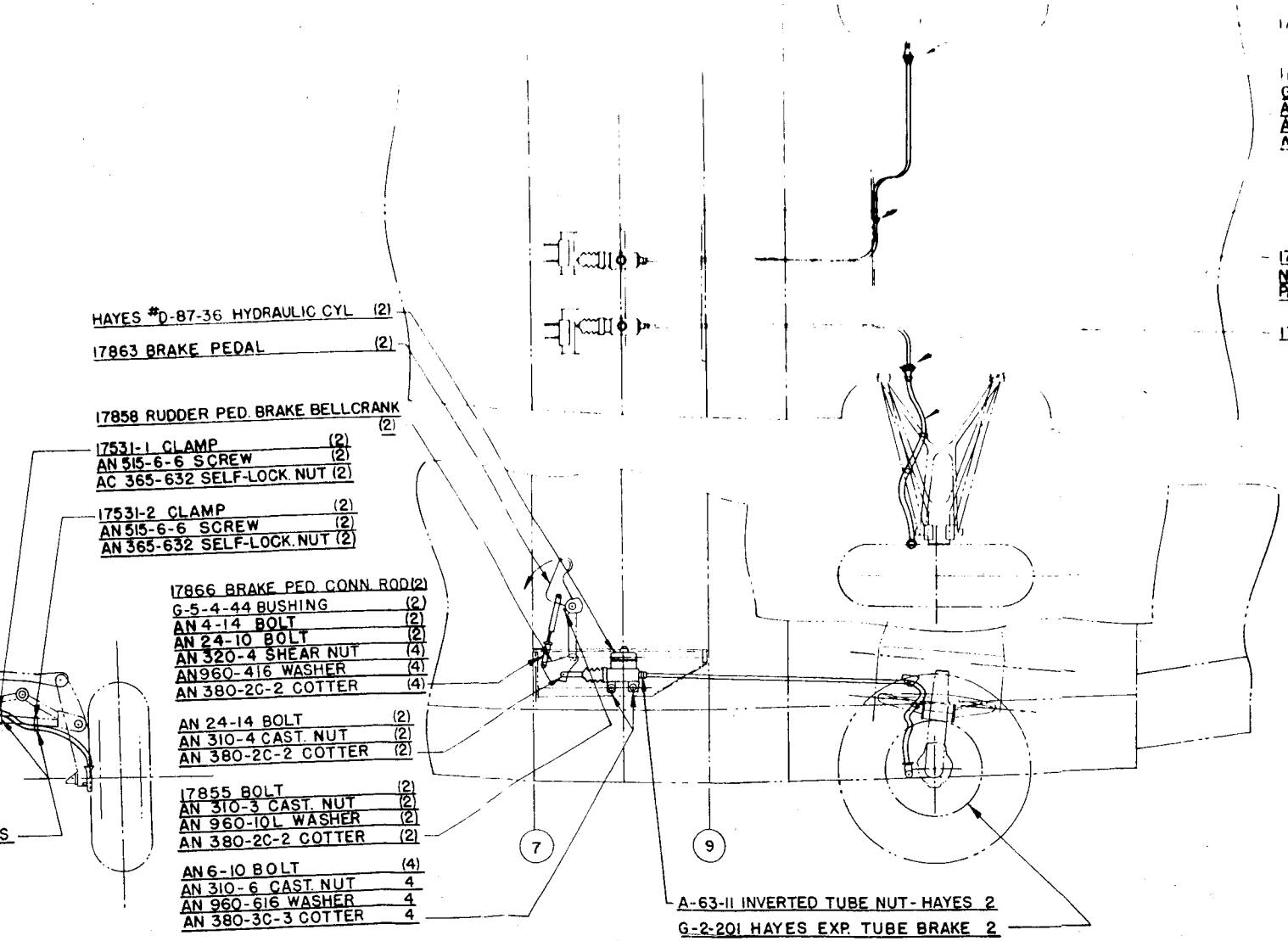


Figure 38 — Brake Control System

H. SURFACE CONTROLS

Aileron Controls

The aileron control wheel, mounted on the control column, is arranged to throw-over, and can be locked in position for either the pilot or co-pilot. The wheel is fitted with a sprocket and chain from which cables are led over ball bearing pulleys and fairleads under the cabin floor, up the left hand side of the cabin at approximately Sta. #18 to a central bellcrank on the face of the rear wing beam. Cables are led from this central bellcrank to bellcranks in the wings which operate the push pull tubes connecting to the ailerons. A fixed control stop is provided for the central bellcrank on the face of the rear wing beam.

The cables are 5/32" dia., 7 x 18 extra flexible tinned carbon steel.

Elevator Control System

Two 5/32" dia., 7 x 19 extra flexible tinned carbon steel cables are attached to the control column extension below the anchorage at the floor.

One cable is led over a ball bearing idler pulley attached to the forward bulkhead of the pilot's compartment and then, together with the other cable, is led aft under the flooring to approximately Sta. #18, thence up the right hand side of the cabin and along the top of the hull to the elevator control horn.

Adjustable control column stops are provided in the cockpit, one under and one above the floor. Additional stops of laminated phenol are fitted at the tail to prevent battering when parked tail to the wind. The stops in the cockpit and the tail stops should be so adjusted that the cockpit stops act first when there is no load on the system.

Elevator Tabs

The elevator tabs are hinged to the elevator trailing edge. The left, a trimming tab, is manually controlled from the cockpit; and the right, a balance tab, is interconnected with the wing flap control.

Trimming Tab

The trimming tab control mechanism consists of a handcrank on the left hand side of the Upper Control Panel which is attached directly to a pulley behind the panel. From the pulley, cables are led thru fairleads in the cabin ceiling to a pulley attached to the actuator unit at Sta. #32. The rotation of the pulley axle is converted by this actuating unit into push-pull motion of a flexible lead which is attached to the tab control horn. This push-pull motion in the control is also transmitted forward by a cable to the tab position indicator on the Upper Control Panel adjacent to the tab control handcrank.

The handcrank is turned Clockwise for Nose Up and Counter-Clockwise for Nose Down. Position of the tab can be checked by the indicator located just above the handcrank. The average take-off position is indicated on the scale.

Balance Tab

The right elevator tab control cable is spliced into the flap position indicator cable in the right wing just inboard of the pulley at the flap actuating cylinder, and operates in conjunction with the flaps. The tab, therefore, has no separate control.

The tab is hinged to the lower surface of the elevator and is designed for downward movement only. It is lowered with the wing flaps thus counteracting nose heaviness which is consequent to wing flap operation.

The tab control cable is attached to a bellcrank in the elevator which actuates a push-pull tube connecting to the tab. As the wing flaps return to the UP position, tension in the control cable is released and a tension spring in the elevator returns the tab to neutral.

A tube, acting both as a static balance and stop, is riveted to the upper surface of the tab and extends forward over the elevator. This tube must always be securely in place.

Rudder Control

The over-riding rudder pedals are located on the left hand side of the cockpit. A linkage connects the pedal units with a bellcrank on a torque tube below the floor. Control from here is by means of 5/32" dia., 7 x 19 extra flexible tinned carbon steel cables running over ball bearing pulleys, which are rigidly supported in metal brackets under the flooring at approximately Sta. #18, thence up the right hand side of the cabin and along the ceiling to the rudder horn.

The cables are adjustable by turnbuckles which are accessible by removing the diagonal metal panel on the right cabin wall. The rudder pedals, themselves, are not adjustable.

The torque tube, to which the rudder pedals bellcrank is attached, is extended to the right hand side of the cockpit where a removable rudder bar may be fitted for control from the right hand seat.

Control stops are provided at the pedal linkage system below the floor and at the aft end of the hull.

Rudder Trimming Tab

This tab is hinged to the right hand side of the rudder's trailing edge and is controlled by a handcrank on the right hand side of the Upper Control Panel. The handcrank is turned Clockwise for Nose Right and Counter-Clockwise for Nose Left. Position of the tab can be checked by the indicator located just above the handcrank.

The control mechanism for the rudder tab is identical with that of the left elevator trimming tab. From the pulley on the handcrank, a flexible cable is led thru fairleads in the cabin ceiling to the tail at Sta. #32, where it is attached to the tab actuator unit.

Wing Flap Operating System

The wing flap operating system is a part of the Main Hydraulic System and consists of a cockpit control lever with locking latches, flap position indicator, selector valve, two single acting hydraulic cylinders with self contained return springs, and aluminum alloy lines with flexible hose connections at the cylinders.

Pressure for lowering the flaps is furnished by the engine driven pump of the Main Hydraulic System. If this pump is not functioning, the hand emergency pump at the left hand side of the pilot's seat is used to build up the necessary pressure.

Normal Operation

The flaps are controlled by the three position Hydraulic Control Lever on the right hand side of the Upper Control Panel. The flap position indicator is installed above the lever.

LEVER UP - FLAPS UP

LEVER CENTER - NEUTRAL

LEVER DOWN - FLAPS DOWN

The flaps are controllable downward from 0° to 40°. Movement may be stopped at the desired angle of droop by returning the lever to the NEUTRAL position.

Emergency Operation

Thumb latches are provided to lock the flap control lever in the operating positions permitting the pilot to have one hand free if emergency hand pump operation is needed. About seven strokes are required to lower the flaps. The white UP latch is located to the left of the control lever slot at the UP position, and the red DOWN latch, at the DOWN position. The white UP latch may be left locked since the flaps are returned to the UP position by the action of the springs in the actuating cylinders.

CAUTION: THE RED DOWN LATCH SHOULD BE USED ONLY WHEN OPERATING THE HAND PUMP AND RELEASED IMMEDIATELY AFTER PUMPING, OTHERWISE, THERE IS NO FLOW THROUGH THE VALVES AND UNRELIABLE OPERATION OCCURS.

Inspection Plates

1. Under surface of wing, outboard at aileron rod. For inspecting aileron control units.
2. Under surface of wings between engine nacelles and hull. (2 plates) For inspecting wing flap actuating cylinder and fittings.
3. On top of hull between Stations #27 - #28. For inspecting tab, elevator and rudder cables.
4. Left hand side of rudder. For inspecting tab control.
5. Left and right hand sides of fin below stabilizer (3 plates). For inspecting tab, elevator and rudder cables and tab actuating units.
6. Top and bottom of right elevator (2 plates) For inspecting balancing tab actuating parts.
7. Lower side of left elevator. For inspecting trimming tab control.

Controls Adjustment - Turnbuckle Locations

Elevator and Rudder - Accessible by removing diagonal metal panel running upward and aft on the right hand cabin wall.

Ailerons - Aft of the wing box beam, accessible by removing the curved upholstered ceiling panel.

Rudder & Left Elevator Tab - Accessible by removing the metal plate on the top of the hull just forward of the fin.

Wing Flap & Right Elevator Balance Tab - The tension of the balance tab actuating cable may be adjusted by the cable turnbuckle which is located on the right hand side of the cabin behind the curved upholstered panel in the cabin ceiling. For proper cable tension, see Rigging Tension Table, herein.

