

HANDBOOK
OF
SERVICE INSTRUCTIONS
(British Air Publication 2021A, Volume 1)
FOR THE
LIGHTNING I AEROPLANE
(Similar To A. A. F. P-38)

MANUFACTURED BY
LOCKHEED AIRCRAFT CORPORATION
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THE LIGHTNING I AEROPLANE

NOTES TO OFFICIAL USERS

Air Ministry Orders and Volume II leaflets as issued from time to time may affect the subject matter of this publication. It should be understood that amendment lists are not always issued to bring the publication into line with the orders or leaflets and it is for holders of this book to arrange the necessary link-up.

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Comments and suggestions concerning the subject matter of this publication should be forwarded through the usual channels.

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**Note - Sections 1 and 2 are published separately as 'Pilot's Notes'; Section 3
is not applicable to this type.

LEADING PARTICULARS

Name.....Lightning I
Duty.....Interceptor Fighter
Type.....Single Seater, Twin-Engine, Land Plane

PRINCIPAL DIMENSIONS

Span, Overall.....52 Ft. 0 In.
Length, Overall.....37 Ft. 9 15/16 In.
Height, Overall, at Rest.....9 Ft. 9 5/8 In.
Height, Airscrew Hub, at Rest.....6 Ft. 9 1/2 In.
Clearance, Airscrew Tips to Ground.....11 In.
Clearance, Airscrew Tips to Fuselage.....9 1/2 In.

MAIN PLANES

Area, Total, Including Ailerons.....327.50 Sq. Ft.
Chord, Root.....9 Ft. 9 In.
Chord, M.A.C.....7 Ft. 1/4 In.
Chord, Tip.....3 Ft.
Dihedral, Chord Plane.....5° 40'
Incidence.....2°
Sweepback Leading Edge.....5° 10'
Span, Centre Plane.....19 Ft. 2 In.
Span, Outer Plane (Incl. Tip).....16 Ft. 5 In.
Airfoil Section, Root.....N.A.C.A. 23016
Airfoil Section, Tip.....N.A.C.A. 4412
Ailerons. Each, Area. Incl. Tab.....12.22 Sq. Ft.
Area Each Tab......50 Sq. Ft.
Flaps, Each, Area.....40.0 Sq. Ft.

TAIL UNIT

Elevators
Area, Including Tab.....24.55 Sq. Ft.
Area, Tab.....1.73 Sq. Ft.
Tail Plane
Span.....21 Ft. 9 In.
Incidence Fixed.....+1° 15'
Area.....53.99 Sq. Ft.
Fins Each (Without Rudder)
Area.....13.71 Sq. Ft.
Rudders, Each
Area (Including Tab).....10.68 Sq. Ft.
Area, Tab.....1.37 Sq. Ft.

ENGINES (TWO)

Engine Make.....Allison V.1710 - C.15 R.H. Rotation
Engine Type & Cooling System.....60° 'V' Liquid Cooled
Thrust Line Incidence to Ref. Line.....Nil
Engine Centres-(Centre Line of Aeroplane to Centre Line of Engines)....8 Ft.
Carburettor.....Bendix Stromberg PT-13E1
Fuel.....100 Octane
Oil.....Summer Spec. DTD 472 Grade C
Winter Spec. DTD 472 Grade B

NOTE: For detailed Service and Maintenance information pertaining to the engines refer to A.P. 2048A.

AIRSCREWS (TWO)

Airscrew Type & Make-Curtiss Electric Full Feathering, Controllable Pitch
Number of Blades.....Three
Diameter.....11 Ft. 6 In.

NOTE: For detailed Service and Maintenance information refer to the relevant Airscrew Manual.

TANKS

Fuel	
Front-Reserve Tanks, Each.....	Normal 31 - Alternate 50 Imp. Gal.
Rear-Main Tanks, Each.....	Normal 62 - Alternate 77 Imp. Gal.
Oil	
Two Tanks, one in each nacelle	
Capacity, Each.....	Normal 7 Imp. Gal. Alternate 10 Imp. Gal.
Air Space.....	1.2 Imp. Gal.
Total.....	11.2 Imp. Gal.

HYDRAULIC SYSTEM

Engine Pump, Make.....	Pesco #466
Operating Pressure.....	1150-1350 lbs. sq. in.
Fluid.....	Intava Servo Fluid or Equiv.

AIRSPEED INDICATOR PRESSURE HEAD POSITION

Position.....	Fuselage Nose Sta. 38 15/16
Incidence.....	Nil
Distance from Centre Line of Aeroplane.....	Nil
Tolerance on Linear Dimensions.....	1/32
Tolerance on Angular Setting.....	1/2°

MOVEMENT OF CONTROL SURFACES

(Linear dimensions measured on chord of arc)

Ailerons (Measured at inboard ends)	
Up.....	23 1/2°.....8 11/16 ± 3/8 In.
Down.....	8°.....3 ± 3/16 In.
Aileron Tab (Measured at inboard ends)	
Up.....	21° (Min.)...25°...(Max.) 1 11/16 In. (Min.) 2 In. (Max.)
Down.....	20°.....1 5/8 ± 1/16 In.
Elevator	
Up.....	30°.....10 3/8 ± 1/8 In.
Down.....	14°.....4 7/8 ± 3/16 In.
Elevator Tab	
Up.....	25°.....2 5/16 ± 1/16 In.
Down.....	25°.....2 5/16 ± 1/16 In.
Rudders Each (Measured at tail plane)	
Right.....	28°.....11 1/2 ± 3/16 In.
Left.....	28°.....11 1/2 ± 3/16 In.
Rudder Tabs Each (Measured at lower end)	
Right.....	25°.....2 7/16 ± 1/16 In.
Left.....	25°.....2 7/16 ± 1/16 In.

UNDERCARRIAGE

Type.....Oleo-Leg, Tricycle, Retractable

MAIN WHEELS

Track.....	16 Ft. 6 In.
Shock Absorber Compression Leg.....	Oleo Pneumatic
Fluid.....	Intava Servo Fluid or Equivalent
Compression Leg Travel.....	10 Inches
Wheels.....	Goodyear
Brakes.....	Goodyear Hydraulic Disc Type
Fluid.....	Intava Servo Fluid or Equivalent
Tyres.....	Goodyear 36" Smooth Contour 10 Ply
Tyre Pressure.....	37 lbs./sq. in.

NOSE WHEEL UNIT

Shock Absorber Compression Leg.....	Oleo Pneumatic
Fluid.....	Intava Servo Fluid or Equivalent
Compression Leg Travel.....	12 Inches
Wheel.....	Bendix
Tyre.....	Goodyear 27" Smooth Contour 6 Ply
Tyre Pressure.....	40 lbs./sq. in.

INTRODUCTION

1. The Lightning I is an all metal, midwing, single-seater interceptor fighter type aeroplane fitted with two Allison V.1710 C.15 liquid cooled engines and Curtiss Electric Pull Feathering Airscrews. The undercarriage is of the fully retractable, tricycle type; each undercarriage well, enclosed by flush, automatically operated doors, when the wheels are retracted. The tail unit is supported by booms extending aft from the engine nacelles. All exposed skin is butt-joined and flush riveted.
2. The fuselage, a stressed skin, semi-monocoque structure of the gondola type extending forward from the trailing edge of the centre main plane at the plane of symmetry, is constructed principally of 24ST Alclad skin and formers, stiffened longitudinally by extruded bulb angle stringers and webs in the nose. The main plane, consisting of the centre plane and port and starboard outer planes is of the full cantilever, stressed skin type. The outer plane is attached to the centre plane by pins at the main and rear spars and 'bathtub' fittings in the upper and lower corrugations. The centre plane, the fuselage and the forward booms may, from a service viewpoint, be considered one unit, since they are mated in a jig and riveted and bolted together. The main spar and front and rear auxiliary spars form the main structure to which the ribs, bulkheads and skin are attached. The tail unit is fabricated of 24ST Alclad spars, ribs, stringers and skin, assembled with rivets, screws and plate nuts, and supported by booms extending aft from the engine nacelles.
3. Entrance to the cockpit is gained from the port side of the centre main plane by opening a hinged portion of the transparent cockpit enclosure. A mounting stirrup at the aft centre portion of the fuselage assists in mounting the centre main plane. The stirrup is replaced by a retractable ladder beneath the aft fuselage on later models.
4. The undercarriage consists of three retractable units, one in the fuselage nose and one in each forward boom. Each undercarriage unit is hydraulically actuated, swinging aft and upward into its respective well in the structure. An electrical indicator in the cockpit shows the position of the undercarriage. A warning horn sounds and a lamp on the instrument panel lights if the throttles are closed with the gear retracted. Each wheel is mounted on an oleo pneumatic leg. The main wheels are equipped with disc type hydraulically operated brakes, each main wheel having an independent brake system controlled by a toe pedal on the corresponding rudder pedal. The nose gear oleo leg is provided with a dual-cylinder hydraulic shimmy damper.
5. The ailerons and elevator are operated by the conventional control column and handwheel, the rudders by adjustable pendulum type pedals which also mount the brake toe pedals. Trimming tabs, provided on the ailerons, elevator and rudders, are adjustable in flight from the cockpit. The Lockheed-Fowler flaps are operated by a hydraulic motor. A flap position indicator on the instrument panel shows the position of the flaps.
6. Two Allison liquid cooled engines are installed in nacelles in the forward booms. The cowling is faired into the booms from the spinner, presenting a smooth streamline contour of small frontal area. Two complete and independent fuel systems are provided, one for each engine. Cross suction lines at the tank selector valves, make it possible to operate both engines on one tank if necessary. Each system contains a disc type tank selector valve, a strainer, an electrically driven booster fuel pump and an engine driven fuel pump. Four tanks of the rubber bag type are installed in the fore and aft portions of the centre main plane between the fuselage and booms. Each engine is provided with an independent oil system. The oil tank is mounted on the front face of the firewall in each nacelle. Two oil coolers mounted under each nacelle are provided with electrically operated air exit flaps controllable from the cockpit to regulate the amount of air passing through the cooler core. The cooling system includes radiators on each side of the aft booms. Hydraulic jacks actuate the air exit flaps, thereby governing the amount of air passing through the radiator core. The engines may be started electrically or by hand crank. The hand crank is carried in the starboard wheel well.
7. Fixed gun mounts are provided in the armament section of the fuselage nose for five .50 calibre machine guns. The centre machine gun may be replaced with a Mark II 20 mm. Hispano gun. Later models also include provisions for the installation of a gun camera in the fuselage nose. Both, ring and bead and optical type gun sights are provided. The armament compartment is fitted with doors hinged at the top of the fuselage giving complete access to guns, ammunition trays, charging controls, etc. Flares mounted vertically in the aft boom are released through spring loaded clam shell type doors on the under side of each boom.
8. A 30 volt-50 amp. generator driven by the port engine provides for lighting and general services, including solenoid gun triggers, airscrew pitch control mechanism, electrically driven auxiliary fuel pumps, engine starting, radio power, flap and undercarriage position indicators, etc. The accumulator is carried in the port aft boom. Other equipment includes armor plate, oxygen apparatus, retractable landing lights, automatic recognition device, formation light, etc.

HANDLING AND GENERAL PREPARATION

CHAPTER I

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CHAPTER I

HANDLING AND GENERAL PREPARATION

General

1. The following paragraphs deal with operations involved in the handling of the aeroplane and its preparation for flight.

2. Steps and Walkways

a. Mounting Stirrup - To assist personnel in ascending to the upper surface of the main plane, a mounting stirrup is provided. The stirrup is carried in a slot in the upper rear portion of the fuselage. (Note: For later series aircraft, a retractable ladder replaces the stirrup. The ladder is carried in the lower rear fuselage, with the ladder actuating handle situated in the upper rear portion of the fuselage.)

b. Walkways - Areas of the upper main plane surfaces on which walking is permissible are classified as walkways. These areas are as follows:

(1) Surfaces of the centre plane on both sides of, and adjacent to the fuselage.

(2) Surfaces of the centre plane on both sides of, and adjacent to both port and starboard booms.

(3) Surfaces of the centre plane between front and rear spars.

(4) Surfaces of the outer planes between main and rear spars.

Pads of suitable type must be placed on walkways before use, in order to protect the skin.

3. Towing and Picketing - (Fig. 1.) - The aeroplane may be towed from the eye on the nose landing gear fork, or from the eyes on the main landing gear struts. Picketing lines should be attached to eyes on the alighting gear and to aft boom eye bolts.

Refueling

4. Fuel - 100 Octane fuel is to be used. For servicing tanks, four filler necks are provided in the upper portion of the centre plane. (See Fig. 1). At each servicing, tanks and fuel strainers shall be drained of any condensate that may have accumulated since the last servicing. Main tank sumps and fuel strainers are accessible through a removable panel in the lower aft portion of the fuselage. (See Fig. 3.) Sumps for forward (or reserve) tanks are located in the lower surface of the centre plane (See Fig. 2). Earthing jacks are located in the inboard boom fillets, near the main tank caps. The condition of self-sealing tanks should be checked as far as possible by inspecting through the filler necks for evidence of swelling or wrinkling. Swollen or deteriorating tanks are evidenced by an abnormally low capacity or by abnormal fuel gauge readings.

5. Oil - Filler necks for servicing the oil tanks are recessed into the upper port sides of the tanks, mounted on the forward face of each firewall. Tanks are to be filled to petcocks (7 Imp. gal.) for the normal fuel load (187 Imp. gal.). For the fuel overload condition (256 Imp. gal.), oil tanks are to be filled to necks (10 Imp. gal.). Dip sticks are provided for determining the quantity of oil in the tanks.

NOTE: Avoid spilling oil around the filler necks and onto the tanks.

6. Engine Cooling System - Coolant system filler caps are reached through access doors located on the starboard side of each engine cowl, just aft of the spinner. Capacity of each system is 17-1/2 Imp. gal. Coolant tanks should be filled, (when aeroplane is in normal ground position) to the level of filler wells. Use ethylene glycol, Spec. D.T.D. 344.

NOTE: If the system has been drained, it must be vented at the cock in the return line.

7. Hydraulic System

a. **Main Reservoir** - The main reservoir is located on the rear face of the bulkhead at Station 195-15/16, in the upper aft portion of the fuselage. A door (closed by Dzus fasteners) in the fuselage skin above the tank provides access to the filler neck for filling and inspection. Tank is to be filled to within one-half inch of the bottom of the filler neck if the system is under pressure; otherwise tank should be filled to the bottom of the filler neck. Tank capacity is approximately 1-3/4 Imp. gal. Intava servo fluid or equivalent is to be used.

NOTE: If the system has been drained, it must be vented. See Chap. 2, of this section.

b. **Emergency Extension Reservoir** - This reservoir is located in the center of the fuselage, just behind the seat. It is filled through an opening in the top which is sealed by a removable plug. Intava servo oil or equivalent is to be used. Capacity is approximately 1-1/5 Imp. gal.

8. Loading Data

a. Three conditions are considered on the loading and C.G. Diagram (Fig. 4):

Condition 1 - With five 50 cal. machine guns.

Condition 2 - With four 50 cal. machine guns, one 20 mm. cannon and 60 rds of 20 mm. ammunition.

Condition 3 - With four 50 cal. machine guns, one 20 mm. cannon and 150 rds of 20 mm. ammunition.

b. A breakdown of the Items of Removable load is shown for each of the above three conditions. An operational all-up weight is obtained by adding the tare weight of the aeroplane to the sum of the Removable Load Items.

c. The Centre of Gravity of each of the Items of Removable Load is located by a small cross on the side view of the aeroplane (Fig. 4). The adjacent numbers refer to the Items of Removable Load which they represent, as indicated by the numbers opposite the Removable Load Items in the tabulated breakdown.

d. Ballast requirements for Items of Removable Load not in the aeroplane, are stated at right of items of removable load table.

e. Fuel tanks are to be loaded in the following manner: Front fuel first, additional fuel, when necessary, to be added to the rear tanks. Rear fuel is to be consumed first.

9.

SAMPLE CALCULATION OF MAXIMUM MILITARY LOAD

AND OF C.G. POSITION FOR OPERATIONAL FLIGHT

OF LIGHTNING I AIRCRAFT NO. AF-154 ON CONTRACT A-242

NOTE: The weights and moments on which the following calculations are based are to be taken from the loading and c.g. data given in Vol. I, Sect. 4, Chap. I.

The first step in calculating the maximum military load and c.g. position is to ascertain the effect of modifications embodied in the aircraft on the tare weight and the corresponding moment. In order to do this, the weight and moment of those modifications embodied in the aircraft which affect the tare weight must be added to, or subtracted from, the tare weight quoted on the loading and c.g. diagram.

Modifications embodied increasing tare weight	Wt. - lbs.	Moment - lb.in.
Installation of new type access ladder	10	2,170
(A) Total addition to tare weight	10	2,170
		Total additions to moment (a)

Modifications embodied decreasing tare weight	Wt. - lb.	Moment-lb.in.
--	-----------	---------------

None

(B) Total deductions from tare weight None	Total deductions from moment (b)
--	--

(C) Change in tare weight (A-B) .+. . 10 . . .lb. Change in tare moment
(a-b) +. .2,170....lb.in. (c)

(D) Tare weight, including weight
of modifications embodied .11,455. . . . lb. Corresponding moment
. . 1,751,676 lb.in. (d)

The next step is to calculate the weight and moment of the typical service load, less bomb or special load.

Removable items of military load to be carried on the flight, <u>excluding bombs or special load.</u>	Wt.-lb.	Moment-lb.in.
---	---------	---------------

Pilot and Chute	200	27,600
Fixed Armament (Complete installation of 4 50 Cal. Machine Guns and 1 20 mm. Cannon)	486	27,684
1200 Rds. 50 Cal. Ammunition	300	16,650
150 Rds. 20 mm. Ammunition	93	7,347
Oxygen Equipment	36	5,877
Wireless	75	14,289
Camera	14	154

(E) Total weight and moment of this load.	1,204	99,601	(e)
--	-------	--------	-----

Fuel necessary for the flight	Wt.-lb.	Moment-lb.in.
-------------------------------	---------	---------------

.....galls, 87 octane fuel at 7.5 lb/gall.		
250 " 100 octane fuel at 7.2 lb/gall.	1,800	298,440
20 " oil at 9 lb/gall.	180	27,360

(F) Total	1,980	325,800	(f)
-----------	-------	---------	-----

Gross weight excluding
bomb or special load.

Corresponding
moment

- (G) (D + E + F) 14,639 lb. (d + e + f) 2,177,077 lb.in. (g)
- (H) Maximum all-up weight at which the aircraft is to be taken-off for this flight . . . lb.
- (J) Bomb or special load which can be carried provided c.g. is within permissible limits. . .
None . lb.

It must now be determined whether when carrying this load the c.g. is within the permissible limits by taking moments.

Moment of bomb or special loadNone lb.in. (k)

Total moment 2,177,077. lb.in. (l)

Position of c.g. = $\frac{\text{Total moment}}{\text{Max. all-up weight}}$ = $\frac{2,177,077}{14,639}$ = 148.72 in.
behind axis of reference Gear Down

a. Fig. 5, Weight & Balance Diagram, shows the c.g. Limits in Percent of Mean Aerodynamic Chord (M.A.C.) to be:

Forward Limit	17.50%	Mac Gear Down
Rearward Limit	27.50%	Mac Gear Up

To determine whether the c.g. of the aeroplane, as loaded, falls between these limits, the Horizontal c.g. in percent of Mac. is computed from the following formula:

$$\frac{Ha - 130.51 \times 100}{84.25} = \% \text{ Mac.}$$

$$\text{viz. } \frac{148.72 (Ha) - 130.51 \times 100}{84.25} = 21.61\% \text{ Mac.}$$

To determine Gear up position, add the Gear Retraction Moment (41,813) to the total moment (l) and recalculate.

If the c.g. position is not within permissible limits the load must be so adjusted as to move the c.g. to a position within its permissible limits, or alternatively, a part of the load may have to be sacrificed to enable ballast to be carried. The adjustment should be made as follows:

- | | |
|--|---------------------------|
| (H) Maximum all-up weight.....lb. | Total moment.....lb.in. |
| | (h) |
| (M) Deduct load to be sacrificed...lb. | Deduct moment.....lb.in. |
| | (m) |
| (N) Reduced weight.....lb. | Reduced moment.....lb.in. |
| | (l-m) |
| (O) Add Ballast weights at
lb. each.....lb. | Moment.....lb.in. (o) |
| (P) Revised all-up weight.....lb. | Revised moment.....lb.in. |
| | (p) |

New position of c.g. = $\frac{\text{Revised max. all-up weight}}{\text{Revised moment}}$

= _____ = in. behind axis of reference.

b. Since this aircraft has no bomb or special load except for the possible carrying of equipment in the baggage compartment, it will not be necessary to continue the sample calculations through the remainder of the prescribed form. The maximum capacity of the baggage compartment is 50 pounds. If no ammunition is carried, however, this must be compensated for by 70 pounds of ballast carried in the ammunition boxes. As indicated on the loading diagram (Fig. 4) the range of the centre of gravity is temporarily set at 17.5% M.A.C. Gear Down to 27.5% M.A.C. Gear Up. However, for all normal operational loading conditions, the centre of gravity is within proper limits and any loadings using the baggage compartment may be compensated for as stated above.

c. Weight & C.G. Determination - It will only be necessary to reweigh the airplane in the event of added modifications or major repairs that are impossible to compute and added mathematically. If this occasion does arise, the following procedure is prescribed:

1. Place the aircraft on scales that have been previously calibrated for accuracy making sure that brakes are off and there is no binding or side load to affect the scale reading.

2. Place the aircraft in a longitudinally level position. This is accomplished by placing the front wheel sufficiently below the rear wheel level so that a spirit level placed on the fixed leveling pads (See Chap. 2, Para. 3) will read zero. Adding or removing air from the wheel shock struts will provide a fine adjustment after the airplane has been put in an approximately level position.

3. Take scale readings and measurements as per the Actual Weight and Balance Form (Fig. 6) and compute new weight and centre of gravity.

NOTE: The fixed Datum point is fuselage Sta. 160 and is located at centreline of lower portion of the Main Spar inboard of the nacelles on both sides of the airplane.

ARMAMENT

10. Lifting the armament hood provides access for servicing the guns. Four boxes of 500 rounds capacity each, carried in the armament compartment, feed the four outer guns. A 20 mm. cannon magazine of 60 rounds capacity or a 300 round .50 calibre ammunition box is mounted in the centre of the compartment to feed the cannon or centre machine gun whichever is installed. On later models the 20 mm. cannon magazine is replaced by a 150 round magazine and Chatellerault feed.

11. Gun Adjustment - A gun sighting chart (Fig. 3) showing the range of gun adjustment and the attitude of the aeroplane at various speeds is located on the inside of the armament hood. A set of adjustable lugs is provided for use in leveling the guns.

a. To check the setting of the adjustable gun leveling lugs--

(1) Level the aeroplane laterally and longitudinally using the fixed leveling plates in the cockpit. (See Chap. 2, Para. 3)

(2) Place a shim of .091 thickness on the forward gun leveling lug.

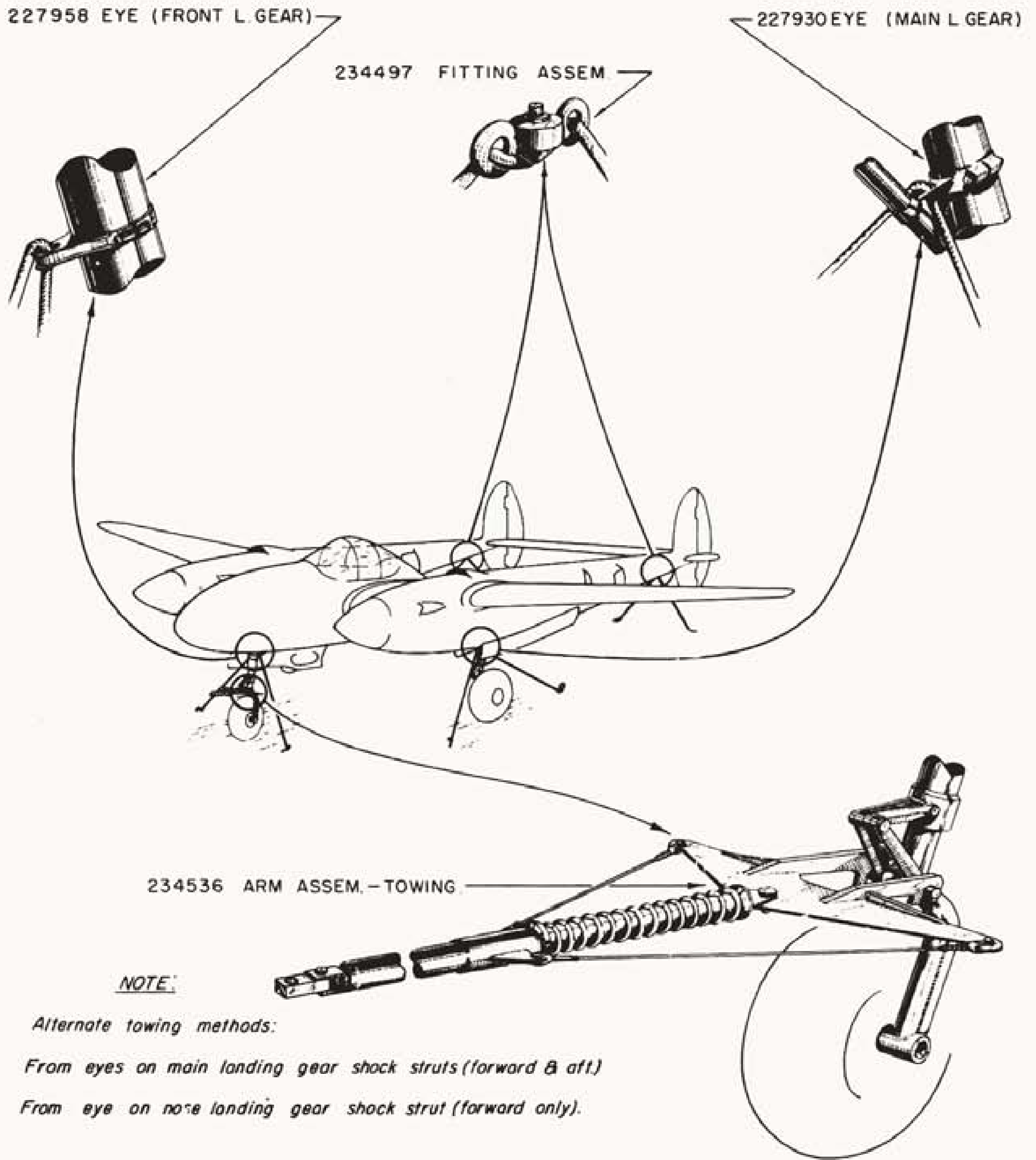
(3) A spirit level resting on the rear lug and on the shim stock on the forward lug should read zero.

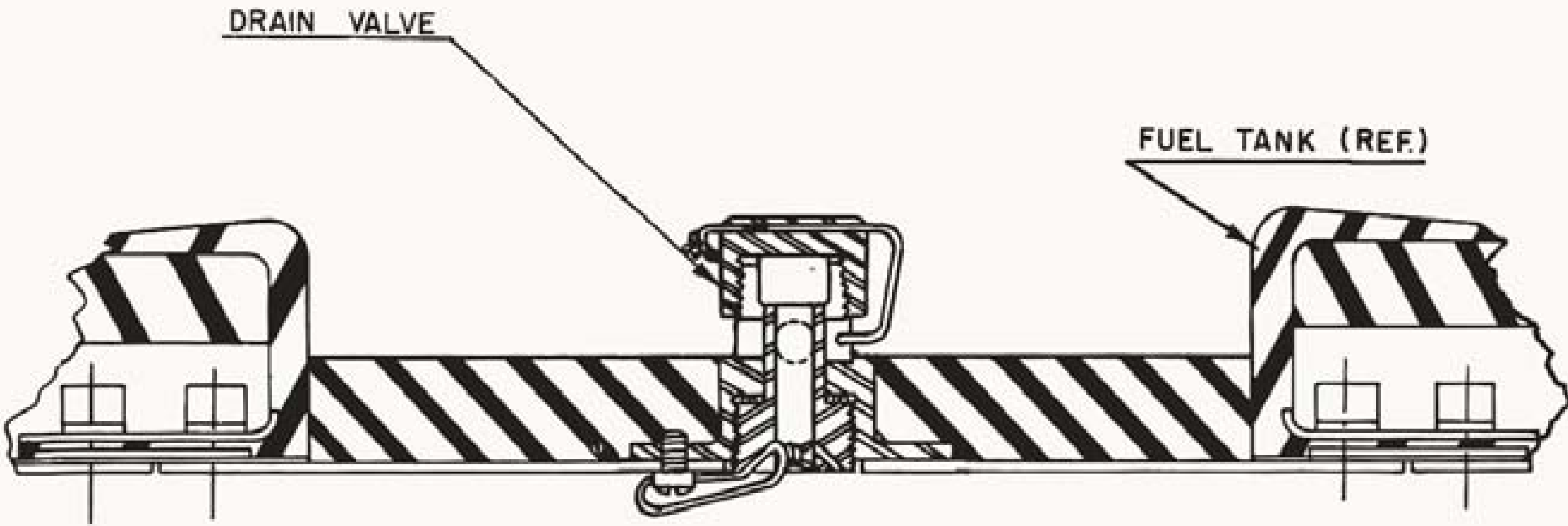
b. Use of Gun Leveling Lugs - After the lugs have been set as prescribed in "a", a scribe-mark should be made on the face of the adjustable lug, for future reference. Using the gun-sighting chart, other settings of the adjustable lug should be made, to correspond to the attitude of the aeroplane at various indicated speeds, and scribe-marks made for future reference. The gun-sight is first adjusted so that at a pre-determined speed the sight-line will be parallel to the line of flight. Then the machine guns are adjusted at their rear mounting posts, using Tool No. 238215 and 238216, so that their line of fire intersects the sight line at the desired range. The leveling lugs are then used to set the guns at the desired angle without the necessity of leveling the aeroplane. With the lugs at the desired setting adjust the guns parallel to the leveling lugs.

12. Gun Sights - The gun sighting chart (Fig. 3) shows the vertical distance from the centerline of each gun trunnion to the mean line of sight through the optical sight or the ring and bead sight. Both sights may be adjusted to accommodate the change in attitude at various speeds.

13. Nose Covers - Five flush covers are provided for the nose openings when no armament is carried.

14. Gun Camera - On later models provisions are made for the installation of a gun camera in the nose of the fuselage. The camera is accessible for servicing and reloading through a hinged door in the nose of the aeroplane.

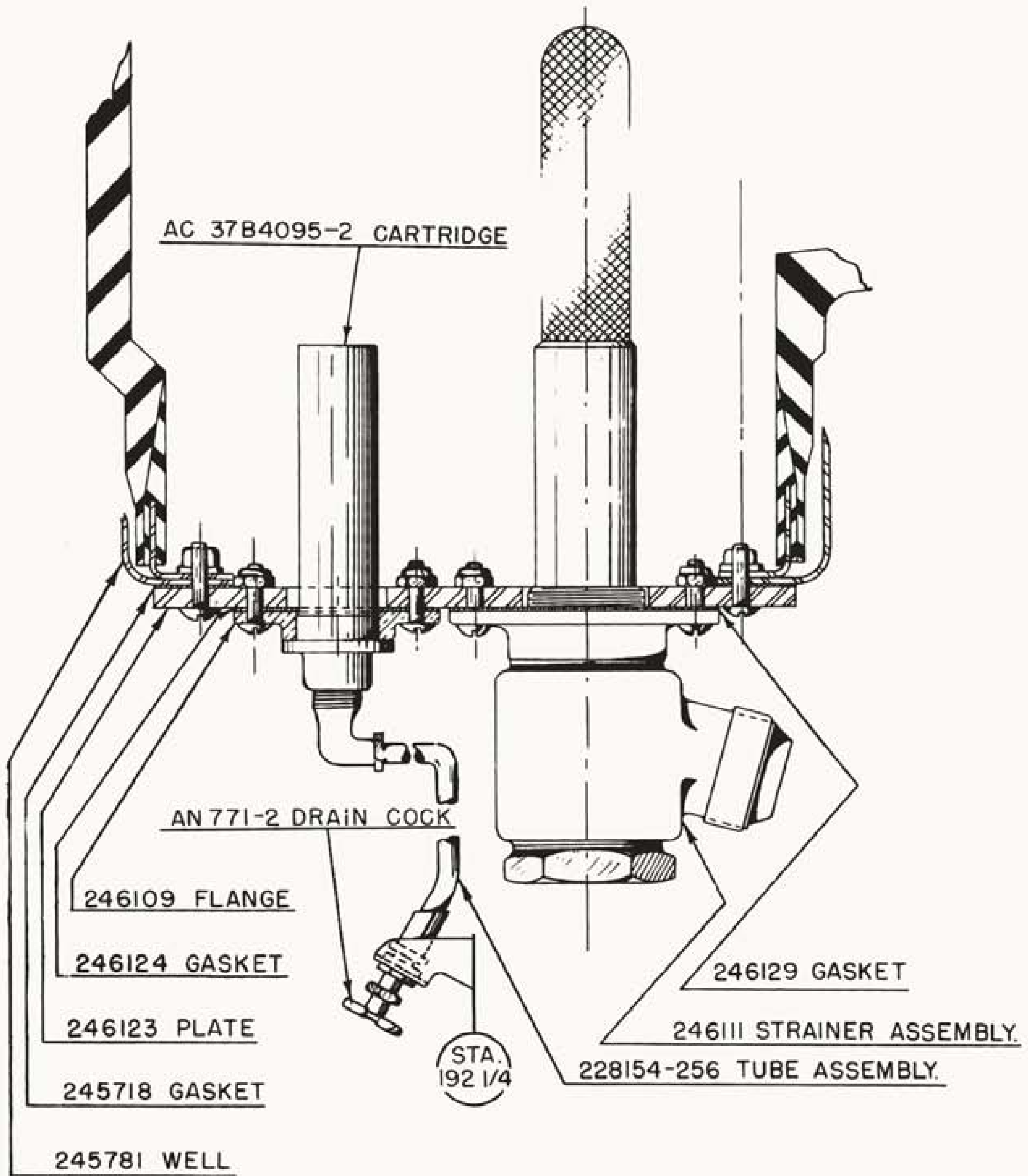




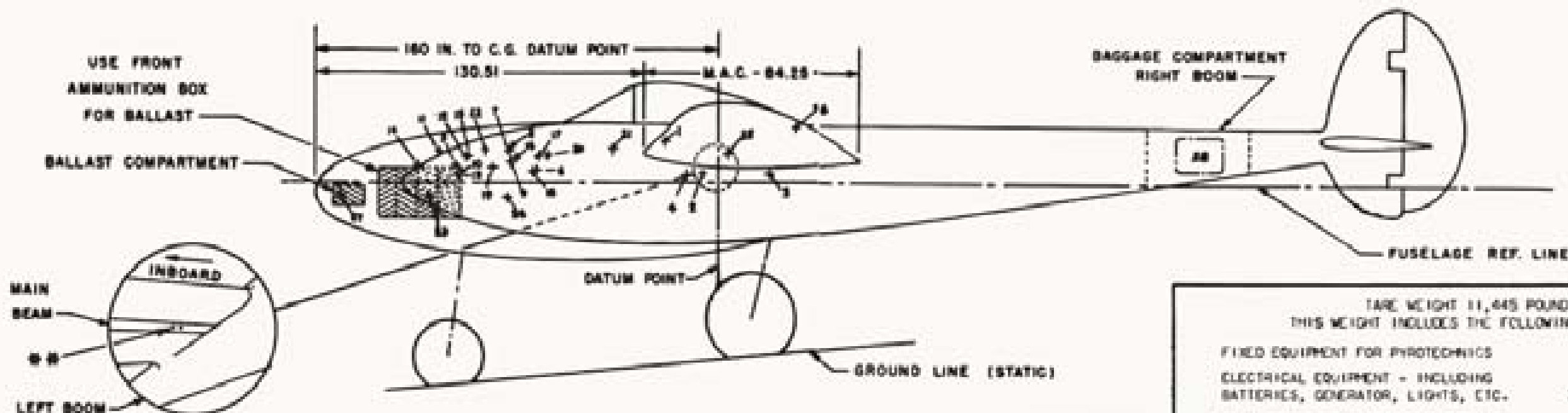
- 14 -

Note
Refer to dwg.no.245397

RESERVE FUEL TANK SUMP



A.P.2021A VOL. I SECT. 4 CHAP. I FIG. 4



ITEM NO.	REMOVABLE ITEMS OF MILITARY LOAD	CONDITION I - WITH FIVE 50 CAL. MACH. GUN			CONDITION II - WITH FOUR 50 CAL. M.G., ONE 20 MM CANNON AND ONE 60 RD. 20 MM AMMUNITION BOX			CONDITION III - WITH FOUR 50 CAL. M.G., ONE 20 MM CANNON AND ONE 150 RD. 20 MM AMMUNITION BOX		
		WEIGHT	HORIZONTAL		WEIGHT	HORIZONTAL		WEIGHT	HORIZONTAL	
			ARM	MOMENT		ARM	MOMENT		ARM	MOMENT
1	Pilot and Co-pilot	200.00	130.00	27,000	200.00	130.00	27,000	200.00	130.00	27,000
2	Oil 20 Imp. Gal. 9.75 Gal.	180.00	152.00	27,360	180.00	152.00	27,360	180.00	152.00	27,360
	Petrol 250 Imp. Gal. 7.27 Gal.	1,000.00	165.00	292,440	1,000.00	165.00	292,440	1,000.00	165.00	292,440
3	Rear Tanks 150 Imp. Gal. 7.27 Gal.	1,000.00	179.00	183,300	1,000.00	179.00	183,300	1,000.00	179.00	183,300
4	Front Tanks 100 Imp. Gal. 7.27 Gal.	720.00	146.00	105,120	720.00	146.00	105,120	720.00	146.00	105,120
	Armament	360.00	57.23	20,607	400.00	58.34	23,337	400.00	58.34	23,337
5	One 20 MM Hispano Suiza Cannon				112.60	56.25	6,304	112.60	56.25	6,304
6	Charging Mechanism				15.00	89.00	1,335	15.00	89.00	1,335
7	One 20 MM Ammunition Box				21.30	79.00	1,675			
8	150 Rd. Am. Box							36.39	78.75	2,868
9	Controller's Feed				8.00	58.00	464	20.40	78.75	1,607
10	Machine-Cannon Attach.				256.00	50.00	12,800	256.00	50.00	12,800
11	Four 50 Cal. M.G.	256.00	50.00	12,800	256.00	50.00	12,800	256.00	50.00	12,800
12	Four Solenoid Assemblies, G-4	9.92	60.38	599	9.92	60.38	599	9.92	60.38	599
13	Four Mfg. Post Assemblies, A-4	6.00	57.83	347	6.00	57.83	347	6.00	57.83	347
14	Four Truss and Brkt. Assemblies	9.64	41.49	400	9.64	41.49	400	9.64	41.49	400
15	Charging Control Mechanism	3.44	60.43	208	3.78	60.43	229	3.59	60.43	218
16	One 50 Cal. M.G.	64.00	60.57	3,877						
17	One Solenoid Assembly, G-4	2.48	81.50	202						
18	One Mfg. Post Assembly, A-4	1.50	87.50	131						
19	One Truss and Brkt. Assembly	2.41	72.13	174						
20	Charging Control M.C.	2.11	92.40	195						
21	Gunight	3.50	118.00	413	3.50	118.00	413	3.50	118.00	413
	AMMUNITION	375.00	52.75	19,782	308.96	50.11	15,480	360.40	54.25	21,306
22	60 or 150 Rds. 20 MM Ammunition				36.96	79.00	2,920	92.40	79.00	7,300
23	1200 Rds. 50 Cal. Ammunition	300.00	48.62	13,986	300.00	48.62	13,986	300.00	48.62	13,986
24	300 Rds. 50 Cal. Ammunition	75.00	77.28	5,796						
25	Oxygen Equipment	36.00	163.25	5,877	36.00	163.25	5,877	36.00	163.25	5,877
26	Wireless	75.00	190.52	14,289	75.00	190.52	14,289	75.00	190.52	14,289
27	Gun Camera							11.00	11.00	121
28	Ballast	50.00	344.00	17,200	50.00	344.00	17,200	100.00	344.00	34,400
	Removable Load	3,082.00	140.00	431,495	3,123.00	130.20	402,500	3,204.40	139.25	457,090
	Tare Weight	11,445.00	152.06	1,749,506	11,445.00	152.06	1,749,506	11,445.00	152.06	1,749,506
	Operational All-Up Weight - Gear Down	14,527.00	150.13	2,181,001	14,573.00	149.73	2,182,039	14,728.44	149.83	2,216,596
	Gear Retraction Moment			41,013			41,013			41,013
	Operational All-Up Weight - Gear Up	14,527.00	153.01	2,222,114	14,573.00	152.60	2,223,052	14,728.44	152.60	2,240,409

TARE WEIGHT 11,445 POUNDS
THIS WEIGHT INCLUDES THE FOLLOWING ITEMS:

FIXED EQUIPMENT FOR PYROTECHNICS 9.00#
ELECTRICAL EQUIPMENT - INCLUDING BATTERIES, GENERATOR, LIGHTS, ETC. 300.00#
PROVISION FOR INSTALLATION OF WIRELESS EQUIPMENT INCLUDING ANTENNA 33.00#

BALLAST INFORMATION

WHEN THIS SHIP IS FLOWN WITHOUT GUNS THE FOLLOWING BALLAST MUST BE CARRIED:

- 130# IN NOSE, IF CANNON IS REMOVED AND MACHINE GUNS LEFT IN.
- 125# IN FRONT AMM. BOX IF MACHINE GUNS ARE REMOVED AND CANNON LEFT IN.
- 130# IN NOSE AND 125# IN FRONT AMM. BOX IF ALL GUNS ARE REMOVED.