NOTE: See Right Elevator Balance Tab Control Diagram, herein, for the proper location of the clamps, #17898-1 and #17898-2. These clamps must be inspected at frequent intervals as to their security of mounting on the flap cylinder in order that the control cable is maintained at its proper tension.

RIGGING TENSION TABLE

Cable Name	Size	Initial Tension Lbs.
Elevator	5/32 7 x 19 Extra flex. cor. res. steel	100
Rudder	5/32 7 x 19 Extra flex. cor. res. steel	100
Aileron	5/32 7 x 19 Extra flex. cor. res. steel	100
Flaps	1/16 7 x 7	50
Tabs	1/16 7 x 7	50

NOTE: To maintain a maximum of safety and performance of the controls, a definite range of tensions must be present in the control cables. These tension ranges for specific cable sizes are tabulated above. When new cables are installed, it is essential that a flight period of one hour should transpire previous to establishing the final tensions.

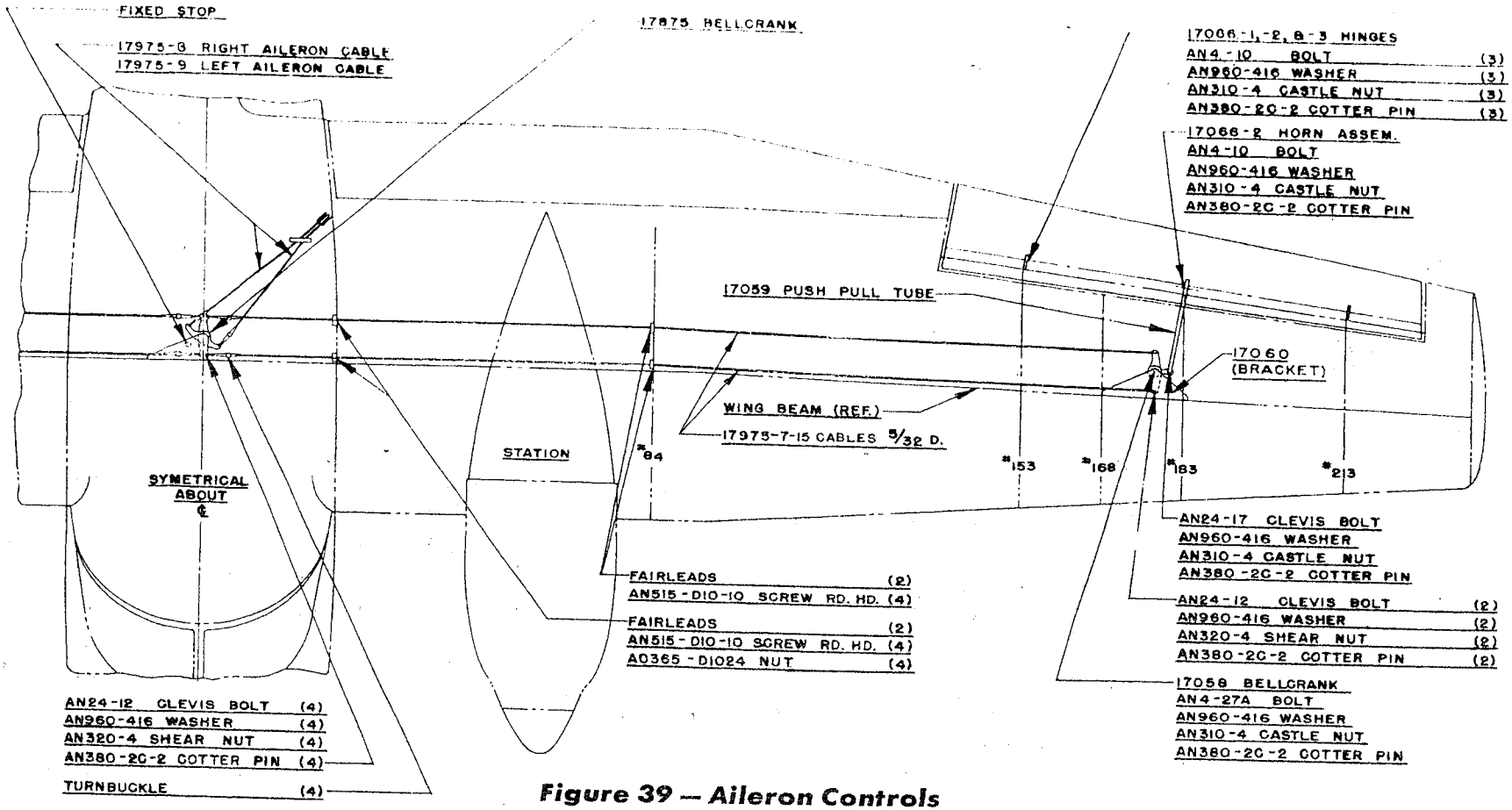


Figure 39 — Aileron Controls

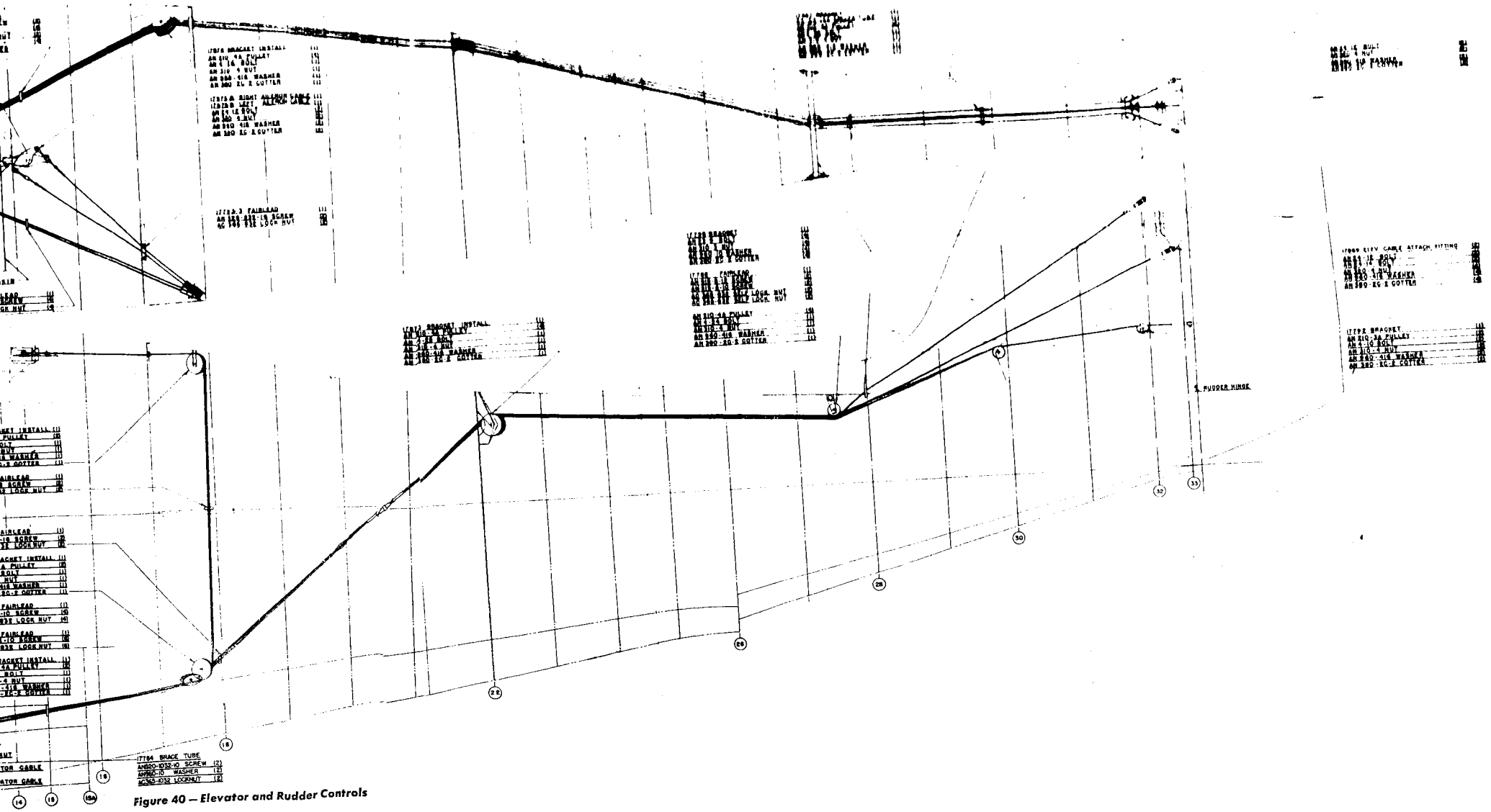


Figure 40 — Elevator and Rudder Controls

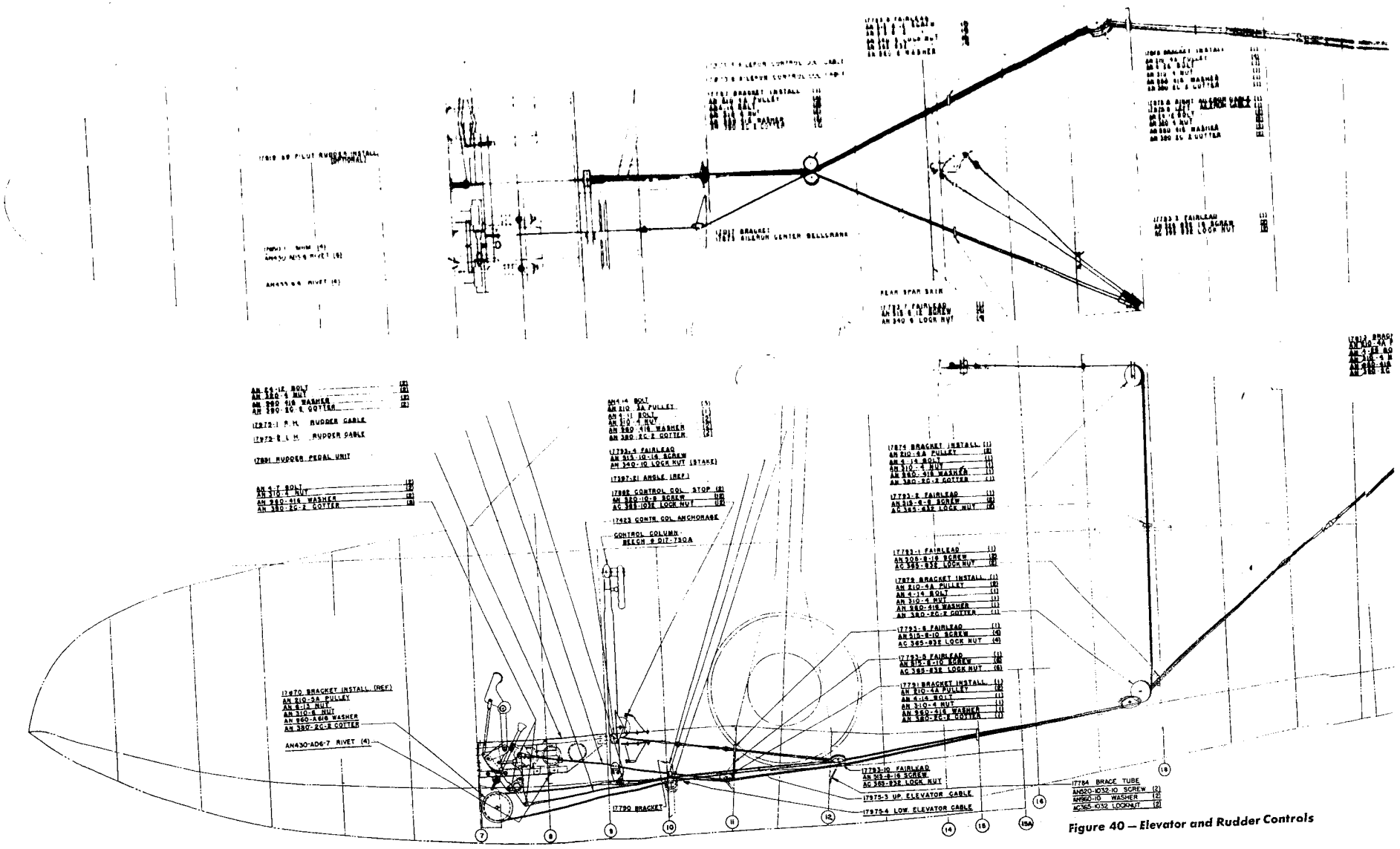


Figure 40 — Elevator and Rudder Controls

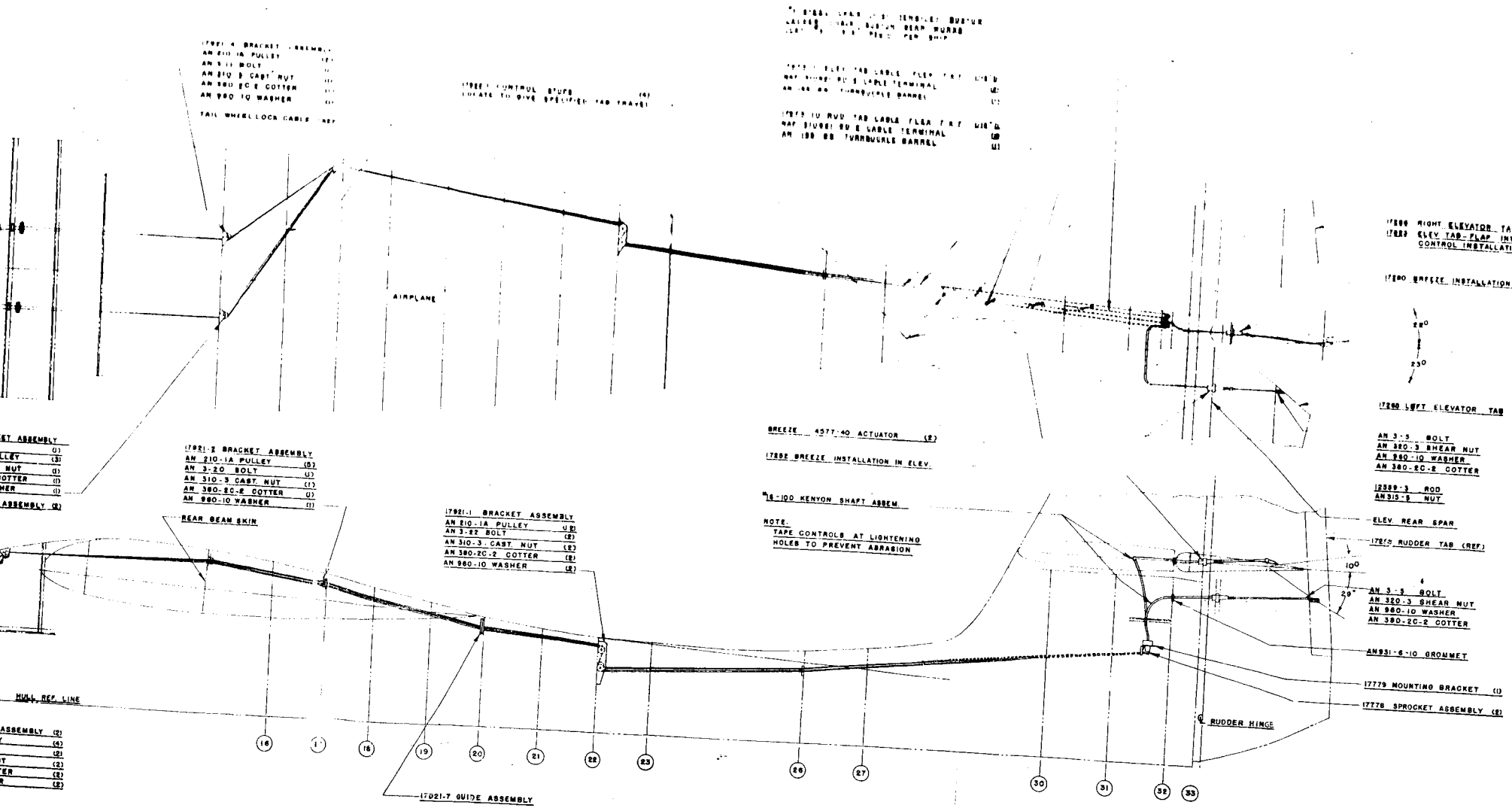


Figure 41 – Elevator and Rudder Tab Control System

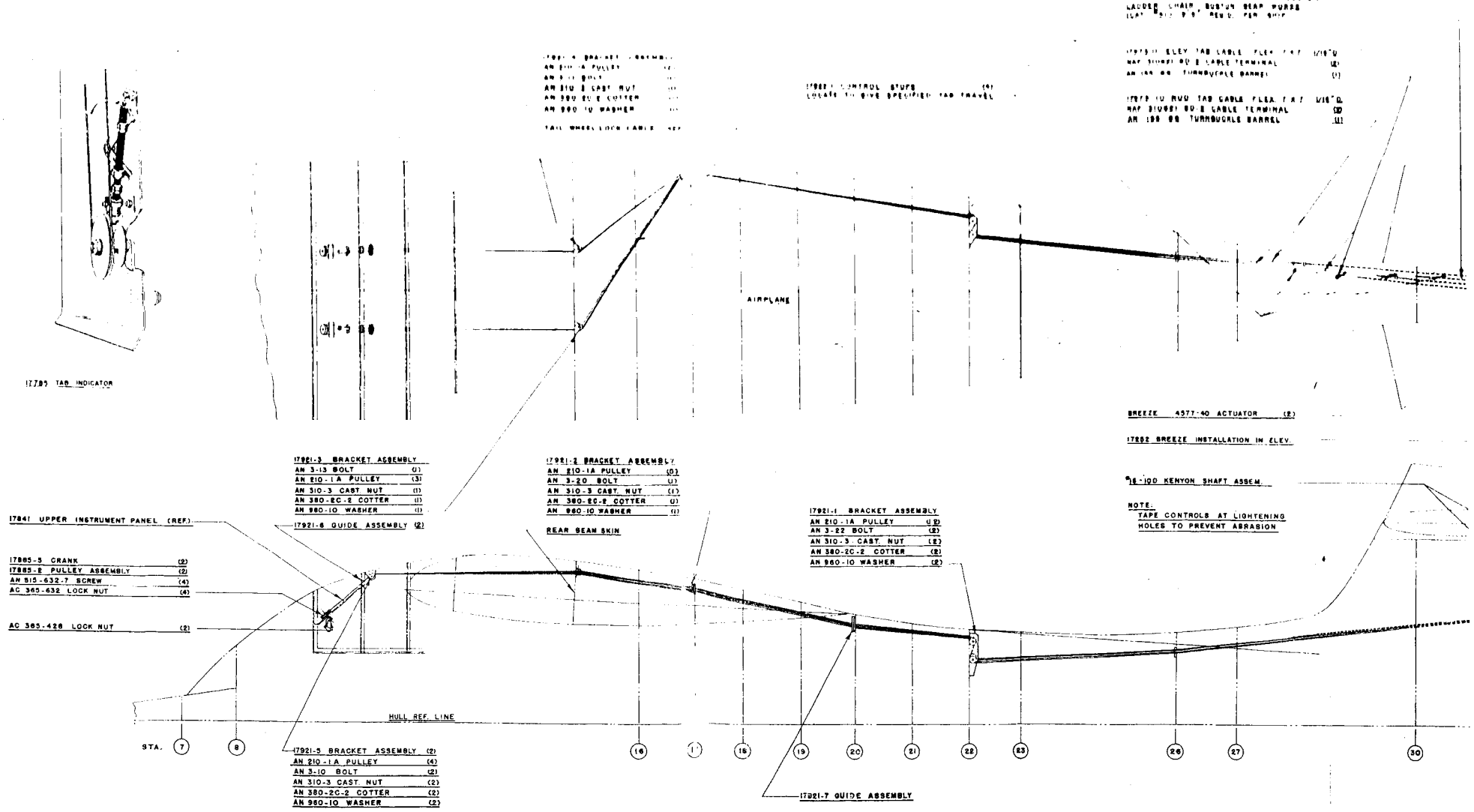


Figure 41 — Elevator and Rudder Tab Control System

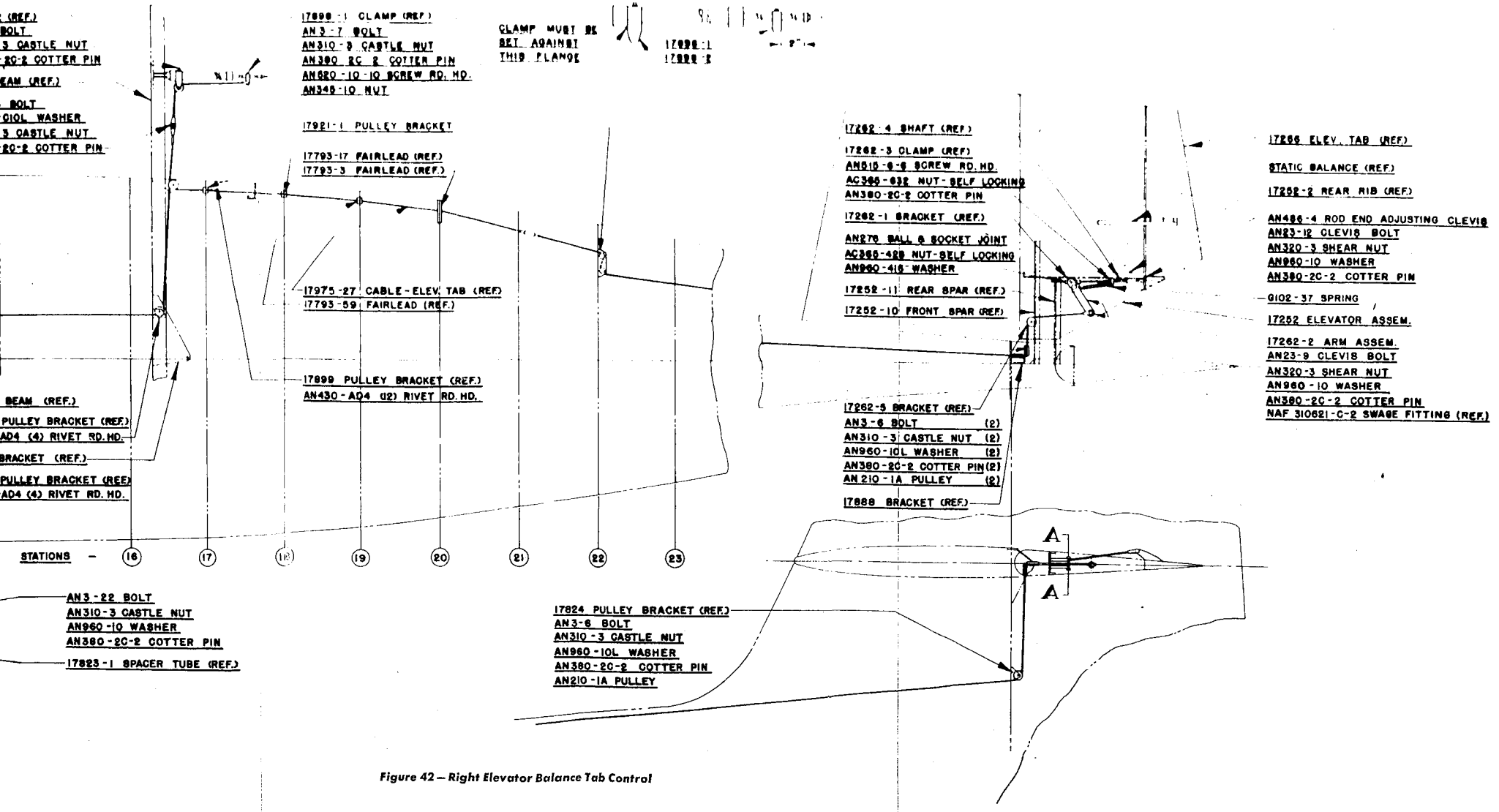


Figure 42 — Right Elevator Balance Tab Control

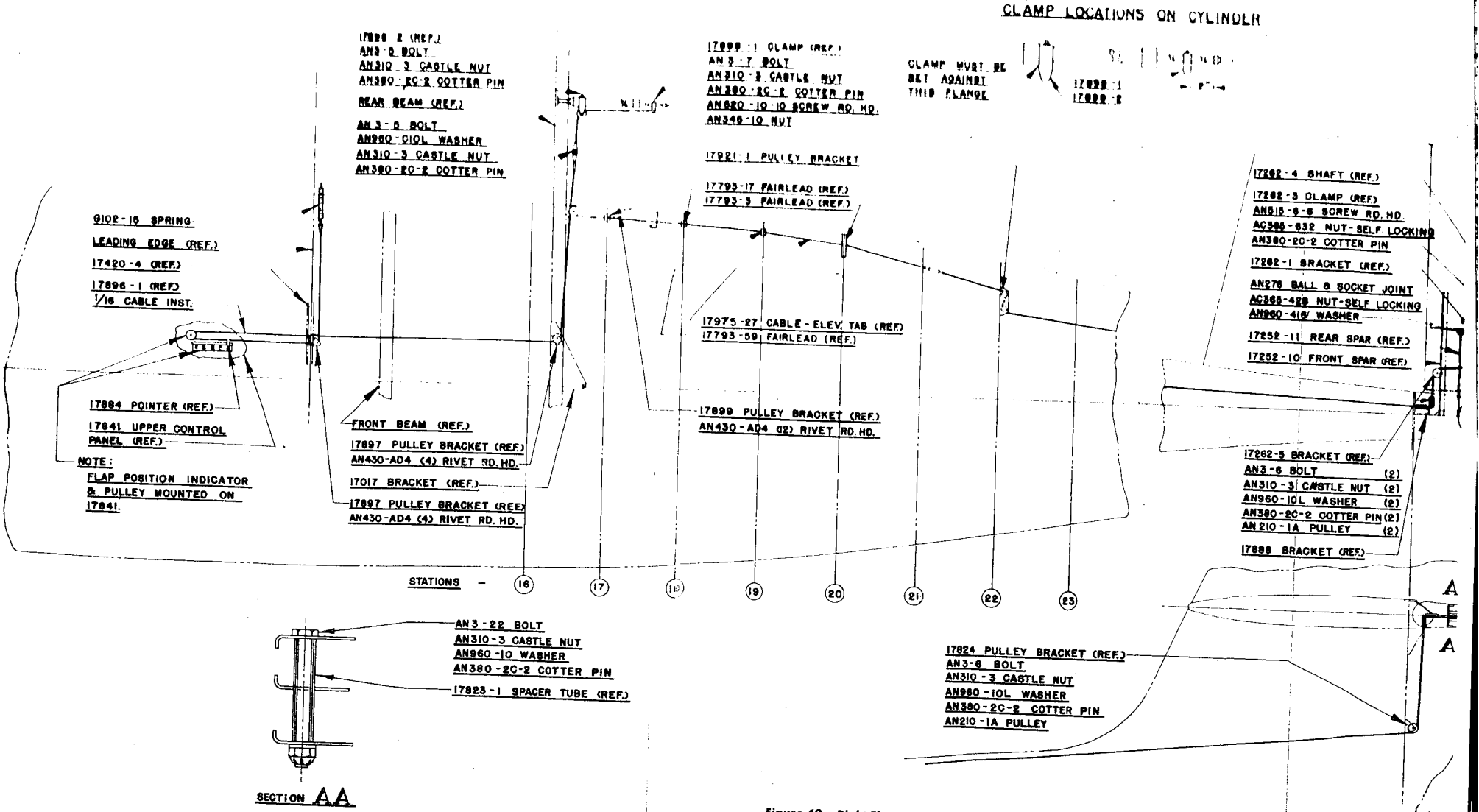


Figure 42 — Right Elevator Balance Tab Control

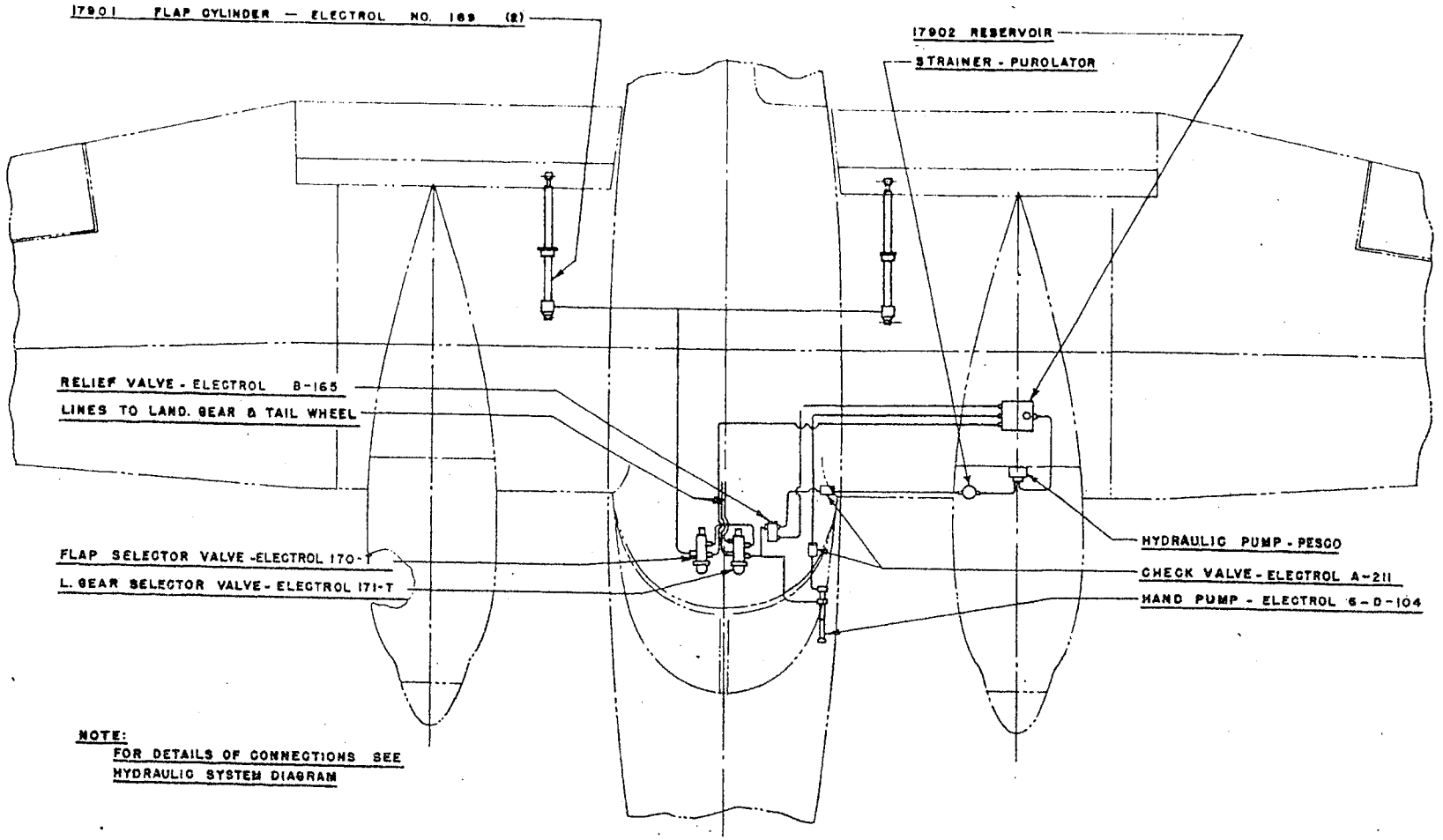


Figure 43 — Wing Flap Control

I. HEATING AND VENTILATING

Heating System

The cabin heating system consists of an exhaust manifold heater tube assembly in each engine nacelle, cold air screened inlet ports in the wing leading edges, two remote control mixing valves with control handles in the cabin, and air ducts.

Air from the exhaust intensifier tubes is carried to the cabin through the wing leading edge by flexible tubing, into which is let cold air from intake. The mixing valves regulate the mixture of hot and cold air which is let into the cabin at two points in the floor, at the front of the cockpit and under the auxiliary seat.

CAUTION: HEATER TUBES IN EXHAUST MANIFOLDS ARE REMOVABLE AND SHOULD BE CAREFULLY INSPECTED EVERY 40 HOURS, OR AT LEAST EVERY TWO MONTHS, AND REPLACED EVERY 300 HOURS REGARDLESS OF CONDITION. THESE TUBES ARE MADE OF "INCONEL", A SPECIAL MATERIAL WHICH IS THE BEST OBTAINABLE FOR THIS USE, BUT AS THEY ARE CONTINUOUSLY SUBJECTED TO HOT EXHAUST BLAST, THEIR LIFE IS LIMITED.

THE IMPORTANCE OF CHECKING THE CONDITION OF THESE TUBES AT REGULAR SHORT INTERVALS CANNOT BE EMPHASIZED TOO HIGHLY, AS ANY LEAK OR CRACK WILL ALLOW POISONOUS EXHAUST GASES TO BE CONDUCTED DIRECTLY TO THE CABIN.

Ventilation

An adjustable scoop, in the cabin ceiling, is provided for fresh air supply.

Figure 44 – Cabin Interior – Looking Forward

Figure 45 – Cabin Interior – Looking Aft

J. JACKING, HOISTING, TOWING AND ANCHORING

To remove or replace a wheel, the airplane may be raised by using the axle as a jacking point.

A fitting is provided on top of the wing on the centerline for hoisting the airplane.

A drawing of the hull supports used at the factory is shown on Fig. 46. Operators are urged to have a set built so that adjustment of the landing gear and repairs to the hull may be carried out conveniently. These supports are of such size that they may easily be placed under the hull without a hoist. Proceed as follows:

1. With airplane resting on wheels, lift tail high enough to place support under Sta. #15.
2. Pull tail down far enough to place support under Sta. #7.
3. Slide support under tail and push forward as far as possible to Sta. #22, approximately.

The bow is provided with a cleat for use in towing, anchoring or mooring the airplane. Wing handling rings are provided at the wing tips.

A twelve pound Northill folding type anchor with 100 feet of 1/2" dia. manila line is stowed in the bow compartment. Access to this compartment is through either the bow hatch (double outwardly hinged doors) or the door leading to the pilot's compartment.

Spirit Levels

Two spirit levels are located in the hull for leveling the airplane; one on the wall at the pilot's elbow and the other under the upholstery on the aft section of the right hand side of the landing gear wheelpocket.

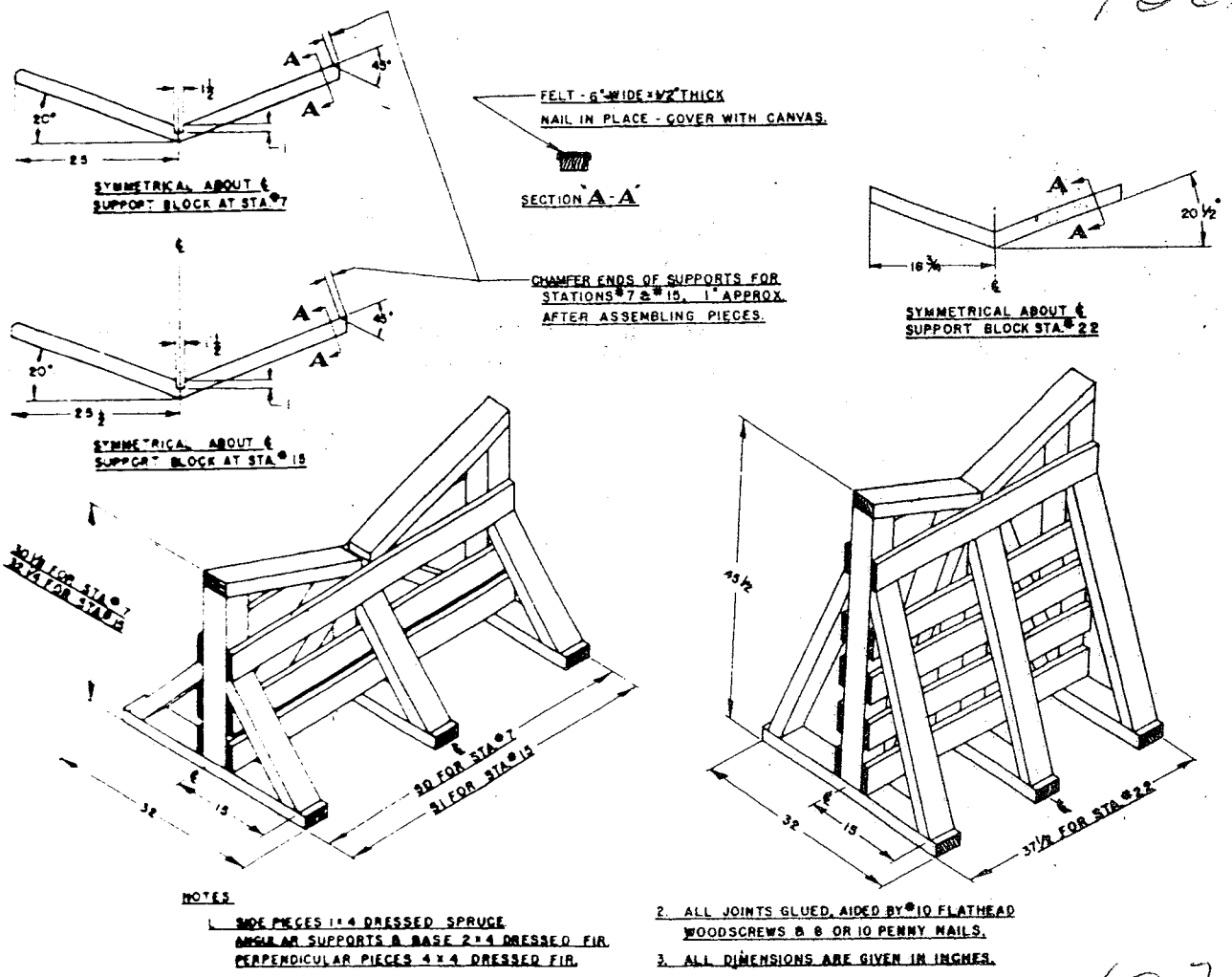


Figure 46 — Hull Supports

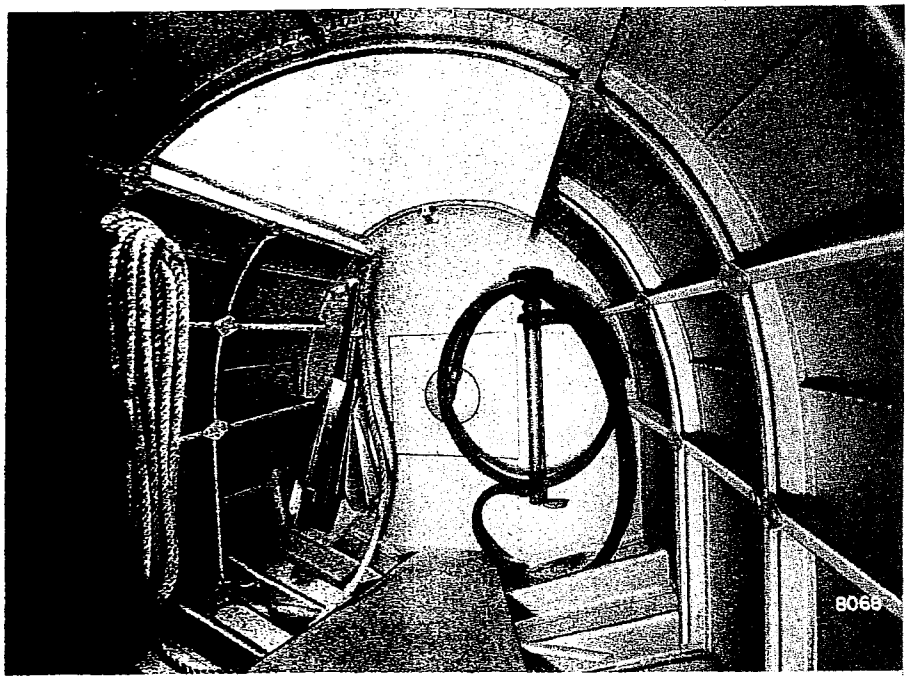


Figure 47 — Bow Compartment

SECTION V

USEFUL LOAD

A. LOADING SCHEDULE

This schedule has been prepared to permit a relatively simple and rapid check on balance by operating personnel for any combination of Useful Load and Special Equipment, or with Weight Empty Equipment removed for some particular mission.

The definition of terms used in this schedule are listed below:

1. Basic Weight

   This weight represents the actual weight empty plus non-expendable useful load items (Radio Equipment, etc.)

2. Index Unit

   An index unit is the moment (weight x distance) of any item in the airplane about the horizontal reference line divided by 1000 to allow greater ease of handling.

3. Limiting C.G. Lines (See Fig. [redacted] 50).

   The diagonal lines represent the recommended balance limits between which the center of gravity should be maintained.

4. A sample calculation showing how these data are used has been included on page 109.

Crew, Passengers & Variable Items of Equipment

Item	Weight	Index Unit
Basic Weight	3210	376.69
Pilot	170	15.98
Co-Pilot	170	15.98
1 Passenger (Auxiliary Seat)	170	20.23
1 Passenger (Aft)	170	25.84
1 Passenger (Aft)	170	25.84
Oil (8.3 Gals. Approx.)	62	6.82
Fuel	See Fig. 49	
*Baggage in Rear	See Fig. 49	
Baggage in Bow Compartment	20	1.00

*Maximum 400# Subject to C. G. Check.

Sample Calculation

Basic Weight	3210	376.69
Pilot	170	15.98
Co-Pilot	170	15.98
Oil (8.3 Gals.)	62	6.82
Fuel (108 Gals.) (From Fig. 1)	648	78.70
Baggage in Bow Compartment	20	1.00
Baggage in Rear (Fig. 1)	220	41.80
	4500	536.97

Plotting these coordinates on Fig. 50, shows the C.G. within the allowable limits.