LOADING INSTRUCTIONS

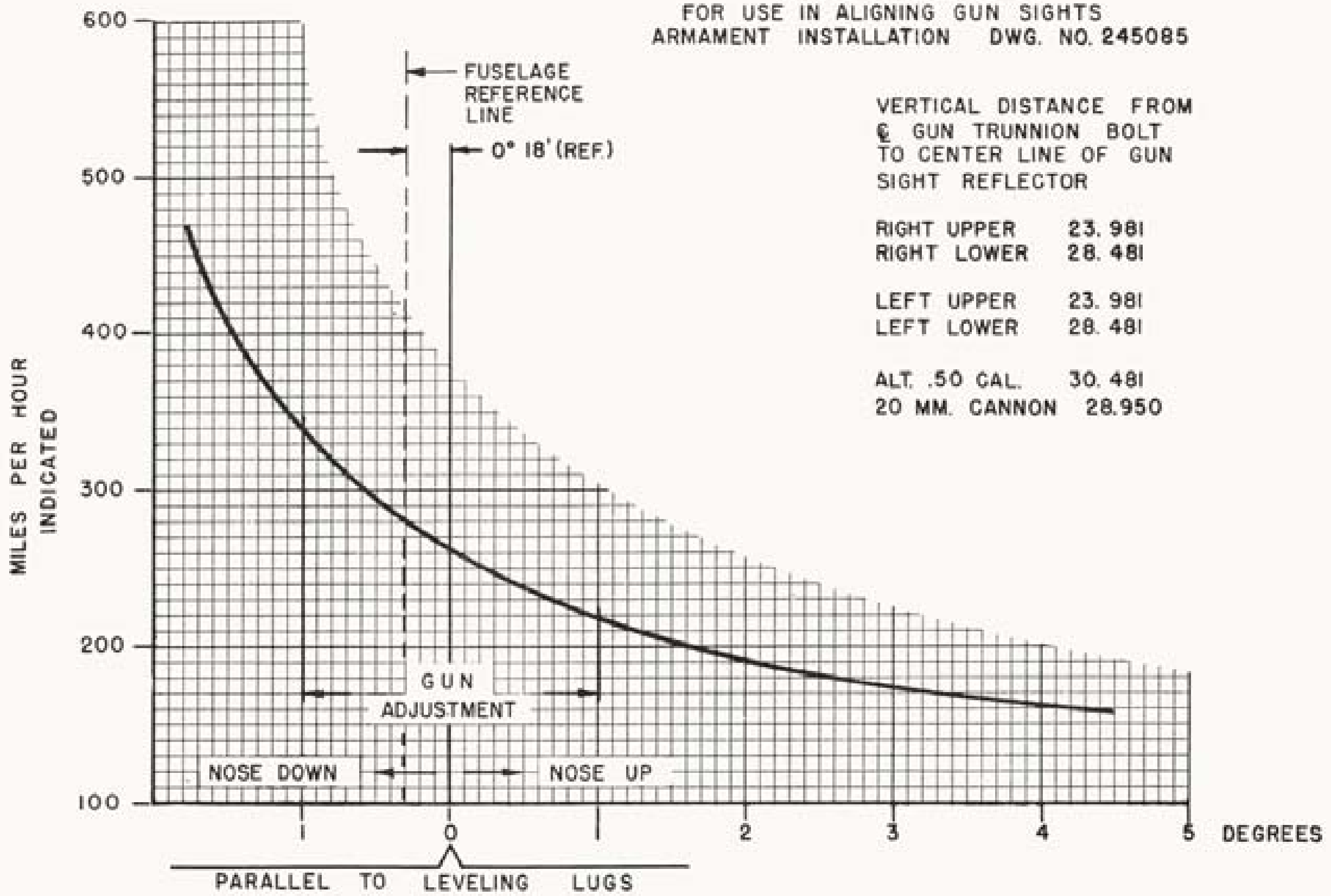
- FRONT FUEL TANKS MUST BE FILLED (120 GALS.) BEFORE ADDING FUEL IN REAR TANKS.
- FUEL IN REAR TANKS MUST BE CONSUMED FIRST.
- AMM. SHALL NOT EXCEED 200 RDS. PER GUN.
- 50# OF BALLAST MUST BE PLACED IN EACH BAGGAGE COMPARTMENT WHEN 1500 RDS OF AMM (300 RDS. PER GUN) ARE CARRIED.
- 200# OF BALLAST MUST BE PLACED IN FRONT AMM. BOX WHEN NO AMM. IS CARRIED.
- BAGGAGE, IN ADDITION TO CONDITIONS SPECIFIED ABOVE, MAY BE CARRIED IN BOOM BAGGAGE COMPARTMENT PROVIDING COMPENSATING BALLAST, IN THE RATIO OF 14# OF BALLAST TO 10# OF BAGGAGE, IS PLACED IN THE FRONT AMM. BOX.

◆ DATUM POINT IS 160" AFT OF THE AXIS OF REFERENCE AND IS LOCATED AT JACK PAD POINTS ON LOWER CAP OF THE MAIN BEAM.

THE FOLLOWING C. G. LIGHTS FOR THE LIGHTNING I AIRPLANE ARE TEMPORARY PENDING FURTHER FLIGHT TESTS.

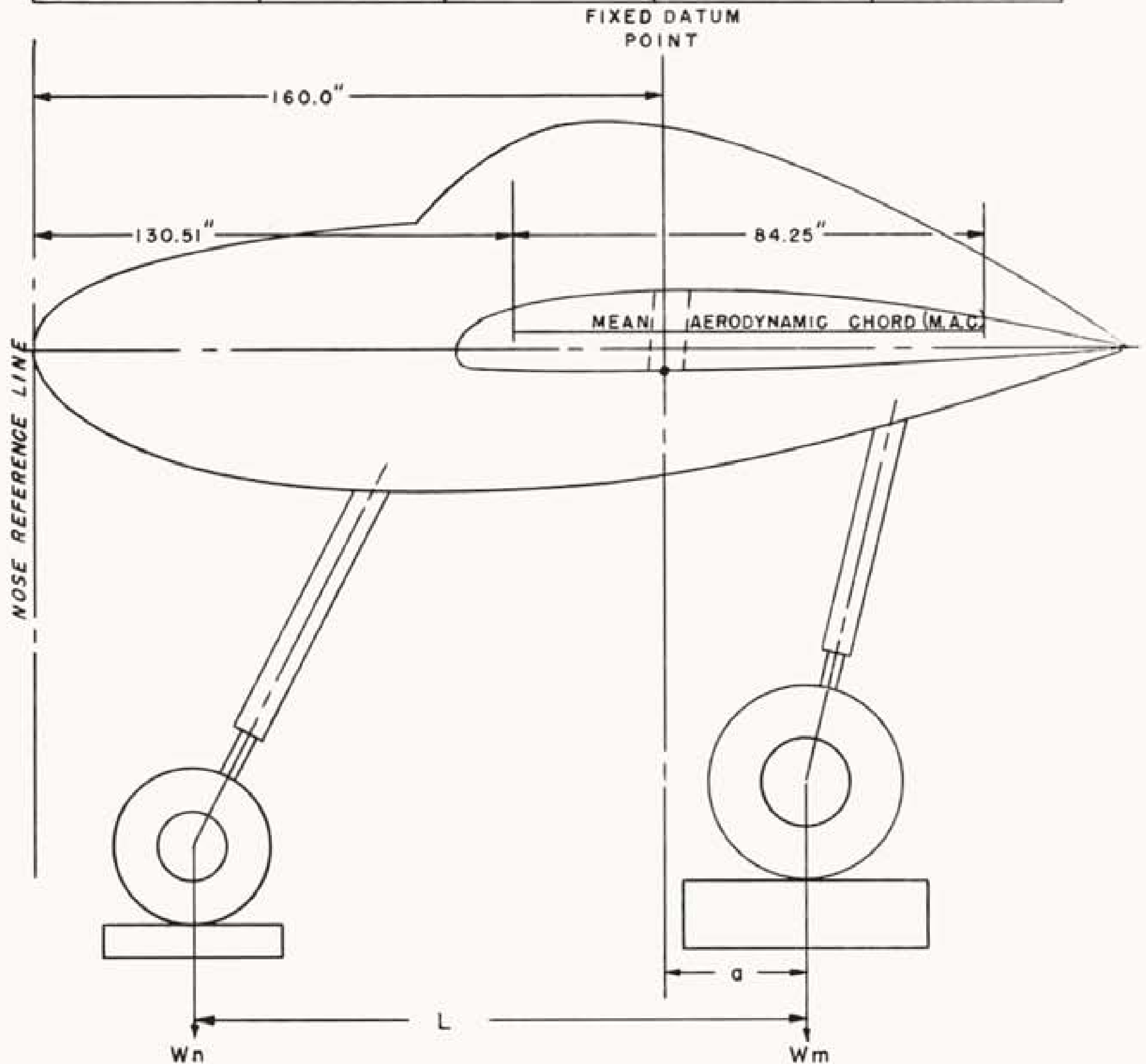
FORWARD	306 H.A.C.	GEAR DOWN
REAR	27.506 H.A.C.	GEAR UP

AIRPLANE MODEL 322
FOR USE IN ALIGNING GUN SIGHTS
ARMAMENT INSTALLATION DWG. NO. 245085



GUN SIGHTING CHART

A.P. 2021A	VOL. I	SECT. 4	CHAP. I	FIG. 6
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REAR WHEEL WEIGHT - W_m			NOSE WHEEL - W_n			TOTAL WEIGHT - W_w		
GROSS WEIGHT	TARE	NET WEIGHT	GROSS WT.	TARE	NET WT.	REAR WHEELS W_m	NOSE WHEEL W_n	TOTAL W_w

C.G. CALCULATIONS

$$C.G. (H_0)^* = 160 + a - \left(\frac{L \times W_D}{W_w} \right) = \text{_____} \text{ (AFT OF NOSE REF. LINE)}$$

$$C.G. \text{ in \% of M.A.C.} = \frac{H_0 - 130.51}{84.25} \times 100 = \text{_____} \%$$

* (H_0) = Horizontal Arm from Nose Ref. Line.

ACTUAL WEIGHING AND
C.G. DETERMINATION FORM

MAINTENANCE

CHAPTER 2

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CHAPTER 2
MAINTENANCE

1. General - The following information is intended to implement the instructions given in the maintenance schedule.
2. Access and Inspection Panels - Locations are shown on Figures 1 and 2 at the end of this section.
3. Leveling - Fixed plates upon which to place a spirit level for transverse and longitudinal leveling are attached to the upper fuselage channels in the cockpit, one on the port and two on the starboard side. Adjustable gun leveling lugs, set at an angle of $0^{\circ} 18'$ to the fixed plates, are under the armament hood on the starboard side of the compartment. Plate nuts for plumb bob attachments are located on the fuselage forward of the undercarriage door and on the tail plane $3 \frac{7}{8}$ inches left of the centreline. Each is circled with red paint.
4. Jacking and Lifting Points - Diagrams of the necessary hoisting and jacking positions are shown on Figure 3. Pin holes for installing centre main plane jacking pads are located on the main spar just inboard of each forward boom. Fittings, normally plugged, are located in each aft boom at Station 393, for installing eye bolts used to attach the tail jacks.

NOTE: With the engines installed, the C.G. is forward of the main spar, and in jacking the main plane, the tail jacks must be bolted to the eyebolts and counterpoised with 2 cwt. each.

- a. To Jack Main Plane (Engines Installed)
 - (1) Set jacks in position using spar pad and aft boom fittings.
 - (2) Lift with main plane jacks maintaining transverse level.
 - (3) Follow with tail jacks if fore and aft leveling is desired.
- b. To Jack from Main Plane (Engines Removed)
 - (1) Set jacks in position using the spar pads and aft boom fittings.
 - (2) Lift at all four points.
- c. To Jack Main Wheels
 - (1) Use jacking points provided on oleo legs.
- d. To Jack Nose Wheel
 - (1) Lower the tail by the aft boom fittings until nose wheel clears the ground.

HOISTING

5. General - Hoisting lugs are permanently attached to the main spar under inspection plates on the Inboard side of each forward boom. Plugged fittings for installing eye-bolts are attached to the top centre of bulkhead (Station 265) in each boom. (See Fig. 3.)
6. To Hoist, (Engines Installed)
 - a. Attach hoisting sling (Part No. 234651) to the spar lugs.
 - b. Install aft boom fittings at Station 393 and attach lines.
 - c. Lift by the hoisting sling and balance by holding down on the tail lines.
7. To Hoist, (Engines Removed)
 - a. Install eye-bolts at Station 265 in each boom.
 - b. Attach hoisting sling at spar lugs and eye-bolts.
 - c. Hoist at the lifting eye of the sling.

RIGGING

8. General - All of the main surfaces are fixed being jig-mated at the factory. No adjustments for symmetry, dihedral or incidence are provided. Rigging is confined to the adjustment of the movable surfaces for proper neutral position, travel and tension in the cables. These dimensions are shown on Figures 4, 5 and 6 - Rigging Diagrams.

9. Access to Turnbuckles - (See Figures 1 & 2)

Fuselage - Between the wheel well webs and the outer skin.

Wing - Through the inspection plates in the lower wing surface between Stations 146 and 158.

Booms - Through inspection plates in the inboard wheel web and through the baggage and accumulator compartments.

Empennage - Through inspection plates in the tail plane.

10. Access to Pulleys and Drums

Fuselage

a. In the control column.

b. Between the wheel well web and the outer skin.

Main Plane

a. Through inspection plates in the main spar aft of the pilot's seat.

b. Through inspection plates in the forward web of the main spar inboard of Station 89, accessible from the engine nacelles.

c. Through inspection plates at Station 182 aft of the main spar and forward of the aileron hinge.

d. Through inspection plates between Stations 218 and 230 aft of the main spar and forward of the aileron hinge.

Booms

a. At Station 207 27/32 and 220 through the inboard wheel web.

b. At Station 265 through the inboard radiator cowl.

c. At Station 295 through the boom manhole.

d. At Stations 334 9/16, 366 and 376 through the baggage compartment.

e. At Station 401 7/8 through the removable lower outboard fillet on the empennage boom.

Empennage

a. Through inspection plates on the vertical and horizontal surfaces.

b. Through the notch for the upper rudder balance.

c. Through the removable lower outboard fillet on the empennage boom.

(5) Tabs: Set the pilot's indicator to zero and with the rudders neutral bring the tabs into neutral position by adjusting the turnbuckles, keeping proper tension in the cables. Set stops to allow proper travel.

b. Elevator - (See Fig. 5)

(1) With the control column secured in the neutral position, bring the elevator into neutral position by adjusting the turnbuckles, maintaining proper tension in the cables.

(2) Set the stops in the fins to permit proper travel.

(3) Through the aft removable panel in the right hand wheel well adjust the control column stops so that a .003 feeler gauge will pass under them when the elevator is against its stops.

(4) Tab: Set Pilot's indicator to zero, align tab with elevator trailing edge, maintaining proper cable tension. Set stops at drum to permit correct travel.

c. Ailerons - (See Fig. 6)

(1) With a pin in the neutral hole of the reduction drum, rig cables from the control wheel to the reduction drum, maintaining control wheel in neutral, and proper tension in cables.

(2) With the reduction drum and differential drum pinned in neutral and cables at proper tension, adjust the length of the push-pull tubes so that the trailing edge of the ailerons have 1/4 inch droop.

(3) Adjust stops in the control column to permit proper travel, and adjust stops at differential pulleys with $1/32 \pm 1/32$ clearance when control wheel is against its stops.

(4) Tabs: Set pilot's indicator to zero. Align tab with aileron trailing edge maintaining proper tension in cables. Set stop to permit correct travel.

13. Main Plane Flaps: Adjust so that trailing edge of the flaps is in contact with the trailing edge of the main planes and that the lower surface of the flap is tangent to the lower surface of the main plane.

a. Eccentrics for adjusting the flaps are located at the forward roller of each carriage, the lower carriage rods are provided with screw adjustments. Nuts for adjusting cable lengths and tension are contained in the attaching lugs on the push-pull tubes. Access to the pulleys, cables and tubes is gained through the flap opening, through cut-outs in the wing structure and through removable inspection plates. (See Figs. 1 and 2).

NOTE: Adjustments (b) and (c) should be made simultaneously.

b. To Bring Flap Tangent to Lower Main Plane Surface:

(1) With the flap retracted, note whether it should be raised or lowered.

(2) Extend the flap.

(3) Remove bolt holding the eccentric lock.

(4) Rotate the eccentric as required to effect the desired adjustment.

(5) Replace the eccentric lock.

(6) Retract the flap and check the adjustment.

(7) Repeat the preceding steps if necessary.

(8) When the adjustment is accomplished, safety the eccentric lock.

c. To Bring the Trailing Edge of the Flap in Contact with the Trailing Edge of the Main Plane Trailing Edge.

(1) With flap retracted, note the amount of adjustment required.

(2) Extend the flap.

(3) Adjust the length of the lower carriage rod to produce the desired adjustment.

(4) Retract the flap to check the adjustment.

(5) Readjust if necessary.

(6) Safety the rod when adjustment is accomplished.

d. Synchronize all four flaps by adjusting cable lengths.

e. Rig all cables to proper tension (See Cable Tension Table, Paragraph 11, this section).

f. To adjust Pressure cut-off valve, See Paragraph 48.

14. Engine and Airscrew Controls (See Fig. 8)

a. The throttle and mixture control levers are mounted in the side control stand on the left side of the cockpit. Forward of these controls are the airscrew and carburettor heat control levers. These levers are connected to their respective units by steel cables, cranks, and push-pull tubes. The cable adjustments are made at turnbuckles located in the fuselage under the removable panel between Station 145 $9/16$ and 162 $1/4$ and under each inboard rear lower engine cowl. Cable tension shall be 55 pounds \pm 5 pounds. Threaded terminals are provided on the push-pull tubes for length adjustment. The control linkage shall be adjusted so that the stops on the engine are reached not more than $1/8$ inch or less than $1/16$ inch before the control levers touch the stops provided on the control unit.

15. Main Undercarriage Doors (See Fig. 10)

a. Adjust the piston length so that the connected carriage reaches the full "UP" position above the spring-loaded latch when the piston is bottomed.

b. Maintaining a cable tension of 70 lbs., adjust the cable length so that the front and rear operating carriages are synchronized. The cam lock on the forward carriage should have $1/4$ inch clearance above the top of the engaging needle bearing.

NOTE: Operations "a" and "b" are accomplished with the door disconnected from the carriage arms.

c. Attach aft carriage arm to one door and adjust arm so that aft end of door is to contour when piston is bottomed. With the piston extended $7/32$ inch, attach and adjust forward carriage arm to bring forward end of door to contour.

d. Operate door to determine if cam lock functions satisfactorily. There should be a slight gap between the cam lock and the engaging needle bearing. The tension in the "UP" cable will increase to approximately 125 lbs. due to the $7/32$ inch piston travel after the forward carriage has stopped.

e. Disconnect the door just checked but do not alter the length of the carriage arms.

f. Repeat operations "c" and "d" on the opposite door. Reconnect previously adjusted door and check both for proper closing.

UNDERCARRIAGE

16. Oleo Legs (See Figs. 12 - 13)

The oleo legs and linkage require lubrication as shown on the lubrication diagram and periodic checking for proper inflation. A few parts such as the gland packing, bearing nut or piston head may require replacement due to normal wear throughout the life of the aeroplane and the following instructions will explain the method of making such replacements should they become necessary.

17. Inflation of Oleo Legs

Oleo legs are inflated with compressed air. When fully loaded, the main leg will require approximately 490 p.s.i. pressure, while the nose leg will require approximately 240 p.s.i. Proper inflation of the leg is measured by the distance the piston tube extends from its fully compressed position with the weight of the aeroplane on the legs. A red line is painted around the piston, flush with the lower edge of the gland nut when the leg is fully compressed. The following table will assist in the proper inflation of the legs:

	Max. Distance from Red Line to Lower Edge of Gland Nut	
	Main Oleo Leg	Nose Oleo Leg
Full Load	2 1/2 Inches	3 Inches
Light Load	3 Inches	4 Inches

While inflating the struts it is advisable to move the aeroplane forward and back several feet to overcome friction, thus preventing over-inflation. After inflating, check the air valve for leakage.

18. Oil Leakage

The oleo leg should be inspected frequently for oil leakage. When there is evidence of excessive oil leaking past the gland nut, the packings should be replaced. In case of emergency, a split washer may be placed between the bearing and the adapter to allow more "take-up" on the rings. A ring which shows signs of excessive wear may be replaced by a split ring, until such time as the leg can be repacked.

19. Storage of Oleo Legs

If the aeroplane is to be stored for any great length of time, the air pressure should be released and the legs allowed to assume the fully compressed position with the weight of the aeroplane on the legs. Where clearances or other factors do not permit deflating, coat the exposed bearing surface of the piston tube with grease. When storing legs in a stock room they should be stored in the upright position with all bearing surfaces and finished attachment surfaces coated with grease.

MAIN UNDERCARRIAGE

20. Adjustment of Linkage (See Figure 14)

The main undercarriage must be adjusted so that when in "DOWN" position Point "A" of the drag links is on top centre or 1/16 ahead of top centre. When in the "UP" position the Points "A", "C" and "D" should be in a straight line with a tolerance at Point "C" of 0 above and 1/16 below dead centre. The wheel must rest against the bumper with 3/16 clearance between the uplock plunger and the inside of the axle.

CAUTION: These adjustments are critical and must be maintained.

a. Wheels Down - To align the drag links:

(1) With the piston rod disconnected from the drag links, align the legs with the links and clamp or block in place.

(2) With the down lock engaged adjust the length of the piston rod at eye bolt "RR" (Fig. 25), so that it can be assembled with the clamped drag links.

(3) Using wrench No. 234572 replace the pin, washers and nut connecting the piston rod with the drag links. Retract the gear using the hand pump, or manually, without hydraulic pressure.

b. Wheels Up-Adjust the piston stroke with end cap "CC" (Fig. 25) so that points "A", "C" and "D" (Figure 14) are in alignment. If there is not sufficient adjustment, vary the length of the piston rod by loosening locknut "QQ" and adjusting eye bolt "RR" (Fig. 25). With wrench No. 248856 adjust the length of the drag strut to bring the wheels into the uplock and against the bumper leaving a clearance of 3/16 inch between the lock and the axle. The basic dimension of the drag strut is 34.694 inches between centres. Adjustment is $\pm 1/4$ inch. When replacing a drag strut, measure the length of the old strut or set to the basic dimension and adjust after installation.

NOTES:

(1) Always make the first retraction or extension with the hand pump after adjusting.

(2) When any change has been made in the adjustment, check the undercarriage in both "UP" and "DOWN" positions.

(3) See that all safeties have been replaced.

(4) After installing the undercarriage or any of its details, it should be operated through three or four cycles while the aeroplane is still supported as a check on the proper functioning of the gear and its locks, also to work any air out of the hydraulic system. If the brake lines have been disconnected, the brake system must be vented. See Section 4, Chapter 2, Paragraph 27.

21. To Replace Main Oleo Leg Packing - See Fig. 12

- a. Remove oleo leg and place on bench. (See Section 5, Paragraph 37).
- b. Slowly deflate the oleo leg, remove air valve body "C" and empty the leg of oil.
- c. Remove lock-nut and unscrew gland nut "O" from cylinder using Menasco Tool No. ST 245024-1.
- d. Remove torque arms.
- e. Replace air valve and inflate with just enough pressure to force the bearing and packings from the cylinder.
- f. Unscrew the sleeve "J" using Menasco wrench No. ST 245039-1.
- g. Remove piston assembly from the cylinder.
- h. Unscrew the piston head "I" using a strap wrench, after heating sufficiently to soften the solder used in sweating.
CAUTION: Do not exceed 600°F.
- i. Check the bearing and the piston head for wear. Inspect the inside of the cylinder "G" and the outside surface of the piston tube "P". These surfaces must be smooth and free from rough spots. Any scratches or scores should be lapped out and parts thoroughly cleaned. Any scores on the outside of the piston tube may cause leakage of fluid past the packing.
- j. Replace the parts on the piston tube in the order shown on Figure 12, sweating the head in place to form a pressure tight joint.
CAUTION: Do not exceed 600°F.
- k. The orifice plate may be removed, if necessary, by heating (600° max.) to soften the solder in the threads.
- l. Insert piston assembly in cylinder and screw in sleeve "J" securely.
- m. Insert male spacer "K".
- n. The packing rings must be installed one at a time, making sure that each ring is properly seated before inserting the next one. Moistening each ring with oleo leg fluid will assist in their installation.
- o. Insert the female spacer "R" and bearing "M".
- p. Screw on gland nut and safety.
- q. Replace the torque arms.
- r. With the leg fully compressed and in the vertical position, fill to the level of the filler hole with Intava servo fluid. To insure that no air has been trapped within the strut, it is advisable to work the piston up and down several strokes and then check the oil level with the piston fully compressed.
- s. Assemble the air valve body and gasket, tightening securely.
- t. To insure minimum friction it is advisable to "run in" the leg at the rate of 20 strokes per minute for two or three hundred strokes.

22. Tyres and Tubes - The main undercarriage is supplied with two Goodyear 36 inch smooth contour, ten-ply smooth tread tyres and two Goodyear regular type inner tubes. Inflation pressure is 37 p.s.i. for 35% deflection, the main undercarriage reaction being 6096 pounds per wheel.

BRAKE SYSTEM

23. General - (See Fig. 15) - An independent hydraulic disc type brake is provided for each wheel.

24. Fluid - Fluid reservoirs, located on the forward side of the bulkhead at Station 95 are accessible for checking and filling by raising the armament hood. Use Intava servo fluid or equivalent.

25. Master Cylinders - (See Fig. 16) - The master cylinders are located on brackets attached to the forward side of the bulkhead at Station 95. These cylinders should be adjusted so that with the brake pedals in the full "OFF" position there will be a slight amount of play between the piston rod "F" and the piston "J". Check this by shaking the rudder pedal. Adjustment is made by loosening locknut "B" and turning collar "D".

26. To Adjust Discs for Proper Clearance

- a. Remove wheels.
- b. With air pressure clean out discs thoroughly to remove any accumulation of dust or grit.
- c. Remove locking clip from adjustment flange.
- d. With a spanner wrench tighten flange snugly against discs.
- e. Back off flange until a feeler gauge of .072 inches may be inserted between discs.

NOTE: Above clearance applies to the entire set of discs, not each disc separately.

- f. Replace locking clip, making sure it engages with slot provided.
- g. Align keys of bronze discs and set brakes to secure them.
- h. Install wheels.

27. Venting

- a. Fill the fluid reservoir.
- b. Remove the vent plug cap screw from wheel cylinder
- c. Attach a standard venting hose, place the open end in a clean glass receptacle.
- d. Open the vent plug one full turn, allow the fluid to flow until the end of the hose is covered.
- e. Push the brake pedal down rapidly and hold.
- f. Close the vent plug while fluid is still flowing and allow brake to return slowly to its full off position.
- g. Open the vent plug and repeat (e) and (f) until no bubbles issue from the vent hose.
- h. Remove the hose and replace vent plug washer and cap screw.

NOSE UNDERCARRIAGE

28. Adjustment of Linkage (Fig. 17)

The nose undercarriage linkage is adjusted so that the hinge point "A" between the lower drag struts is $1/16$ " to $1/8$ " below dead centre when the leg is extended. These adjustments are made by adjusting the stroke and piston rod length of the gear jack as described in paragraph 50 of this section. In the retracted position the axle rests against the rubber bumper block with $3/16$ inch clearance above the uplock plunger. This is obtained by adjusting the upper drag strut at point "B". After adjustment refer to notes (1), (2), (3) and (4) under main undercarriage adjustment, paragraph 20-b of this section. Wrench No. 248856 is used at point "B".

29. To Replace Nose Oleo Leg Packing, (Refer to Figure 13)

- a. Remove oleo leg assembly and place on bench. (See Section 5, Para. 45.)

- b. Slowly deflate the leg, remove air valve body and empty the leg of oil.
 - c. Remove the lock screw and unscrew gland nut "S" from the cylinder using Menasco tool No. ST 245099-1.
 - d. Replace the air valve body and inflate with just enough pressure to force the packings and bearing from the cylinder.
 - e. Remove the lower torque arm bolt.
 - f. Unscrew the sleeve nut "M" using Menasco tool No. ST 245110-1.
 - g. Pull piston assembly from cylinder.
 - h. Remove the set screws from the piston head "H" and heat the threaded portion sufficiently to soften the solder.
- CAUTION: Do not exceed 600°F. Remove the piston head using a strap wrench.
- i. Slide the parts off the piston tube.
 - j. Inspect the piston tube and cylinder bore for scores, scratches or dents which should be lapped out and the parts thoroughly cleaned before replacing the parts in order as shown on Fig. 13.
 - k. If the piston head has been replaced, be sure the cam lobe is in the same relation to the wheel fork as on the original head. It may be necessary to face the end of the piston tube to maintain this alignment. Sweat the head in place to form a pressure tight joint. Flat bottom drill and bottom tap to a maximum depth of 9/32 inches for the four 3/8-24 set screws which are staked in place.

The orifice plate "G" may be removed by heating (600° max.) to soften the solder in the threads.

- l. Insert the piston assembly in the cylinder making certain that the sleeve keys are seated in the keyways.
- m. Screw the sleeve nut securely in place.
- n. Install the male packing spacer.
- o. The packing rings must be installed one at a time making sure that each ring is seated before installing the next. Moistening each ring with oleo leg fluid will assist in the installation.
- p. Insert the female packing spacer and bearings.
- q. Screw gland nut onto cylinder and safety with lock wire.
- r. With the leg fully compressed, fill to the level of the filler hole with Intava Servo fluid. To insure that no air has been trapped within the strut, it is advisable to work the piston up and down several strokes and then check the oil level with the piston fully compressed.
- s. Assemble the air valve body and gasket, tightening securely.
- t. To insure minimum friction of the packing, it is advisable to "run in" the strut at the rate of 20 strokes per minute for two or three hundred strokes.

30. Shimmy Damper

- a. To Repack the Cylinders - (See Fig. 18.)
 - (1) Remove the tubing and drain the tank.
 - (2) Remove the two large jam nuts holding the cylinder in its supporting bracket using wrench No. 225223.
 - (3) Rotate the fork until the piston clears the roller.
 - (4) Slide the cylinder from the supporting bracket.

CAUTION: When disassembling the cylinder, care must be taken in removing the return springs. The cylinder and piston must be held in a press while unscrewing the packing nut. The extended length of the main spring is approximately nine (9) inches longer than its assembled length.

(5) Unscrew the packing nut, "K".

(6) Ease off the press, allowing the piston to come out of the cylinder. The piston head will carry the packing and packing adapters out with it.

(7) Unscrew the connection end "A" of the cylinder to remove the check valve "B".

b. To reassemble the shimmy damper cylinder.

(1) Reverse the procedure prescribed for disassembly. Tighten the packing nut only enough to prevent leakage. The packing must not be tight enough to retard the return action of the springs. Pressure test as prescribed on Fig. 18.

c. Adjustment

Adjust the retaining nut below the damper so that with the lower support bushing resting on the nut there is .005 clearance between the upper bushing and the drag strut attachment fitting.

d. Filling - See Test Chart - Fig. 19

(1) Centre the wheel.

(2) Fill the reservoir with Intava servo fluid or equivalent and replace the filler plug.

(3) Unfasten lower torque arm from wheel fork and extend forward.

(4) Using the extended torque arms as a lever rotate the shimmy damper through its full arc twice.

(5) Add fluid to reservoir and repeat until no more fluid can be added.

CAUTION: If a piston packing nut has been tightened to stop leakage, check the piston's action. It must be free to snap from the fully compressed position to the fully extended position. Note instructions on the fluid reservoir.

31. To Adjust Nose Undercarriage Door

a. Disconnect door operating jack from fitting at aft end of door and retract nose undercarriage. (See Fig. 11.)

b. Door operating jack will retract. A moment after the door jack has completed its travel, the door locking jack will operate the latching hook. For this sequence, the relief valve in the locking jack line must be adjusted to relieve at a pressure of 750 p.s.i.

c. In up position, adjust engaging end of the latch hook approximately 3 degrees above the horizontal. This adjustment is made on the jack itself by loosening locknut "N" and turning clevis "O". (See Fig. 32.)

d. Reconnect door operating jack to door and close door slowly several times, re-adjusting latch if it fails to pull front end of door up tight. Adjust door operating jack to pull aft end up tight by loosening terminal nut "B" and turning terminal "A". (See Fig. 30.)

e. Repeat "d" slowly with a 25 pound weight suspended from the forward end of the door to simulate the air load on takeoff. Forward end of door will hang open until latch operates.

CAUTION: Operate door slowly with suspended weight. A sudden jerky motion may result in damage to the door.

32. Tyre and Tube - The nose undercarriage is equipped with a Goodyear 27 inch, 6 ply, smooth contour tyre, containing a Goodyear Dual-Seal puncture-proof inner tube. The inflation pressure is 40 p.s.i. for 27.5% deflection, the nose gear reaction being approximately 2275 pounds.

a. Inflation - The Dual Seal Tube is equipped with a special valve, and to inflate or check pressure the following steps should be used:

(1) Unscrew valve to left, four full turns.

(2) After inflating, wait 10 seconds, then check pressure and retighten valve by screwing rubber barrel back tight, then twisting 180° by hand to seat securely.

(3) Remove valve plunger and check for leakage. Re-apply plunger and cap for service.

HYDRAULIC SYSTEM

33. General - Detailed instructions covering the maintenance of individual units of hydraulic equipment are given in this chapter. Locating the source of trouble when the system or related parts of the system fail to function properly, requires an understanding of the operation of the entire system and the relationship of the units comprising the system, as described in Section 9 of this manual.

Proper functioning of the system depends upon the complete absence of air from the operating units and pipe lines, freedom of the fluid from grit and foreign matter, condition of valve and piston packings and proper seating of check valves. Fluid drained from the system may be collected in a clean container and used again provided that it is clean. When units are removed or pipe lines disconnected, all parts must be protected against entry of foreign matter.

34. Hydraulic Fluid - Approximately 6 2/3 Imp. gallons of Intava Servo Fluid or equivalent are required to fill the system.

35. To Relieve the Pressure - Operate the wing flaps until the pressure has been relieved.

36. Draining - A plug for draining the reservoir is located on the forward face of bulkhead Sta. 192 1/4 in the lower portion of the fuselage.

37. Filling - A Dzus fastened plate on the fuselage skin at Sta. 195 5/16 provides access for filling the fluid reservoir through a screened filler neck. If the system has been drained, it will be necessary to operate all mechanisms while maintaining the full level of fluid in the reservoir and venting afterward as a precaution to eliminate all air from the system. If system is up to operating pressure, fill to within one-half inch of the bottom of the filler neck. If there is no system pressure fill to the bottom of the neck. The emergency extension reservoir located aft of the pilot's seat should be kept full at all times.

38. Cleaning the Hydraulic System

CAUTION: Relieve system pressure before disconnecting hydraulic lines.

39. System Filter - Clean the Cuno filter daily by turning the "Tee" handle one complete revolution. Drain the sump every twenty hours by removing the plug at the bottom of the filter. Remove and flush the filtering element at engine overhaul periods.

40. Fluid Reservoir - Flush the fluid reservoir at 40 hour intervals using the following procedure:

a. Remove the drain plug at Station 192 1/4 in the lower fuselage compartment.

b. Disconnect the pump supply, and system return lines from the reservoir and the flap motor drain line at the "Tee" connection. Plug reservoir openings and flap motor drain line connection at the tee fitting.

c. Remove the filler cap and finger screen and flush through the filler neck.

41. Complete System - Clean the entire system by following the instructions noted below, at engine overhaul periods. (See System Diagram, Fig. 1, Sect. 9.)

a. Disconnect pump pressure line at Cuno filter. Remove pump from engine pad, leaving lines connected. Apply not more than 10 p.s.i. air pressure through tank vent line to force oil through pump and catch oil at open line. Repeat twice with clean oil. Oil may be filtered and used again.

b. Disconnect line between accumulator and pressure regulator and allow to drain. Reinstall line.

c. Remove all alighting gear, door jacks and nose door locking jack and flush out. Plug all open lines.

With clean oil in reservoir, place the alighting gear selector valve in the "UP" position and with the hand pump, pump oil through the lines as follows:

(1) Remove plug and flush line at nose gear jack downlock, plug line and repeat at main gear downlocks. Plug lines.

(2) Remove plugs from the "UP" lines at the door jacks and at the nose door locking jack. Flush line to nose door jack, depressing the plunger to open the door stop valve. Plug nose door jack line and holding the door stop valve open pump sufficient pressure to force oil through the nose door lock holding valve and the line at the nose door locking jack. Flush main door jack lines by opening main door stop valves.

(3) Put the alighting gear lever in the "DOWN" position.

(4) Remove plug and flush the "DOWN" line at the nose door locking jack. Plug line.

(5) Remove plug and flush "DOWN" line at the nose door jack. Plug line.

(6) Remove plug and flush "DOWN" line at nose gear jack by pumping sufficient pressure to force oil through the up-lock. Plug line.

(7) Remove plug and flush lines at main gear door jacks. Plug lines.

(8) Remove plugs and flush "DOWN" lines at main gear door jacks. (Increased pump pressure will be necessary to force oil through nose and main gear up-locks.)

(9) Open the by-pass valve on the cockpit floor and set the transfer lever on the hand pump to the "emergency" position. With clean oil in the emergency reservoir pump oil through the emergency lines removing the plug at the gear jack and flushing one line at a time.

d. Disconnect the return line at the fluid reservoir. Operate flaps up and down and catch oil at return line.

e. Remove trigger motor, case ejection door and cannon charging jacks and flush out. Pump oil through the lines with the hand pump, operating the selector valves including solenoid firing control valve, in alternate directions. Catch oil at jack end of lines.

f. Remove coolant radiator flap jack. Pump oil through lines, operating control valve in alternate directions, and catch oil at jack end of lines.

g. Flush the return line by applying air pressure to the tank vent and disconnecting the line at the following points one at a time.

(1) Alighting gear and flap control valves.

(2) Pressure regulator.

(3) Control valve, Coolant Radiator.

(4) Solenoid firing control valve.

(5) Cannon charger control valve.

(6) Cannon case ejection door control valve.

h. Disconnect flap motor drain line at flap motor and drain out.

i. Remove pressure regulator and line to Cuno filter and flush out.

j. Remove and disassemble Cuno filter and flush out.

42. Venting

a. Undercarriage System - Jack the aeroplane and operate the undercarriage through three or four cycles.

b. Main plane flaps - Operate the flaps through three or four cycles.

c. Coolant Radiator - Operate the flaps through three or four cycles.

d. Armament system - Operate the Cannon case ejection door, loosen the lines at the trigger motor and cannon charger and operate the control valves allowing air to escape from the lines.

43. Leakage - Internal leakage can be located by systematically isolating the various units using the shut-off valves and control valves provided. Testing can be accomplished with the hand pump or with an outside source of pressure.

44. Replacement of Packings

General - The following are general instructions covering the maintenance of hydraulic units.

a. Disassembled units shall be thoroughly cleaned with kerosene or naphtha and coated with Intava Servo fluid before reassembly. It is necessary that all parts be free of grit or dirt to prevent damage to the polished surfaces and to the packing rings.

b. When replacing packing, wet with Intava Servo fluid before assembly and protect the feather edges of the rings against tearing by using sleeves or shim stock or waxed paper around the ends of piston rods to provide a lead for sliding the rings on, and inside the ends of cylinders to guide the rings past sharp metal edges or threads.

c. Tighten new packing only enough to prevent leakage at the prescribed test pressure. Turning chevron rings down too tightly destroys their holding power and will cause leakage.

d. Operate units to check for binding before re-installation in aeroplane.

45. Pressure Regulator - (See Fig. 20)

a. Adjustments - Adjustment of operating pressure is made at assembly and cannot be changed except by replacing spring (46131). Pressure adjustments will be altered slightly by a variation of cap (46142) tightness, therefore cap should be pulled up snugly to its approximate original position. This will insure that correct operating pressures will be obtainable after reassembling.

b. Disassembly and Inspection

Remove the four nuts (3X-34567) that secure cover (46136). This will allow inspection of spring (50066). Removal of opposite cover (46135) in like manner will permit inspection of Directional Spool (46126) and Unloading Spool (49709). Both spools should operate very freely in their respective bores. This will also allow inspection of Check Valve (38778) and Spring (38792). Check valve must operate freely in its bore and seat must be in good condition.

Unscrewing cap (46142) will allow access to spring (46131), guide (46130) and pilot valve spool (41805). Pilot valve must operate freely in its bore.

Removal of plug (39463) allows access to plunger (49556). This too must operate freely in its bore.

Gaskets (46138 & 46137) should be checked to make sure that they have not been blown-out or torn. Check all drilled passages to make certain that they are free from foreign matter and particularly the small restriction inserts under the covers and adjacent to the directional spool bore.

To reassemble, reverse the above procedure. Make certain that cover (46136) is replaced correctly, and that gaskets (46138 and 46137) are in correct position so that cut-outs in gaskets correspond to correct grooves in covers.

Most important precaution is that parts be absolutely clean before being reassembled.

TROUBLE	CAUSE	REMEDY
Valve will not charge accumulator.	Unloading Spool (49709) or directional spool (46126) stuck in "open to tank" position, or broken unloading spring (50066)	Dismantle valve and check operation of internal parts. Spools must be absolutely free in bores. Replace spring if necessary.
	Broken Pilot valve spring.	Check and replace spring if necessary.
Valve will not "unload" pump to tank.	Spools stuck in bores, or check valve stuck open.	Dismantle to inspect and clean.
Erratic "cut-in" and "cut-out" pressure readings.	Spools sticking slightly in bores, but not sufficiently to make valve inoperative.	Dismantle to inspect and clean.
	Spools scored and burrs raised at edges.	Smooth up spools with fine stone and remove burrs. However, do not break sharp corners on spool lands.
Chatter or excessive leakage. Valve not maintaining pressure in accumulator when there is no leakage in remainder of system.	Check Valve (38778) leaking.	With pressure built up in the accumulator, but pump shut-off, disconnect pressure line and observe for excessive leakage. Replace check valve, or lap slightly with seat.
	Leakage past plunger (49556)	With pressure in accumulator, but pump shut-off, disconnect tank line and check leakage. Should not exceed 30 drops per min. at approximately 100°F.

46. Hydraulic Accumulator - See Fig. 21

a. Adjustments - Air Chamber pressure may be lowered by depressing air fitting stem beneath cap. Condensate may be drained from air fitting by this same method, after oil system pressure is completely relieved.

b. Recharging - Charge with dry compressed air to 500 p.s.i. pressure before starting pump or testing hydraulic system. Use only Intava Servo Oil or equivalent mineral oil.

c. Dismantling & Reassembling - Drop system pressure completely, exhaust air pressure at air fitting, disconnect piping, then unscrew with two special Vickers #51661 wrenches. Do not damage ring lip in diaphragm when reassembling, nor tighten excessively. The ring lip effectively seals against pressure without being compressed.

d. TROUBLE	CAUSE	REMEDY
Leakage of oil or air at joint between oil and air chambers.	Chambers not tightly screwed together.	Tighten (Right hand thread) with two special wrenches #51661.
	Damaged sealing ring lip on diaphragm.	Dismantle to check. Replace diaphragm if necessary.
Loss of accumulator cushioning effect on entire system; or frequent "cutting in" and "cutting-out" of unloading valve (sometimes termed pressure regulator) or sudden extreme pressure drops when system is operated.	Loss of air from accumulator	Check for leaks as above.
	Lack of sufficient air in accumulator.	Charge accumulator to correct required pressure.
	Air pressure in accumulator higher than recommended for given installation.	Check air pressure in accumulator and bleed to correct pressure at air fitting.

TROUBLE	CAUSE	REMEDY
Loss of air in air chambers	Evidenced by chattering of unloading valve, or sudden extreme pressure drop when system is operated.	Check air fitting for leakage and air fitting connections.
	Punctured or torn diaphragm or air leakage as above, or at air fitting (Vickers part #47136)	Replace valve core of fittings, gasket (Vickers part #47139) or both. If cause not at air fitting, dismantle and check diaphragm for leaks. Replace if necessary.
Sluggish response of accumulator operated components to accumulator reserve.	Restricted oil screen (Unusual)	Dismantle and clean screen but DO NOT REMOVE from oil chamber.
Loss of system pressure.	Leakage of other units in system.	Check all units directly connected to accumulator system for leakage. If all are OK check accumulator for above condition.

NOTE: Any one of the above mentioned conditions can exist in the accumulator without causing complete failure of the entire hydraulic system, provided the pump is operating and provided there is oil in the system. Should there be failure of operation of any components dependent upon accumulator oil reserve (when pump is not running), check for loss of system pressure first, then other possible troubles as listed above.

47. Alighting Gear and Flap Control Valve. See Fig. 22

a. General - Under normal circumstances it is unnecessary to disassemble or overhaul these valves at any regular intervals. The valves should never be tampered with as long as the operation is satisfactory regardless of the length of time in service, as the basic design is such that sudden or complete failure is impossible. If a valve is disassembled it is necessary during reassembly to see that all parts are perfectly clean and free from foreign material of any kind. Assemble the parts wet with oil, (Intava Servo fluid) and renew all gaskets and sealing washers.

b. To remove pressure governors (Expansion relief valves).

(1) Cut safety wire holding relief valve cap, remove cap and aluminum gasket.

(2) Unscrew relief valve assembly from housing and remove aluminum gasket beneath valve assembly.

(3) The relief valve can be disassembled by removing the adjusting screw locknut and adjusting screw, then using a short length of 1/8 inch drill rod inserted through the adjusting screw hole to tap the valve seat from the valve cage. A clamp for holding the valve cage in a vise may be made by sawing through one side of a 7/8-18 nut.

(4) Inspect valve ball and replace if rough or corroded.

NOTE: See 6 following.

(5) Check condition of valve seat. A valve seat that is very slightly worn can be reconditioned by carefully lapping with extra-fine grinding compound, such as "Clover Grade 2A".

(a) Select a short length of steel tubing having an inside diameter slightly smaller than the valve ball and force a valve ball into the end of the tube so that a little more than half the ball extends from the tube.

(b) Lap the ball into the seat using a combined tapping and rotary motion to avoid ringing the valve seat.

(c) After a smooth, true seat is obtained, the seat and valve body shall be carefully washed to remove every trace of grinding compound.

(d) The ball used for grinding must not be used in the valve. A new ball must be installed upon reassembly.

(6) If the valve seat cannot be satisfactorily reconditioned by lapping, it must be replaced. Both valve seat and valve ball should be replaced at the same time as it is not possible to obtain a satisfactory seal when a new seat is used with an old ball, or when a new ball is installed without first lapping the old seat to a true surface.

(7) Inspect the general condition of the remainder of the parts. Make necessary replacements, reassemble and test.

c. To remove control valves.

(1) Cut safety wire holding control valve cap, remove cap and aluminum gasket.

(2) Unscrew the control valve retainer bushing, remove the spring and control valve.

CAUTION: Each control valve and its seat is a matched assembly; if more than one valve is removed, it is necessary to use care to avoid mixing the valves and seats. Be sure that the valves and seats are re-installed in their original order.

(3) Remove the control valve seat by using a length of 1/8 inch drill rod formed with a hook end similar to a crochet needle and a bent over end to permit tapping with a hammer. Hook the rod through one of the drilled passageways in the center of the valve seat and remove the seat, being careful to avoid dropping the levers and pins from the unit.

(4) Inspect the valve and seat for roughness or corrosion.

(5) Valves and seats which give evidence of leakage, but which are in fairly good condition, shall be lapped to a seat using extra fine grinding compound equivalent to Clover Grade 2A. Lap with a combined rotary and tapping motion to avoid ringing the seat. Use care to remove all traces of grinding compound after lapping.

(6) Inspect the seat and lever assembly for evidence of wear. If the levers are worn to a point where considerable play is felt, the assembly together with a matched valve shall be replaced.

(7) Inspect the general condition of the remainder of the parts. Make necessary replacements, reassemble and test.

CAUTION: If control valve has been lapped to its seat, it is necessary to check the clearance between valve stem and actuating lever. This should be approximately .002 and can be checked when the valve is assembled in the housing by holding down on top of the valve while the control shaft is rocked. If there is no clearance, the valve will hold open and leak; it will then be necessary to grind off the end of the valve stem until the necessary clearance is obtained.

d. To remove check valves.

(1) Cut the safety wire, remove check valve plug in the side of the selector valve and remove aluminum gasket under plug.

(2) Unscrew the check valve assembly by using the end of a 3/8 drive socket wrench handle in the square opening. Remove aluminum gasket.

(3) If necessary, the check valve may be disassembled in a manner similar to that used for the relief valves. The same clamp may be used to hold the valve body, and a short length of 1/4 inch brass rod used to tap on the valve ball to force ball and seat from the valve bushing.

(4) Inspect and renew the same as prescribed for Relief Valves in "b" preceding.

e. To remove control cam shaft and packing.

(1) Remove the control valves as outlined in "c" preceding.

(2) Remove both end plates.

(3) Unscrew the packing retainer at each end of the valve (Part #62203), and remove packing spacer sleeves (Parts 62202 & 62199).

(4) Remove control cam shaft.

(5) Remove packing, rings, glands and washers.

NOTE: Under ordinary circumstances there should be no necessity of removing either the control shaft or its packing during the life of the selector valve. However, if this is done, the complete packing group should be replaced as experience has indicated that packing in use for an extended period tends to take a permanent set with relation to surrounding parts and may not seal properly if re-installed. The "vellumoid" paper gaskets beneath the valve end plates should be renewed each time an end plate is removed.

f. Test

(1) Install all final fittings.

(2) Plug actuating cylinder outlet ports and reservoir return port. Apply static pressure of 2500 p.s.i. to inlet port and hold for ten (10) minutes. Check assembly and all threads for leaks, moving lever back and forth to distribute pressure in valve.

(3) Plug cylinder outlets only (leave reservoir return open). Apply static pressure to inlet port and check relief valve settings to 1500 ± 50 p.s.i. at both lever positions.

(4) Unplug cylinder ports, set lever in neutral position and check for no discharge at 2500 p.s.i.

48. Pressure Cut-Off Valve - Main Plane Flap. Fig. No. 23. This valve is to be adjusted so that the appropriate ball is seated when the flaps reach the end of their travel.

a. With the flap carriage at the midpoint of its travel on the track, see that pin "J" is vertically above the centre of the gear, as shown on Fig. 23. If adjustment is required loosen the three screws "TT", disengage the worm and turn the gear to the desired position. Tighten and safety screws "TT".

b. Remove the cotters and tighten the two adjusting nuts "T" approximately three turns.

c. With the hydraulic hand pump, extend main plane flaps. Adjust the left hand adjusting nut "T", so that the flaps are stopped in their down travel when the smallest clearance between any carriage and its stop is $1/8$ inch. Tightening nut "T" shortens the travel, loosening it extends travel.

d. Retract the flaps and adjust the right hand nut "T" so that the flaps stop flush with the trailing edge of the main plane.

e. Safety nuts "T" with cotters after adjustment.

49. Flap Actuating Motor - See Fig. 24

a.	TROUBLE	CAUSE	REMEDY
	Motor not turning over or not developing sufficient speed or power.	System overload relief valve not set at correct pressure.	Check system pressure and reset relief valve.
		Driven mechanism binding because of misalignment or other damage.	Remove motor and check torque requirement of driven shaft.
		Scored body or covers due to foreign abrasive matter in oil system.	Replace damaged parts.
		Pump or other components in system not functioning as intended.	Check system throughout, particularly pump pressure and delivery.
		Incorrect motor model for particular circuit.	Check model number. Replace with correct size motor.
	Motor turning in wrong direction.	Incorrect piping between control valve and motor.	Check circuit and determine correct piping.
	External oil leakage from motor.	Shaft packing worn or expansion plug damaged.	Check shaft drive coupling alignment and replace packing.
		Gaskets leaking due to reservoir drain not being properly connected.	Drain line must be piped directly to oil reservoir.
	Motor idling or drifting when control is in "off" position.	Control valve not closing in the "off" position.	Check control valve for port leakage.

b. Dismantling & Reassembling

In order to obtain maximum operating efficiency, manufacturing tolerances throughout these motors are held to extremely close limits. As a result, operating speeds in excess of those recommended, abrasive matter in the oil supply, or other abnormal operating conditions may cause the gears to seize. This may be temporarily remedied by dismantling the motor, inspecting body and covers for evidence of burnishing or scoring, and scraping very lightly where this occurred. Caution should be exercised that scraping is not overdone as it will cause poor volumetric efficiency. This procedure will permit motor to be operated, but should be considered only as a temporary measure. Original efficiency will not be realized until unit can be returned to the manufacturer for complete overhaul and performance tests.

c. Starting Hydraulic Motor in Service

Check all piping to make certain that connections are correct, and such that the desired rotation for a specific control valve position will be obtained.

d. Adjustments

There are no external or internal adjustments on these motors and lubrication is provided entirely by the hydraulic system oil.

50. Main Gear Jacks, Repacking - See Fig. 25

- a. Remove jack from aeroplane. (See Section 5, Paragraph 41.)
- b. With piston fully compressed, measure and record distance between attaching centres shown as $19 \frac{3}{8} + \frac{1}{8}$ on drawing.
- c. Loosen locknut "QQ" and remove end assembly "RR".
- d. Remove lockwire and packing nut "OO".
- e. Remove lockwire and locking key "Z" and fitting "CC".
- f. Raise locking pin "M" by inserting Wedge Tool No. 248862 under nut "N".
- g. Remove piston from barrel being careful not to damage bore.
- h. Remove cotter pin "B" and unscrew locknut "C". Take off packing and adapters.
- i. Wash all parts thoroughly in clean solvent.
- j. Inspect cylinder bore, piston rod and packing adapters for scratches and rough spots which may be reconditioned by using fine emery paper and buffing to a smooth finish.
- k. Replace packing "T".
- l. Assemble the piston and pre-load the packing by tightening the locknut firmly and then backing off until the packing can be rotated with a firm hand motion.
- m. Enter the piston in the cylinder using care not to injure packing.
- n. Screw on the fitting "CC".
- o. Insert the piston rod packing "MM", 3 required. Tighten the nut firmly and back off $\frac{1}{3}$ to $\frac{1}{2}$ turn and wire.
- p. Adjust the stroke with the eye bolt and fitting "CC" and insert locking keys and wire.
- q. Test assembly as shown on Figure 25.

51. Nose Gear Actuating Jack - See Fig. 26.

- a. Repacking and stroke adjustment - see paragraph 50.

52. Down Locks - Repacking, see Figs. 25 and 26.

- a. Remove nut "N". (See Fig. 25 for key in this procedure.)

- b. Remove lockwire and cap "O" being careful to hold cap firmly and compress spring "L" so that it will not suddenly extend when cap is removed.
- c. Carefully pull on pin "M" and remove valve and piston.
- d. Remove nut and bearing "J" and take out packing "H" and filler "I".
- e. Refinish scratched or rough parts with fine emery paper and buffing.
- f. If necessary, lap valve with valve seat, washing all parts in clean solvent.
- g. Assemble the piston and preload the packing by tightening the locknut securely and then backing off until packing can be rotated easily by hand. Carefully enter piston into housing with special packing guide.
- h. Insert stop "K", spring "L" and screw on cap "O".
- i. Carefully check piston operation after assembly. Latch pin must extend and snap back freely without binding under spring load. Adjust locknut further if necessary.
- j. Screw on nut "N" and insert lockwire in cap "O".

53. Shuttle Valves - To Correct Leakage - See Figs. 25 and 26.

- a. Remove guide "JJ" and spring "GG".
- b. Remove piston and spread a thin layer of fine lapping compound on angular valve face in contact with guide "AA". Extreme care must be taken not to allow compound to come in contact with guide surfaces of piston and guide.
- c. Insert piston through port "A" and lap in place carefully.
- d. Remove piston and after applying compound to opposite face of valve, lap by hand into guide "JJ".
- e. Thoroughly wash away all compound with clean solvent.
- f. Reassemble as per Figures 25 and 26 replacing gaskets if necessary and insert lockwires.
- g. Test assembly as shown on Figures 25 and 26.

54. Uplocks - See Figs. 27 and 28

a. Repacking

- (1) Remove lock from aeroplane.
- (2) Disconnect lever "E" by removing bolt "P".
- (3) Remove the housing assembly at "R" by disconnecting at "S" and "T".
- (4) Remove cap "U" from cylinder.

CAUTION: Springs "I" and "V" must be restrained while removing caps "U" by holding lock in a press.

- (5) Lift out stem and piston assembly, remove bearing "X" and replace packing "Y" with new part.
- (6) Replace in body and re-install cap "U".
- (7) Test as specified in test Note 3.
- (8) Replace the housing assembly and the lever.
- (9) Complete test, and reinstall in aeroplane.

b. Adjustment

(1) Main gear uplock - adjust as shown in Fig. 27. An additional adjustment on the length of pin "P" is provided on the main gear uplock to insure proper contact with the gear. With the uplock installed in the aeroplane, adjust by turning pin "P" so that with the gear retracted the pin will project from $5/32$ to $1/4$ inch into the axle of the wheel. After adjustment, replace locking key to keep pin from turning.

(2) Nose Gear Uplock - adjust as shown on Fig. 28.

55. Main Gear Door Jack - See Fig. 29

a. Repacking - Door Jack Cylinder

(1) Remove jack from aeroplane.

(2) With piston compressed carefully measure and record the distance between attaching points given as $15 \frac{3}{32}$ on Figure 29.

(3) Holding piston rod "J" loosen locknut "B" and remove terminal "A".

(4) Remove bearing nut "C"

(5) Replace packing "F" with new part.

(6) Replace bearing nut "C".

(7) Replace terminal "A" and nut "B", adjust terminal to previously recorded dimension and lock with "B".

(8) Test as prescribed on Figure 29 and reinstall in aeroplane.

b. Repacking - Door Jack Piston

(1) Remove the jack from the aeroplane.

(2) Measure and record distance between ports given as $11 \frac{1}{4}$ approximately on Figure 29.

(3) Loosen head locknut and unscrew head "E".

(4) Withdraw piston, remove cotter pin "S", nut "R" and piston head "Q".

(5) Install both sets of new packing rings "P" and replace "Q", "R" and "S".

(6) Reassemble cylinder to recorded measurement.

(7) Test as prescribed on Figure 29 and re-install in aeroplane.

56. Nose Door Jack - See Fig. 30

a. Repacking - Door Jack Cylinder

(1) Remove jack from aeroplane.

(2) With the piston bottomed, measure and record the distance between attaching points, shown on the drawing as $13 \frac{5}{8}$ inches.

(3) Loosen terminal nut "B" and terminal "A".

(4) Remove gland nut "D".

(5) Remove packing adapter "E" and replace packing "F".

(6) Replace adapter and gland nut "D".

(7) Replace terminal "A" and nut "B", adjust terminal to previously recorded dimension, and lock with "B".

b. Repacking - Door Jack Piston

- (1) Remove jack from aeroplane.
- (2) Measure and record the distance between ports, shown as 11 13/16, on Figure 30.
- (3) Remove terminal nut "B", terminal "A", gland nut "D", and cylinder end "K".
- (4) Withdraw piston and remove cotter pin "T" and piston nut "S".
- (5) Remove packing "R" and adapter "Q".
- (6) Install new packing rings and re-insert adapter "Q".
- (7) Re-assemble cylinder to recorded measurement.
- (8) Test in accordance with instructions on Figure 30, and re-install in aeroplane.

57. Door Stop Valves - See Fig. 31

a. Adjustment

(1) Adjust the length of the pin at "A" and "B" with the undercarriage retracted, so that the valve is fully opened with a piece of 1/8" stock in place between the buffer "A" and its point of contact on the gear.

b. Repacking

- (1) Remove valve from aeroplane.
- (2) Measure and record distance between buffer "A" and nut "B".
- (3) Loosen nut "B" and remove buffer "A".
- (4) Remove nut "D"; the packing and adapter will then come out with pin "C".
- (5) Replace packing "F" with new part.
- (6) Replace nut "D" on pin and screw into valve body.
- (7) Replace "A" and "B" according to recorded measurement.
- (8) Test as prescribed on Figure No. 31.
- (9) Safety nut "D" after test is complete and reinstall in aeroplane.

58. Door Holding Valves - Adjust to open at 250 p.s.i.59. Nose Door Lock Holding Valve - Adjust to open at 750 p.s.i.60. Nose Door Locking Jack - See Fig. 32

a. To replace Piston Packing

- (1) Remove jack from aeroplane.
- (2) With piston fully compressed, unscrew packing nut "K" and withdraw piston assembly from cylinder.
- (3) Remove nut "B", replace packing "D" and reassemble.
- (4) Test as prescribed on Figure 32 and reinstall.

b. To Replace Cylinder Packing

- (1) Remove jack from aeroplane.
- (2) Loosen locknut "N" and remove clevis "O".

- (3) Remove packing nut "X".
- (4) Replace packing "J" reassemble.
- (5) Test as prescribed on Figure 32 and reinstall.

61. Solenoid Control Valve - Disassembly and Inspection - See Fig. 33

a. To remove the solenoid for replacement or inspection of contacts.

- (1) Remove the two screws "C" and cap assembly "D".
- (2) Move plug assembly "G" aside, remove nut "R" and remove the solenoid and cover plate.
- (3) In reassembly, it is imperative that the insulating spacer "Q" is in place and the plug assembly properly aligned.

b. To clean and inspect hydraulic chamber.

(1) Loosen cap "X", remove solenoid assembly and pull the solenoid plunger and pilot from the valve body.

(2) Remove cap screw "O", clean and inspect seat "N". If damaged, install new housing "BB" and seat "N" (assembly No. 78628). Make certain that pilot valve "Y" seats properly.

(3) Inspect plunger and pilot valve assembly "K", "Y" and "AA". If replacement is necessary, remove pin "Z" and unscrew pilot valve "Y" from rod "V".

NOTE: The rod is slightly peened together through a small hole in the upper cylindrical portion of the pilot valve.

(4) In reassembly of the solenoid valve be sure all parts move freely and spring "L" is properly aligned.

62. Trigger Motor - Fig. 34 - Disassembly and Cleaning

a. Remove the motor from the bracket assembly by releasing the locking plunger "D".

b. Remove slide cap "P", pull slide "O" until the "Tee" portion hits against the piston "N" then rotate the slide 90° and pull it on through the piston.

c. Remove cap "R", spring "S", and pull piston from cylinder.

d. Remove cup packing "M" and clean all parts thoroughly. Inspect cup "M" for deterioration and replace if necessary.

e. In reassembly, use care when entering the cup into its bore so that the edges will not be broken, or leakage will result.

63. Cannon Charger Control Valve - Fig. 35, Disassembly for Cleaning and Inspection

a. Push in handle "C" and remove pin "B".

b. Remove handle "C" and spring "D".

c. Remove cap screw, spring "F" and detent "V".

d. Remove spring pilot "G", spring "H", ball "I" and pin "J" from the cylinder port.

e. Remove spring pilot "T", spring "S", ball "R" and pin "U" from the pressure inlet port.

f. Remove end cap "K" and valve plunger "A".

g. Remove seal "O". Replace if worn.

h. Remove cap screw "L", spring adjusting screw "M", spring "N", stop "P" and the release valve plunger "Q".

i. Clean all parts thoroughly. Inspect for burrs or score marks and, if present, remove with a stone or fine emery and clean thoroughly so that parts move freely. If deeply scored, replace the valve body assembly.

j. To assemble the valve plunger "A" in valve body or end cap "K", use Bendix special tool No. 78567 to protect the sharp edge of the packing seal "O".

k. When valve is assembled adjust spring "N" with adjusting screw "M" to kick out at 750 p.s.i.

64. Cannon Charger Jack - Fig. 36, To replace packing cup

a. Remove cylinder assembly "A" with Bendix special spanner wrench No. 78566.

b. Remove piston packing cup "B".

c. Clean all parts thoroughly with cleaning solvent.

d. In reassembly use special care to guide the cup seal "B" into the cylinder assembly "A" so that the sealing edge of the cup is not marred, or leakage will occur at low pressure.

65. Cannon Case Ejection Door Control Valve - Fig. 37, Repacking

a. Remove valve from aeroplane.

b. Remove the button from the valve stem.

c. Remove packing nut "H".

d. Replace packings and reassemble.

e. Test as prescribed on Fig. 37.

66. Cannon Case Ejection Door Jack - See Fig. 38

a. To replace piston packing.

(1) Remove jack from aeroplane.

(2) Unscrew packing nut "I" and withdraw piston assembly from cylinder.

(3) Remove nut "A", replace packing "C" and reassemble.

(4) Test as prescribed for nose door locking jack on Fig. 32. Reinstall.

b. To replace cylinder packing.

(1) Remove jack from aeroplane.

(2) Loosen locknut "K" and remove clevis "L".

(3) Remove packing nut "I".

(4) Replace packing "G" and reassemble.

(5) Test as prescribed for nose door locking jack on Fig. 32 and reinstall.

67. Coolant Radiator Exit Flap Control Valve - See Fig. 39

a. General. Complete disassembly and overhaul of these valves should not be required under normal operating conditions except at rare intervals; usually only minor repairs will even then be required, such as lapping or reseating a leaking valve poppet. The design of these valves is such that sudden or complete failure is impossible and they should not be tampered with as long as they function properly, regardless of length of time in service.

b. To disassemble.

(1) Cut lockwire "A" and remove both upper caps "B".

(2) Remove springs "C".

(3) Remove as a single unit upper poppet "E" and lower poppet "I", including spring "F", spacer "G" and Cup "H", which separate the poppets. If the upper poppet comes out alone, a pair of tweezers may be used to lift out the remaining spring, spacer, cup and lower poppet.

NOTE: These poppets are in matched sets and should be kept together to insure that they are reassembled as such.

(4) Cut lockwire "K" and remove the screws from the retainer "J".

(5) Remove retainer and pull out camshaft "P", washer "L", and cup "N".

(6) Inspect the valve poppets and seats for scoring, abrasions and corrosion. If in such a condition as to require lapping, proceed as in (c) following. If poppets cannot be lapped enough to secure good seats, they should be replaced.

c. Reseating poppets.

(1) Poppets and seats which give evidence of leakage but are in fairly good condition should be seated by lapping with an extra fine lapping compound such as "Clover Grade 2A". Lap using a combined rotary and tapping motion to avoid "ringing" the seat. A piece of tubing may be fitted over the upper poppets to serve as a handle during lapping. A piece of soft metal rod or wood fitting snugly into the hole can be used on the lower poppets.

CAUTION: After lapping remove all traces of grinding compound.

(2) After the poppets have been lapped to their seats, the clearance between the bottom of the poppets and the camshaft must be checked. This should be approx. .010" and can be checked when the valve is assembled by rotating the camshaft back and forth. If there is no clearance, the valve will be held open and leak. This may be corrected by grinding the ends of the poppets until the necessary clearance is obtained. The total amount of rotation required for .010" clearance is approximately 16 degrees.

d. Assembly.

(1) Inspect the rubber cups "H" and "N" for signs of deterioration and replace if necessary.

(2) Inspect the camshaft at the place where it is in contact with the rubber sealing cup. If corrosion is present, polish shaft with crocus cloth or equivalent. Inspect cams for wear and roughness and if excessive, replace camshaft.

(3) Thoroughly clean all ports so that absolutely no foreign matter is present.

(4) Assemble parts, wet with oil (Intava Servo Fluid or equivalent) in reverse of disassembly procedure. Renew necessary washers. Safety screws and caps.

e. Testing.

(1) With valve in closed position, plug the jack outlet and reservoir return ports and apply pressure of 2000 lbs. per sq. in. to pressure port. Hold for ten minutes. Check assembly and upper caps for leaks.

(2) Remove plugs from ports and apply 2000 lbs. pressure to pressure port. Check seating of upper valve as evidenced by leakage at jack outlet ports.

(3) Plug pressure port and apply pressure of 2000 to each jack outlet port separately. Check seating of lower valve, and its sealing cup as evidenced by leakage at return port.

(4) Plug pressure and cylinder ports and apply pressure of 2000 lbs. at return port. Check camshaft sealing cup and bottom caps for leakage.

68. Coolant Radiator Exit Flap Jack. Figure No. 40

a. To replace cylinder packing.

(1) Remove jack from aeroplane.

(2) Loosen locknut "P" and remove terminal assembly "Q".

(3) Remove bearing nut "O" using tool No. 234584.

(4) Remove packing "M" and replace with new parts.

(5) Replace bearing nut "O".

(6) Test as prescribed on Figure No. 40.

(7) Safety nut "O", replace "P" and "Q" to 6 15/16" dimension and reinstall in aeroplane.

b. To replace piston packing.

(1) Remove jack from aeroplane.

(2) Remove "P" and "Q".

(3) Remove "A", "B", and "C" using tool No. 234583.

(4) Remove piston assembly from cylinder.

(5) Remove nut "E" and all packing and adapters.

(6) Replace packings with new parts, reassemble piston and cotter.

(7) Remove bearing nut "O" and packing "M".

(8) Replace piston assembly in cylinder.

(9) Replace "M", "O", "P", and "Q".

(10) Replace "C" and "B".

(11) Test as directed on Figure No. 40.

(12) Replace "A" and "N" and reinstall in aeroplane.

69. Emergency Relief Valve - Adjust to open at 1000 ± 50 p.s.i.

MISCELLANEOUS

70. Self Sealing Fuel Tanks - Inspect daily for leakage as evidenced by fuel stains on the lower surface of the centre plane and fuselage. After every 100 hours of operation the tanks should be removed (see Sect. 5, Par 17-19) and inspected for chafed or worn spots, condition of attaching flanges, punctures or breaks as evidenced by swelling of the surface, and corrosion of fuel gauge transmitting units. Repair of these tanks is described in A.P. 2021A, Vol. 2.

71. Lubrication - Requirements for lubrication and the location of points of lubrication are shown on the diagram, Figure 41.

72. Bonding - The aeroplane is bonded for electrical continuity in accordance with Lockheed Specification M-1B.

73. Piping Joints - Sections of piping are fastened together with Parker Triple Tube Couplings.

a. Slight leakage at piping joints may be checked by gently tightening on the union nuts. Take care not to tighten excessively or damage to piping and nuts may result.

b. If leakage cannot be checked by the procedure in (a), relieve all pressure and drain the line. Unscrew the union nuts and inspect flared ends of the pipes for cracks. Replace if necessary.

NOTE: Use ample thread lubricant when recoupling the pipes.

74. Piping Color Code - All piping lines are identified by encircling bands of tape near the pipe fittings and at intervals along their lengths according to the following code:

<u>System</u>	<u>Color</u>
FuelRed
OilYellow
CoolantWhite-Black-White
HydraulicBlue-Yellow-Blue
OxygenGreen
Manifold PressureWhite-Blue
VacuumWhite-Green
Airspeed PressureBlack
Airspeed StaticGreen-Black

75. Mounting Ladder - On later models, a retractable ladder is carried in a longitudinal slot beneath the aft portion of the fuselage. A small lever protruding from the upper rear fuselage releases the ladder actuating handle which lifts upward, allowing the ladder to swing down from its slot beneath. A downward push on the handle swings the ladder to its fully extended position and a forward push on the handle locks it there. When locked in position, the handle serves as a grip for assistance in ascending the ladder. A button on the handle releases the ladder from the extended position, allowing it to be swung upward into the fuselage by pulling the handle upward until the latch catches, then pushing the handle forward to its flush position, where it locks in place.

a. Adjustment - An adjusting screw for setting the ladder flush with the lower fuselage surface is accessible through the slot in which the handle rests. Skin panels on the rear fuselage, adjacent to the ladder, are removable for access to the ladder mechanism.

Key to Figure 1

Diagram - Main Plane Stations & Removable Panels

- A. CAUTION: Disconnect Electrical Wiring Before Removing Main Plane Tip
- B. Aileron Counterweight
- C. Aileron Push-Pull Tube
- D. Tab Actuating Mechanism Lubrication
- E. Aileron Differential Mechanism
- F. Tab Idler Pulley
- G. Tab Pulley
- H. Flap Controls
- I. Aileron & Tab Turnbuckles
- J. Flap Cables
- K. CAUTION: Disconnect Electric Wiring Before Removing Outer Plane
- L. Main Plane Joint
- M. Jack Here
- N. Engine Control Cables
- O. Removable Fuel Tanks
- P. Fuel Drain (Reserve Tank)
- Q. Main Fuel Tank
- R. Auxiliary Fuel Tank
- S. Flap Cables
- T. Flap Cables
- U. Hoist
- V. Earthing Jack
- W. Coolant
- X. Engine Oil
- Y. Main Plane Joint
- Z. Flap Cables
- AA. Tab Cables
- BB. Hoist
- CC. Flare Attachment
- DD. Flap Cables
- EE. Elevator Tab Actuating Mechanism
- FF. Rudder Tab Stop
- GG. Elevator Tab Stop
- HH. Picketing Jack
- II. Main Plane Pins
- JJ. Empennage Control Cables

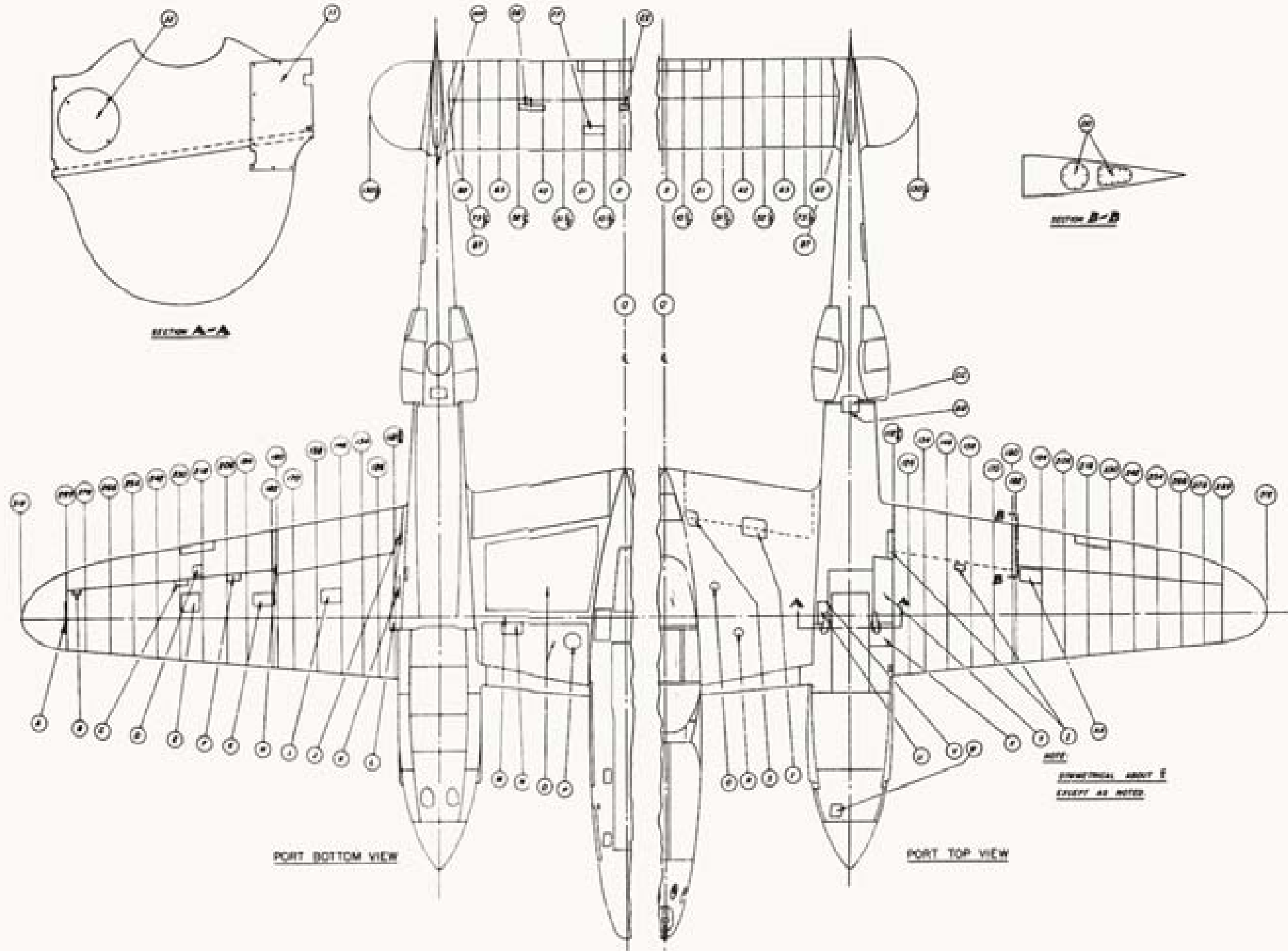


DIAGRAM - MAIN PLANE STATIONS & REMOVABLE PANELS

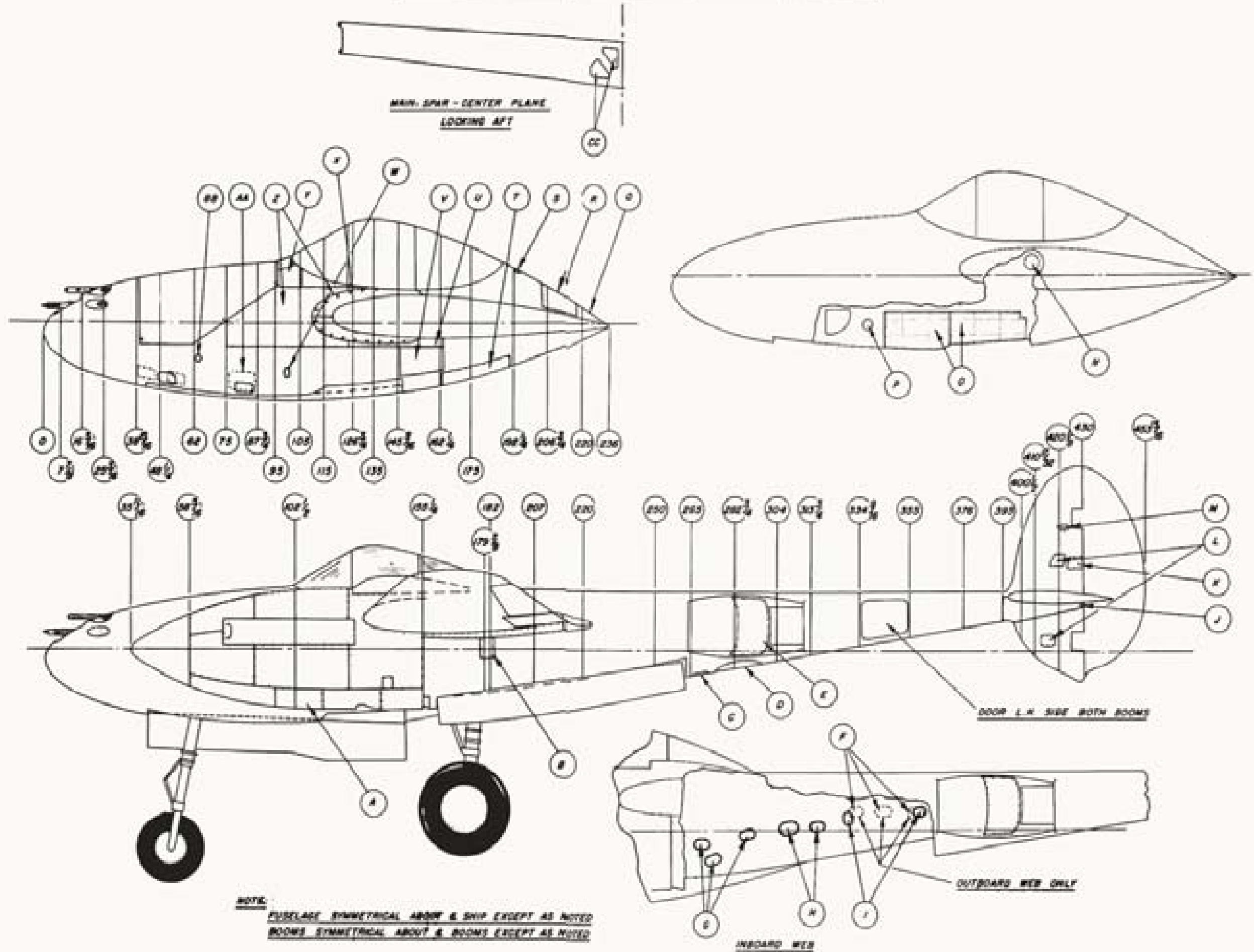
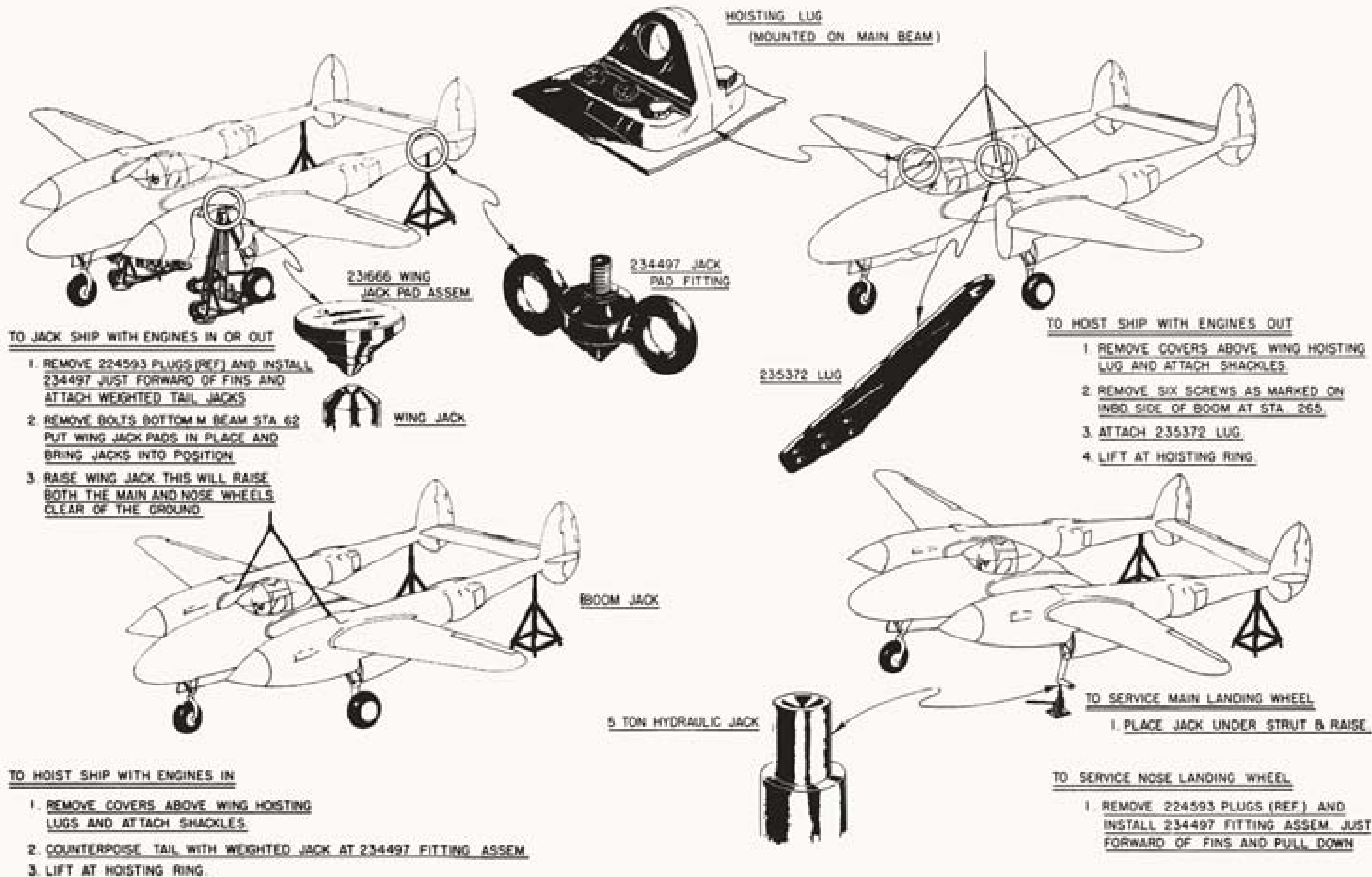


DIAGRAM - FUSELAGE STATIONS & REMOVABLE PANELS

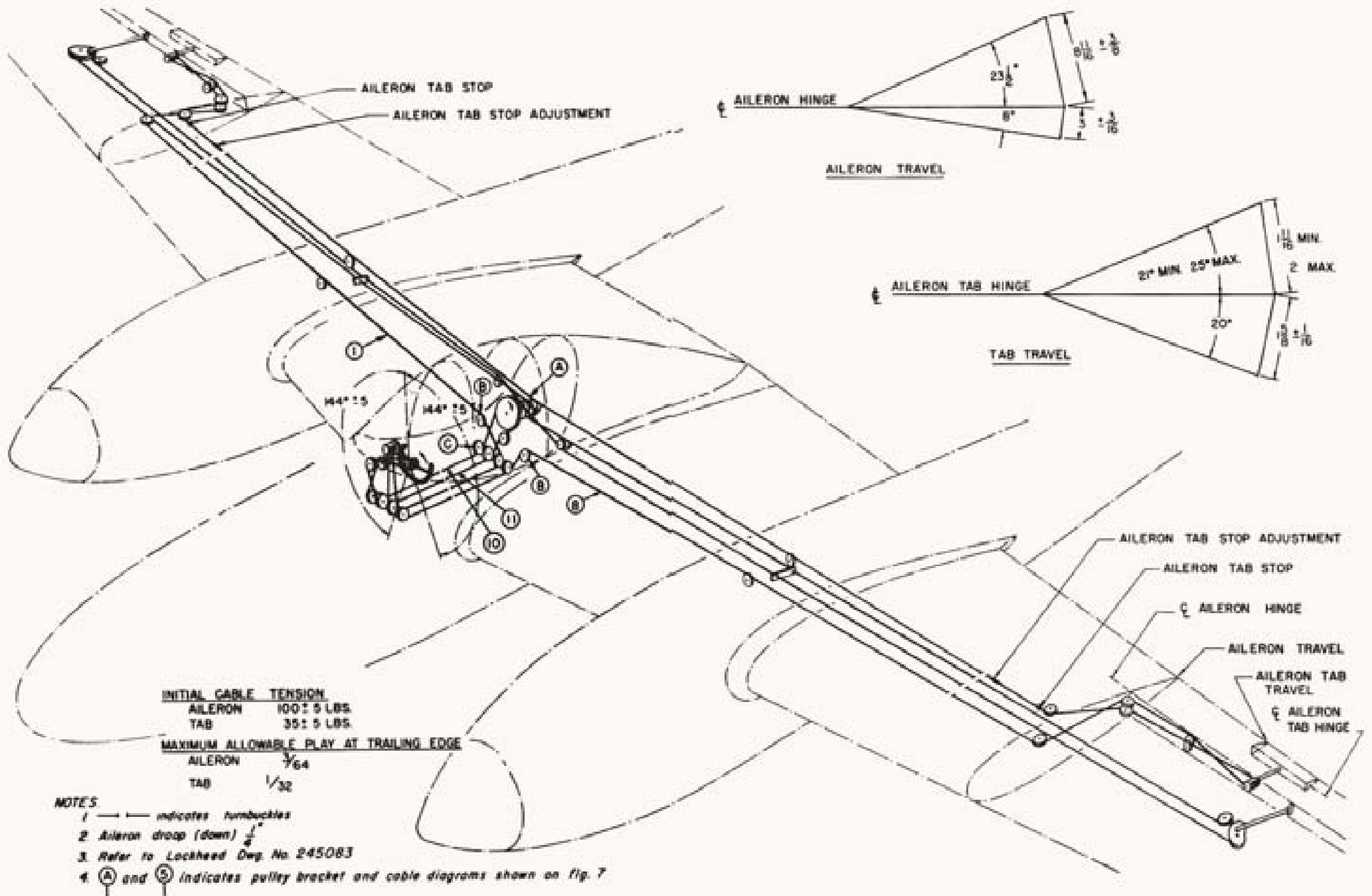
Key to Figure 2

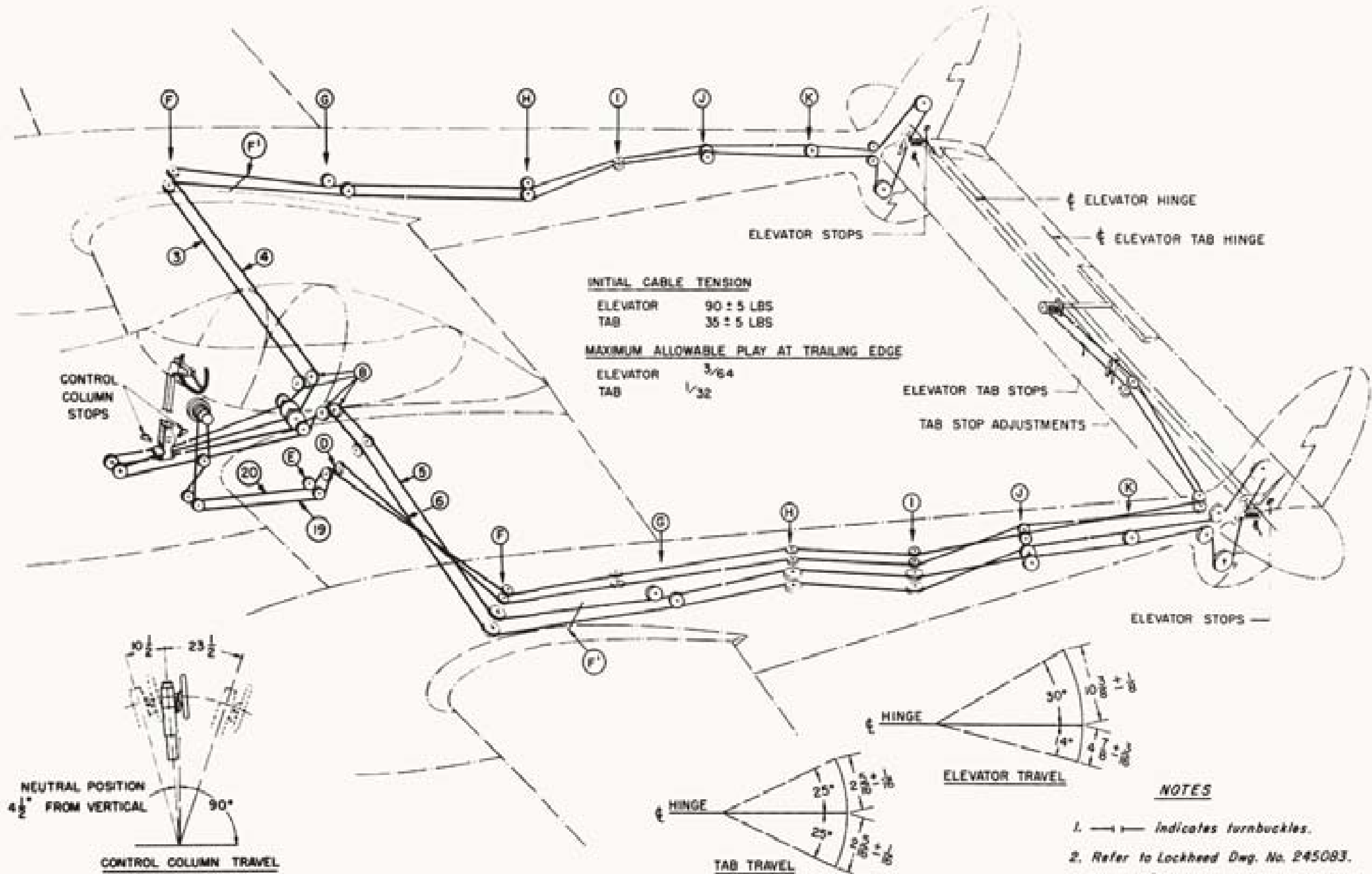
Diagram - Fuselage Stations & Removable Panels