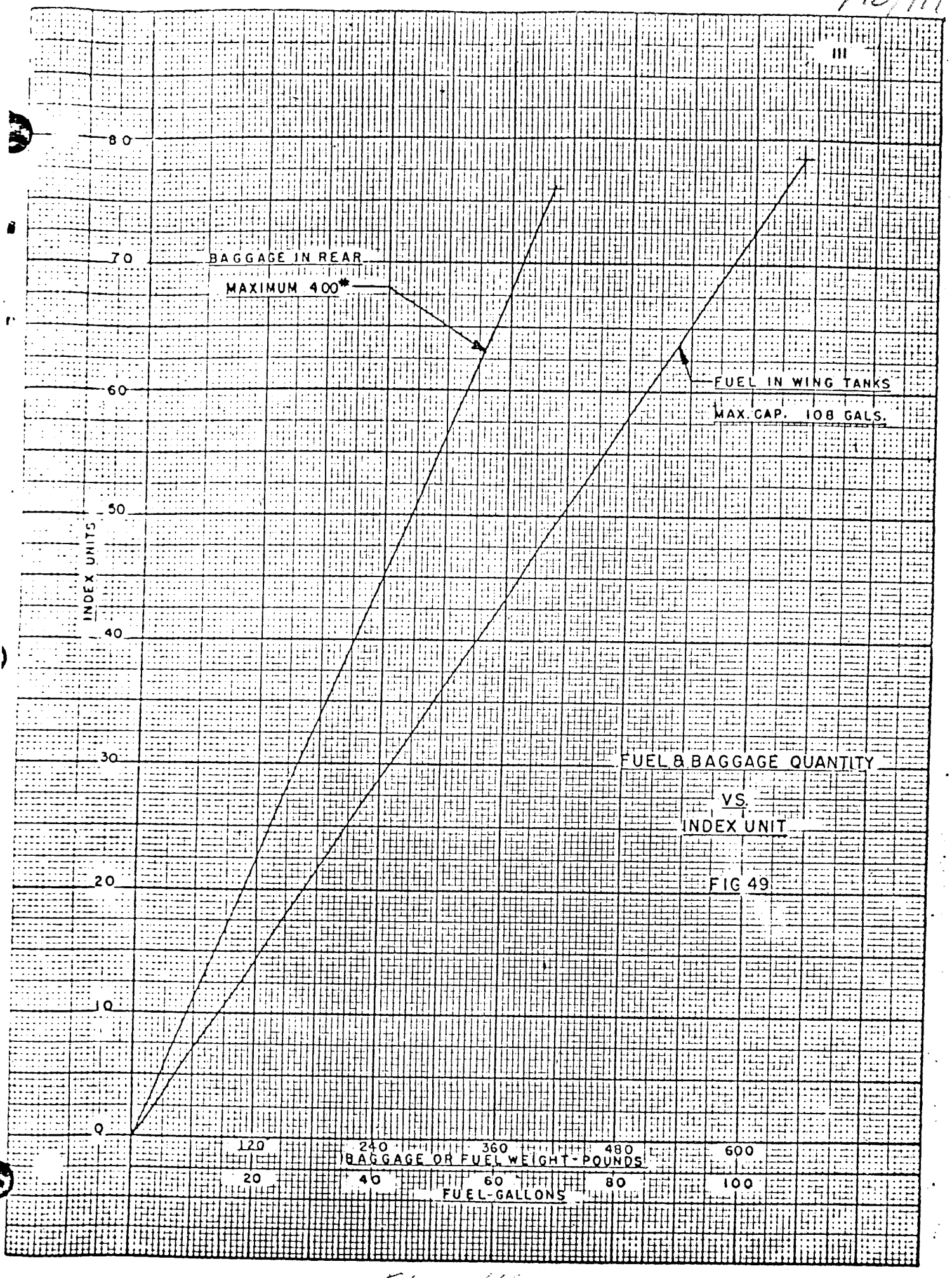
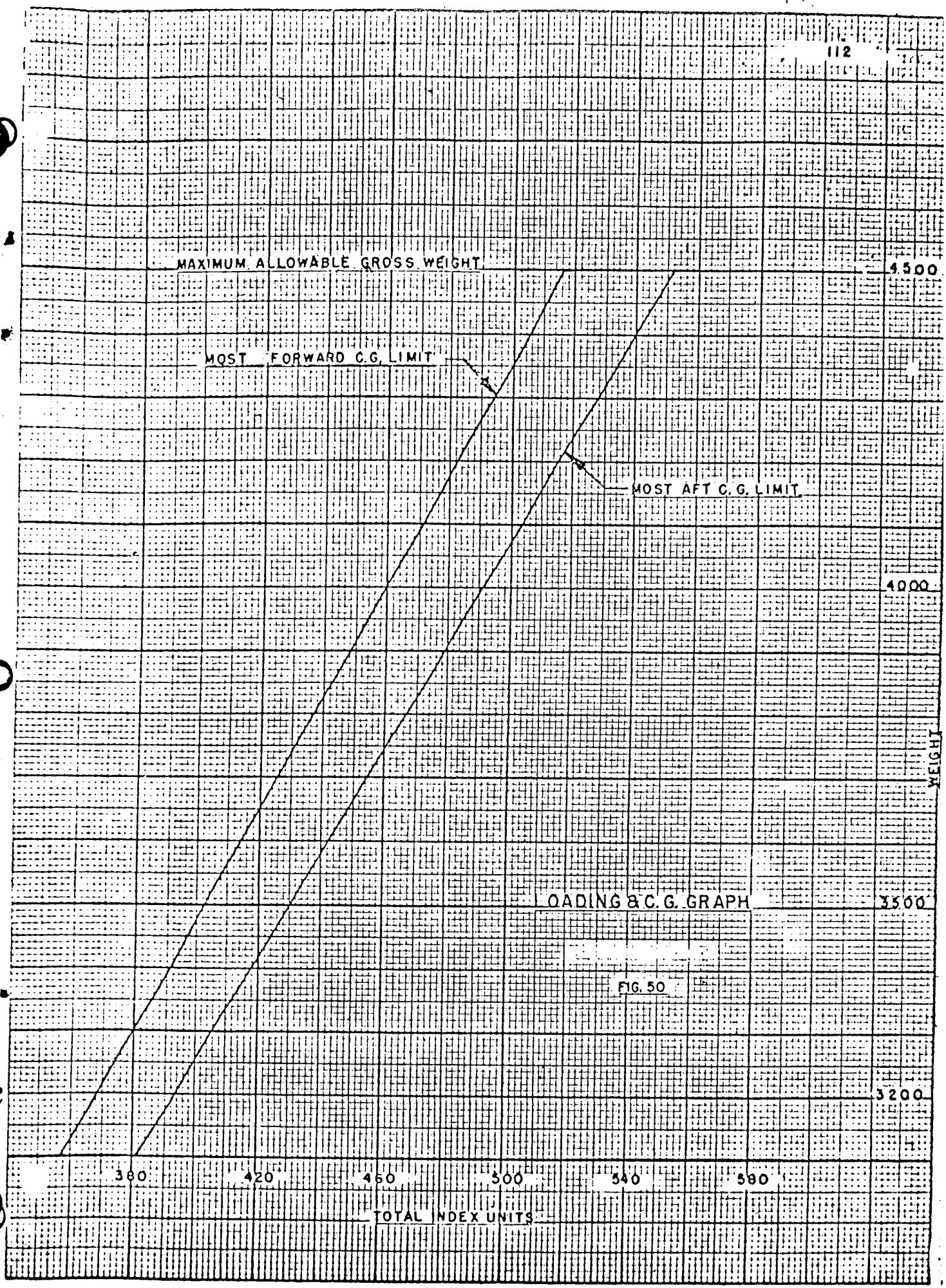

III
80
70
60
50
40
30
20
10
0
INDEX UNITS
BAGGAGE IN REAR
MAXIMUM 400*
FUEL IN WING TANKS
MAX. CAP. 108 GALS.
FUEL & BAGGAGE QUANTITY
VS.
INDEX UNIT
FIG 49
120
240
360
480
600
BAGGAGE OR FUEL WEIGHT-POUNDS
20
40
60
80
100
FUEL-GALLONS

FIG. 48


MAXIMUM ALLOWABLE GROSS WEIGHT
MOST FORWARD C.G. LIMIT
MOST AFT C.G. LIMIT
4500
4000
3500
3200
WEIGHT
LOADING & C.G. GRAPH
FIG. 50
380
420
460
500
540
580
TOTAL INDEX UNITS

B. EQUIPMENT

1. Communication

The following radio equipment is installed in the airplane:

1 Transmitter and Receiver - Lear T-30-RCBB

1 Trailing Reel Antenna - Lear

2 Headphone Sets

1 Microphone

The transmitter and receiver unit is installed in the bulkhead immediately aft of the co-pilot's seat (See Fig. 51), The dynamotor for the unit is located under the co-pilot's seat.

The trailing antenna is strung from the fairlead at the top of the rudder forward through the lead-in tubing projecting from the top surface of the wing center section and terminates on the reel mounted above the Upper Control Panel.

2. Miscellaneous

Map Case - located on the right hand wall of the pilot's cockpit.

Luggage rack - installed on the right hand wall in the aft section of the cabin.

Carbon tetrachloride "Pyrene" portable hand fire extinguisher - installed under the pilot's seat.

Five seats - two in the pilot's cockpit and two in the cabin. The cabin also contains an auxiliary seat. All seats are equipped with safety belts.

One Engine Tool Kit, two Pilot's Handbooks and one Erection and Maintenance Manual are also included.

The bow compartment is equipped with the following:

One 12#, non-magnetic steel, stockless (Northill Type) anchor, with 100 feet of 1/3/4" manila line.

One bilge pump with hose.

Figure 57 – Radio Panel

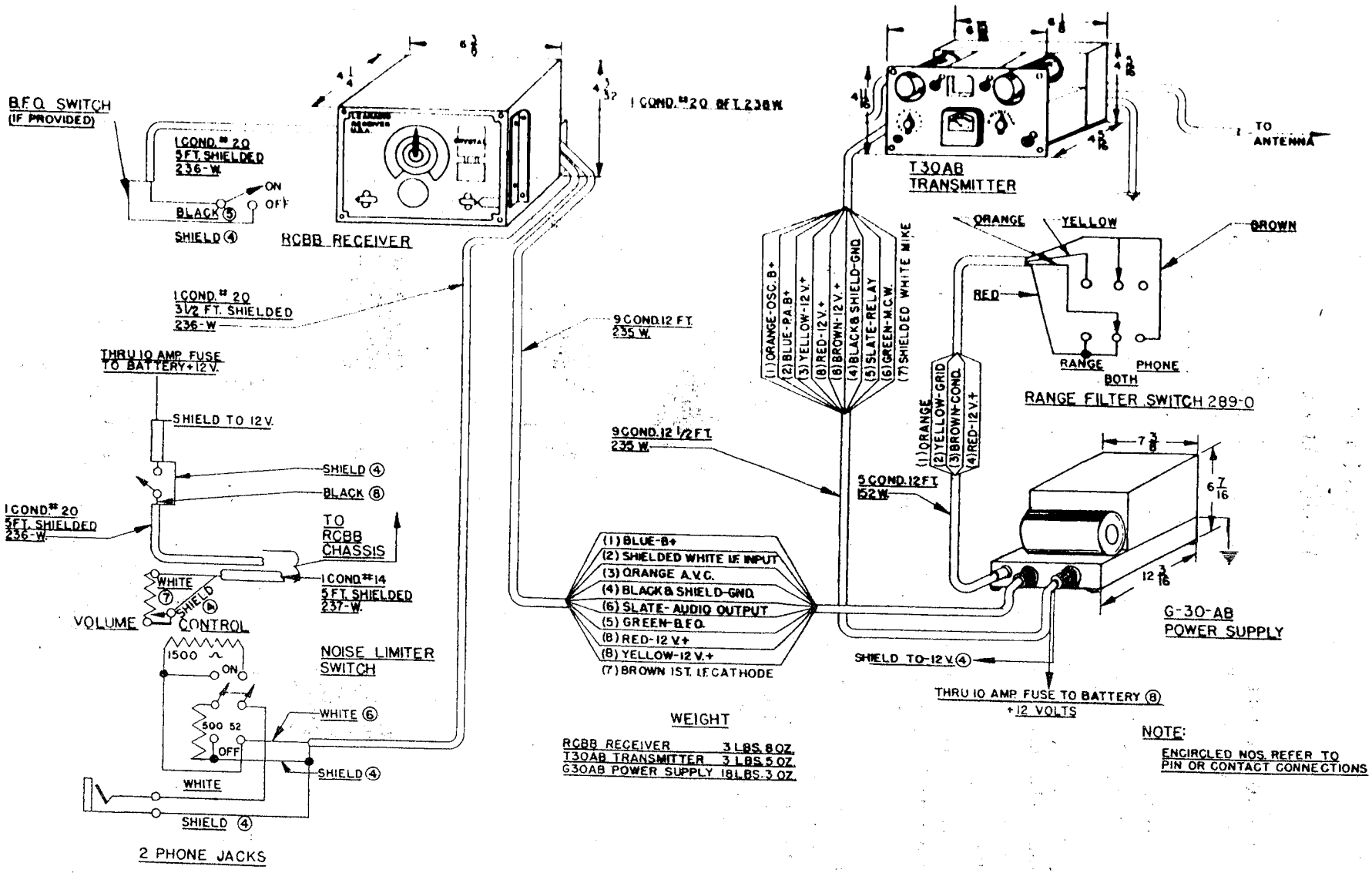


Figure 52 - Radio Connection and Cording Diagram

SECTION VI

INSPECTION AND LUBRICATION

A. INSPECTION

The standard airplane inspection routine applies to this airplane. It is suggested, however, that in addition to the routine inspection, special attention be paid to the following items.