- A. Oil Temperature Regulators
- B. Undercarriage Pin
- C. Flares
- D. Flares - Radiator Flap Jack
- E. Coolant Radiator
- F. Coolant Tube
- G. Coolant Tube
- H. Coolant Tube - Empennage & Tab Cable
- I. Coolant Tube - Tab Cable
- J. Controls
- K. Tab Actuating Unit
- L. Elevator Pulleys
- M. Junction Box - Running Light
- N. Auxiliary Fuel Gage
- O. Plumbing & Controls
- P. Construction Handhole
- Q. Stirrup
- R. Flap Motor
- S. Hydraulic Reservoir
- T. Fuel Sump Strainers & Valves
- U. Window Mechanism
- V. Control Cables & Plumbing
- W. Jettison Valve
- X. Fillets - Fuselage to Centre Main Plane
- Y. Instruments
- Z. Plumbing & Electrical
- AA. Case Ejection Door
- BB. Undercarriage Pin
- CC. Surface Controls



HOISTING AND JACKING DIAGRAM





INITIAL CABLE TENSION

ELEVATOR	90 ± 5 LBS
TAB	35 ± 5 LBS

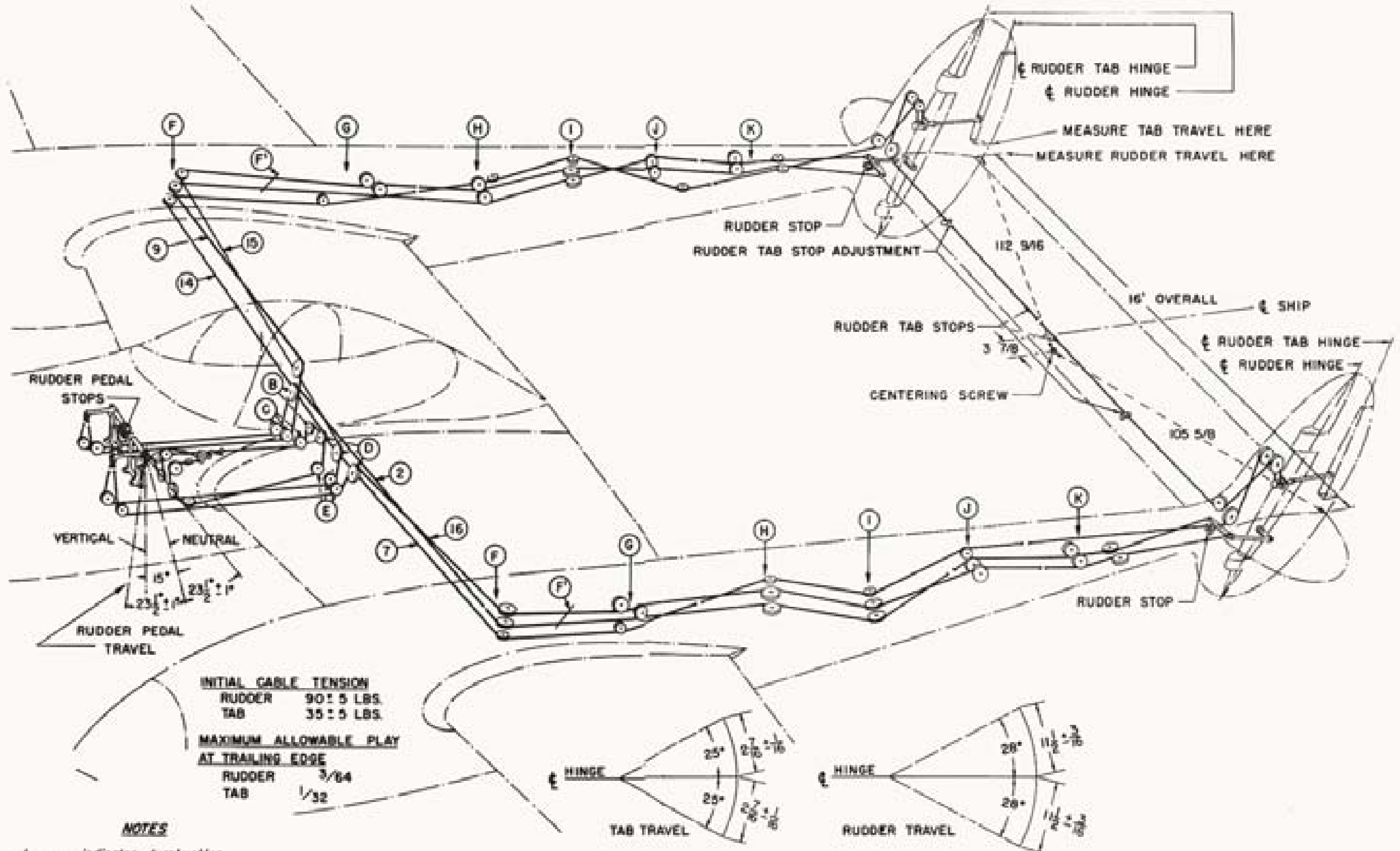
MAXIMUM ALLOWABLE PLAY AT TRAILING EDGE

ELEVATOR	3/84
TAB	1/32

NOTES

1. ——— Indicates turnbuckles.
2. Refer to Lockheed Dwg. No. P45083.
3. (A) and (B) indicate pulley bracket and cable diagrams shown on fig. 7

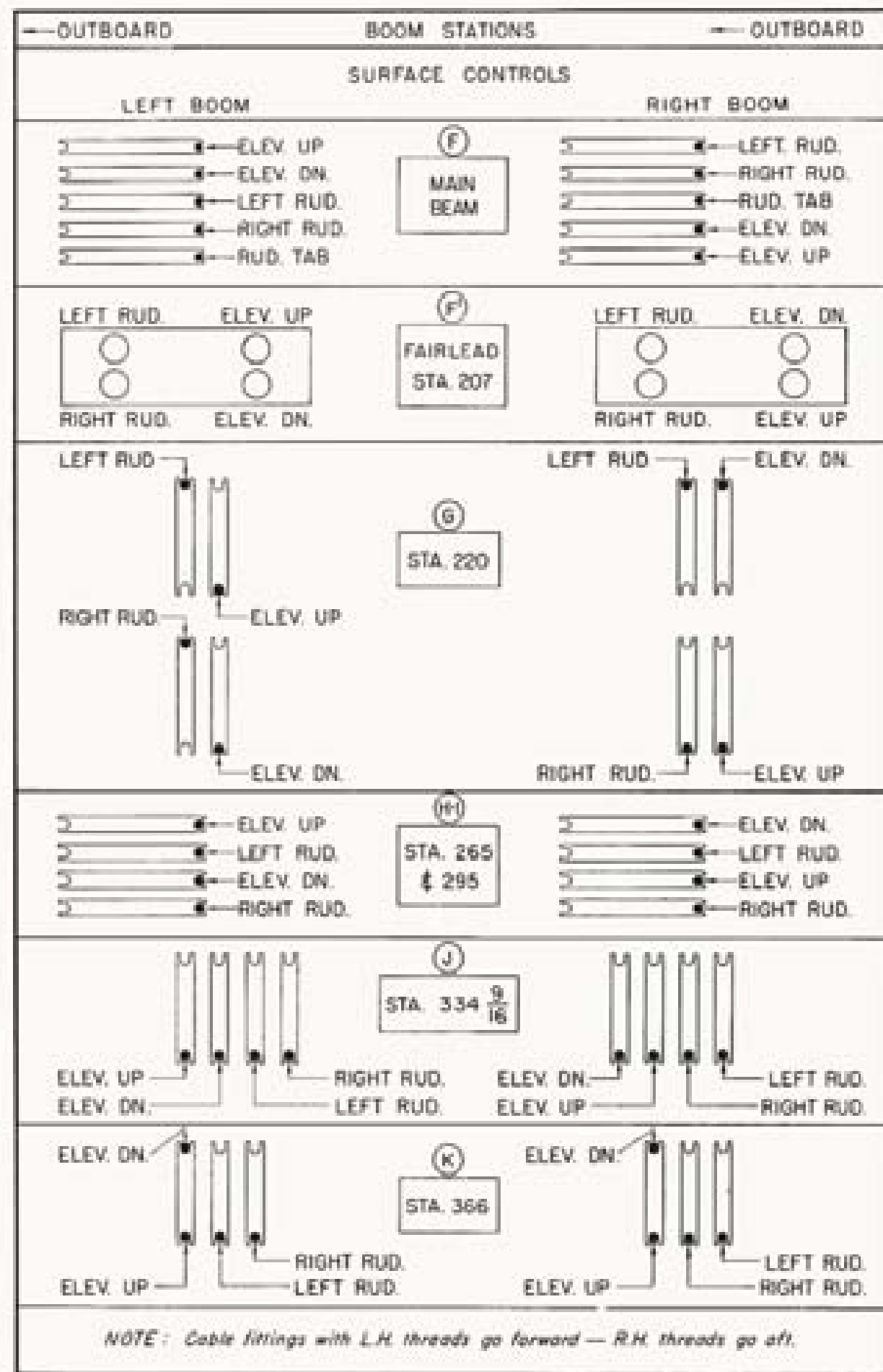
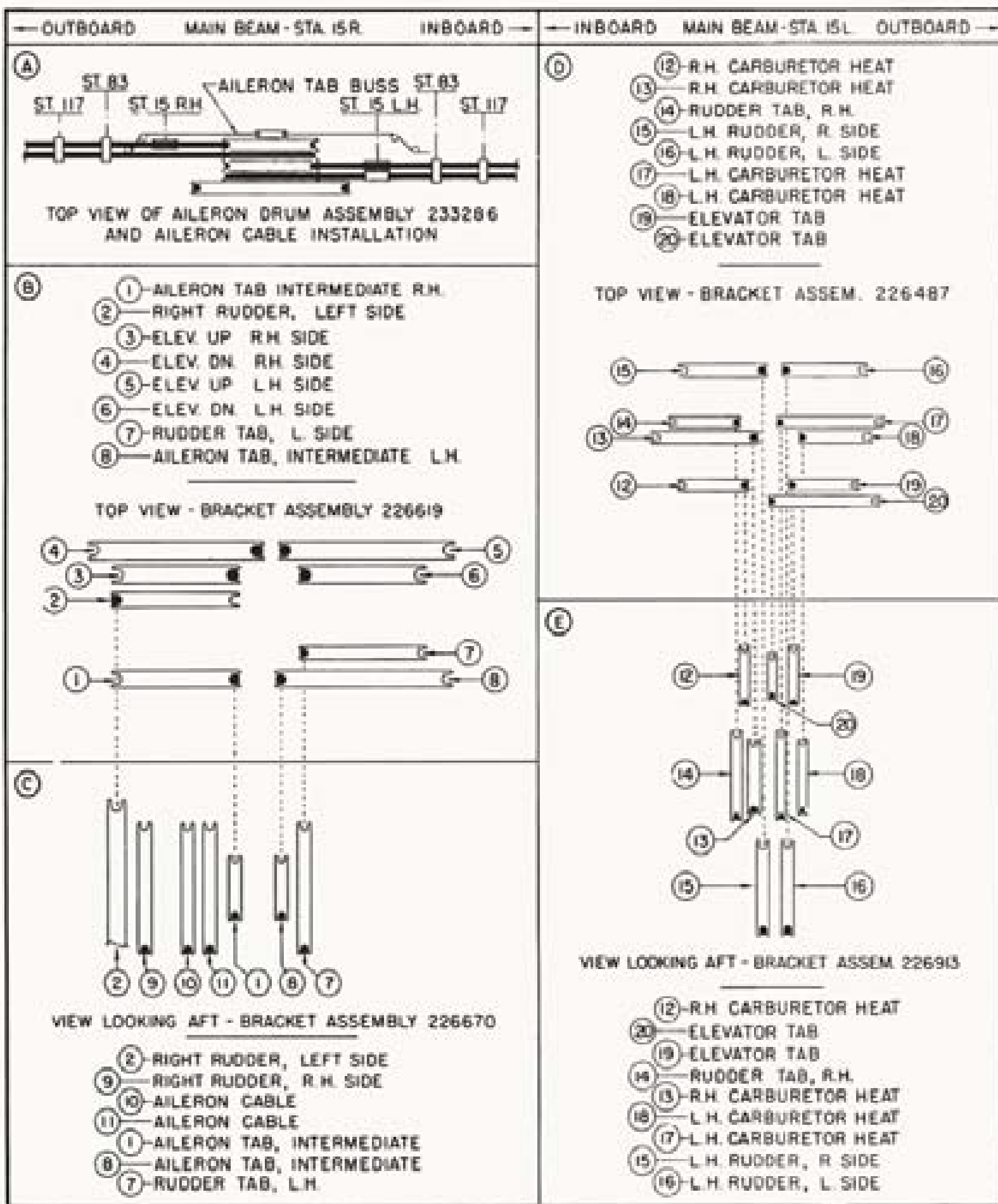
ELEVATOR CONTROL SYSTEM

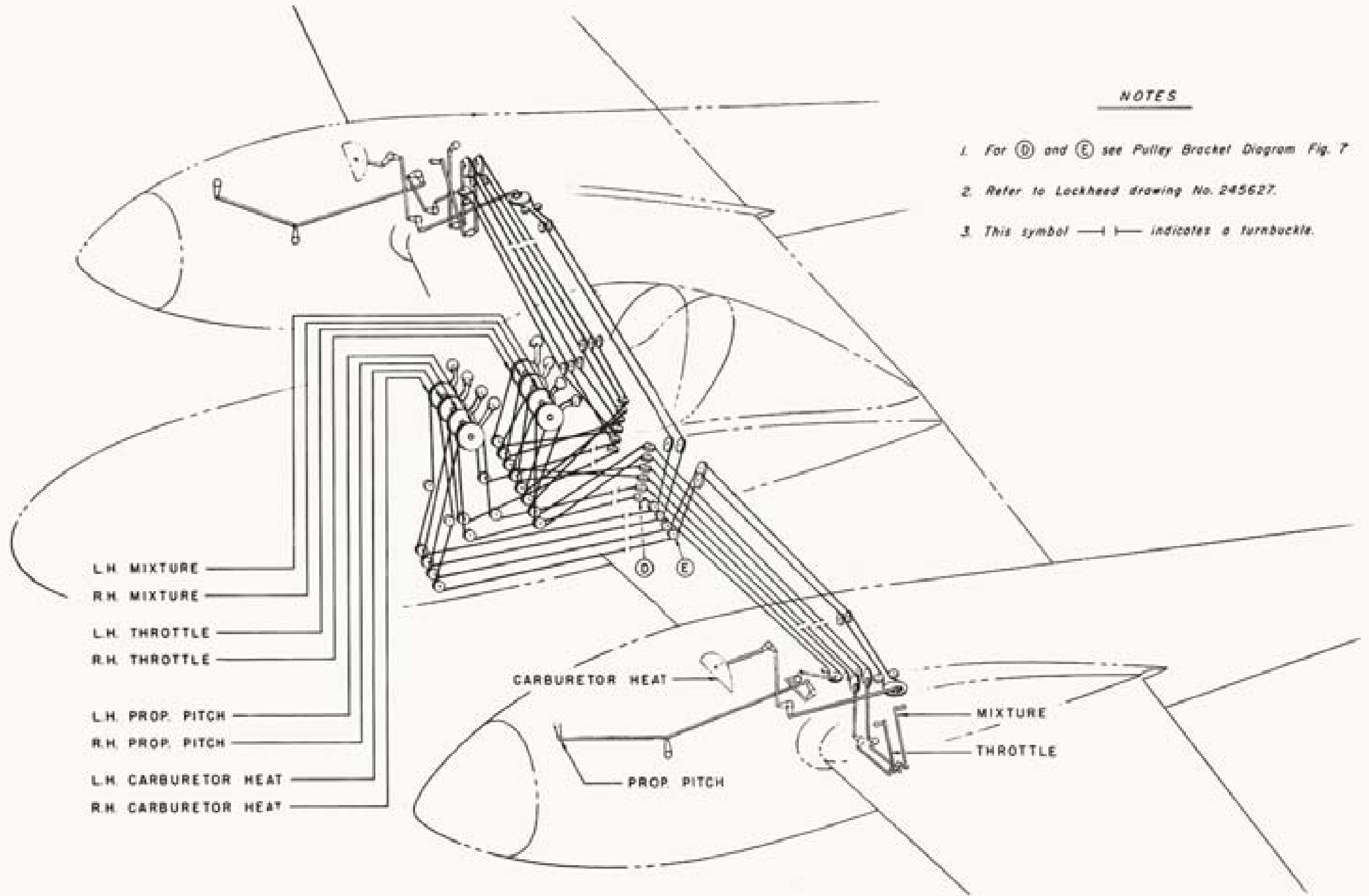


INITIAL CABLE TENSION	
RUDDER	90 ± 5 LBS.
TAB	35 ± 5 LBS.
MAXIMUM ALLOWABLE PLAY AT TRAILING EDGE	
RUDDER	3/64
TAB	1/32

NOTES

- 1. — — indicates turnbuckles
- 2. Refer to Lockheed Dwg. No. 245083
- 3. (A) and (5) indicates pulley bracket and cable diagrams shown on fig. 7

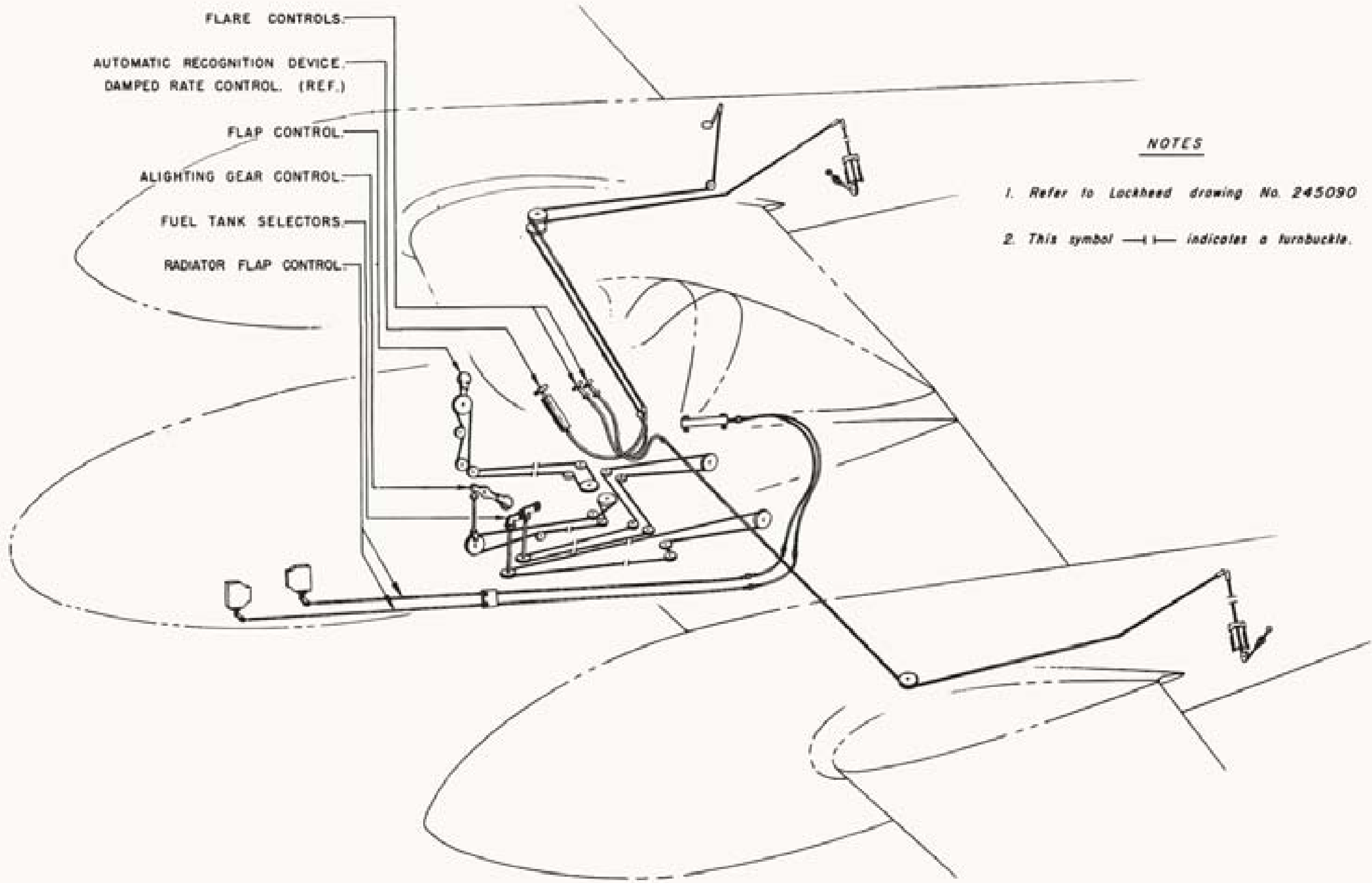




NOTES

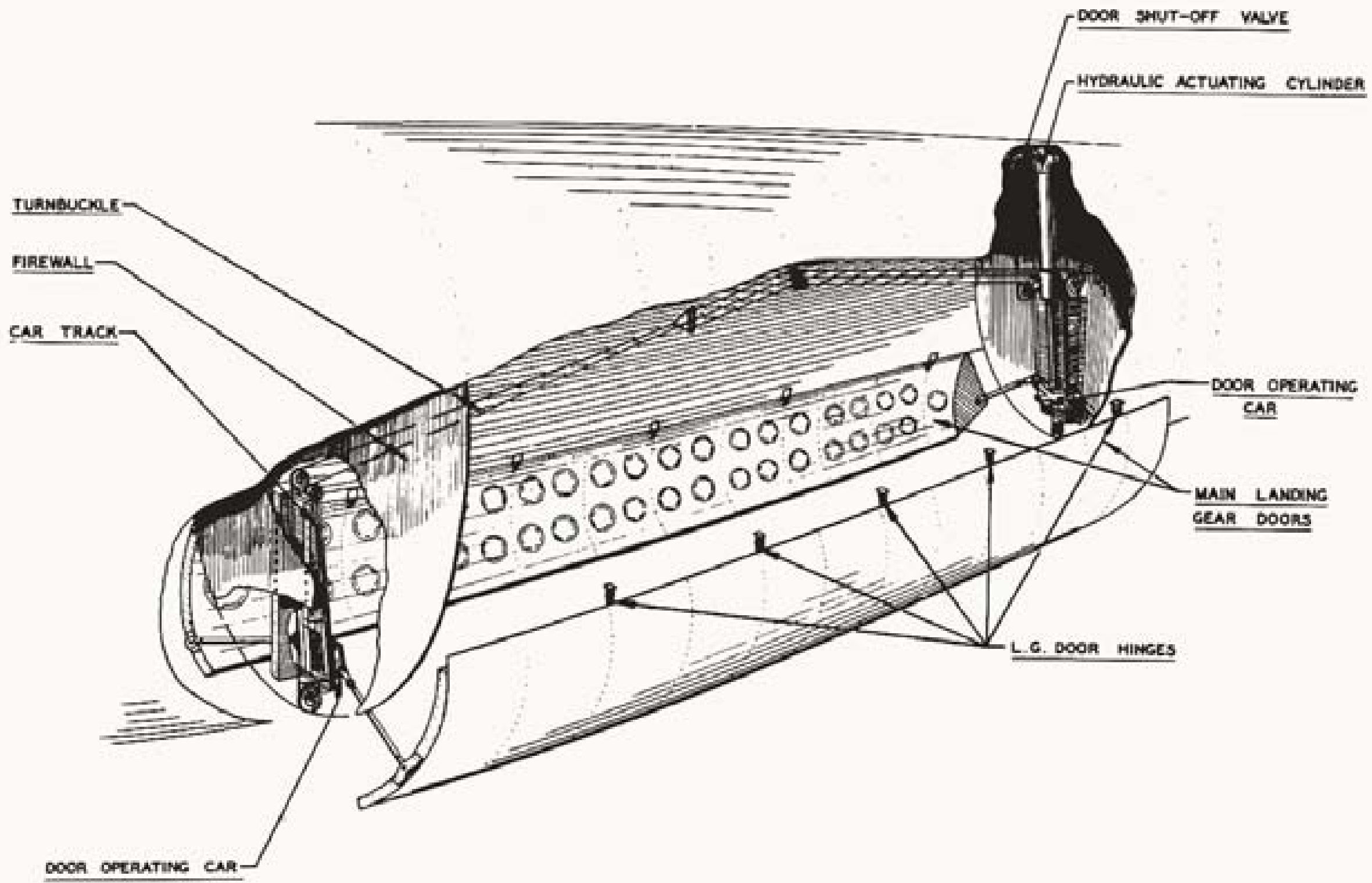
- 1. For (D) and (E) see Pulley Bracket Diagram Fig. 7
- 2. Refer to Lockheed drawing No. 245627.
- 3. This symbol —|— indicates a turnbuckle.

ENGINE CONTROLS

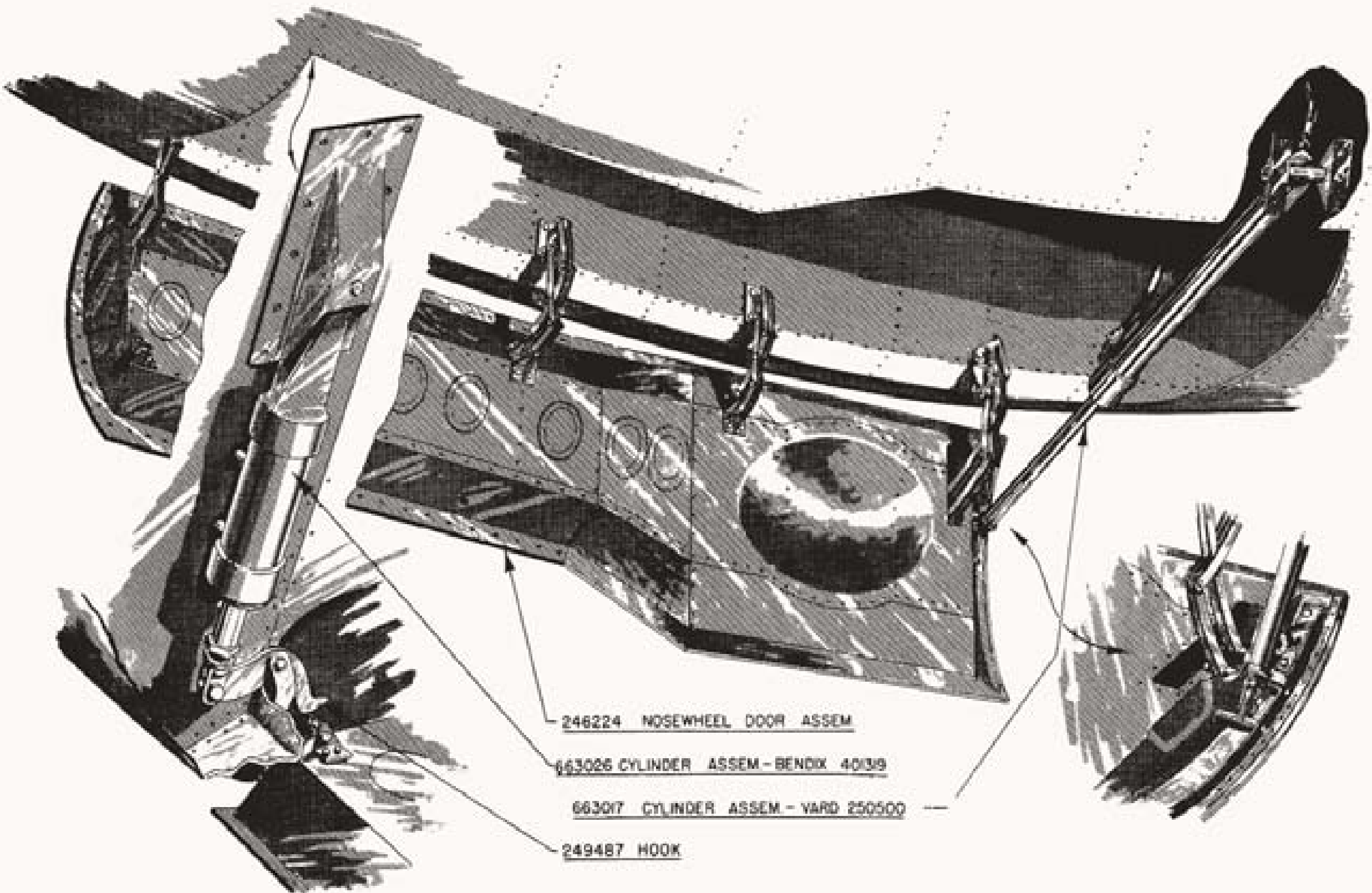


NOTES

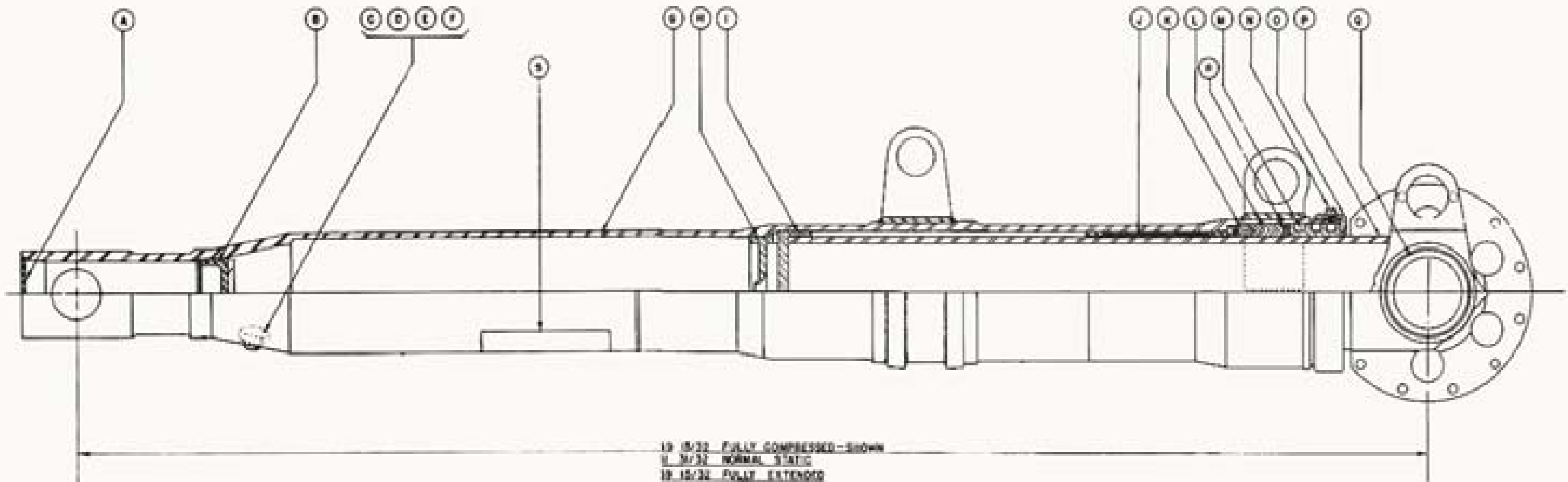
- 1. Refer to Lockheed drawing No. 245090
- 2. This symbol —|— indicates a turnbuckle.



MAIN ALIGHTING GEAR DOOR OPERATION



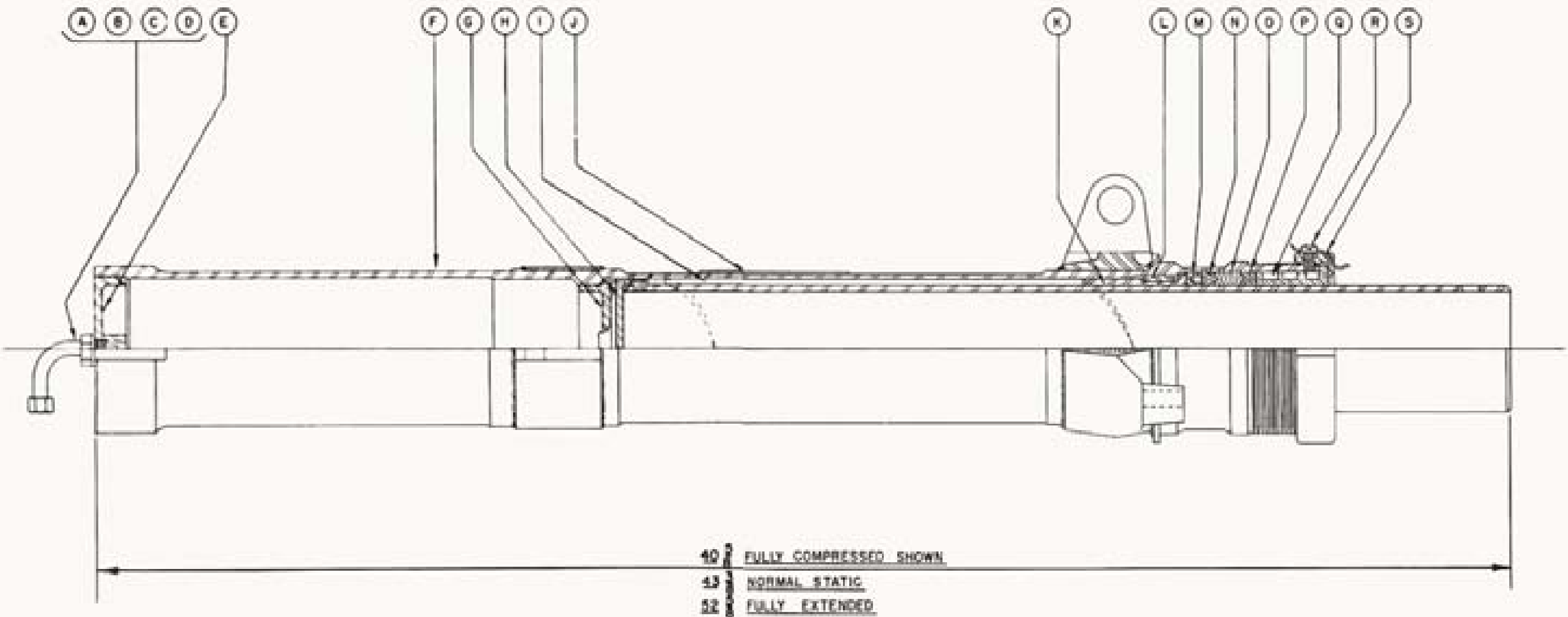
NOSE ALIGHTING GEAR DOOR OPERATION



LET	PART NO.	NAME
A	2.318 DIA	EXPANSION PLUG
B	245044	PLUG
C	AC 17A 1229	AIR VALVE BOOT
D	7190	AIR VALVE GASKET
E	AC 14A 121	AIR VALVE GASKET
F	7193	CONE
G	245090	CYLINDER
H	245083	PLATE
I	245019	PISTON HEAD
J	245028	SLIDING
K	245027	PACKING SPACER

LET	PART NO.	NAME
L	CARLOCK	PACKING
M	245020	BEARING
N	6520A 10-1	LOCK BUSH
O	245025	WGT
P	245026	FILTER
Q	245024	AXLE
R	245029	PACKING SPACER
S		SAFETY PLATE

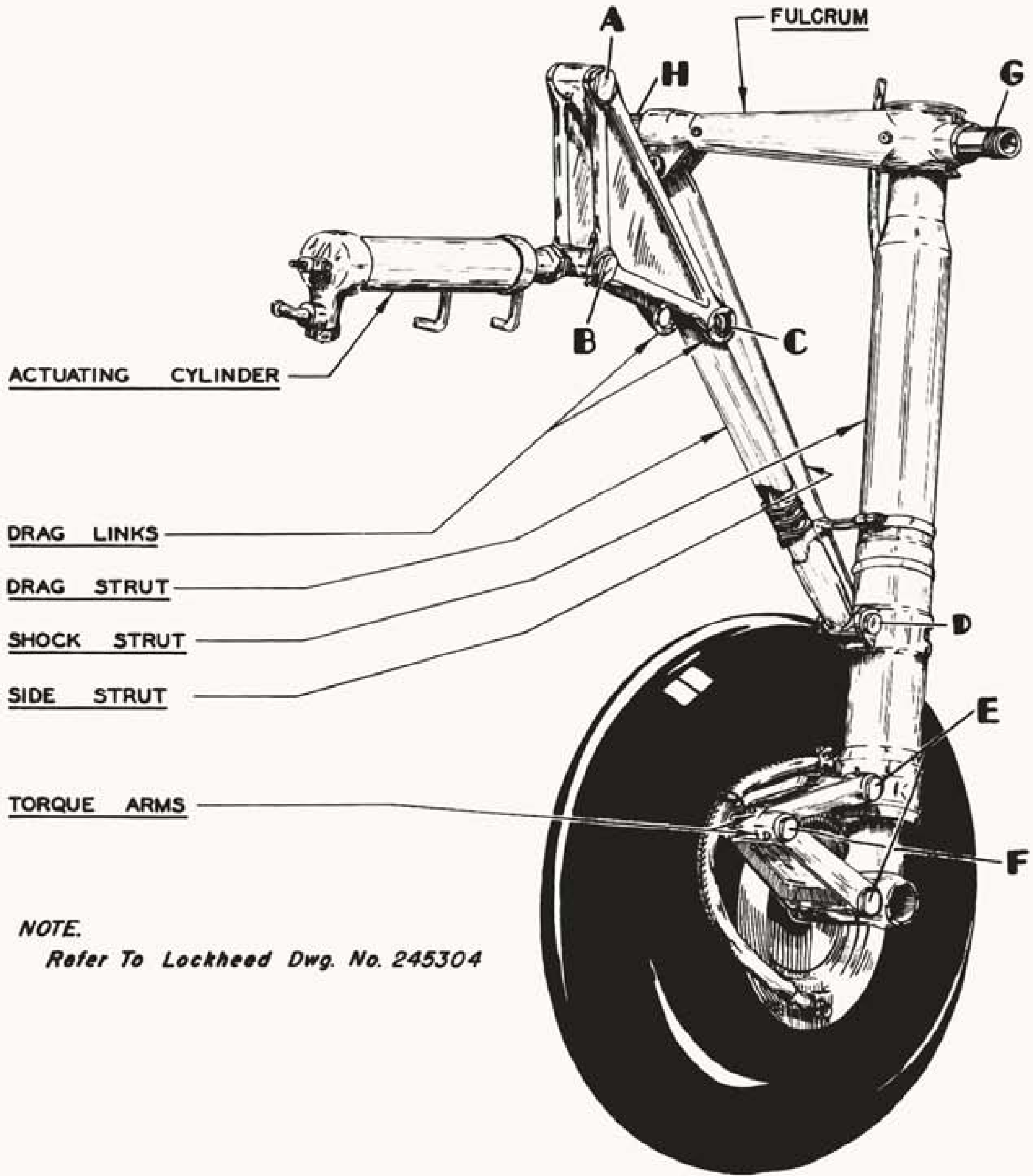
NOTE:
 LOCKING PART NO. 661024 L.H. SIDE
 R.H. OPPOSITE
 MEMASCO PART NO. 661040



LET.	PART NO.	NAME
A	0.16	AIR VALVE BODY
B	A.17	GAP
C	0050	GASKET
D	C.V.180	INSIDES
E	245117	PLUG
F	245118	CYLINDER
G	245119	ORIFICE PLATE
H	245120	HEAD
I	245115	PISTON
J		NAMEPLATE

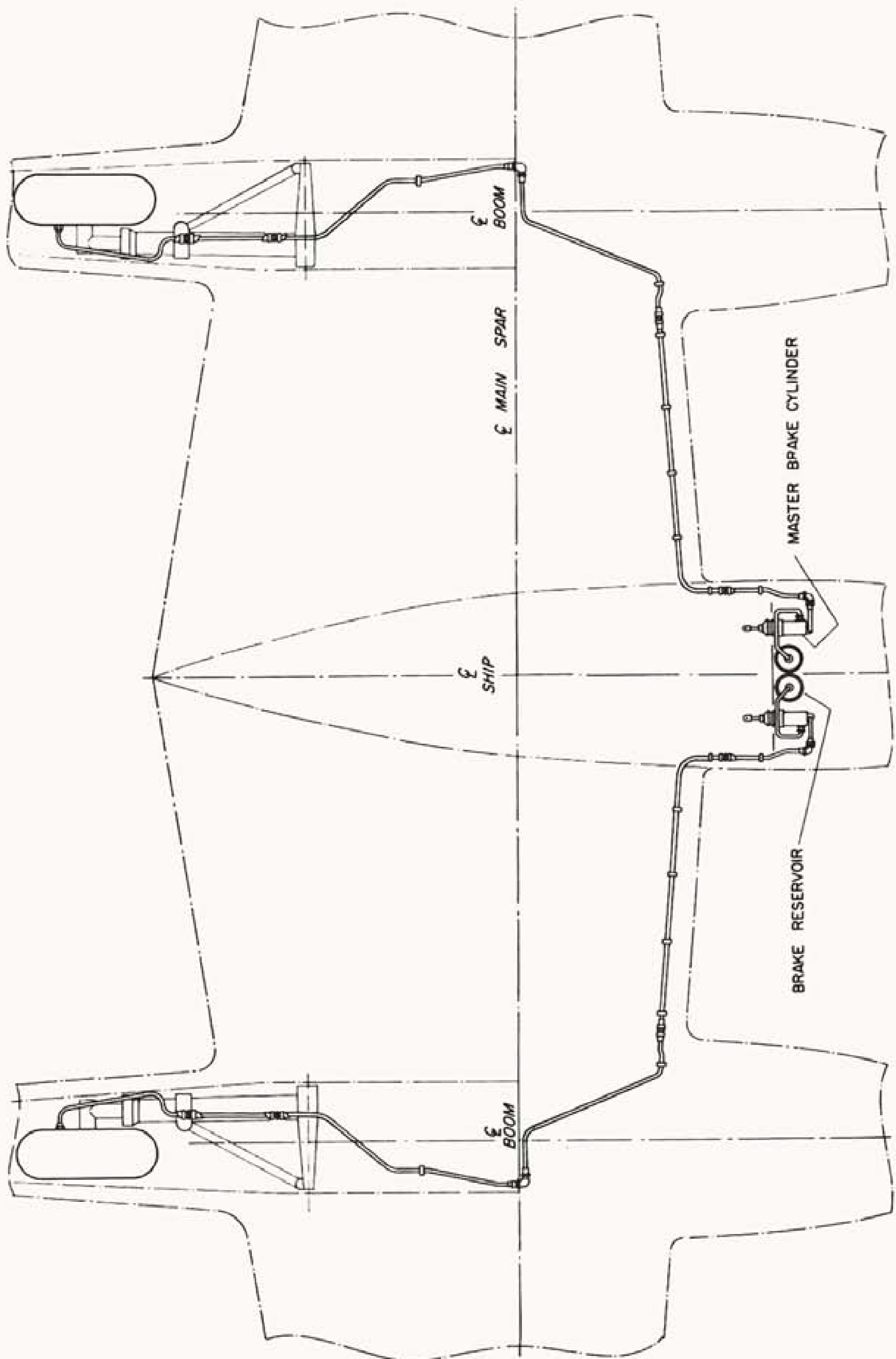
LET.	PART NO.	NAME
K	245107	SLEEVE
L	245108	KEY
M	245110	NUT
N	245111	SPACER
O	0ARL001	PACKING
P	245112	SPACER
Q	245101	BEARING
R	AG.301A116	LOCK SCREW
S	245099	NUT

NOTES-
 1-LOCKHEED PART NO. 661011
 2-MENASCO PART NO. 661011

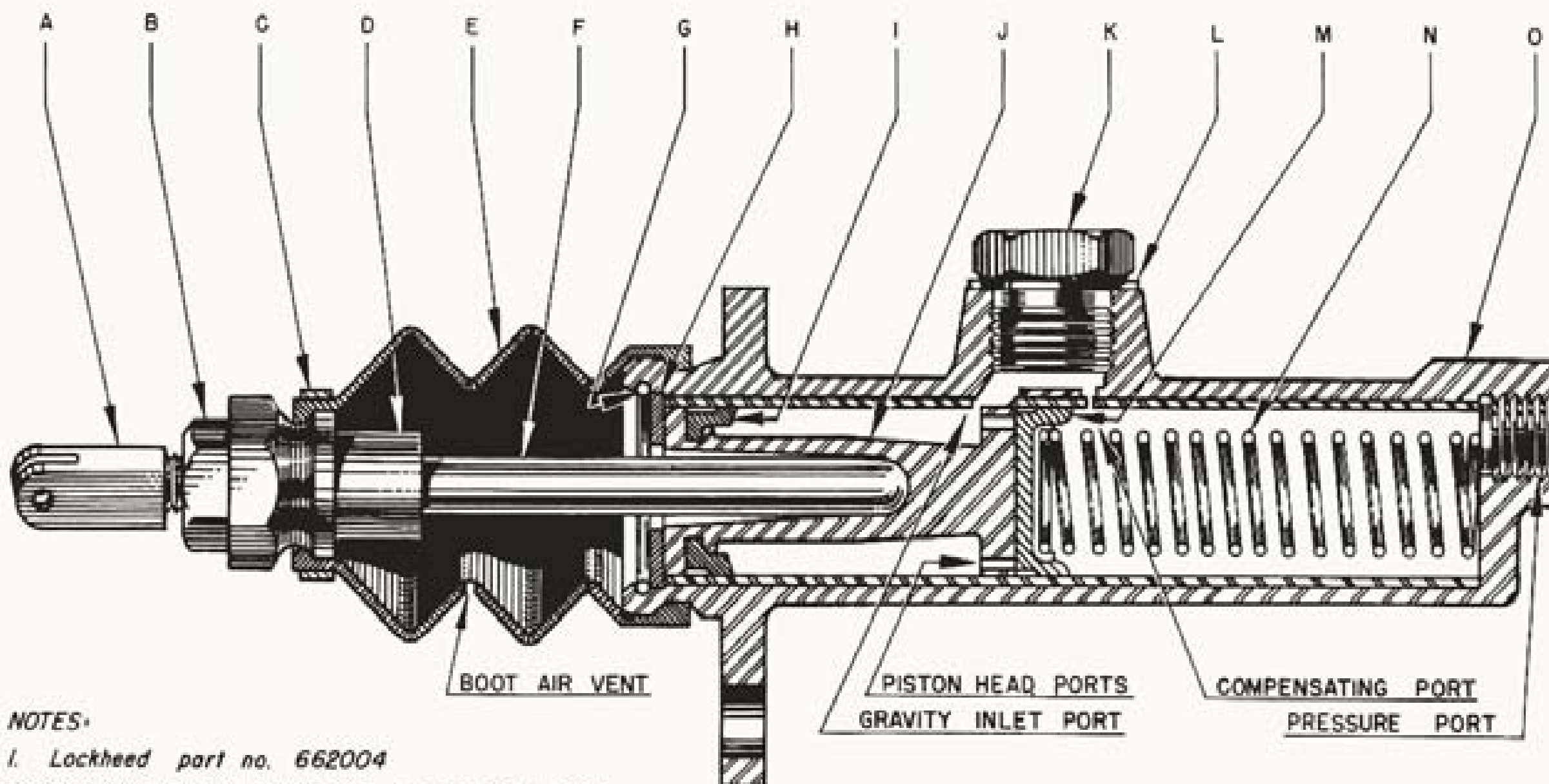


NOTE.
Refer To Lockheed Dwg. No. 245304

MAIN ALIGHTING GEAR



HYDRAULIC BRAKE SYSTEM DIAGRAM



NOTES:

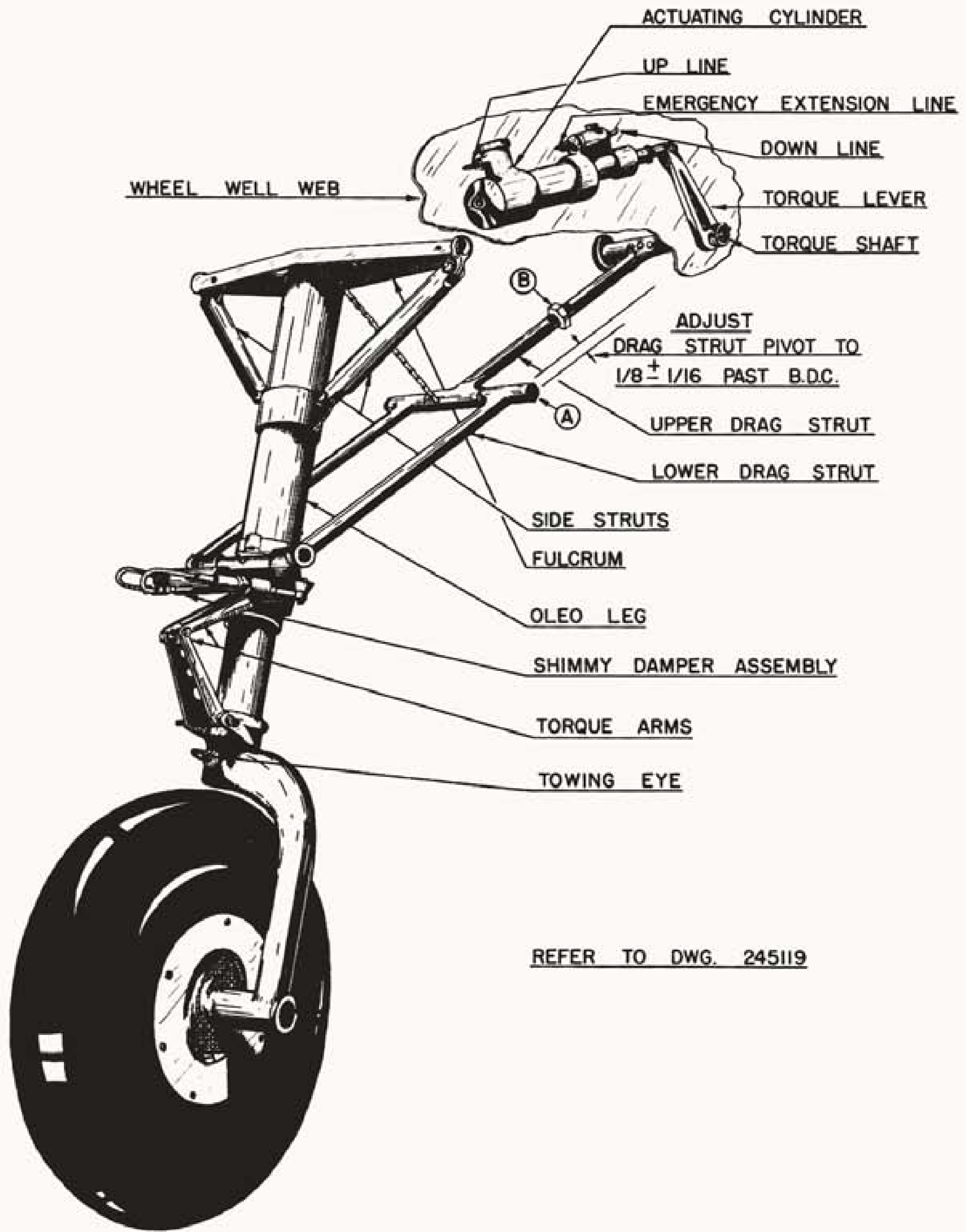
1. Lockheed part no. 662004
2. Goodyear Tire & Rubber Co. part no. 95-080

NO.	PART NO.	PART NAME
A	213797	EYE BOLT
B	AN316-8R	CHECK NUT
C	217723-1	RUBBER BOOT STRAP
D	213799	PISTON ROD COUPLING
E	217722	RUBBER BOOT
F	213800	PISTON ROD
G	213794	LOCK WIRE
H	213795	PISTON RETURN STOP

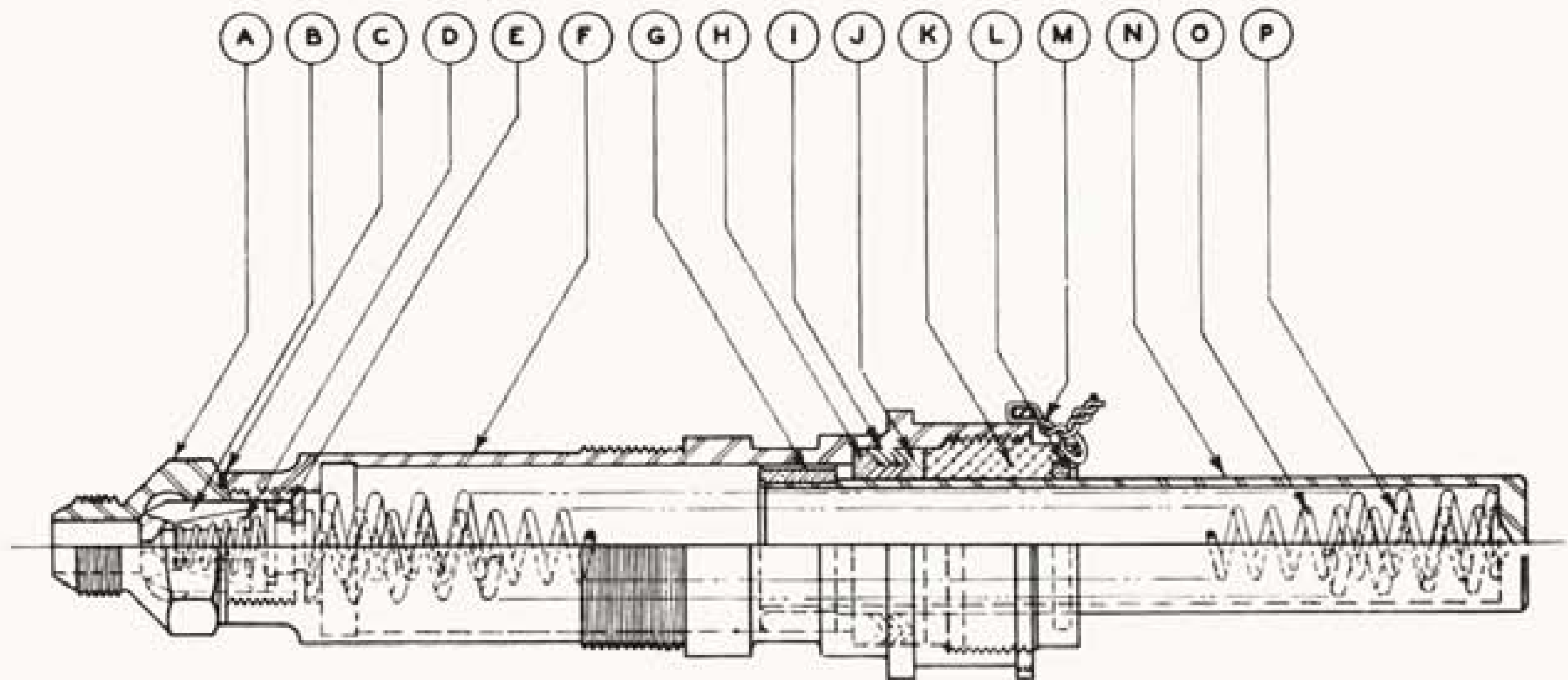
NO.	PART NO.	PART NAME
I	216347-3	PISTON SEAL
J	213801	PISTON
K	213788	INLET CONNECTOR FITTING
L	217750-1	INLET CONNECTOR GASKET
M	213793	PISTON SEAL
N	216268	SPRING
	218019	SEAT
O	218017	CYL. CASTING WITH INSERT SLEEVE

HYDRAULIC BRAKE MASTER CYLINDER

A.P.2021A	VOL. I	SECT. 4	CHAP. 2	FIG. 17
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NOSE ALIGHTING GEAR

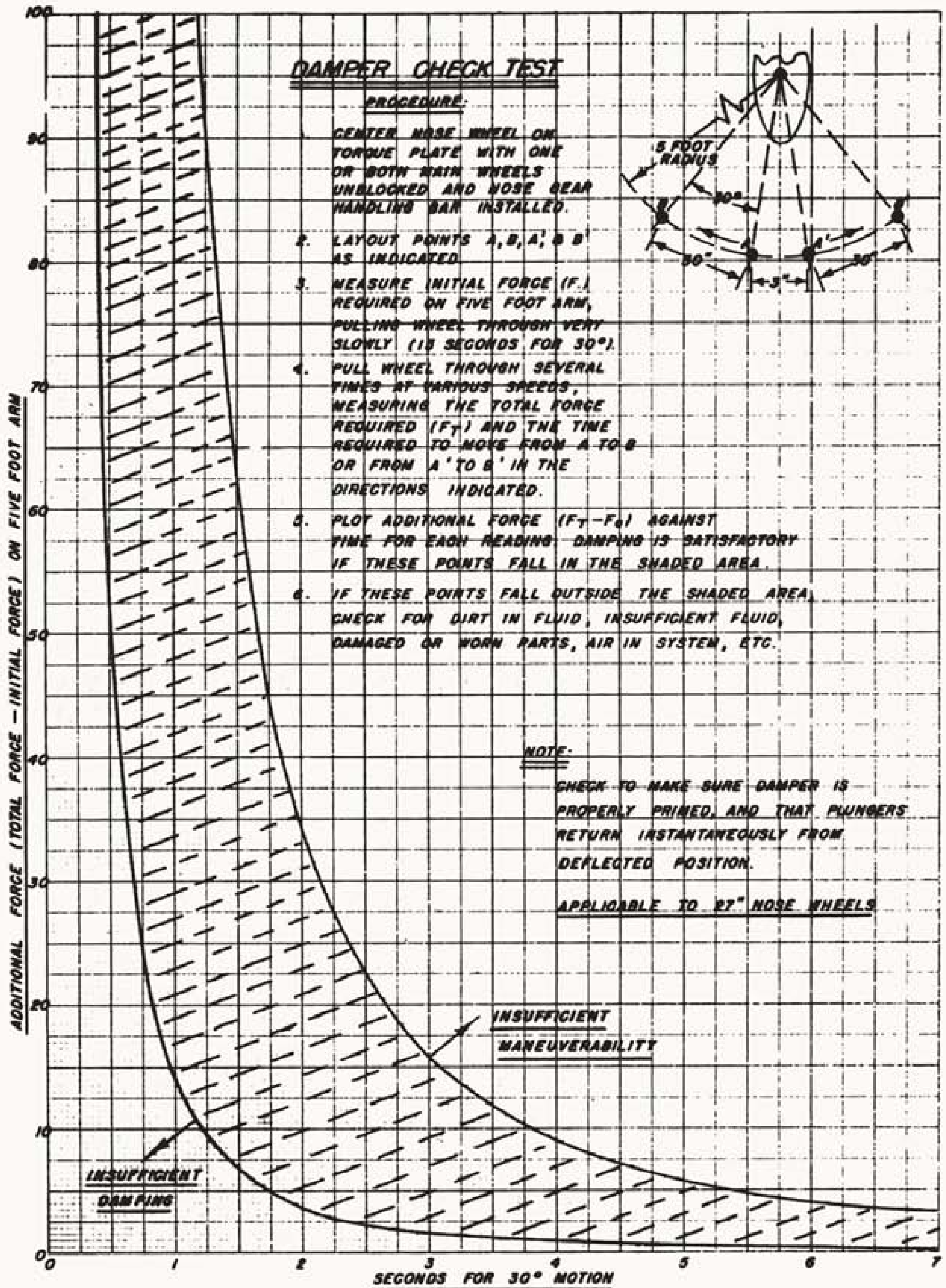


LET.	PART NO.	NAME
A	225243	END
B	225242	VALVE
C	225240	GASKET
D	225244	SPRING
E	225241	RETAINER
F	225217	CYLINDER
G	225220	COLLAR
H	225316	ADAPTER
I	GARLOCK NO. 7815	CHEVRON RINGS 1 1/2 O.D. X 1 I.D.
J	225123	SPACER
K	225224	NUT
L	225326	WASHER - FELT -
M	AC 995-32-3	LOCKWIRE
N	225218	PISTON
O	225222	SPRING
P	225221	SPRING

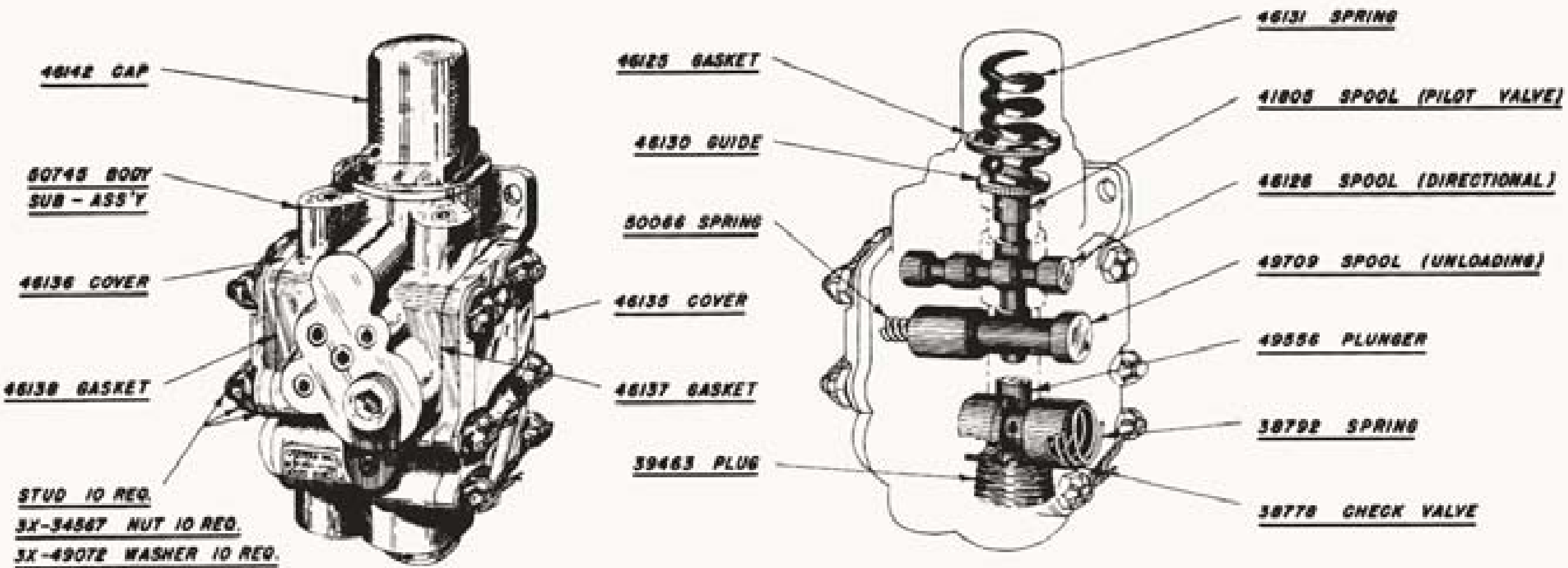
NOTES:

1. Lockheed Part No. 225201.
2. No external leakage permitted at 1200 p.s.i.
Test pressure to be applied for 5 minutes.
3. Low pressure test at 10 to 25 p.s.i.

SHIMMY DAMPER CYLINDER

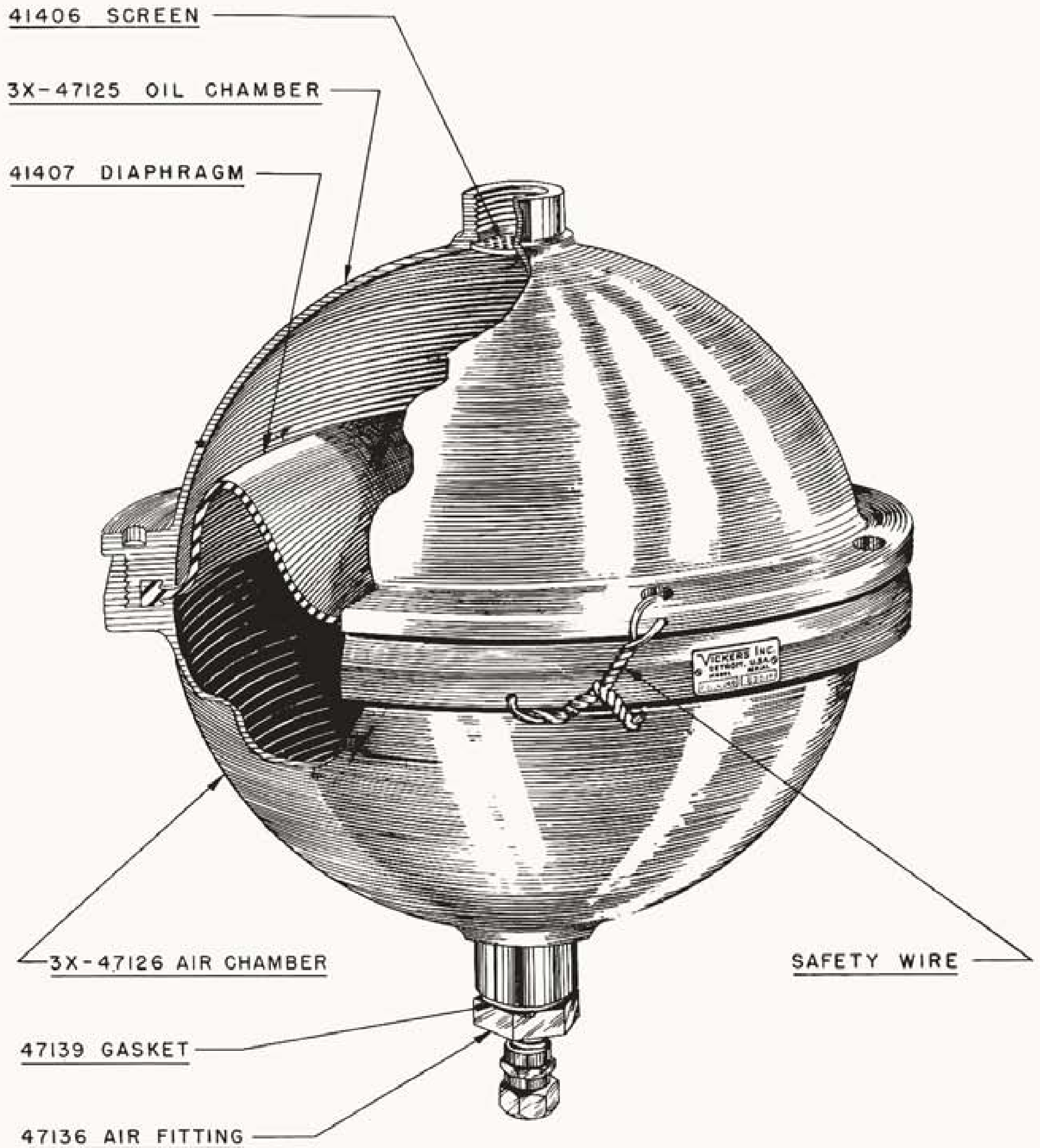


SHIMMY DAMPER TEST CHART



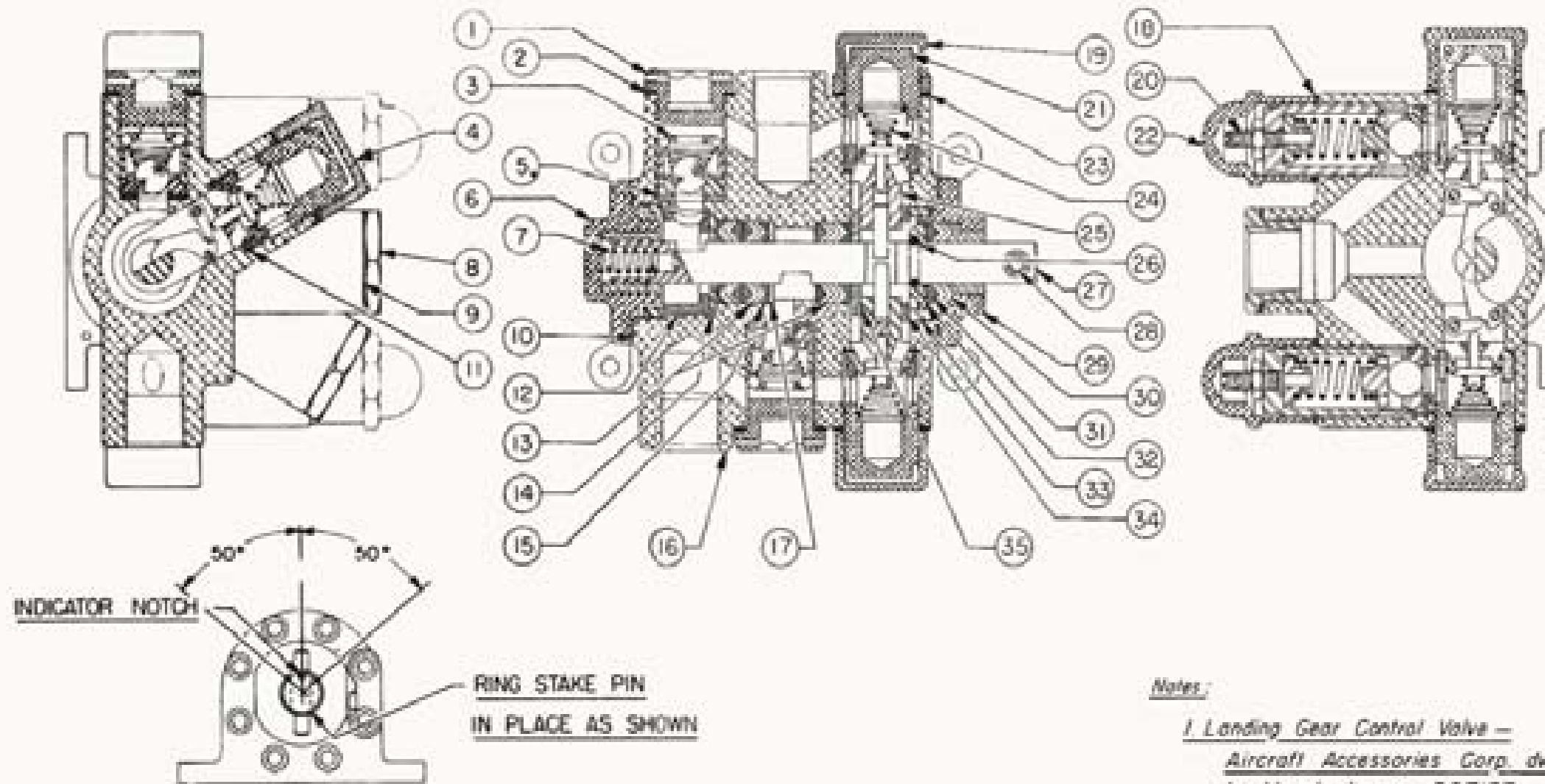
- NOTE:**
1. SPECIFY MODEL NUMBER AND SERIAL NUMBER, WHEN ORDERING REPAIR PARTS.
 2. VICKERS INC. MODEL AA-14501
 3. LOCKHEED PART. NO. 667080
 4. MAX. TEST. PRESSURE 2500 P.S.I.

HYDRAULIC PRESSURE REGULATOR

NOTES:

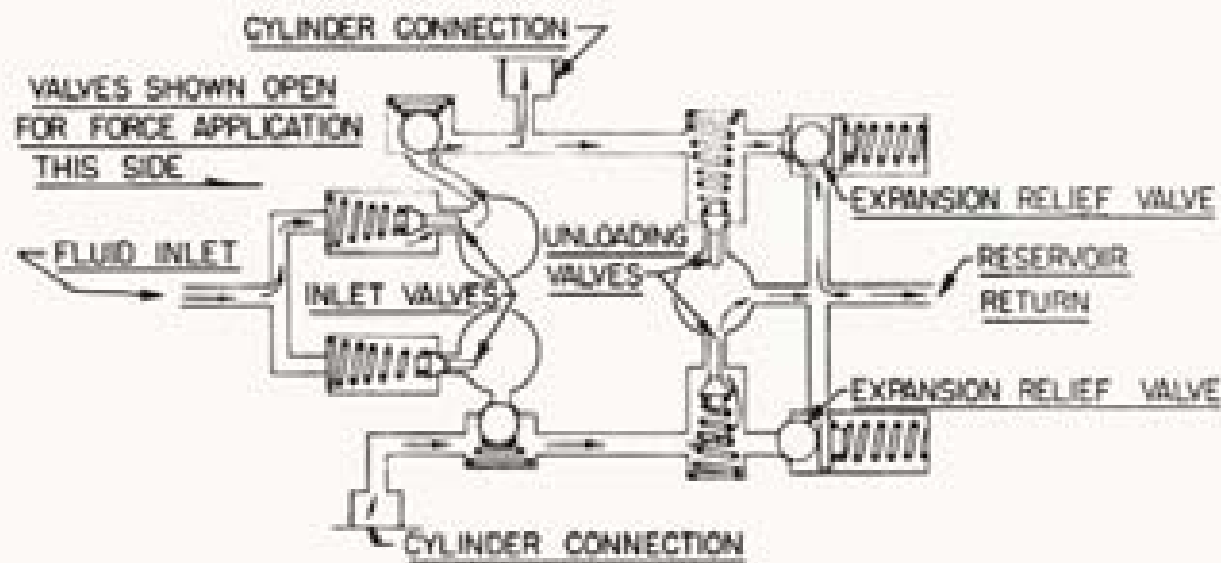
1. Vickers, Inc. model AA-14000 Aircraft Accumulator.
2. Specify model No. and serial No. on nameplate when ordering parts.
3. Lockheed part No. 667018.
4. Max. test pressure 2500 P.S.I.

HYDRAULIC PRESSURE ACCUMULATOR



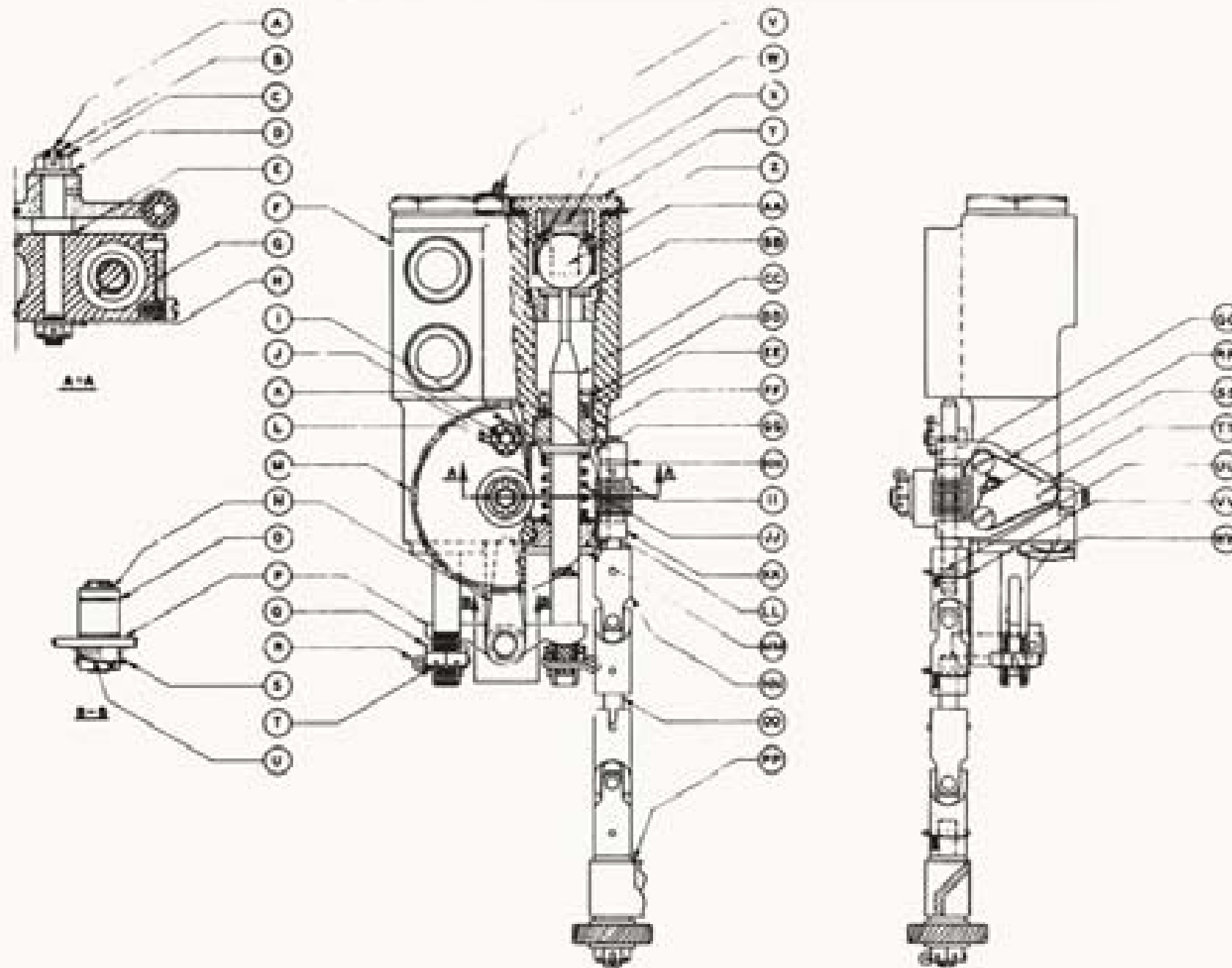
Notes:

- 1. Landing Gear Control Valve -
Aircraft Accessories Corp. dwg. no. 62046-1
Lockheed dwg. no. 667137
- 2. Flap Control Valve -
Aircraft Accessories Corp. dwg. no. 62047-1
Lockheed dwg. no. 667138



NO.	PART NO.	NAME	NO.	PART NO.	NAME
1	62204	Check valve cap	19	1239	Cap nut retainer
2	34134	Sealing washer	20	1238	Relief valve assem.
3	1236	Valve retainer bushing	21	62323	Retainer nut - valve seat
4	6234	Cap nut-retainer	22	1208	Valve cap
5	34110	Sealing washer	23	62193	Sealing washer
6	62359	End cap	24	60113	Spring
7	62227	Spring	25	62327	Assem. - valve
8	60116	Adapter	26	62225	Shoulder ring
9	62193	Sealing washer	27	62486	Cam shaft
10	1003	Sealing gasket	28	62484	Cam shaft pin
11	36349	Sealing washer	29	62360	Assem. - control cap
12	62199	Spacer	30	65248	Packing - linear - par 876
13	65150	Packing	31	65151	Packing ring
14	62198	Packing retainer	32	62224	Shoulder packing
15	65152	Packing gland	33	62203	Retainer nut
16	62101-7	Housing	34	62202	Spacer
17	62200	Packing spacer	35	62201	Packing - retainer
18	34122	Sealing washer			

ALIGHTING GEAR AND FLAP CONTROL VALVE



LET	PART NO.	NAME
A	AN 380-2-3	COTTER
B	222447	SPINDLE
C	AN 380-4	NUT
D	222448	WASHER
E	222431	GASKET
F	222422	BODY
G	222423	GASKET
H	AN 380-4-B	WASHER
I	AN 380-3-C	COTTER
J	222439	PIN
K	AN 380-3	NUT
L	AN 380-2-2	WASHER
M	WING NUT CO NO. 222440	NUT