Brakes

Check the oil reservoirs every twenty (20) hours; fill to within 1/4" of the top of the reservoir and inspect for possible leaks and abrasion of hydraulic lines. Maintain proper brake shoe clearance on drums as per instructions herein.

Engine Cowling

The cowling and attachments should be checked periodically to insure proper fitting on the engine compartment. Check for cracked or broken fitting supports and cowl plates.

Landing Gear and Tail Wheel

It is recommended that at the 100 hour inspection period the airplane be hoisted clear of the ground and a thorough check of the retracting mechanism made.

Shock Struts

The landing gear and tail wheel shock strut air pressures should be checked frequently and in addition, the struts should be inspected for corrosion, pitting of pistons and leaks.

Tires

Proper inflation pressure for main wheel tires is 40 lbs. and for tail tire is 45 lbs.

Corrosion Prevention

CAUTION: WHEN OPERATING IN SALT WATER, ALL LUBRICATORS EXPOSED TO WATER SHOULD BE PRESSURE LUBRICATED IMMEDIATELY AFTER EVERY EXPOSURE IN ORDER TO FORCE WATER FROM THE JOINTS, THUS PREVENTING CORROSION AND CONSEQUENT JAMMING.

Also, after each exposure to salt water, the entire ship should be washed off thoroughly with fresh water using a hose. Drain plugs should be removed and if any water is inside, that compartment should be thoroughly flushed with fresh water.

All exposed steel bolts and fittings may be effectively protected from corrosion by coating with Par-Al-Ketone "B" rustproofing compound, or equivalent.

Drain Plugs - (11)

1 - Forward of W.T. Bulkhead at Sta. #3

1 - Forward of W.T. Bulkhead at Sta. #7

1 - Forward of Step Bulkhead at Sta. #15

2 - Forward of T.W. Pocket at Sta. #26

1 - Forward of T.W. Pocket at Sta. #28

1 - Aft of W.T. Bulkhead at Sta. #30

2 - Each Wing Tip Float

All drain plugs are located near the keel on the starboard side, except those at the tail wheel pocket, which are located on both sides.

Regular inspection for the presence of bilge water should be made after overnight mooring. All hull compartments can be pumped free of water with any standard bilge pump.

Windows

All windows, including the windshield, are of various thicknesses of Plexiglass, a superior plastic material of exceptional clearness. This material is not affected by sunlight, salt water, gasoline or oil and will not discolor with age.

While it is considerably harder than ordinary pyralin, it will scratch if cleaned with gritty rags. Always wipe off carefully with a soft clean rag, thoroughly loosening dirt or grease with water or gasoline before rubbing hard. Scratches, even deep ones, may be removed as follows:

Small scratches: Work out with a turpentine and chalk mixture and polish with Berryloid lacquer polish using a clean flannel rag. As the polishing material in this product is extremely fine, considerable patience is required for a fine job.

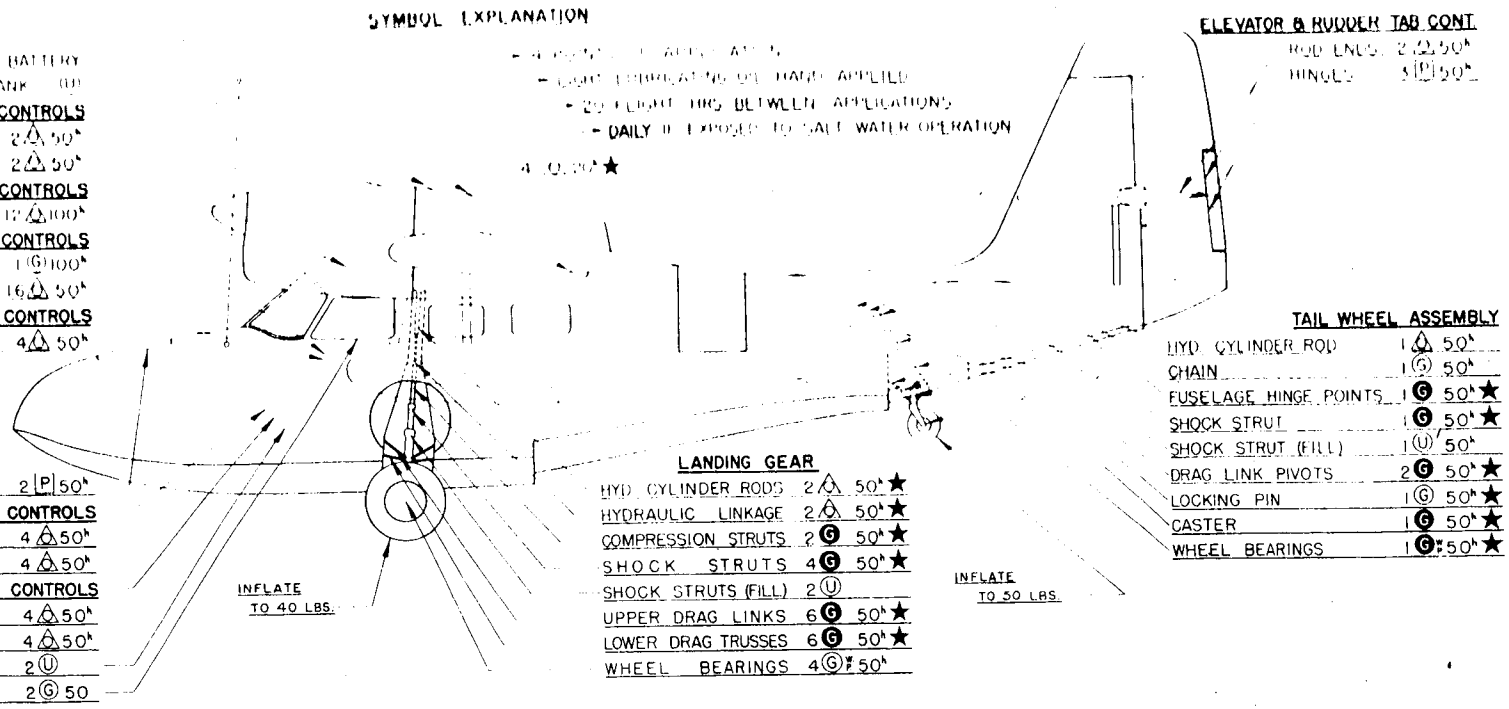
Deep scratches: Wet sand with #420 Wet-or-Dry paper until scratches disappear. Remove sandpaper frosting with "Kenite" rubbing compound, finally finishing off with chalk and Berryloid polish as above. A soft buffing wheel mounted on an electric drill will reduce labor involved in the final polishing operation.

WARNING: DO NOT USE GRITTY SOAPS OR CLEANERS. NEVER CLEAN PLEXIGLASS WITH DOPE OR LACQUER THINNER OR ANY OF THE FOLLOWING SOLVENTS: ACETONE, ETHYL ACETATE, BENZENE OR ETHYL DICHLORIDE. ALL THESE LIQUIDS ARE ABSORBED BY PLEXIGLASS AND WILL SO CHANGE ITS STRUCTURE THAT EXPOSURE TO WATER OR MOIST AIR WILL CAUSE SEVERE CLOUDING.

B. LUBRICATION

The lubrication chart contained herein should be followed when lubricating the airplane.

The chart indicates plainly the units, points of lubrication, lubricant to be used and the proper lubrication periods. All gun type lubricators are painted yellow.



AFTER EXPOSURE TO SALT WATER ALL PRESSURE LUBRICATOR FITTINGS SHOULD BE GREASED, THUS EJECTING POSSIBLE WATER AND PREVENTING CORROSION

FOR ENGINE LUBRICATION INFORMATION - REFER TO THE ENGINE MANUFACTURERS MANUAL

LEGEND	GRUMMAN RECOMMENDATION
Ⓖ HIGH PRESSURE GREASE	TEXACO MARFAK #2
△ LIGHT LUBRICATING OIL	MARVEL MYSTERY OIL
Ⓟ ANTI-CORROSION GREASE	PAR-AL-KETONE-B
Ⓤ HYDRAULIC FLUID (MINERAL BASE)	UNIVIS #40
Ⓖ* WATER-PROOF GREASE	GULF W.P. GREASE
Ⓖ GREASE GUN-APPLICATION	TEXACO MARFAK #2
★ DAILY IF EXPOSED TO SALT WATER OPERATION	TEXACO MARFAK #2

ALL BALL BEARINGS AND CONTROL PULLEYS ARE LUBRICATED AND SEALED BY THE MANUFACTURER AND REQUIRE NO FURTHER ATTENTION. ALL EXPOSED FITTINGS SHOULD BE PROTECTED BY PAR-AL-KETONE - B

Figure 53 - Lubrication Chart

SECTION VII

MATERIALS OF CONSTRUCTION

A. Materials

In general the airplane is constructed of 24ST aluminum alloy sheets, extrusions, bar and tubing. These materials are fabricated in accordance with U. S. Specifications.