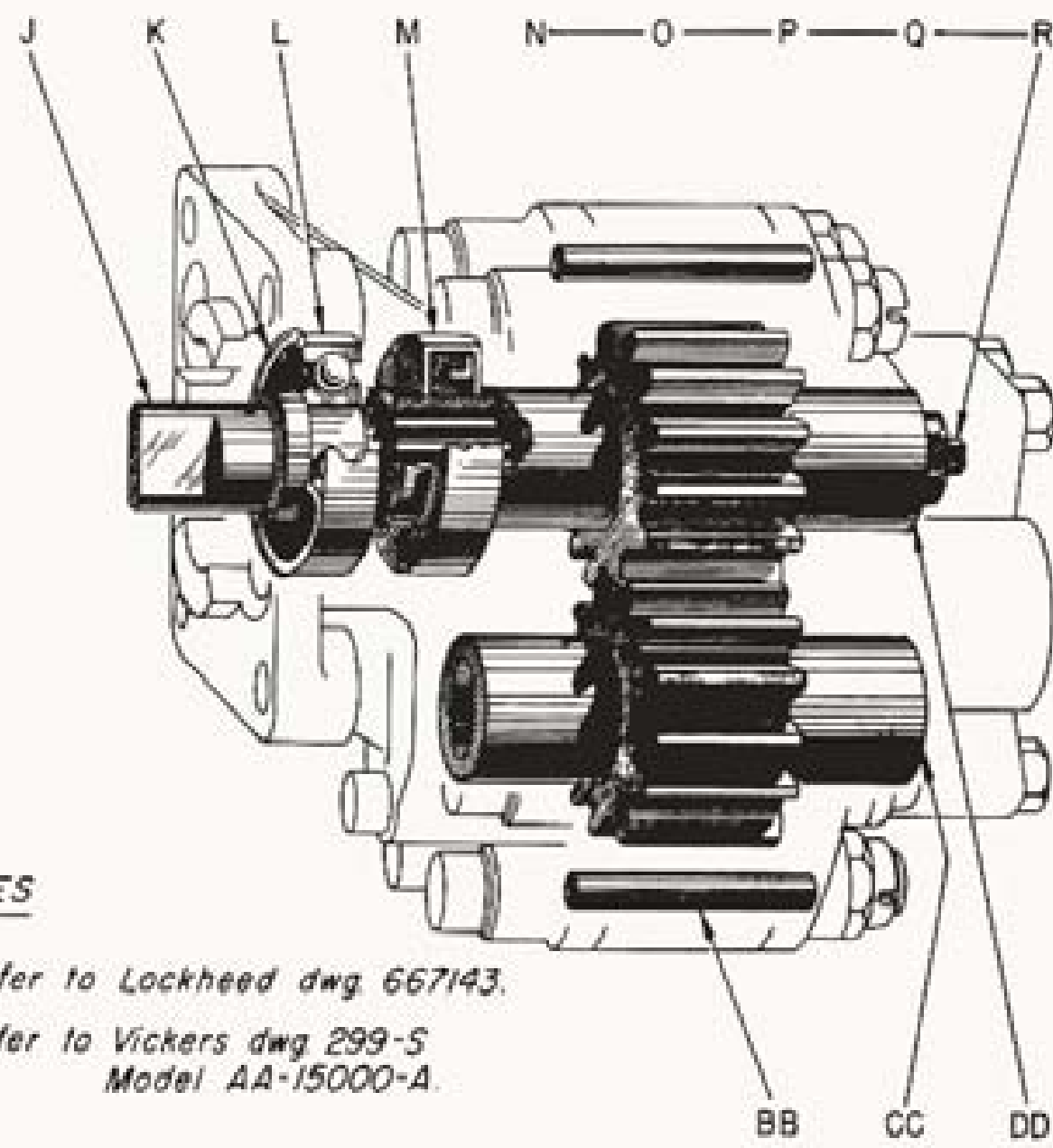
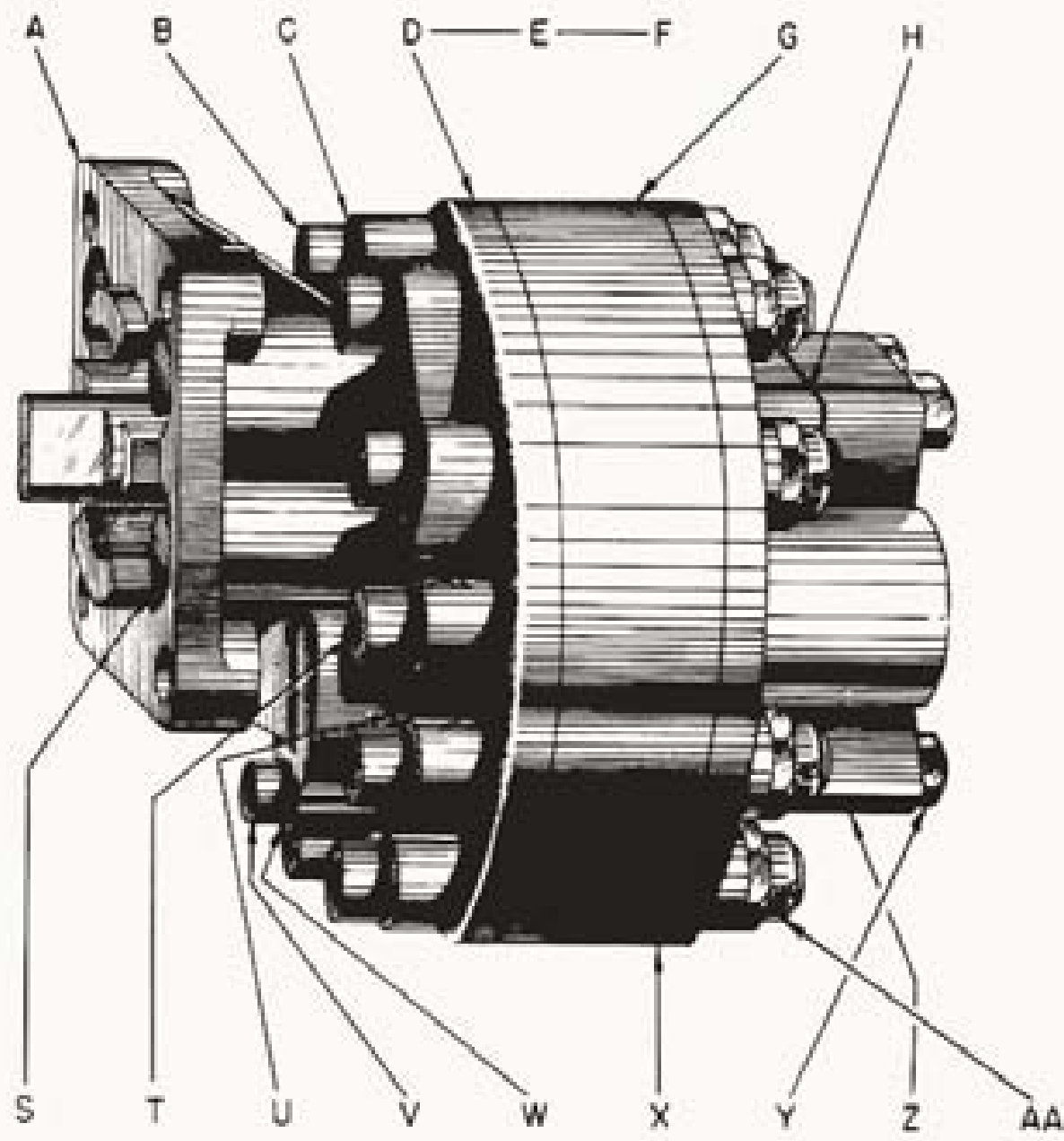
LET	PART NO.	NAME
N	222432	CRANK
O	222441	WASHER
P	222430	ROCKER ASSEMBLY
Q	222438	PAD
R	AN 380-2-3	COTTER
S	AC 285-40-1	TAPER PIN
T	AN 380-8	NUT
U	AC 285C32-2	LOCKWIRE
V	AC 285C32-3	LOCKWIRE
W	222442	RING
X	222424	SPRING
Y	222425	RETAINER
Z	AN 380-18	GASKET
AA	3/4" DIA.	BALL

LET	PART NO.	NAME
BB	222428	SEAT
CC	222429	STEM
DD	222427	ADAPTER
EE	BARLOCK NO. 7412	CHEMION RINGS
FF	222426	GLAND
GG	AC 285C32-1	LOCKWIRE
HH	222424	WASHER
II	WING NUT CO. NO. 222440	NUT
JJ	222423	SPRING
KK	222422	BEARING
LL	222420	SHAFT
MM	222418	GUIDE

LET	PART NO.	NAME
NN	222420	JOINT
OO	222420	SHAFT
PP	222420	SCREW ASSEMBLY
QQ	AC 285-40-4	TAPER PIN
RR	AC 285C32-4	LOCKWIRE
SS	L3-300-10-14	FIN
TT	AN 380-2-2	SCREW
UU	AC 285-40-2	TAPER PIN
VV	AC 285C32-2	LOCKWIRE
WW	AC 285C32-4	LOCKWIRE

NOTE:-
 1-LOCKWIRE PART NO. 222421
 2-TEST PRESSURE-2000 P.S.I.
 3-WORKING PRESSURE-1000 P.S.I.
 *LOW PRESSURE TEST AT 10 TO 25
 P.S.I. FOR LEAKAGE

MAIN PLANE FLAP PRESSURE CUT-OFF VALVE

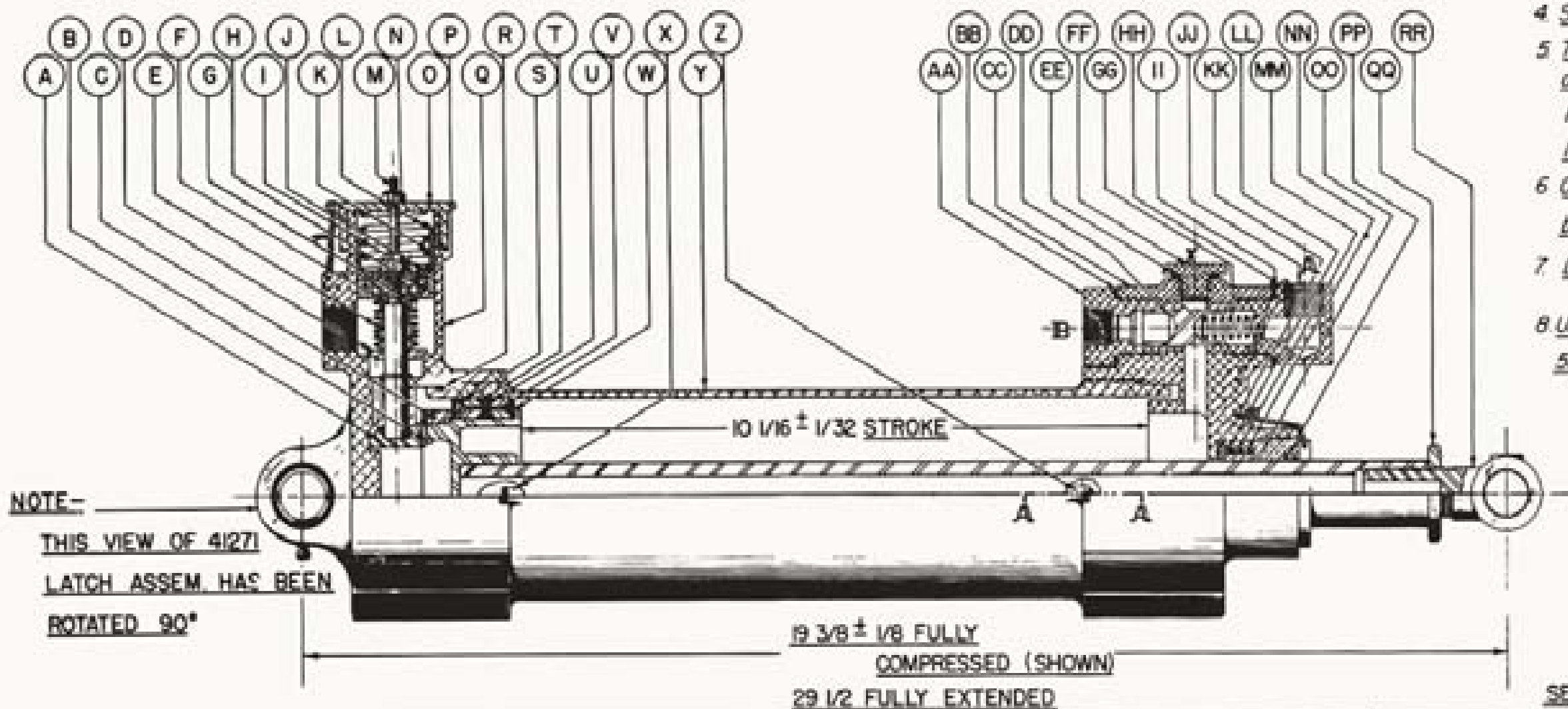


NOTES

- 1. Refer to Lockheed dwg 667143.
- 2. Refer to Vickers dwg 299-S Model AA-15000-A.

NO.	PART NO.	NAME	NO. REQ.	NO.	PART NO.	NAME	NO. REQ.	NO.	PART NO.	NAME	NO. REQ.
A	52320	FLANGE	1	L	46457	BEARING	1	V	3X-52383	SCREW	1
B	3X-52382	SCREW	8	M	46478	OIL SEAL	1	W	3X-49245	WASHER	10
C	3X-49072	WASHER	18	N	46486	SUB-ASSEM.	1	X	52316	COVER	1
D	52314	SUB-ASSEM.	1	O	46483	SCREW	1	Y	3X46372	SCREW	5
E	52319	COVER	1	P	46485	PACKING	1	Z	52317	CAP	1
F	52376	PLUG	1	Q	46484	WASHER	1	AA	3X34567	NUT	8
G	52315	BODY	1	R	46482	NUT	1	BB	15953	DOWEL	2
H	52318	GASKET	1	S	3X-52603	SCREW	4	CC	46257	GEAR-DRIVEN	1
J	46459	COUPLING	1	T	3X-52381	SCREW	2	DD	46256	GEAR-DRIVE	1
K	46460	SNAP RING	1	U	52321	GASKET	1				

MAIN PLANE FLAP ACTUATING MOTOR



NOTES

- 1 Use ample approved threadlube
- 2 Test both ends to 2500 p.s.i.
- 3 Use Intova Servo fluid
- 4 Set piston drag approx 20 p.s.i.
- 5 There shall be no more than 15 drops/min leakage at either port 'A' or 'B' when testing with 1000 p.s.i. at opposite port
- 6 Clean all parts thoroughly before assembly
- 7 Lockheed part no. 663011
- 8 United Aircraft Products part no. 51227

NOTE—
THIS VIEW OF 41271
LATCH ASSEM. HAS BEEN
ROTATED 90°



A	21267	ROD ASSEM.
B	AN 380-2-3	COTTER
C	21269	NUT
D	11287	VALVE
E	11279	SPRING
F	20300-006 SROG-040	WASHER
G	11286	ADAPTER
H	20333-4G-024C	PACKING
I	20323-4G-302	FILLER
J	11288	BEARING
K	11289	STOP

L	11280	SPRING
M	21292	PIN
N	AC 365-632	NUT
Q	11285	GAP
P	11290	NUT
R	41271	LATCH ASSEM.
S	20312-093-311	RING
T	20308-0212-010-003	RING
U	20333-5G-212 C	CHEVRONS
V	11284	SPACER
Y	20323-5G-807	FILLER

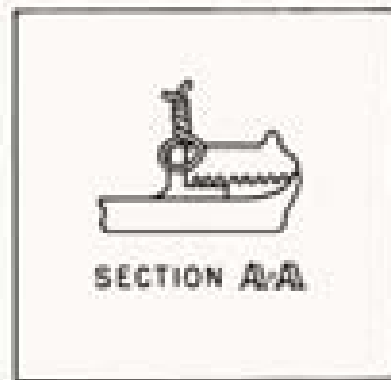
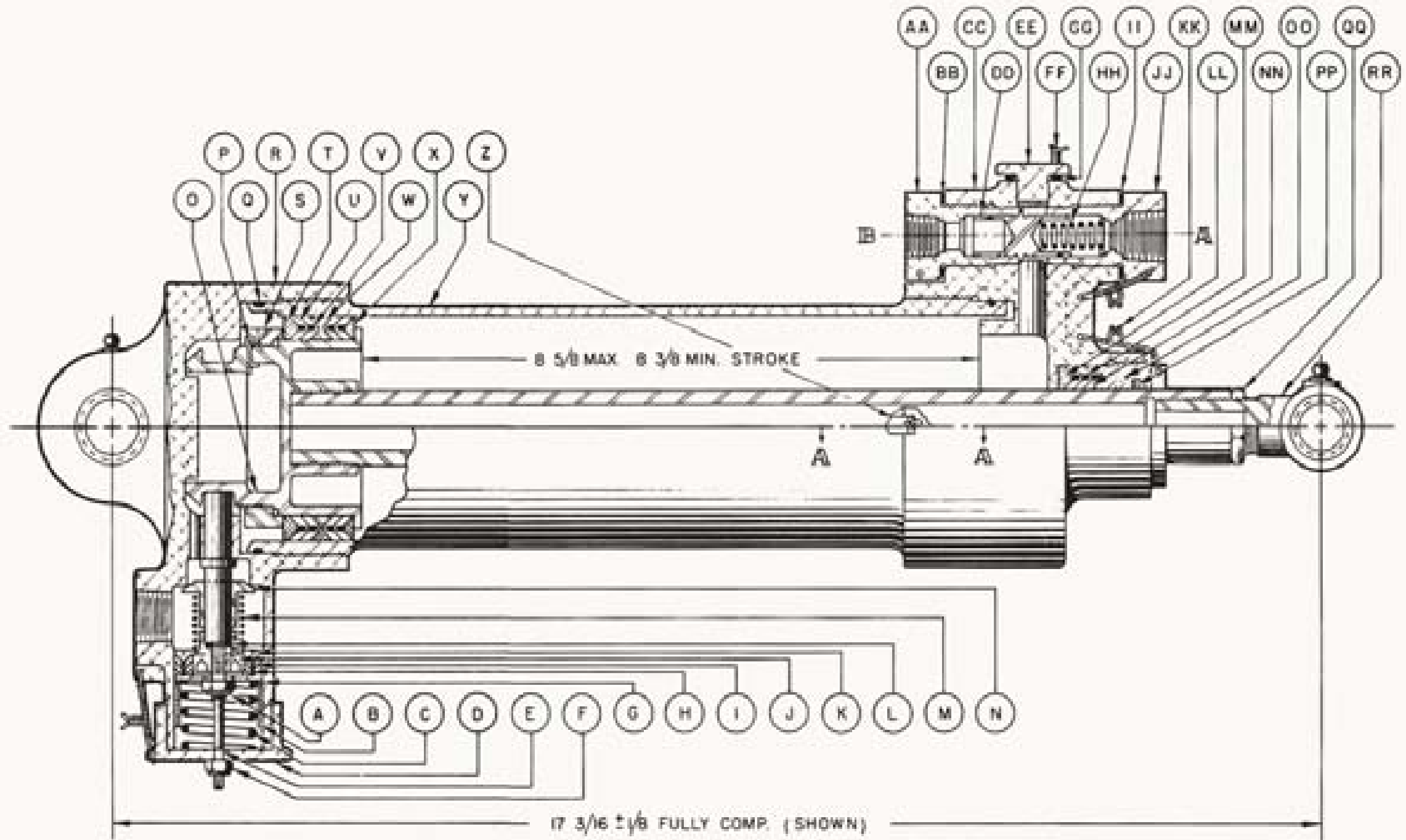
W	20308-D212-010-001	RING
X	11272	KEY
Y	21255	BARREL
Z	11272	KEY
AA	11277	GUIDE
BB	20300-028-TC-104-040	WASHER
CC	41257	FITTING
DD	11291	PISTON
EE	20300-D16TC-024-062	WASHER
FF	11282	PLUG
GG	11278	SPRING

HH	20300-028-TC-104-040	WASHER
II	20300-028-L-104-032	WASHER
JJ	11357	GUIDE
KK	AC 995-C40-6 L	WIRE
LL	20308 D100-010-002	RING
MM	20333-5G-100C	CHEVRONS
NN	20323-5G-402	FILLERS
OO	11281	NUT
PP	20300-031F 108-187	WASHER
QQ	11270	NUT
RR	11265	END

MAIN GEAR ACTUATING JACK

NOTES

1. Use ample approved threadlube.
2. Test both ends to 2500 p.s.i.
3. Use Intava Servo fluid.
4. Set piston drag approx. 20 p.s.i.
5. There shall be no more than 15 drops min. leakage at either port "A" or "B" when testing with 1000 p.s.i. at opposite port.
6. Clean all parts thoroughly before assembly.
7. Lockheed part no. 663015.
8. Ref. Aircraft Precision Products dwgs. nos. 41271 - 51229.



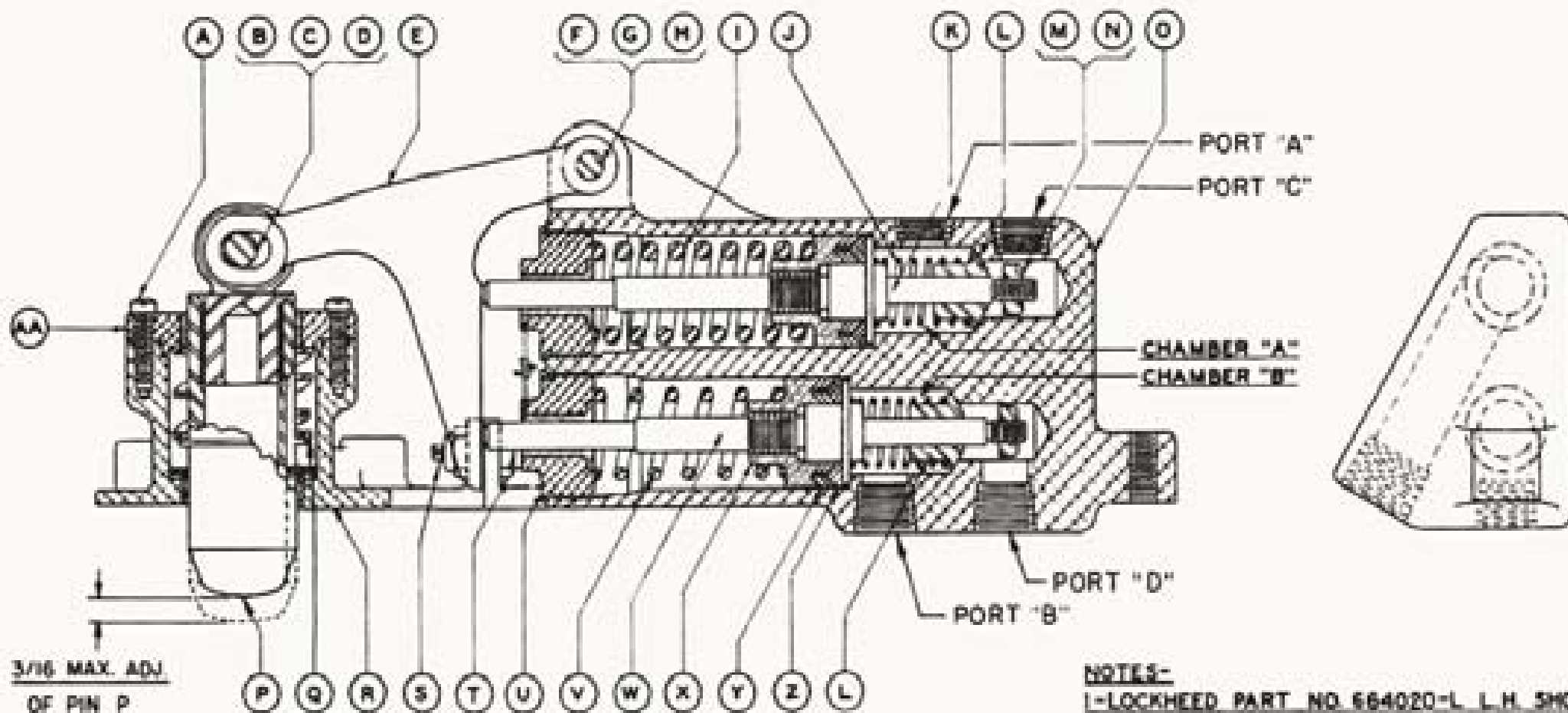
A	AC365-1032	NUT
B	11289	STOP
C	11280	SPRING
D	11285	CAP
E	21292	PIN
F	AC365-632	NUT
G	11288	BEARING
H	20323-4G-302	FILLER
I	20333-4G-024C	PACKING
J	11290	NUT
K	11286	ADAPTER

L	20300-0065R012-040	WASHER
M	11279	SPRING
N	11287	VALVE
O	21267	ROD ASSEM.
P	AN380-23	COTTER
Q	20312-093-311	RING
R	41271	LATCH UNIT
S	21267	NUT
T	20308-D212-010-003	RING
U	20333-5G-212C	CHEVRONS
V	20323-5G-807	FILLER

W	11284	SPACER
X	20308-D212-010-001	RING
Y	21255-1	BARREL
Z	11272	KEY
AA	11277	GUIDE
BB	20300-028-TC-104-062	WASHER
CC	41257	FITTING
DD	11291	PISTON
EE	11282	PLUG
FF	AC995 C40-B	WIRE
GG	20300-016-TC-024-062	WASHER

HH	11278	SPRING
II	20300-208-TC-104-062	WASHER
JJ	11276	GUIDE
KK	AC995 C40-6	WIRE
LL	20308-D100-010-002	RING
MM	20323-5G-402	FILLER
NN	20333-5G-100C	CHEVRONS
OO	11281	NUT
PP	20300-031 F 108-187	WASHER
QQ	11662	NUT
RR	11334	END ASSEM.

NOSE GEAR ACTUATING JACK



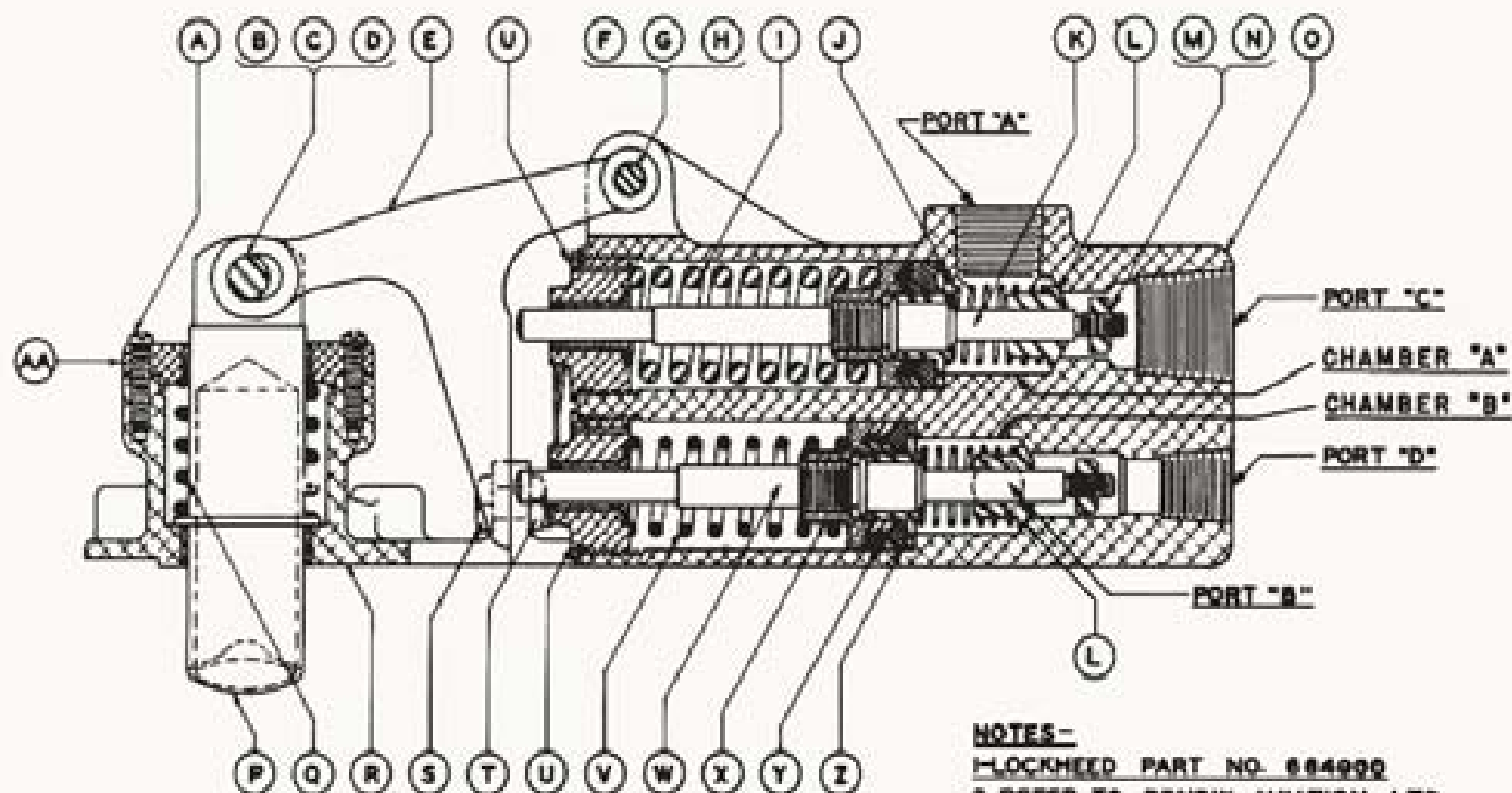
NOTES-
 1-LOCKHEED PART NO. 664020-L L.H. SHOWN
 R.H. OPPOSITE
 2-REFER TO BENDIX AVIATION LTD.
 DRAWING NO. 400932

LET	PART NO.	NAME
A	AN 502-8-10	SCREW
B	AN 25-16	BOLT
C	AN 310-3	NUT
D	AN 380-2-3	COTTER
E	10593	LEVER
F	AN 4-13	BOLT
G	AN 320-4	NUT
H	AN 380-2-3	COTTER
I	10583	SPRING
J	10582	SPRING
K	400952	PISTON STEM
L	10579	VALVE
M	AN 310-3	NUT
N	AN 380-2-2	COTTER

LET	PART NO.	NAME
Q	400934	BODY ASSEMBLY
P	400548	PIN
Q	400544	SPRING
R	400954	HOUSING ASSEMBLY
S	400930	STUD
T	AN 365-1032	NUT
U	400931	CAP
V	10581	SPRING
W	400935	PISTON STEM
X	400929	BEARING
Y	GARLOCK NO. 7815	CHEVRON RINGS
Z	400928	I.O.D. X 1/2 I.O.
AA	10512	SPACER
		BEARING ASSEMBLY

TEST NOTES-
 1-APPLY PRESSURE AT PORT "A"
 PIN "P" TO LIFT $\frac{1}{16}$ WHEN VALVE "L" OPENS
 2-PLUG PORT "C" APPLY 2000 P.S.I. AT
 PORT "A" FOR 1 MIN. WITH NO
 LEAKAGE PAST CAP "U"
 3-APPLY PRESSURE AT PORT "B"
 PIN "P" TO LIFT $\frac{1}{16}$ WHEN VALVE "L" OPENS
 4-PLUG PORT "D"-APPLY 2000 P.S.I. AT
 PORT "B" FOR 1 MIN. WITH NO
 LEAKAGE PAST CAP "U"
 5-STROKE OF PIN "P" TO BE $\frac{1}{2} \pm \frac{1}{32}$
 IN CONDITIONS NO. 2 AND 4
 6-REPEAT TEST AT 10 TO 25 P.S.I. FOR LEAKAGE

MAIN GEAR UPLOCK

**NOTES-**

- 1-LOCKHEED PART NO. 684900
 2-REFER TO BENDIX AVIATION LTD.
 DRAWING NO. 10814

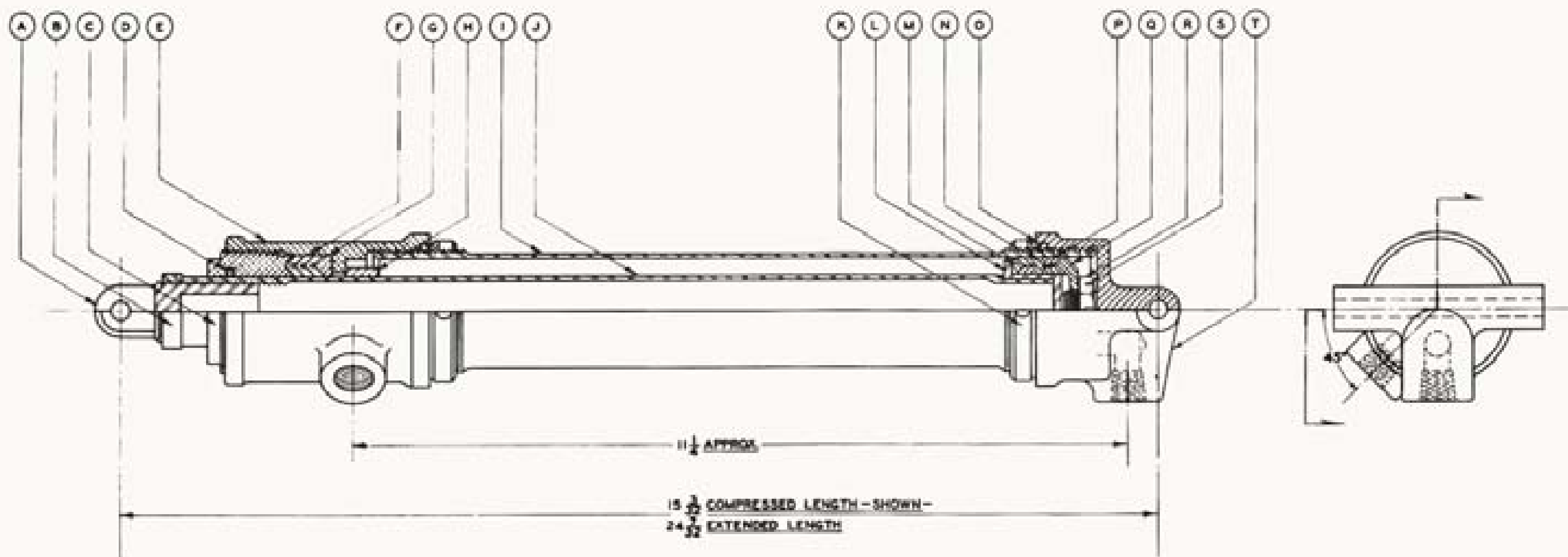
TEST NOTES-

- 1-APPLY PRESSURE AT PORT "A".
 PIN "P" TO LIFT $\frac{1}{16}$ WHEN VALVE "L" OPENS.
 2-PLUG PORT "C"-APPLY 2000 P.S.I. AT
 PORT "A" FOR 1 MIN. WITH NO
 LEAKAGE PAST CAP "U".
 3-APPLY PRESSURE AT PORT "B".
 PIN "P" TO LIFT $\frac{1}{16}$ WHEN VALVE "L" OPENS.
 4-PLUG PORT "D"-APPLY 2000 P.S.I. AT
 PORT "B" FOR 1 MIN. WITH NO
 LEAKAGE PAST CAP "U".
 5-STROKE OF PIN "P" TO BE $\frac{1}{2} \pm \frac{1}{32}$
 IN CONDITIONS NO. 2 AND 4.
 6-REPEAT TEST AT 10 TO 25 P.S.I. FOR LEAKAGE

LET.	PART NO.	NAME
A	AN302-8-10	SCREW
B	AN 5-10	BOLT
C	AN320-5	NUT
D	AN380-2-3	COTTER
E	10583	LEVER
F	AN 4-12	BOLT
G	AN320-4	NUT
H	AN380-2-3	COTTER
I	10583	SPRING
J	10582	SPRING
K	10573-2	PISTON STEM
L	10579	VALVE
M	AN320-3	NUT
N	AN380-2-2	COTTER

LET.	PART NO.	NAME
Q	10815	BODY ASSEMBLY
P	10584-1	PIN
Q	10580	SPRING
R	10818	HOUSING ASSEMBLY
S	AN 3-5A	BOLT
T	AN385-1032	NUT
U	10584	CAP ASSEMBLY
V	10581	SPRING
W	10573-3	PISTON STEM
X	10577	BEARING
Y	GARLOCK NO. 7815	CHEVRON RINGS I.O.D. X 1/2 I.D.
Z	10578	SPACER
AA	10813	BEARING ASSEMBLY

NOSE GEAR UPLOCK

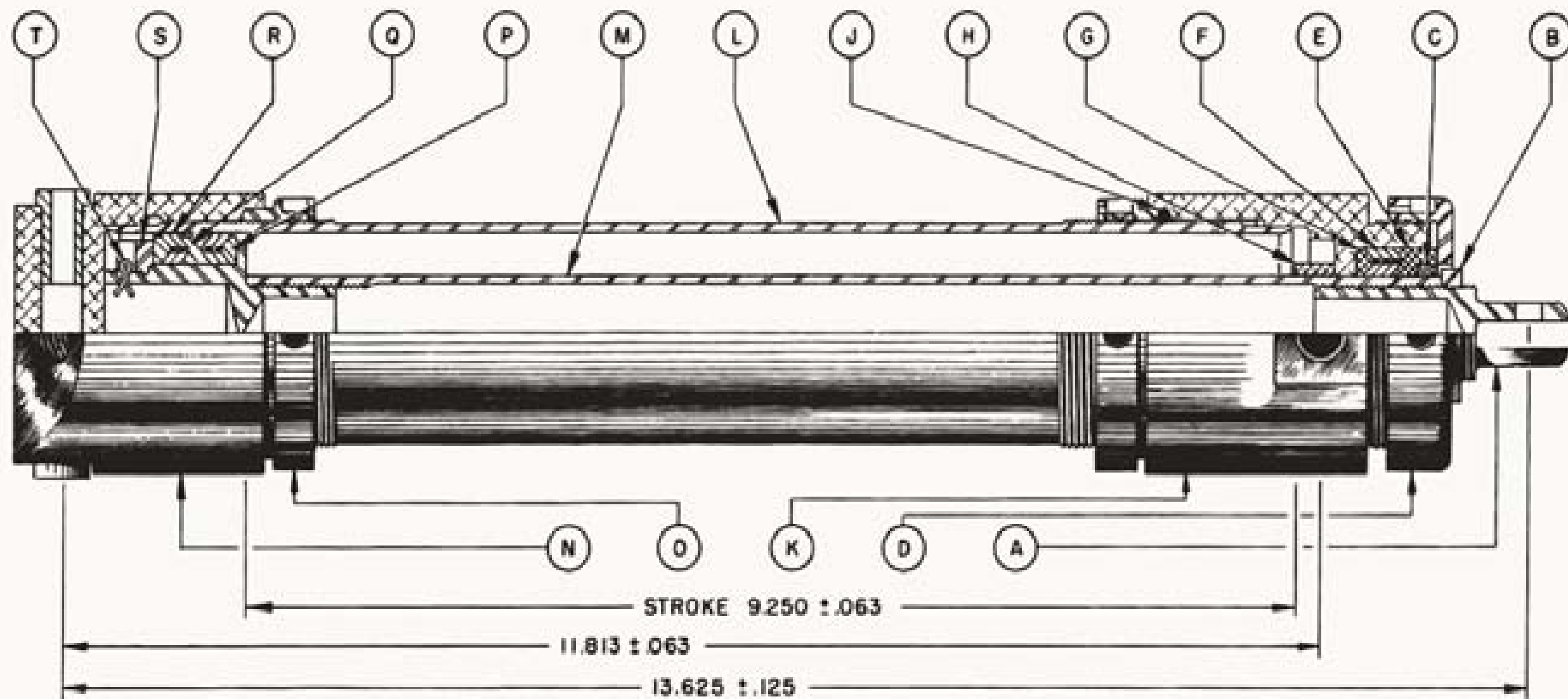


LET	PART NO.	NAME
A	10462	TERMINAL
B	10463	NUT
C	10469	BEARING
D	10511	WIPER
E	10460	HEAD
F	GARLOCK NO. 7812	CHEVRON RINGS 1 3/8 O.D. X 1 I.D.
G	10464	SPACER
H	10472	STOP
J	10481-2	BARREL
J	10473-2	PISTON ROD

LET	PART NO.	NAME
B	10468	LOCK NUT
L	10458	PISTON
M	10465	SPACER
N	10466	BEARING
Q	10470	GASKET
P	GARLOCK NO. 7812	CHEVRON RINGS 1 1/2 O.D. X 1 I.D.
Q	10467	PISTON HEAD
R	A.N. 320-8	NUT
S	A.N. 380-2-2	COTTER
T	10459-2	BASE

NOTES:

- 1-LOCKHEED PART NO. 863010-L, L.H. SHOWN
R.H. OPPOSITE
- 2-REFER TO BENDIX AVIATION LTD.
DRAWING NO. 10455
- 3-TEST PRESSURE-2000 P.S.I.
- 4-WORKING PRESSURE-1000 P.S.I.
- 5-LOW PRESSURE TEST AT 10 TO 25 P.S.I. FOR LEAKAGE

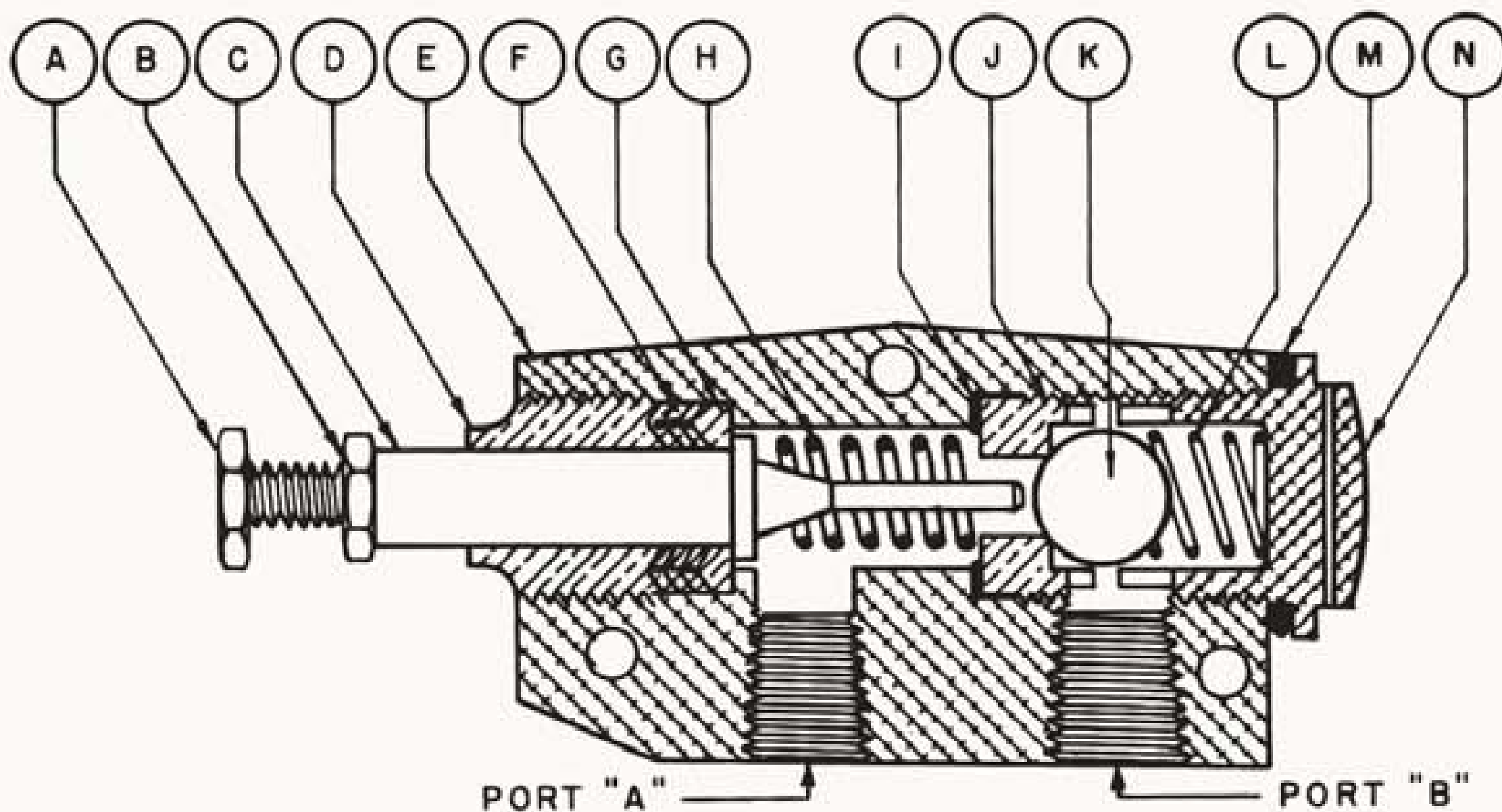


A	250516	TERMINAL	H	250512	PISTON STOP	O	250504	RING
B	250517	TERM. NUT	J	250519	SEAL	P	250508	ADAPTER
C	250518	WASHER	K	250502	CYL. END	Q	250509	ADAPTER
D	250515	NUT	L	250503	CYLINDER	R	7815	CHEVRON
E	250514	ADAPTER	M	250511	PISTON	S	250510	NUT
F	7815	CHEVRON	N	250520	CYL. CAP	T	AN 380-2-3	COTTER
G	250513	ADAPTER						

NOTES

1. Cylinder test pressure 2000 p.s.i.
2. Cylinder ends to hold test pressure for 5 minutes without appreciable leakage.
3. Wrench pressure on 250504 packing ring to be 30 ± 5 lbs.
4. Ample thread lube to be used on all threaded joints.
5. Refer to Vard drawing No. P250500. (LOCKHEED NO. 663017)

NOSE GEAR DOOR ACTUATING JACK



LET.	PART NO.	NAME
A	10477	BUFFER
B	AN 316 - 4R	NUT
C	10475	PIN
D	10480	NUT
E	10488	BODY
F	GARLOCK NO. 7815	CHEVRON RINGS 3 4 O.D. X 3 8 I.D.
G	10479	ADAPTER
H	10492	SPRING
I	10486	GASKET
J	10484	SEAT
K	1/2 DIA	STEEL BALL
L	10493	SPRING
M	AN 900 - 14	WASHER
N	10483	CAP

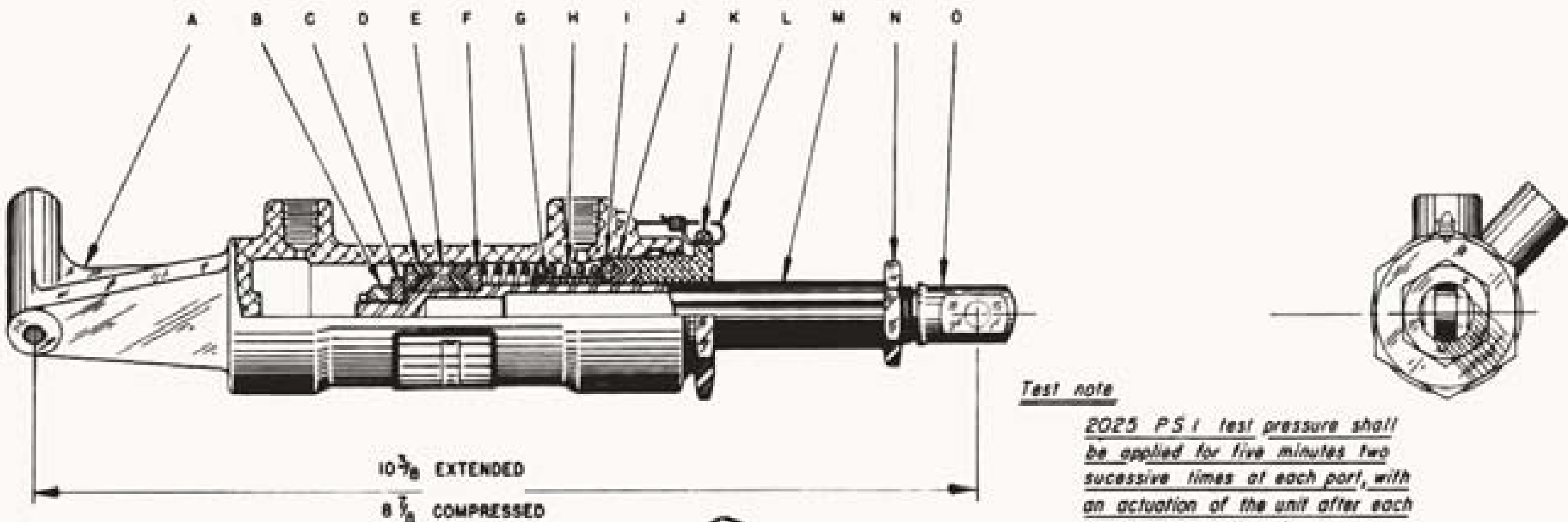
Test Notes

- 1- Plug port "B" apply 2000 P.S.I. at port "A"
- 2- With port "A" open apply 2000 P.S.I. at port "B"
- 3- Repeat leakage test using 10 to 25 P.S.I.

Note

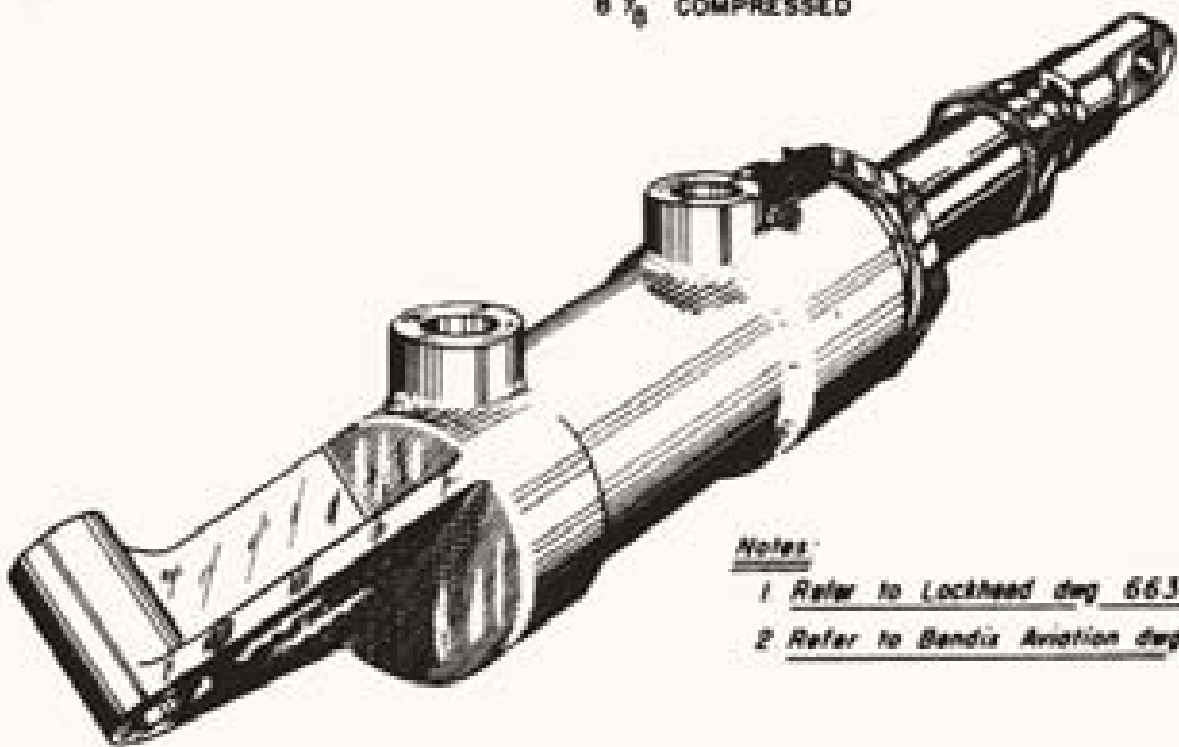
Lockheed dwg. no. 664008.
Bendix Aviation Limited dwg. no. 10474

ALIGHTING GEAR DOOR STOP VALVE



Test note

2025 P S i test pressure shall be applied for five minutes two successive times at each port, with an actuation of the unit after each application. No distortion, permanent set or leakage shall occur.

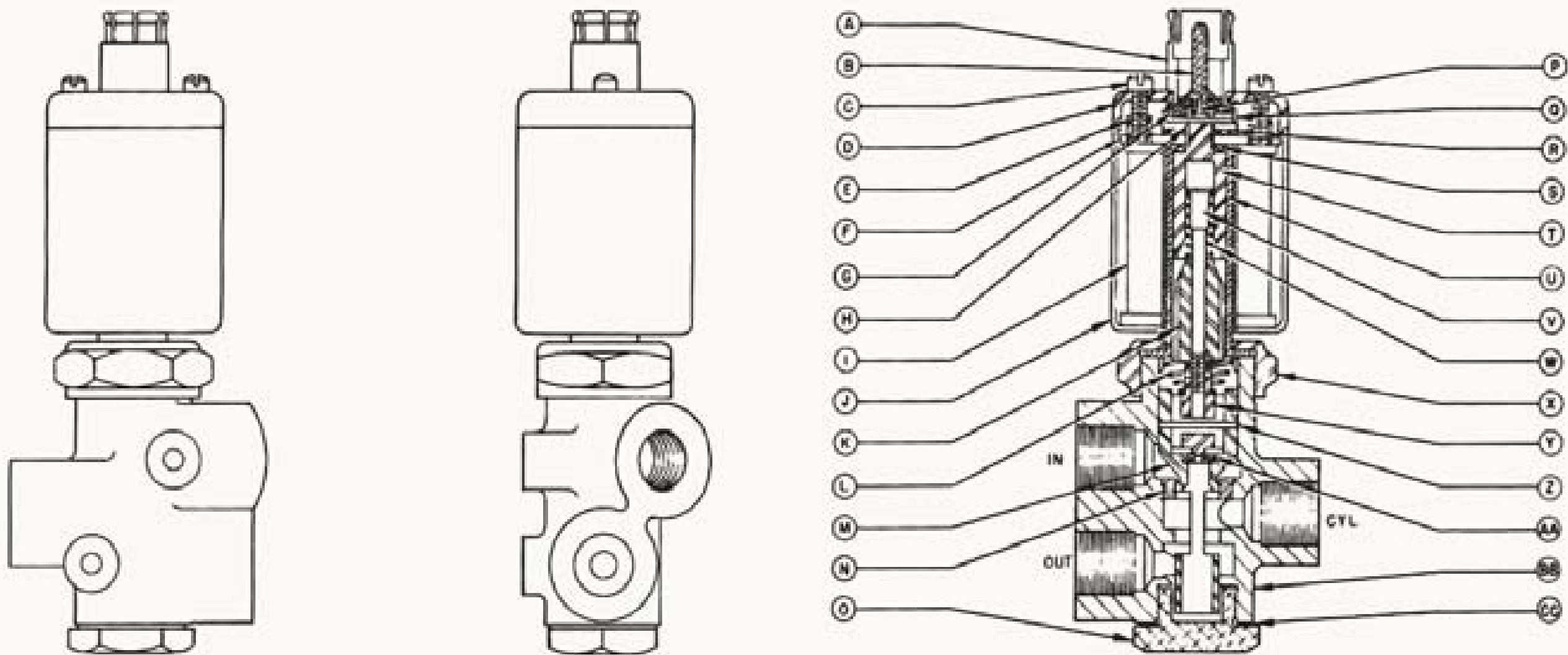


Notes

- 1 Refer to Lockheed dwg 663026
- 2 Refer to Bendix Aviation dwg. 401319

LET.	PART NO.	NAME	NO REQ.
A	400008	BODY	
B	400407	NUT	
	400362	COTTER	
	400408	WASHER	
	7815 C.S.D.	GARLOCK CHEVRON RINGS	
	10514	BEARING	
	10516	SPACER	
	401489	SLEEVE	
	401488	SPRING	
	10508	SPACER	
	7815 C.S.D.	GARLOCK CHEVRON RINGS	
	10507	PACKING NUT	
	AC995C51	LOCKWIRE	
	401487	ROD	
	10521	LOCKNUT	
	10520	CLEVIS	

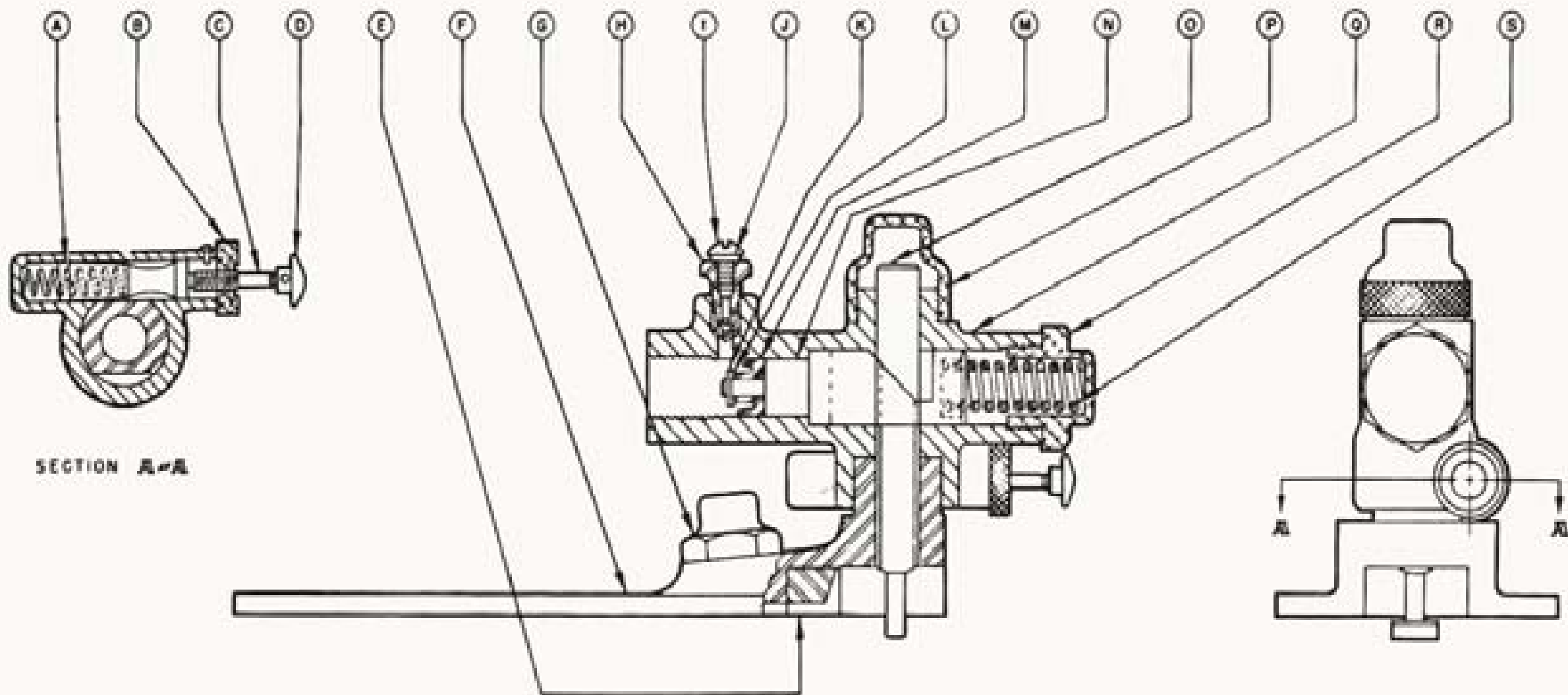
NOSE DOOR LOCKING JACK



NOTE: 1. Refer to Bendix drawing No. 78595
 2. Refer to Lockheed drawing No. 600017

A	78608	CONNECTOR RECEPTACLE	I	78633	SOLENOID	Q	78632	SPACER	Y	78604	PILOT VALVE
B	78641	PLUG PIN	J	78614	COVER	R	78637	NUT - SOLENOID	Z	78643	PIN VALVE
C	390011	SCREW	K	78601	PLUNGER	S	78630	WASHER	AA	78642	SEAT - PILOT VALVE
D	78609	CAP - SOLENOID	L	78599	SPRING - PILOT VALVE	T	78610	STOP PLUNGER	BB	78613	HOUSING
E	78603	NUT	M	78631	VALVE - PLUNGER	U	78605	SLEEVE - SOLENOID	CC	174 522	GASKET
F	78602	COVER PLATE	N	78597	SEAT	V	78600	ROD PLUNGER			
G	78626	BASE PLUG	O	78640	CAP SCREW	W	78625	SPRING			
H	78647	SOLDERING TERMINAL	P	78633	SOLDERING - PLUG PIN	X	78598	CAP			

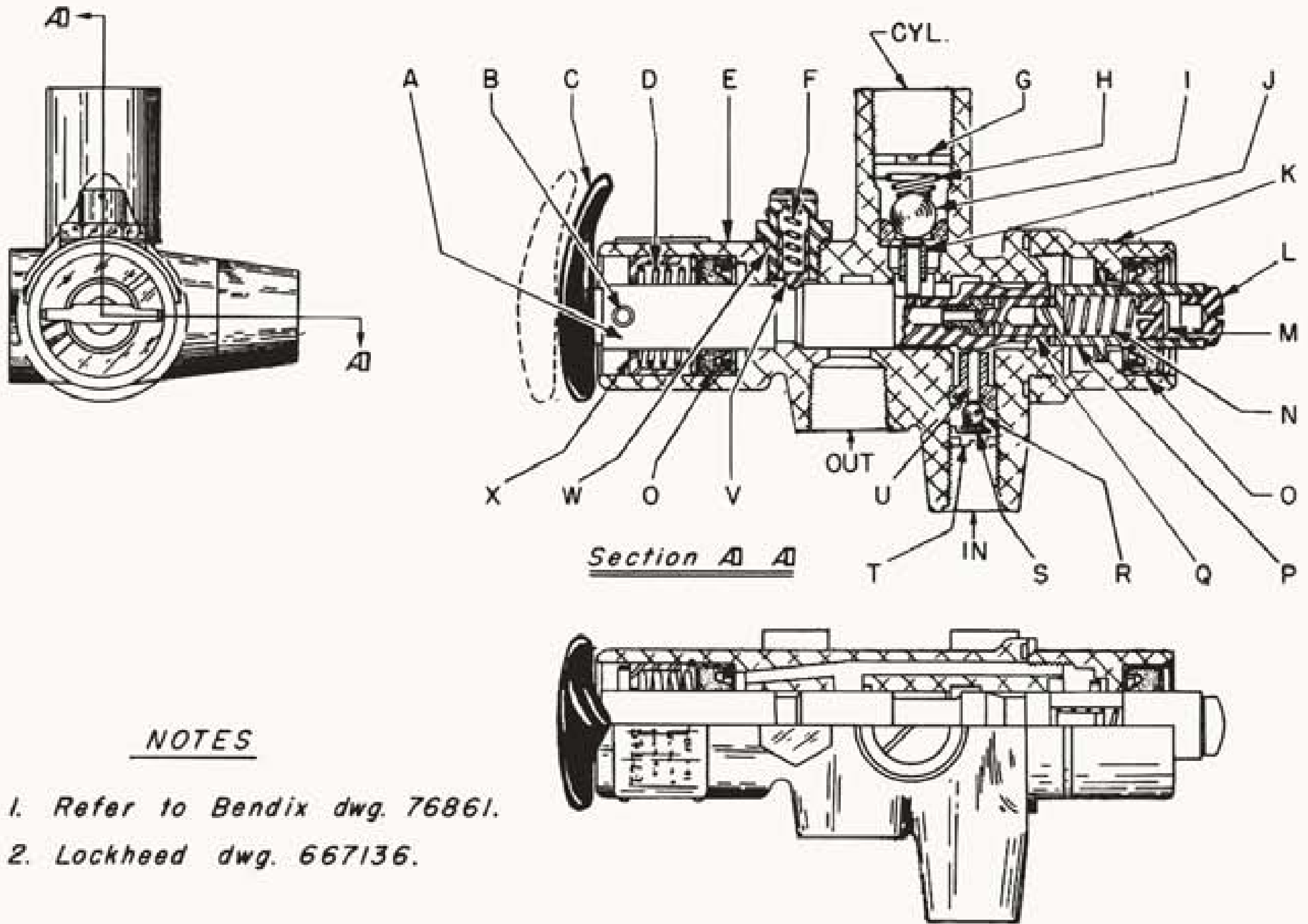
SOLENOID CONTROL VALVE



NOTE: 1. Refer to Bendix drawing No 78594
 2. Refer to Lockheed drawing No 60005

A	78620	SPRING (RELEASE PIN)	F	78646	BRACKET	K	78152	SEAT WASHER	P	78611	CAP SLIDE
B	78644	ELASTIC FASTENER CAP	G	78624	SPRING RETAINER	L	78139	WASHER - CUP RETAINER	Q	78645	HOUSING
C	78615	PIN RELEASE	H	57144	BLEEDER SCREW	M	78078	CUP PISTON	R	78621	CAP (RETURN SPRING)
D	78623	THUMB KNOB	I	57158	SCREW	N	78622	PISTON	S	78619	SPRING RETURN
E	78616	INSERT BRACKET	J	125 S B	LOCKWASHER	O	78617	SLIDE			

HYDRAULIC TRIGGER MOTOR

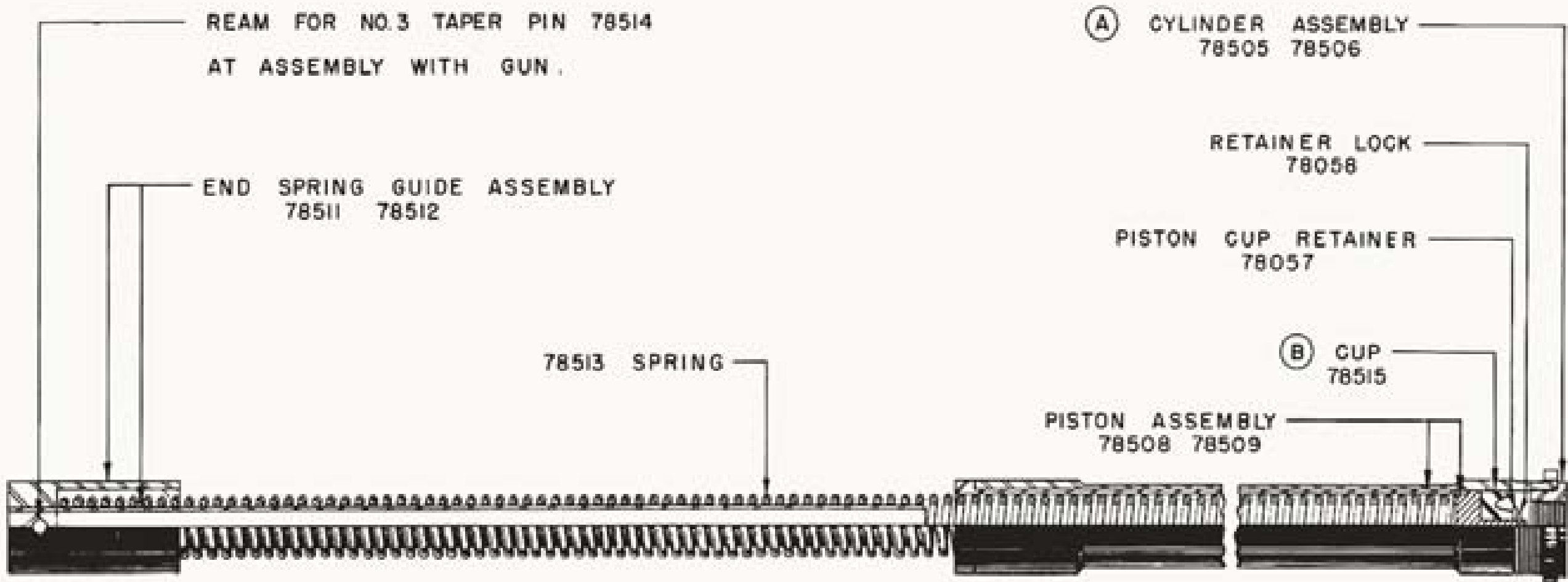


NOTES

1. Refer to Bendix dwg. 76861.
2. Lockheed dwg. 667136.

NO.	PART NO.	NAME
A	78156	Plunger
B	78117	Pin
C	78115	Handle
D	78146	Return spring - plunger
E	78144	Assembly housing
F	78145	Spring - detent
G	78153	Pilot-spring outlet check valve
H	78152	Spring
I	97-S-11	Ball-outlet check valve
J	78128	Pin - outlet check valve
K	78107	End cap
L	78110	Cap screw - plunger

NO.	PART NO.	NAME
M	78111	Screw - spring adjustment
N	78118	Spring-release valve
O	78137	Seal
P	78116	Stop-release valve
Q	78122	Plunger - release valve
R	97-S-5	Ball-inlet check valve
S	78151	Spring - outlet check valve
T	78154	Pilot - valve inlet
U	78136	Pin
V	78129	Detent
W	78133	Cap screw - detent
X	78150	Detent



NOTES

Refer to Bendix drawing No. 78003

Refer to Lockheed drawing No. 600014

CANNON HYDRAULIC CHARGER

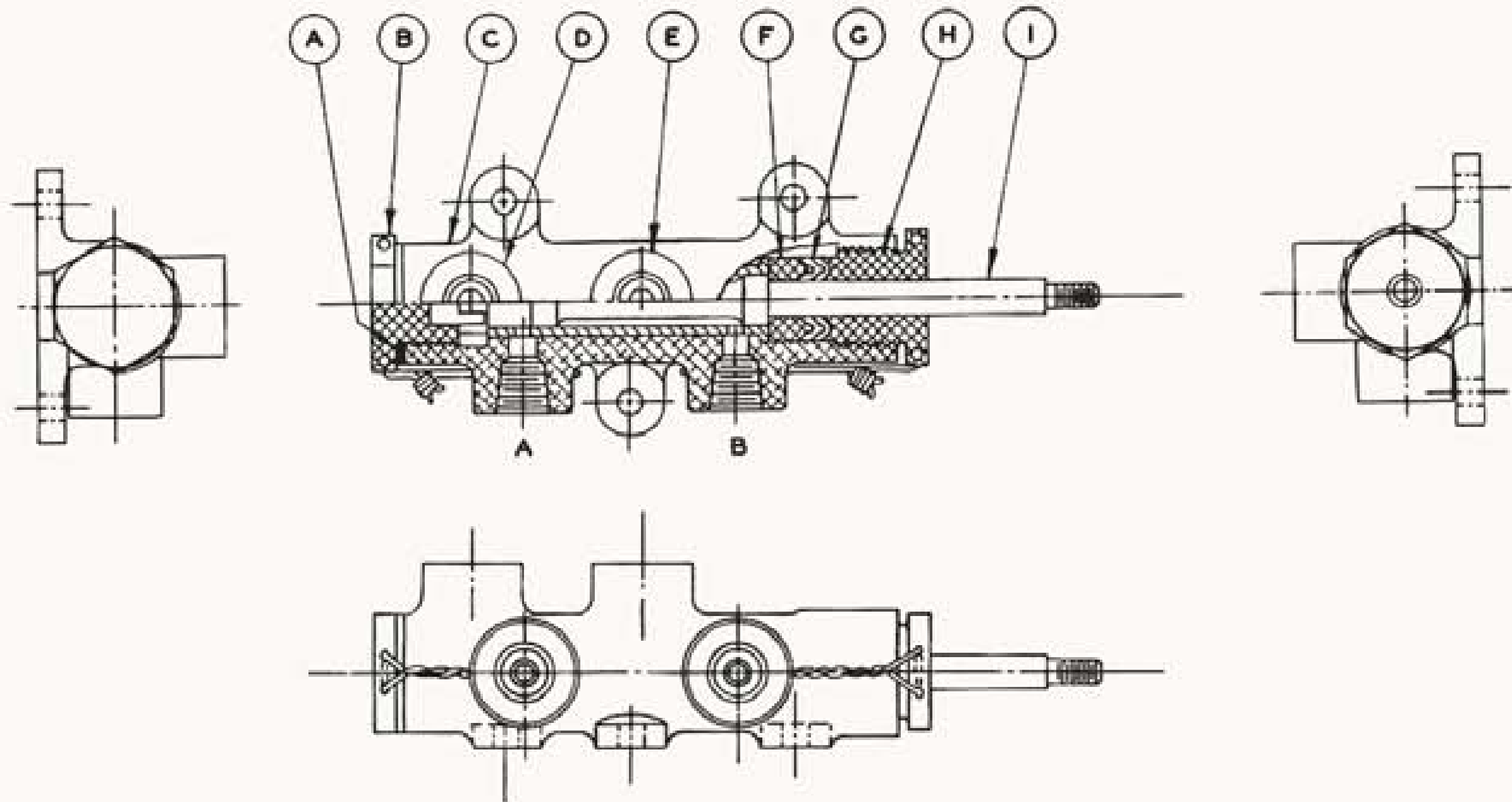
A.P. 2021A

VOL. I

SECT. 4

CHAP. 2

FIG. 37

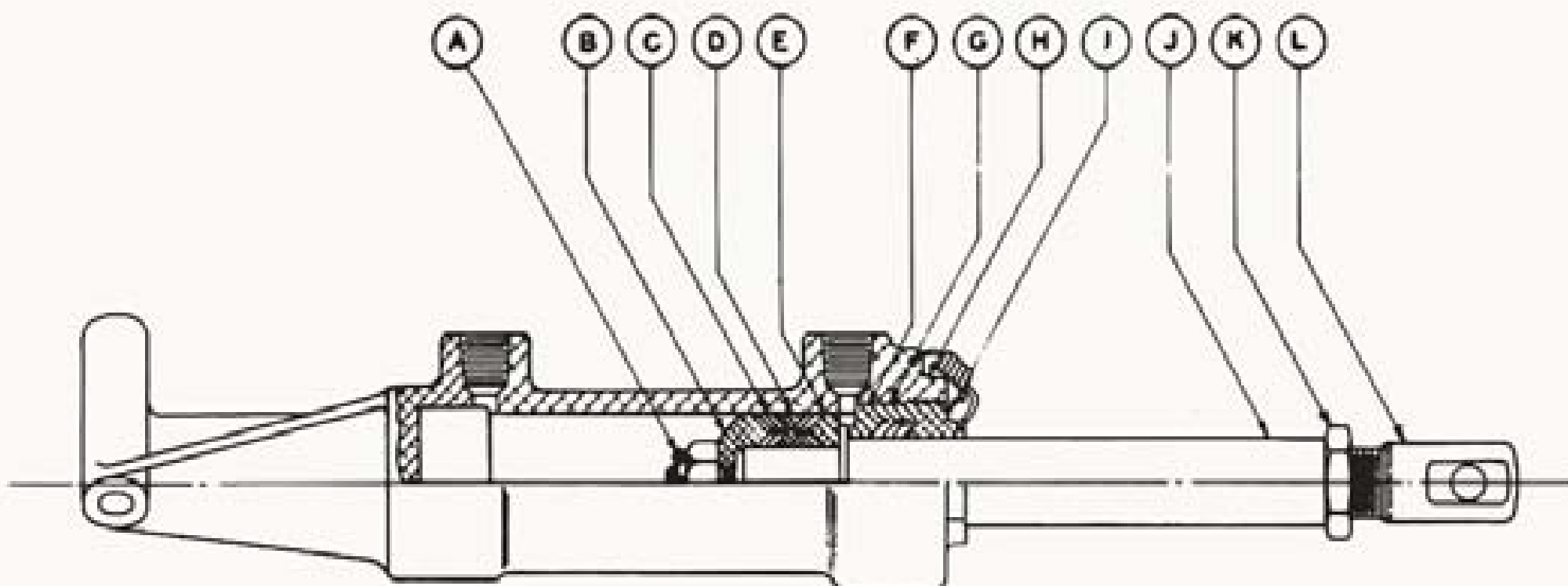
**TEST NOTES:**

1. USE MINERAL OIL IN ALL TESTS.
2. WITH ALL OTHER PORTS PLUGGED, APPLY 2000 P.S.I. AT SUPPLY PORT & CHECK FOR LEAKS, THERE IS NO LEAKAGE ALLOWABLE AT ANY POINT. OIL FILM ON VALVE STEM WILL NOT BE CAUSE FOR REJECTION PROVIDED A DROP IS NOT FORMED & DROPPED DURING A 15 MIN. TEST.
3. WITH PORT A & RETURN PLUGGED & VALVE STEM PUSHED IN APPLY 1000 P.S.I. AT SUPPLY PORT. LEAKAGE AT PORT B SHALL NOT EXCEED 30 TO 50 DROPS / MIN. VALVE SHOULD COMPL. FILLED WITH FLUID SO THAT LEAKAGE IF ANY WILL BE APPARENT AT ONCE.
4. REPEAT TEST 3 WITH PORT B & RETURN PLUGGED & VALVE STEM PULLED OUT. TEST LEAKAGE AT PORT A WITH SAME ALLOWANCE AS IN TEST 3.
5. REPEAT ALL TEST USING 10 TO 25 P.S.I.
6. REFER TO LOCKHEED PART NO. 667052

LET.	PART NO.	NAME
A	20300-020C027-062	WASHER
B	11092 AC995C40-8	STOP LOCKWIRE
C	21237	BODY
D		RETURN
E		SUPPLY
F	11095	ADAPTER
G	20333-3G-008C	PACKING RING
H	11094	PACKING NUT
I	21091	VALVE

REFER TO UNITED AIRCRAFT
PRODUCTS INC. DWG. N. 41088

CASE EJECTION DOOR CONTROL VALVE



LET.	PART NO.	NAME
A	AN 310-5 AN 380-2-3	CASTLE NUT COTTER
B	10516	PISTON HEAD
C	GARLOCK NO. 7815	CHEVRON RINGS 1 O.D. X 1/2 I.D.
D	10514	BEARING
E	10509	SPACER
F	10508	SPACER
G	GARLOCK NO. 7815	CHEVRON RINGS 1 1/8 O.D. X 5/8 I.D.
H	400008	BODY
I	10507	PACKING NUT
J	10519	PISTON
K	10521	LOCK NUT
L	10520	GLEVIS

NOTES-

- 1-LOCKHEED PART NO. 663002
- 2-REFER TO BENDIX AVIATION LTD.
DRAWING NO. 10501
- 3-TEST PRESSURE-2000 P.S.I.
- 4-WORKING PRESSURE - 1000 P.S.I.
- 5-CYLINDER STROKE $2\frac{1}{4}$

CASE EJECTION DOOR JACK

A.P. 2021 A VOL. I SECT. 4 CHAP. 2 FIG. 39

NOTES:

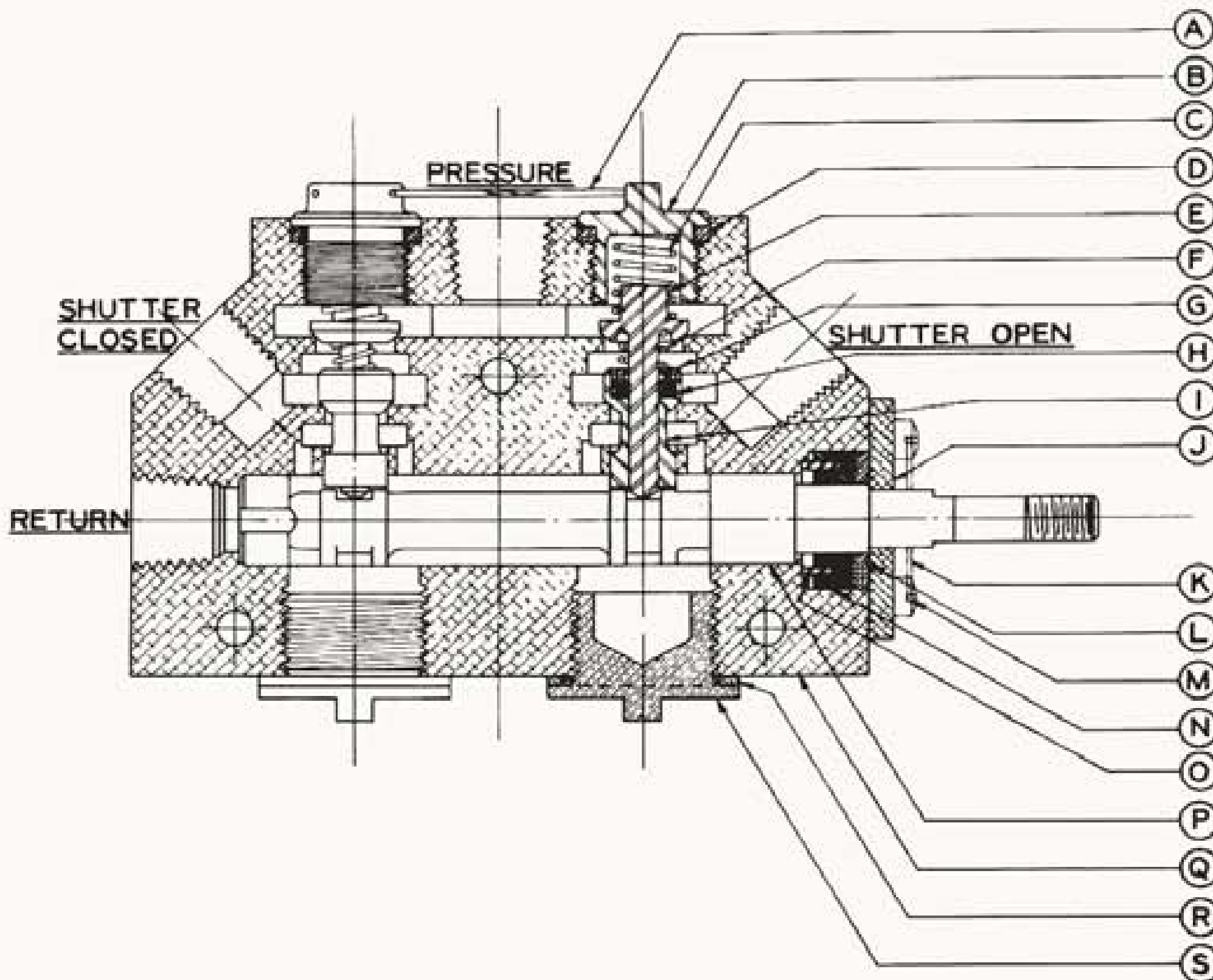
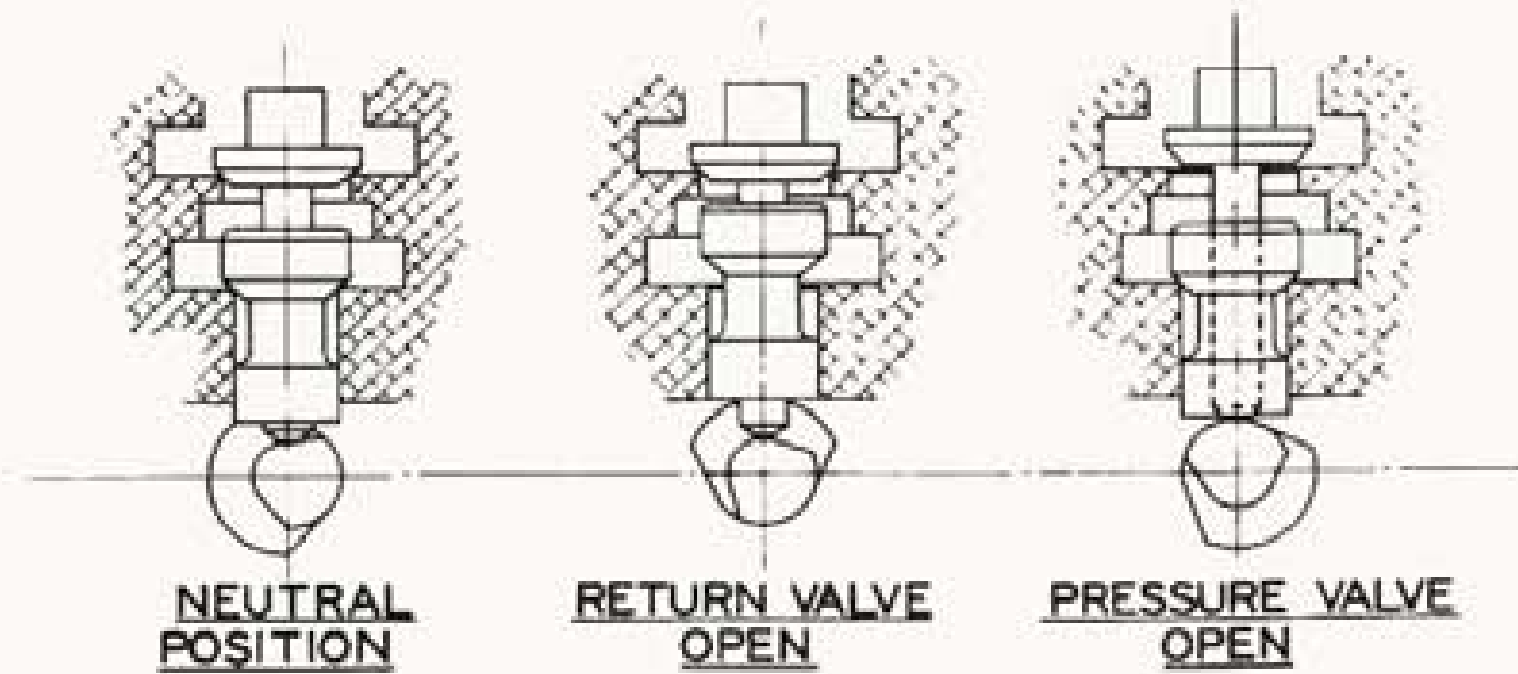
1. REFER TO:

ADEL PRECISION PROD. INC. DRAWING NO. B-9201
 LOCKHEED DRAWING NO. 667135

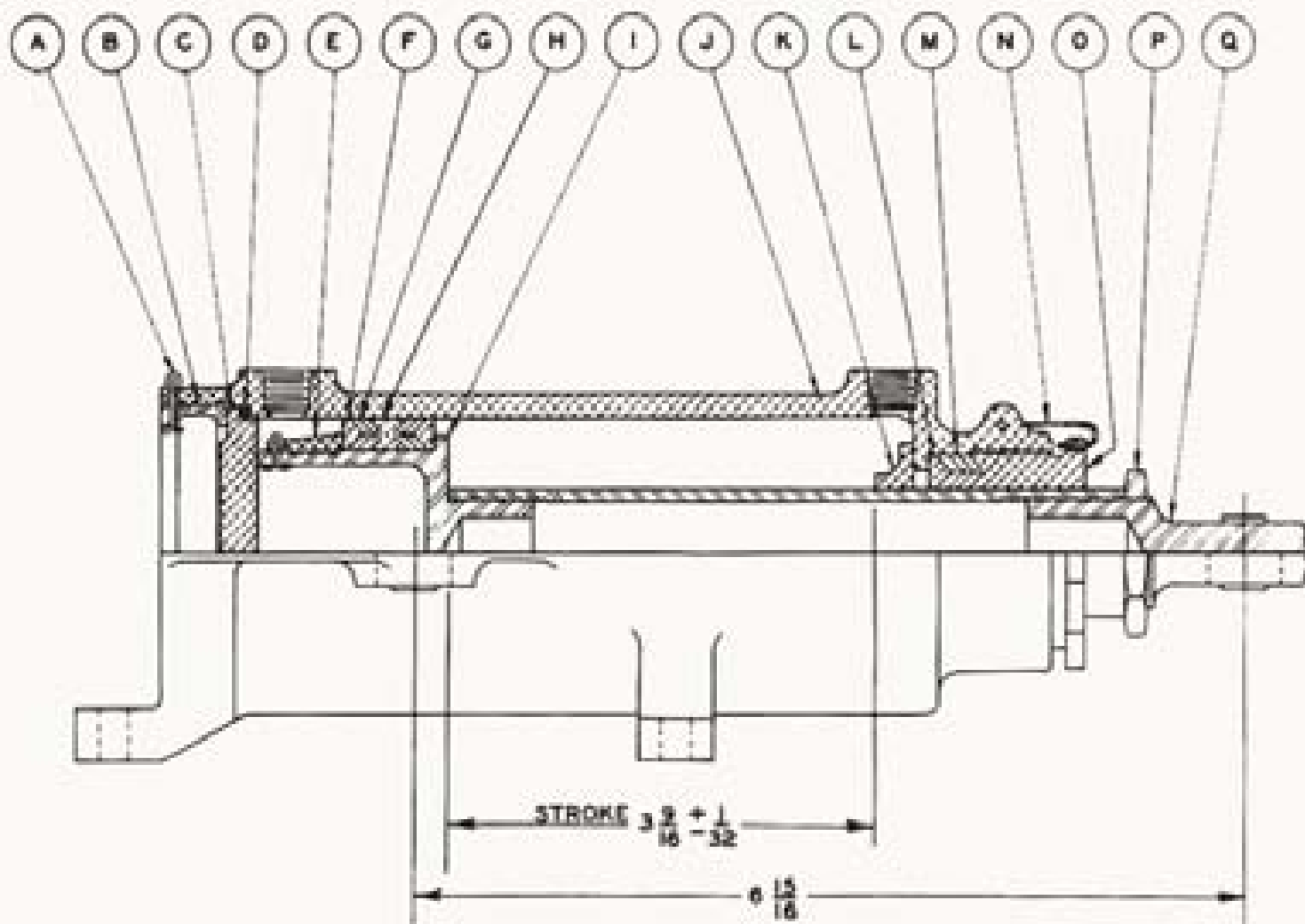
TEST NOTES:

1. PRESSURE TEST AT 2000 P.S.I. FOR LEAKS
2. PRESSURE TEST AT 10 TO 25 P.S.I. FOR LEAKS
3. WORKING PRESSURE 1000 P.S.I.

LET.	PART NO.	NAME	REQ.
A	AC995-C 40	LOCKWIRE	1
B	A-9101	CAP	2
C	A-9109	SPRING	2
D	S-304A-685:566-0375	WASHER	2
E	A-9104	STEM	2
F	A-9105	LOWER SPRING	2
G	A-9106	SPACER	2
H	A-9107	CUP	2
I	A-9108	STEM	2
J	A-9114	RETAINER	1
K	AC995-C40	LOCKWIRE	2
L	A-9111	WASHER	1
M	AC 503-8-6	SCREW	4
N	S-9113-A-012	CUP	1
O	A-9112	SPACER	1
P	B-9115	SHAFT	1
Q	G-9117	BODY	1
R	S 303-8A	WASHER	2
S	A-9616	PLUG	2



COOLANT RADIATOR FLAP CONTROL VALVE



LET	PART NO.	PART NAME	LET	PART NO.	PART NAME
A	AN380-2-2	COTTER	O	10792	NUT
B	10796	NUT	P	10793	NUT
C	10795	END	Q	10797	TERMINAL ASSEM.
D	20300-2003R206-094	GASKET			
E	10788	NUT			
F	10790	ADAPTER			
G	20333-4G120C 20323-4G-515	GARLOCK PACKING FILLER			
H	10789	SPACER			
I	10723	PISTON ASSEM			
J	40873	CYLINDER			
K	10791	STOP			
L	10794	ADAPTER			
M	20333-4G100C- 20323-4G-315	GARLOCK PACKING FILLER			
N	AC895C40-8	LOCKWIRE			

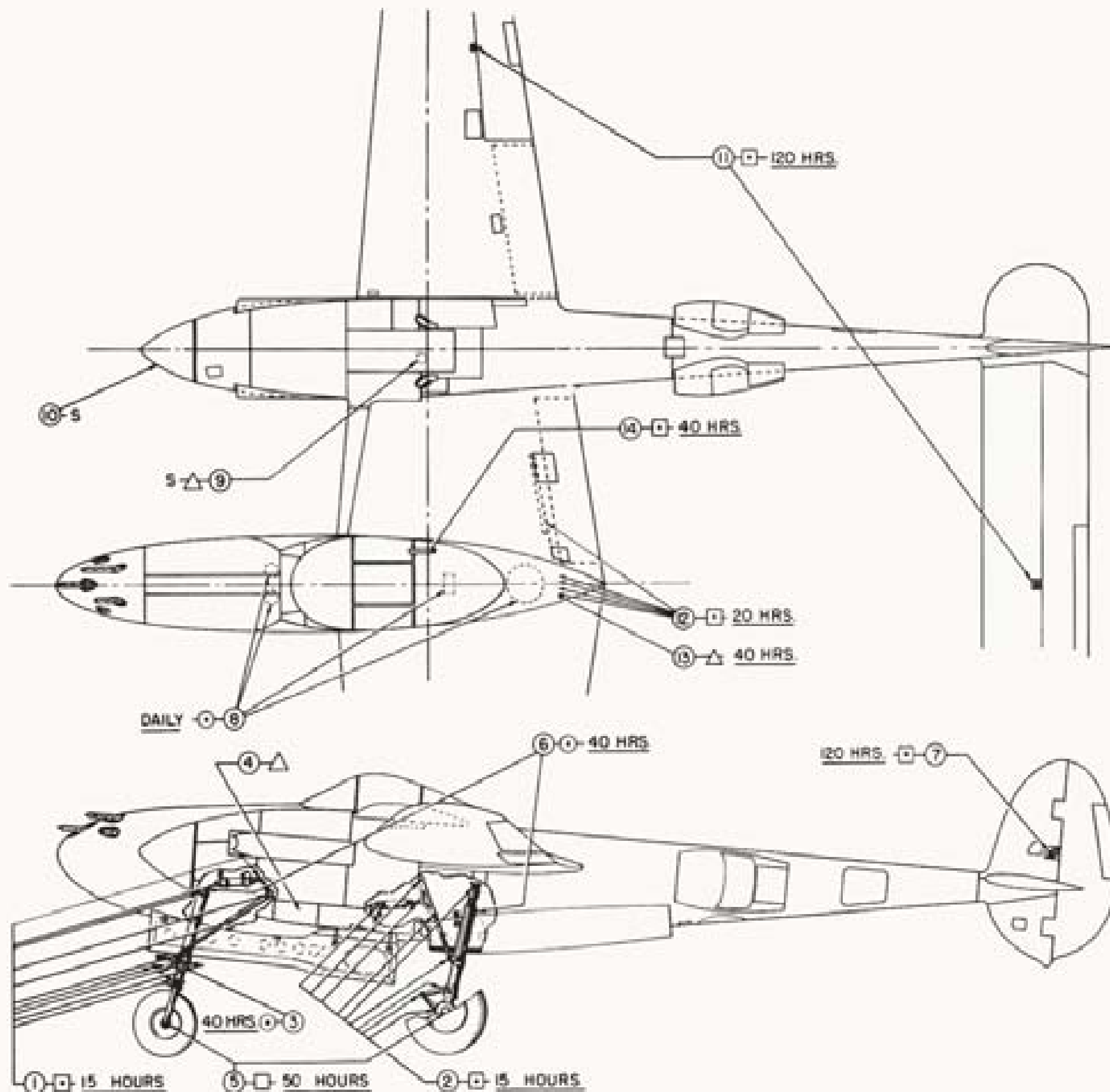
NOTES:

1. LOCKHEED PART NO. 663013
2. REFER TO UNITED AIRCRAFT PRODUCTS DRAWING NO. 40787.

TEST NOTES:

1. TEST AT 2000 P.S.I. FOR LEAKAGE.
2. WORKING PRESSURE = 1000 P.S.I.
3. LOW PRESSURE TEST AT 10 TO 25 P.S.I. FOR LEAKAGE

COOLANT RADIATOR EXIT FLAP JACK



EXPLANATION OF CODE

- △ ③ ———→
- △ INDICATES TYPE OF LUBRICANT - SEE LUBE SYMBOLS.
- ③ INDICATES PART NAMES - SEE KEY.