The following is a list of heat treated parts:

Wings

Part No.	Name	H.T. p.s.i.	Material
17020-1	Support Fitting - Wing Front & Rear Beam	125,000	Chr. Moly. Steel
17020-2	Support Fitting - Wing Front & Rear Beam	125,000	Chr. Moly. Steel
17020-3	Support Fitting - Wing Front & Rear Beam	125,000	Chr. Moly. Steel
17020-4	Support Fitting - Wing Front & Rear Beam	125,000	Chr. Moly. Steel
17021	Fitting - Wing Hoisting Sling	125,000	Chr. Moly. Steel
17024-17	Splice Plate - Beam, Wing Center Section & Outer Panels	125,000	Chr. Moly. Steel
17024-20	Splice Plate - Beam, Wing Center Section & Outer Panels	125,000	Chr. Moly. Steel
17024-21	Splice Plate - Beam, Wing Center Section & Outer Panels	125,000	Chr. Moly. Steel
17024-25	Splice Plate - Beam, Wing Center Section & Outer Panels	125,000	Chr. Moly. Steel
17024-26	Splice Plate - Beam, Wing Center Section & Outer Panels	125,000	Chr. Moly. Steel
17041-2	Fittings - Wing Tip Float Connection	150,000	Chr. Moly. Steel
17041-3	Fittings - Wing Tip Float Connection	150,000	Chr. Moly. Steel
17578	Angle Clip - Wing Tip Float	150,000	Chr. Moly. Steel

Landing Gear - Main Wheels & Tail Wheel

17378-1	Fitting - Landing Gear Support	125,000	Chr. Moly. Steel
17378-2	Fitting - Landing Gear Support	125,000	Chr. Moly. Steel
17378-3	Fitting - Landing Gear Support	125,000	Chr. Moly. Steel
17378-4	Fitting - Landing Gear Support	125,000	Chr. Moly. Steel
17501	Axle Member - Landing Gear	180,000	Chr. Moly. Steel
17502	Truss - Landing Gear Lower Drag (Assem)	150,000	Chr. Moly. Steel
17503	Link - Landing Gear Upper Drag	150,000	Chr. Moly. Steel
17504	Link - Landing Gear Compression	150,000	Chr. Moly. Steel
17509	Support - Landing Gear UP Catch	150,000	Chr. Moly. Steel
17516	Tube - Landing Gear Compression Link Support	125,000	Chr. Moly. Steel
17521	Terminal - Hyd. System L.G. Actuating Cylinder Lower	125,000	Chr. Moly. Steel
17523	Catch - Landing Gear Actuating Linkage	150,000	Chr. Moly. Steel
17528	Washer - Landing Gear Assembly	150,000	Chr. Moly. Steel
6646	Hook - Tail Wheel Latch	150,000	Chr. Moly. Steel

Part No.	Name	H.T. p.s.i.	Material
6654	Drag Link - Tail Wheel Assembly	125,000	Chr. Moly. Steel
6659	Bushing - Tail Wheel Torque Tube	125,000	Chr. Moly. Steel
6660-1	Plunger - Tail Wheel Swivel Stop	150,000	Chr. Moly. Steel
6669-1	Bushing - Tail Wheel Assembly	125,000	Chr. Moly. Steel
6669-3	Bushing - Tail Wheel Assembly	125,000	Chr. Moly. Steel
6669-4	Bushing - Tail Wheel End Strut	125,000	Chr. Moly. Steel
17551	Fork - Tail Wheel	150,000	Chr. Moly. Steel
17558	Bolt - Tail Wheel Drag Link	125,000	Chr. Moly. Steel
17067	Bushings - Aileron & Tail Wheel Bell-cranks	125,000	Chr. Moly. Steel
17257-3	Stabilizer Strut - Adjustable End	125,000	Chr. Moly. Steel
17281	Bolt - Lower Rudder Hinge	125,000	Nickel Steel
17712	Exhaust System - Stainless Steel Tubing		
17853	Pedal - Pilot's Rudder	125,000	Chr. Moly. Steel
17854	Pedal - Co-pilot's Rudder	125,000	Chr. Moly. Steel
17864	Pawl - Rudder Pedal Lock	125,000	Chr. Moly. Steel

B. PROPRIETARY LIST

Standard items of equipment used on this airplane are listed below, together with the name and address of the respective manufacturer.

Questions arising relative to care, maintenance or repair of these parts may be referred directly to the manufacturer's instruction manual.

Engines

Ranger Aircraft Model 6-440C-5

Ranger Aircraft Engines
Farmingdale, L.I., N.Y.

Starters and Generator

Eclipse Type E-80 (Starters)
Eclipse D-1-309-9 (Generator)

Eclipse Aviation Corp.
East Orange, New Jersey

Propellers

Sensenich 82-RS-72

Sensenich Brothers
Lititz, Pennsylvania

Wheels, Master Brake Cylinders, Expander Tube Brakes

Hayes Industries, Inc.
Jackson, Michigan

Hydraulic Actuating Cylinders, Selector Valves and Hand Pump

Electrol, Inc.
Kingston, N.Y.

Tires & Tubes

B.F. Goodrich Company
Akron, Ohio

Landing Light

Grimes Manufacturing Company
Urbana, Ohio

Instruments

Pioneer Instruments
Division of Bendix Aviation
Bendix, New Jersey

Kollsman Instrument Company
Elmhurst, L.I., N.Y.

Lewis Engineering Company
Naugatuck, Connecticut

Weston Electrical Instrument Co.
Newark, New Jersey

Aero Instrument Company
3401 Vega Avenue
Cleveland, Ohio

United States Gauge Company
44 Beaver Street
New York, New York

Shock Struts (L.G. & T.W.)

Bendix Products Division
Bendix Aviation Corporation
South Bend, Indiana

Electrical Fuses

Litelfuse Incorporated
4749 Ravenswood Avenue
Chicago, Illinois

Fuel & Hydraulic Pump (Pesco)

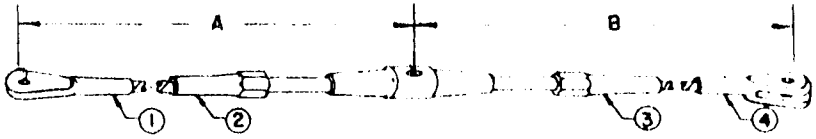
Pump Engineering Service Corporation
12910 Taft Avenue
Cleveland, Ohio

Radio Equipment

Lear Avia, Inc.
Dayton, Ohio

Tab Actuators

Breeze Corp.
24 S. 6th Street
Newark, New Jersey



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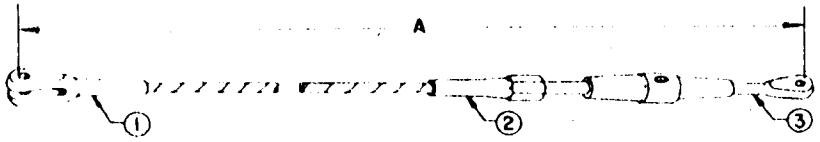

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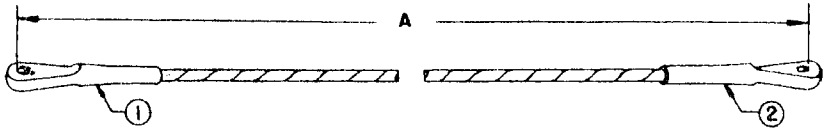
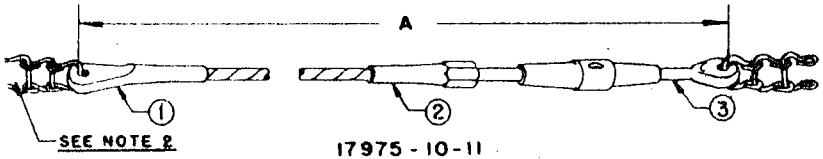


17975-5-6-13-14



17975-10-11

CABLE LOCATION	PART NO.	A	B	TERMINAL	BARREL	TERMINAL	*CABLE SIZE
AILERON-HULL L.H.	17975-9	14'-7 1/4"		1. AN 667-5 2. AN 669-5S L.H.	AN 155-32S	3. TURNBUCKLE FORK AN 160-32S	5/32 D 14'-11"
AILERON-HULL R.H.	17975-8	14'-7/8"		1. AN 667-5 2. AN 669-5S L.H.	AN 155-32S	3. TURNBUCKLE FORK AN 160-32S	5/32 14'-4"
AILERON-WING, FORWARD	17975-7	14'-9 5/8"		1. AN 667-5 2. AN 669-5S L.H.	AN 155-32S	3. TURNBUCKLE FORK AN 160-32S	5/32 15'-4"
AILERON-WING, AFT	17975-15	14'-10"		1. AN 667-5 2. AN 669-5S L.H.	AN 155-32S	3. TURNBUCKLE FORK AN 160-32S	5/32 D 15'-4"
COLUMN - L.H.	17975-6	1'-9"		1. AN 668-4		2. AN 668-4	1/8 2'-3"
COLUMN - R.H.	17975-5	2'-3 15/16"		1. AN 668-4		2. AN 668-4	1/8 D 2'-7"
ELEVATOR-UPPER	17975-3	12'-10 3/4"	10'-13/8"	1. AN 668-5 2. AN 669-5S R.H.	AN 155-32S	3. AN 669-5S L.H. 4. AN 667-5	FWD 5/32 D 10'-5" AFT 5/32 D 13'-3"
ELEVATOR-LOWER	17975-4	11'-11 1/4"	15'-5/8"	1. AN 668-5 2. AN 669-5S R.H.	AN 155-32S	3. AN 669-5S L.H. 4. AN 667-5	FWD 5/32 D 5'-5" AFT 5/32 D 12'-3"
ELEVATOR-TAB-L.H.	17975-11	38'-10 1/4"		1. AN 668-2 2. NAF 310621-S8D-2 L.H.	AN 155-8S	3. TURNBUCKLE EYE AN 170-8SR	1/16 D 39'-3"
ELEVATOR TAB-R.H.	17975-12	13'-5 1/2"	6'-7/8"	1. AN 667-2 2. AN 669-2 R.H.	AN 155-8S	3. AN 669-2 L.H. 4. AN 668-2	FWD 1/16 D 5'-10 3/8" AFT 1/16 13'-3
ELEVATOR TAB INDICATOR	17975-14	1'-10 1/16"					1/16 2'-4"
FLAP INDICATOR	17975-13	9'-13/16"		1. AN 668-2		2. AN 668-2	1/16 D 9'-5"
RUDDER - L.H.	17975-2	12'-8 1/4"	12'-1/2"	1. AN 668-5 2. AN 669-5S R.H.	AN 155-32S	3. AN 669-5S L.H. 4. AN 667-5	FWD 5/32 D 13' AFT 5/32 D 12'-5"
RUDDER - R.H.	17975-1	11'-10"	12'-11"	1. AN 668-5 2. AN 669-5S R.H.	AN 155-32S	3. AN 669-5S L.H. 4. AN 667-5	FWD 1/16 - D 12'-4" AFT 5/32 D 13'-4"
RUDDER TAB	17975-10	37'-3 1/2"		1. AN 668-2 2. NAF 310621-S8D-2 L.H.	AN 155-8S	3. TURNBUCKLE EYE AN 170-8SR	1/16 D 37'-7"

NOTE:
1. * AN-RR-C43
2. #1 BOSTON LADDER CHAIN

NO
1. * AN-RR-C43
2. #1 BOSTON LADDER CHAIN

CABLE CHART

FIG. 54