LUBE SYMBOLS

- INTAVA "E" OR EQUIVALENT.
- INTAVA "D" OR EQUIVALENT.
- INTAVA SERVO FLUID OR EQUIVALENT.
- △ ENGINE OIL.
- 5- AS PER VENDORS INSTRUCTIONS.

KEY

- ① NOSE LANDING GEAR LINKAGE _____ 19 POINTS
- ② MAIN LANDING GEAR LINKAGE _____ 36 POINTS
- ③ SHIMMY DAMPER RESERVOIR _____ 1 POINT
- ④ OIL COOLER FLAP OPERATOR _____ 1 POINT
(Refill at Engine Change.)
- ⑤ WHEEL BEARINGS _____ 3 POINTS
- ⑥ OLEO LEGS _____ 3 POINTS
- ⑦ RUDDER DRUMS _____ 2 POINTS
- ⑧ BRAKE, EMERGENCY AND HYDRAULIC SYSTEM RESERVOIRS _____ 4 POINTS
- ⑨ OIL TANK FILLER _____ 2 POINTS
SEE VENDORS INSTRUCTIONS.
- ⑩ AIRSCREW - SEE VENDORS INSTRUCTIONS.
- ⑪ AILERON AND ELEVATOR TAB DRUMS _____ 2 POINTS
- ⑫ FLAP DRIVE - GEARS, FLAP POSITION INDICATOR _____ 1 POINT
- UNIVERSAL JOINTS _____ 2 POINTS
- GEARS HYD. VALVE _____ 1 POINT
- FLAP SCREW _____ 2 POINTS
- ⑬ FLAP DRIVE - GEAR BOX _____ 1 POINT
(Refill at Engine Change.)
- ⑭ HYDRAULIC HAND PUMP _____ 1 POINT

LUBRICATION DIAGRAM

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SECTION 5

Volume 1

REMOVAL AND ASSEMBLY OPERATIONS

1. General - This section describes removal and assembly operations for complete structural and airframe components which might require removal for repair or replacement. In cases where no assembly or installation instructions are given, the reverse of the removal instructions should be followed. For disassembly of the aeroplane the following order of operations is recommended:

Airscrews
Outer Planes and Flaps
Engines
Tail Unit
Aft Booms
Undercarriage
Ailerons
Elevator
Rudders
Fins

2. Illustrations showing necessary trestling and the locations of access doors are contained in Section 4 of this manual.

3. Airscrews - The removal of airscrews is described in the appropriate airscrew manual.

4. Spinners - The spinners are dynamically balanced and must be reassembled as they were originally, to preserve their balance. The assemblies are serially numbered and the parts of each marked to indicate their respective location. The screws used to fasten the forward portion to the rear portion are L. S. 577 screws 1/2 inch long, and must not be confused with the L. S. 577-7/16 inches long used at the rear edge. The replacement of any part necessitates rebalancing the spinner.

OUTER MAIN PLANES

5. To Remove Flaps and Carriages

- a. Extend the flaps and remove from carriages.
- b. Slacken cables and detach from carriages.
- c. Remove the stops from the aft end of tracks.
- d. Roll the carriages out the aft end of the tracks.

6. To Remove Outer Main Planes (Weight Approx. 390 lbs.) (See Fig. 1.)

- a. Remove the engine cowling and the boom fillets adjacent to the junction of the outer and centre main planes.
- b. Remove the two outboard plates of the firewall covering the spar pins.
- c. Disconnect the electrical conduit at the cannon plug, under the lower outer plane fillet.
- d. Open hand hole "I" (Fig. 1, Sect. 4, Chap. 2). Turn the aileron tab adjustment so that the turnbuckles are accessible through the hand hole. Tape the adjusting control so that it cannot be turned.
- e. Disconnect the tab cables. Attach shock absorber cord stretchers to the outboard cables and fish wires to the inboard cables.
- f. Disconnect the aileron cables. Secure the outboard cables near the hand hole and attach fish wires to the inboard cables.
- g. Lower the flaps. Disconnect the flap push-pull tube by removing the bolts from the outboard flap tube connection.
- h. Support the engine with a sling and remove the outboard motor mounts struts attached to outer plane. After struts are removed the engine sling may be removed. DO NOT ATTEMPT TO START THE ENGINE IN THIS CONDITION.
- i. Support the outer plane by slings or horses.
- j. Remove the screws from the upper and lower surface of the main plane aft of the rear spar at the junction.

k. Remove the bolts from the lower, then from the upper "Bathtub" fittings. Use tool No. 248857.

l. Remove the attaching bolts from the rear spar.

m. Using pin pullers 248863 and 248861 together, remove first the lower and then the upper spar pin.

NOTE: If the engine has been removed, a slide hammer may be substituted for tool no. 248861 in pulling the spar pins.

n. Move the outer plane straight outboard until the flap tube is clear of the centre main plane. Draw the aileron and tab cables out. Disconnect the fish wire and attach to the outer panel. Attach stretchers to the tab cables remaining in the centre plane to prevent their unwinding on the drums.

7. To Install Outer Main Planes

a. Reverse the procedure prescribed for removal.

CAUTION: Be sure that the cables from the centre main plane are properly placed in the fairlead before mating the main plane fittings and that they are not crossed when reassembling the turnbuckles. The flap should be extended so that the push-pull tube will not have to be guided in place during the attachment of the main plane.

8. To Remove Aileron

a. Remove the main plane tip. (See Par. 11, this section.)

b. Open handholes "I", "G", and "C" in the lower surface of the outer plane and handhole "AA" in the upper surface (See Fig. No. 1, Sect. 4, Chap. 2).

c. Turn the tab adjustment so that the turnbuckles are accessible through the handhole "I" and secure the adjusting handle with tape so that it cannot be turned.

d. Attach shock absorber cord stretchers to the inboard side of the cables at handhole "I", disconnect the turnbuckles and attach fish wires to the outboard cables.

e. Remove the tab cable pulleys from their brackets through "G" in the lower surface and "AA" in the upper surface.

f. Through "C" in the lower surface disconnect aileron push-pull tube. Do not allow the aileron counterweights to strike the skin.

g. Support the aileron and withdraw the hinge pin from the outboard end using a slide hammer and clamp No. 248868 after first pouring carbon tetrachloride along the entire hinge.

h. Pull the aileron straight aft being careful to guide the counterweights clear of the main plane.

i. Wire the tab cables together at the drum to prevent their unwinding.

j. Pull the cables out of the main plane, detach the fish wires and secure at handhole "I" and in the aileron cutout.

9. To Install Aileron

a. Reverse the procedure prescribed for removal. Replace hinge pin using rivet gun and telescoping tube (See note following) and adjust in accordance with Sect. 4, Paragraph 11. Maintain tension on the tab cables while cutting the safety wire at the drum just prior to mating the hinge. Insert the projecting end of the hinge pin in the tube provided in the main plane tip. Apply carbon tetrachloride to the aileron hinge and pin before installing.

NOTE: Tubes are composed of 17 gauge (.058) (if not available, use 18 gauge - .049) steel tubing of 1/4, 3/8 and 1/2 inch outside diameter. Three sets are used, first set being about 40 inches long, second set 18 inches and the third set about 4 to 6 inches long. These tubes are placed one inside the other and are set over the hinge pin to prevent buckling while being driven into place.

10. To Remove Aileron Tab

- a. Through the handhole in the lower surface of the aileron disconnect the tab push-pull tube at the actuating unit.
- b. Depress the aileron and at the inboard end remove the safety clip from the tab hinge pin.
- c. Remove the hinge pin and pull the tab straight aft to remove.

11. To Remove the Main Plane Tip

- a. Remove the screws from the lower and upper surfaces attaching the tip to the outer plane.
- b. Move the tip outboard just enough to provide access to disconnect the electrical conduit.

ENGINES

12. To Remove Engine - The engine installation is designed so that it may be detached as a single unit in order to reduce to a minimum the time required for an engine change.

CAUTION: The aft booms must be supported by jacks when the engines are removed as the centre of gravity of the aeroplane is aft of the main undercarriage in this condition.

- a. Remove the cowling with the exception of the carburettor air scoop panel. Detach the carburettor air heater door control rod at the door, then remove the scoop panel.
- b. Drain the oil and coolant systems.
- c. Disconnect and remove the exhaust manifolds, shrouds and intensifier tube aft of the cylinder blocks.
- d. Remove the spinner.

CAUTION: First remove the brush assembly, then the airscrew.

- e. At Station 67, remove all piping and conduit leading to the engine. Use tool no. 234585 hose clamp wrench.
- f. Disconnect the conduit at the cannon plug on the front of the firewall and remove the clip attaching the conduit to the support bay strut.
- g. Break the hose connections at the engine "out" coolant lines at the firewall and in the engine "in" line below the pump.
- h. Disconnect at the engine all piping leading to the engine from the firewall.
- i. Disconnect the oil lines at pump inlet and at the oil tank and remove cowl formers (2 per engine).
- j. Disconnect the airscrew governor control rod at the bell-crank in the accessory section and all other control rods at the engine.
- k. Disconnect the upper and lower cowl formers at rear of support bay and oil cooler flap and rear scoop.
- l. Remove fuel pump. (See Par. 13)
- m. Loosen four rear engine mounting bolts. (Points A, B, C & D, Fig. 10, Section 8.)
- n. Attach hoisting harness number PE3142E.
- o. Check to see that everything is disconnected between the engine, the support bay, the firewall and the centre main plane.
- p. Remove the two lower bolts attaching the engine mounting trusses to the support bay.
- q. Remove the two upper bolts attaching the diagonal supporting struts to the main plane.

- r. Swing the assembly straight forward out of the aeroplane guiding the rear accessories clear of all obstructions.
- s. Attach the assembly to the work stand.

NOTE: When removing or installing an engine the oil tank must be protected to prevent possible damage.

13. To Remove Engine Accessories - When removing engine accessories a careful note must be made of the correct location and angle of plumbing elbow fittings, as these units must be bench assembled before installation. The fittings cannot be adjusted after installation on the engine. Incorrect settings will cause undue strain and possible failure of the plumbing lines.

- a. To remove any engine accessory disconnect plumbing lines at flexible hoses or electrical connections at the cannon plugs.
- b. Remove Palnuts and lift from engine.
- c. When installing the tachometer generator, screw on as far as possible then back off until the flexible conduit fitting points to the starboard side of the engine and tighten the lock bolt.

OIL SYSTEM

14. Drainage and Removal of Oil Tank

- a. Remove the accessory section cowling, and drain the tank and engine through the "Y" type drain cock.
- b. Remove the upper rear cowl formers adjacent to oil tank.
- c. Cover the carburettor opening.
- d. Remove the exhaust tail pipes.
- e. Disconnect and plug all lines attached to the oil tank.
- f. Disconnect the bonding braid.
- g. Disconnect the strap turnbuckles and lift the tank out.

15. To Remove Oil Coolers

- a. Remove the skin panel covering the oil coolers.
- b. Drain the oil coolers by removing the plugs in the bottom of the coolers.
- c. Disconnect the clamps holding the neoprene and metal seals to the ducts at each end of the radiators.
- d. Remove the exit flap and operating unit, being sure to disconnect the two cannon plugs at the forward side of the motor.

NOTE: The exit flap and operating unit are removed together by taking out the sections of cowl former that support the assembly.

- e. Disconnect the hose couplings.
- f. Remove the nipples from the forward ends of the regulators.
- g. Remove the bolts attaching the supporting bracket to the engine mount.

16. To Remove Oil Cooler Flap Mechanism

- a. Remove the sections of cowl former below the assembly.
- b. Disconnect the two cannon plugs at the forward end of the motor.
- c. Remove flap.
- d. Remove the bolts from the webs located between the oil coolers.

FUEL SYSTEM

17. To Remove the Main Tanks

- a. Remove the access panel on the underside of the fuselage below the anti-surge tank sump.
- b. Remove the drain plug in the anti-surge tank sump, and drain completely of fuel.
- c. Detach the panel of the lower surface of the centre plane between the main spar and the rear shear spar, below the tank to be removed. The tank is then supported by ledges at the inboard and outboard ends of the tank opening.
- d. Remove the manhole cover in the bottom of the tank.
- e. Remove the screws inside the tank which fasten the tank to the filler cap fitting.
- f. Reaching through the manhole, release the clamps on the three tubes leading to the anti-surge tanks.
- g. Disconnect the vent line at the outboard end of the tank.
- h. Lower the tank from the aeroplane.

18. To Remove Anti-Surge Tanks

- a. Remove the main fuel tank.
- b. Remove the diagonal bulkhead at the outboard side of the anti-surge tank.
- c. Remove the manhole cover on the outboard side of the tank.
- d. Remove the sump plate, including the strainer and drain cock, through the access panel in the bottom of the fuselage.
- e. Disconnect the electrical connection of the quantity gauge transmitter on top of the surface of the centre plane. This is accessible through the top of the fuselage.
- f. Remove the fuel quantity gauge transmitter through the fitting by which it is attached to the centre plane structure. This will also release the tank.
- g. Remove the tank through the main tank compartment.

19. To Remove Reserve Tanks

- a. Drain the tank through the sump in the lower surface of the centre plane.
- b. Detach the tank from the lower plane surface at the sump by removing the outer ring of screws.
- c. Disconnect the electrical conduit at the plug on the head of the fuel quantity gauge transmitter inboard of the rib at Sta. 19 1/2.
- d. Remove the gauge transmitter attaching screws and remove the transmitter through the attaching fitting. This may be done through a hole in the fuselage web.
- e. Remove the screws in the upper centre plane surface which attach the tank to the structure around the filler cap.
- f. Remove the panel of the lower surface of the centre plane which is below the tank. The tank is then supported by small corner brackets at three corners of the opening and by the control cable tube.
- g. Remove the sump cover plate.
- h. By reaching through the sump hole release the clamp at the outlet tube.
- i. Remove vent lines connections.
- j. Lower the tank from the aeroplane.

20. To Remove Fuel Valves - (See Fig. 2)

- a. Drain the tanks in the section of the fuel system controlled by the valve to be removed.
- b. Make sure that the other selector cock is in the "OFF" position.
- c. Remove the control drum from the valve housing.
- d. Disconnect the pipe connections at the valve.
- e. Remove the valve through the bottom of the fuselage.

21. To Remove Electric Fuel Pumps - (See Fig. 2)

- a. Turn both fuel selector cocks to the "OFF" position.
- b. Disconnect the hose, pipe, and vent line connected to the pump.
- c. Remove the bolts which attach the pump housing base to the bulkhead at Station 162 1/4.

22. To Remove Fuel Strainer - (See Fig. 2)

- a. Turn both fuel selector cocks to "OFF".
- b. Disconnect the hose leading to the electric fuel pump, and the pipe connection into the "Tee" at the top of the stringer.
- c. Disconnect the pipe leading into the aft port of the strainer.
- d. Remove the bolt which attaches the strainer housing to the bulkhead bracket at Station 175.

TAIL UNIT

23. To Remove Complete Tail (Weight 422 lbs.) (Fig. 3)

- a. Remove the tail plane tips. See Para. 24.
- b. Remove the lower outboard quadrant of skin from the tail unit booms.
- c. Secure the rudder and elevator tab cranks in the cockpit. Through the rear of the accumulator and baggage compartments, slack all of the control cables, disconnect the rudder tab cables and attach fish wires to the aft ends. Attach shock absorber cord stretchers to the forward tab cables.
- d. Disconnect the elevator tab cables in the tail plane and tape together at the actuating unit. Attach fish wires to cables leading to the cockpit.
- e. Disconnect elevator and rudder cables from the operating horns in the tail boom, attach fish wires and remove elevator cable pulleys.
- f. Disconnect the electrical conduits at the junction of the tail and aft booms, Station 393.
- g. Support the tail unit and remove the screws attaching the tail booms to the aft booms.
- h. Pull the tail unit aft, rocking downward to remove.

NOTE: It is recommended that the complete tail unit be removed when major repairs are required.

24. To Remove Tail Plane Tip

- a. Remove the screws from the inboard contour at the junction and pull straight outboard until the shear pins clear the tail boom.

25. To Remove the Elevator

- a. Raise the elevator and disconnect the tab push-pull tube from the actuating unit, through the gap in the lower surface.
- b. Remove the small skin plates at the port end of the elevator. See 3 on Fig. 3.
- c. Remove the screws connecting the elevator to the torque tubes. See 2 on Fig. 3.
- d. Raise the elevator until the skin notch at the port end clears the tail boom.
- e. Slide the elevator to port until the hinge pins are disengaged from their bearings in the tail plane brackets.
- f. Pull the elevator up and aft to remove.

26. To Remove the Elevator Tab

- a. Raise the elevator and disconnect the tab push-pull tube as prescribed in Par. 25 preceding.
- b. Remove the screw and clip securing the hinge pin to the elevator at the left end of the elevator.
- c. Withdraw the hinge pin.
- d. Pull the tab aft to remove.

27. To Remove Rudders

- a. Remove the screws connecting the upper and lower sections of the rudders.
- b. Disconnect the tab push-pull tube from the actuating unit through the cutout in the rudder leading edge.
- c. Remove the skin plates on the fins at the rudder balance weight cutouts. See 6 on Fig. 3.
- d. Remove the screws connecting the rudders to the rudder torque tube. See 4 on Fig. 3.
- e. Raise the upper rudder and lower the bottom rudder until the hinge pins are disengaged.

NOTE: Either the upper or lower rudders may be removed independently.

28. To Remove Rudder Tabs

- a. Remove the upper rudder.
- b. Remove screw attaching push-pull tube to tab.
- c. Remove clip securing the hinge pin to the rudder.
- d. Withdraw the hinge pin.
- e. Remove the tab.

29. To Remove the Fins

- a. Remove the lower outboard quadrant of tail boom skin.
- b. Remove the rudders.
- c. Remove the bolts attaching the rudder torque tube to the tail plane.
- d. Slack the elevator control cables, detach from the control horn and attach fish wires.
- e. Remove the pulleys in the upper and lower fin to allow cable terminals to thread back through the brackets.
- f. Disconnect the rudder tab control cables at the centre of the tail plane and in the aft boom. Remove the stop in the fin. Attach fish wires to the cable. Secure the rudder tab crank in the cockpit so that it cannot be turned and attach stretchers to the cable remaining in the airplane.

- g. Disconnect the electrical conduit at Station 393.
- h. Remove the screws attaching the fins to the boom.
- i. Raise upper fin and lay it on tail plane. Through the opening in the boom remove the rudder tab cable pulleys.
- j. Remove the fins.

30. To Remove the Tail Plane

- a. Remove the complete tail unit. (See Par. 23.)
- b. Remove the fins, elevator and elevator torque tubes.
- c. Remove the cable guard pins on the elevator tab control pulleys in the port boom.
- d. Remove the screws attaching the booms to the tail plane and slide the booms outboard.

31. To Remove Aft Tail Boom

- a. Remove tail plane tip.
- b. Remove the lower rudder.
- c. Remove the screws at the joint with the forward tail boom.
- d. Pull aft to remove.

32. To Remove Rudder Torque Tube

- a. Remove the lower outboard quadrant of skin from the tail boom.
- b. Remove the rudders.
- c. Remove the aft tail boom.
- d. Disconnect the push-pull tube from the torque tube arm.
- e. Remove the bolts and screws attaching the torque tube bearing brackets to the fins.
- f. Slip tube assembly aft to remove.

33. To Remove Elevator Torque Tube and Balance Weight

- a. Remove the lower fin and elevator.
- b. Remove the taper pins attaching the control horn to the torque tube.
- c. Remove the torque tube supporting bracket in the tail boom.
- d. Remove the nut on the inboard end of the torque tube and the four bolts attaching the pin flange to the torque tube. Slide the tube outboard to clear the bearing.
- e. Slide the tube inboard and aft to free it from the control horn and balance weights.
- f. Remove the control horn from the boom.

34. To Remove the Aft Boom - (The aft boom is that portion of the boom between Stations 265 and 393. See Fig. 5)

- a. Remove the tail unit as described in this section.
- b. Remove the accumulator (if the port boom is being removed.)
- c. Remove radiator scoops.
- d. Drain cooling system and remove hose connections from coolant lines at Station 265.

- e. After relieving hydraulic pressure remove hydraulic pressure and return lines from radiator exit flap control valve and plug ends quickly to avoid spilling hydraulic fluid. Remove clips securing tubing to aft boom.
- f. Disconnect cannon plug on bulkhead at Station 265.
- g. Disconnect flare control cable from flare mechanism.
- h. Remove spring loading mechanism on flare control cable and withdraw cable from aft boom.
- i. Through the inspection plates in the inboard wheel well web, disconnect all control cables. (Cables may be removed from boom by removing guard pins from pulley brackets and pulling cables out, if desired.)
- j. Support the boom by an overhead sling or stand and remove the Phillips head screws at Station 265.
- k. Remove the bolts from the lower channel attachment fittings.
- l. Move the boom aft to clear fittings, etc.

MAIN UNDERCARRIAGE

35. To Remove a Wheel

- a. Jack up the wheel.
- b. Remove the cover plate over the axle.
- c. Remove the dust cap.
- d. Remove the cotter pin, retaining nut and washer using Tool No. 234578.
- e. Slide the wheel off the axle, being careful not to allow the bearings to be dropped.

36. To Replace a Wheel

- a. With a straight edge align the keys extending from the bronze brake discs and set the parking brake to maintain the alignment while replacing the wheel.
- b. Replace the bearings and the wheel.
- c. Replace the washer and retaining nut but do not key.
- d. Release the parking brake.
- e. Spin the wheel to see that there is no brake drag and with the wheel spinning tighten the retaining nut until a bearing drag slows the wheel.
- f. Back off the retaining nut to its next locking position and secure.
- g. Replace the dust cap and cover plate.

37. To Remove an Oleo Leg (Weight approx. 105 lbs.)

- a. Jack aeroplane from main planes.
- b. Disconnect the upper brake hose and drain into a clean bucket.
- c. Remove the nut and pin from the lower end of the drag strut.
- d. Remove bracket, bolt and pin from lower end of side strut.
- e. Remove retaining bolt from inboard fulcrum pin.
- f. Support the assembly to remove its weight from the fulcrum pin.
- g. Through inboard handhole in outer skin remove fulcrum pin nut using Tool No. 248853.

h. Withdraw fulcrum pin enough to clear strut using slide hammer and pin puller, Tool number 234581.

i. Lower the assembly from the wheel well.

NOTE: The wheel and brake may first be removed to lighten the assembly and will also give clearance to lower strut.

38. To Install an Oleo Leg

a. Reverse the procedure prescribed for removal. Be sure to install spacers at each end of the fulcrum and washers under the fulcrum pin nuts.

NOTE: Adjustment of these nuts requires special Tool No. 248853.

39. To Remove the Drag Links

a. Jack aeroplane at main planes.

b. Remove pin attaching drag strut to the links with Tool No. 248854.

c. Remove pin attaching actuating piston rod to the links with Tool No. 234572.

d. Remove the two screws from the inboard pivot retainer and the nut from the outboard pivot retainer.

e. Slide the links off the pivots.

40. To Remove the Fulcrum

a. Remove the oleo leg. See Para. 37, this section.

b. Remove the position indicator link.

c. Through the handholes in the outer skin remove the fulcrum pin nuts with Tool Number 248853.

d. Remove the fulcrum pin retaining bolts.

e. Withdraw the fulcrum pins using a slide hammer and fulcrum pin puller number 234581.

f. Lower the fulcrum from the wheel well.

41. To Remove the Main Gear Jack

a. Jack aeroplane from main plane.

b. Relieve hydraulic pressure by operating flaps.

c. Disconnect and plug the hydraulic pipe lines.

d. Detach the firewall seal at the firewall.

e. Remove the pin attaching the piston to the drag links.

f. Remove the elbow from the aft cylinder jack port.

g. Remove the nut attaching the clevis to the support bay.

h. Slide the jack aft to the firewall and drop as far as possible.

i. Remove the bolt attaching the jack to the clevis.

42. To Install the Gear Jack

a. Reverse the operations prescribed for removal.

b. For adjustment after installation see Section 4, Para. 20.

NOSE UNDERCARRIAGE

NOTE: It is not necessary to wing jack the aeroplane. Place pads on the ground to protect the skids on the lower fins and pull the tail down. Hold tail down by aft boom fittings, or distribute weights over the tail plane surface.

43. To Remove the Wheel (Follow the instructions given for removal of main wheels. Para. 35.)

NOTE: Special wrench No. 234579 is necessary for removal of axle nut.)

44. To Install the Wheel (Follow the same instructions as given for installation of main wheels. Para. 36., except that no brakes are provided in nose wheel.)

45. To Remove the Oleo-Leg

- a. Remove the nut and pin from the drag strut attachment.
- b. Support the assembly.
- c. Remove the diagonal side brace struts.
- d. Lower the assembly.

46. To Install the Oleo-Leg

- a. Reverse the operations described for removal being sure to install the keys in the fulcrum.

47. To Remove the Torque Lever Assembly

- a. Remove bolt connecting upper drag strut with lower drag struts, using special Tool No. 234572.
- b. Remove the three taper pins connecting the upper drag strut with the torque lever shaft (accessible from the wheel well).
- c. At Station 75 remove the inspection plate on the port side of the fuselage.
- d. Disconnect armament heater duct.
- e. Remove bolt connecting jack piston rod to torque lever arm.
- f. Remove torque lever shaft bearing from port web.
- g. Remove torque lever arm and shaft out through side of fuselage.

48. To Remove the Nose Fulcrum - (Same as given in Para. 40 of this Section with the following exceptions:)

- c. Tool number 234575.
- e. Fulcrum pin puller number 234582.

49. To Remove the Shimmy Damper

- a. Remove the axle, fork, and piston assemblies.
- b. Remove the damper retaining nut using Tool No. 225209.
- c. Slide the supporting bracket off the strut.

50. To Remove the Nose Gear Jack (See Fig. 6)

- a. Relieve the hydraulic pressure by operating the flaps.
- b. Remove lower port gun. See Para. 59.
- c. Remove gun charger cable pulley brackets.
- d. Disconnect hot air duct.

- e. Remove armament floor plates above gear jack.
- f. Remove web section above gear jack.
- g. Disconnect the torque lever arm from the piston rod.
- h. Disconnect the hydraulic lines from the gear jack.
- i. Through the wheel well remove gear jack trunnion nut.
- j. Remove the trunnion bolt and lift gear jack upward and out through the armament compartment.

51. To Install the Nose Gear Jack

- a. Reverse the procedure prescribed for removal.
- b. Adjust as prescribed in Section 4 Para. 28.

FUSELAGE AND CENTRE MAIN PLANE

52. The fuselage and centre main plane are jig mated at the factory, the portion of the fuselage located aft of the main spar is riveted to the centre main plane and the forward portion is attached with screws and bolts. The removal of the fuselage is not considered a service operation and will not be included in this manual.

53. To Remove Cockpit Sliding Panel

- a. Remove top canopy.
- b. Remove lower wing fillet to gain access to cables (See Sect. 4, Chap. 2, Fig. 2) and disconnect cable fittings from bracket on bottom edge of sliding panel.
- c. Remove sliding panel hand crank by removing pin through shaft.
- d. Remove cover plate over cable drum mechanism.
- e. Remove cable drum assembly.
- f. Remove bracket on bottom edge of sliding panel through hole made by removal of drum assembly.
- g. Remove retaining strip along aft edge of windshield and forward edge of sliding panel.
- h. Lift out sliding panel.

54. To Remove Cockpit Top Canopy

The top canopy is held in place by four sliding pins. The pins on the port side are operated by a shaft having handles on the interior and exterior of the cockpit. The pins on the starboard side normally serve as hinge pins for the canopy.

a. For emergency exit on early models all four pins are withdrawn by the lever on the starboard side which allows the canopy to blow away. This handle may be used to release the canopy for servicing.

b. On later models, removal of the canopy is accomplished by operating both port and starboard handles. Emergency release is effected by operating a vertical lever located on the starboard side of the fixed windshield frame. This emergency release lever is wired in locked position and should never be used to remove the canopy in normal service.

55. To Remove Rear Cockpit Enclosure

- a. Remove antenna attachment on frame and disconnect lead-in through enclosure.
- b. Remove screws from retainers and rear cockpit enclosure all the way around.
- c. Lift all rear enclosures.

56. To Remove Centre Plane Flaps - (Removal and assembly operations for the centre plane flaps are the same as described for the outer plane flaps in this sections, Par. 5.)

57. To Remove the Rudder Pedals

- a. Disconnect the rudder pedals.
- b. Disconnect the brake rods.
- c. Disconnect the walking beam links.
- d. Remove the bolts attaching the bearing supports to the fuselage and to the centre bracket.

NOTE: The bearings in the pedals and in the bearing supports are packed with grease at assembly and require lubrication only at the time of overhaul.

58. To Remove the Control Column

- a. Remove the leather boot.
- b. Remove the panel in the wheel well web.
- c. Disconnect the control cables.
- d. Disconnect the electrical conduit.
- e. Remove the bolts attaching the pivot bearing housings to the fuselage and lift the column out.

59. To Remove the Machine Guns

- a. Unplug the electrical conduits from the firing solenoid and the contactor. Stow the conduits in their retainers if the gun is to be left out.

NOTE: Stowage brackets are provided for each firing solenoid in case it is desired to remove them from the guns.

- b. Disconnect the link ejection and ammunition feed chutes at their quick release fittings.
- c. Disconnect the charging cable at its quick detachable coupling.
- d. Release the collars on the mounting trunnion and the rear mounting post.

NOTE: If the gun is to be left out of the aeroplane, the detachable parts of the trunnion and the rear post should be removed from the gun and re-installed on the mounts.

- e. Move the gun aft until it clears the fixed blast tube and lift out of the aeroplane.

60. To Remove the Alternate .50 Cal. Machine Gun

- a. Follow the procedure outlined in Para. 59 (a) through (d).
- b. Remove the machine gun blast tube.
- c. Move gun forward and lift out of aeroplane.

61. To Remove the 20 MM Cannon

- a. Remove the cannon ammunition box by releasing the box from the feed chute and rolling it out on the starboard side.

- b. Disconnect the link ejection chute from the Chatellerault feed.
- c. Remove the Chatellerault feed and feed chute together from the aeroplane.

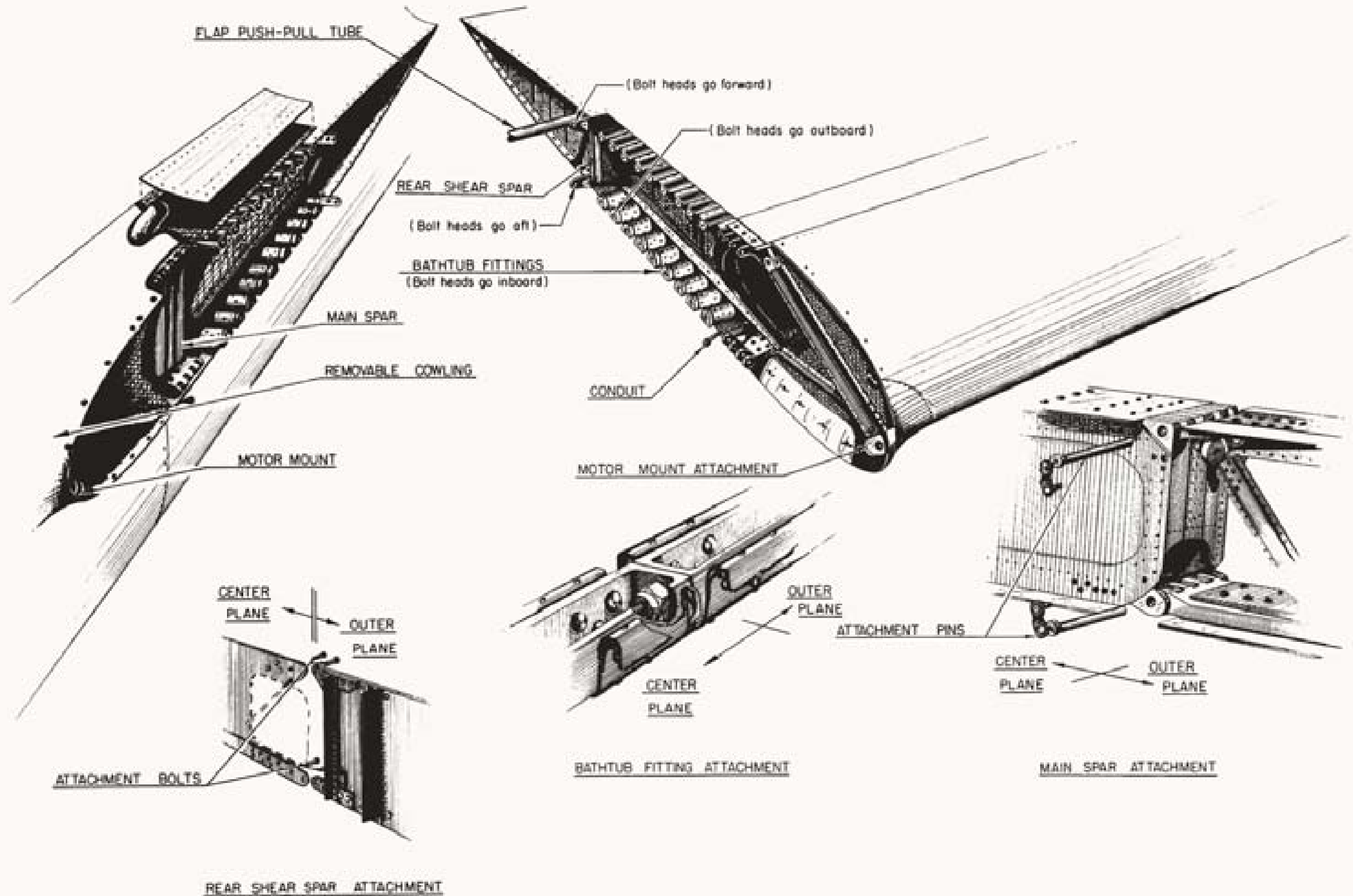
NOTE: Steps "a", "b" and "c" apply to installation with 150 round ammunition box. If 60 round magazine is installed, it may be removed by releasing the latch on the cannon at the rear end, tilting the magazine forward and sliding aft and up out of the aeroplane.

- d. Disconnect the hydraulic charging line from the gun at the self-sealing release fitting.
- e. Release the trigger motor firing mechanism from the gun and stow.

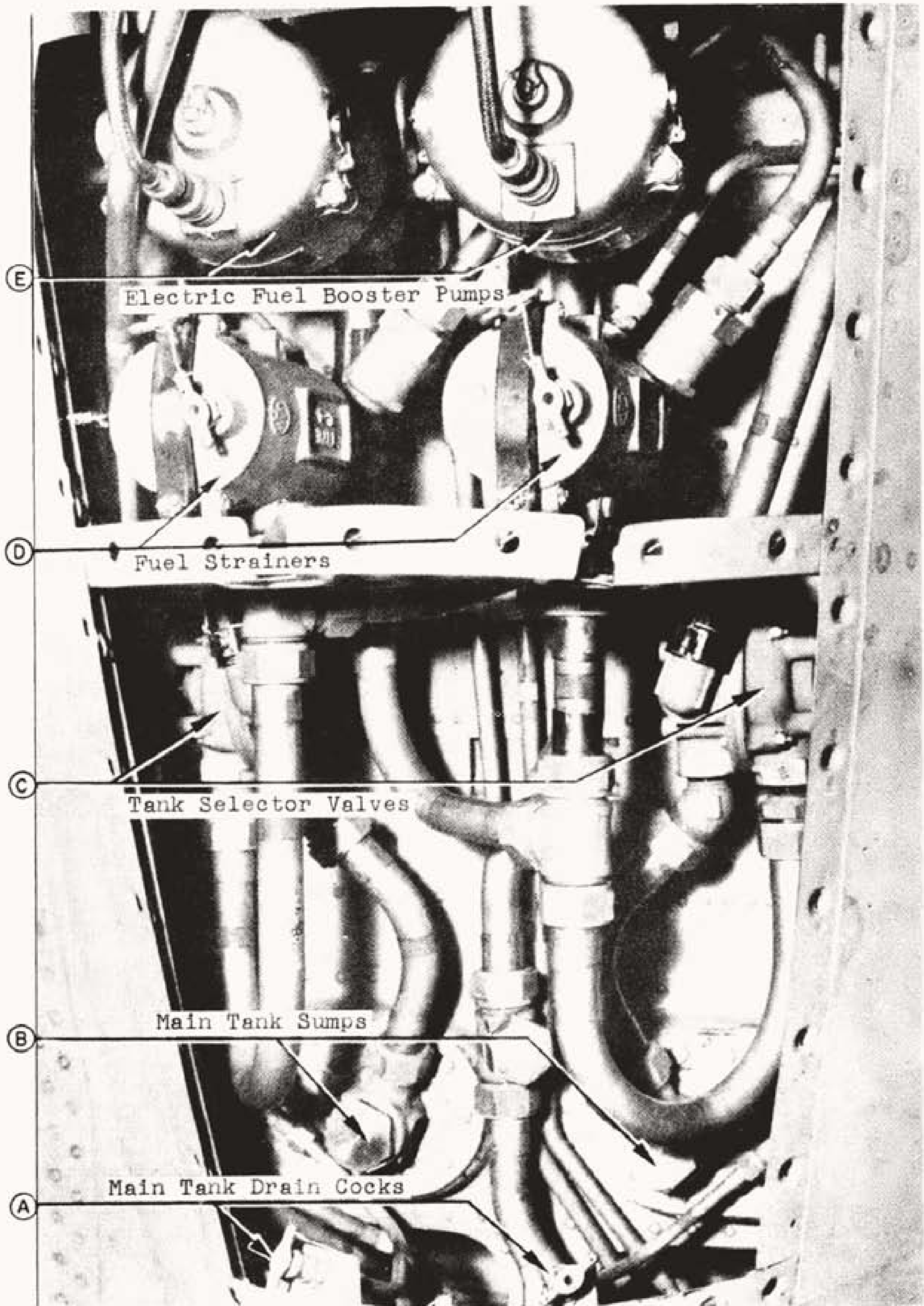
NOTE: Do not disconnect the hydraulic line from the trigger motor.

- f. Remove the cannon blast tube seal.
- g. Remove the upper machine gun link ejection chutes.
- h. Release the front cannon support fitting through the cannon blast tube opening.
- i. Release the pressure clamp at the trunnion support.
- j. Remove the cannon by rolling it out through the blast tube opening on the track provided.

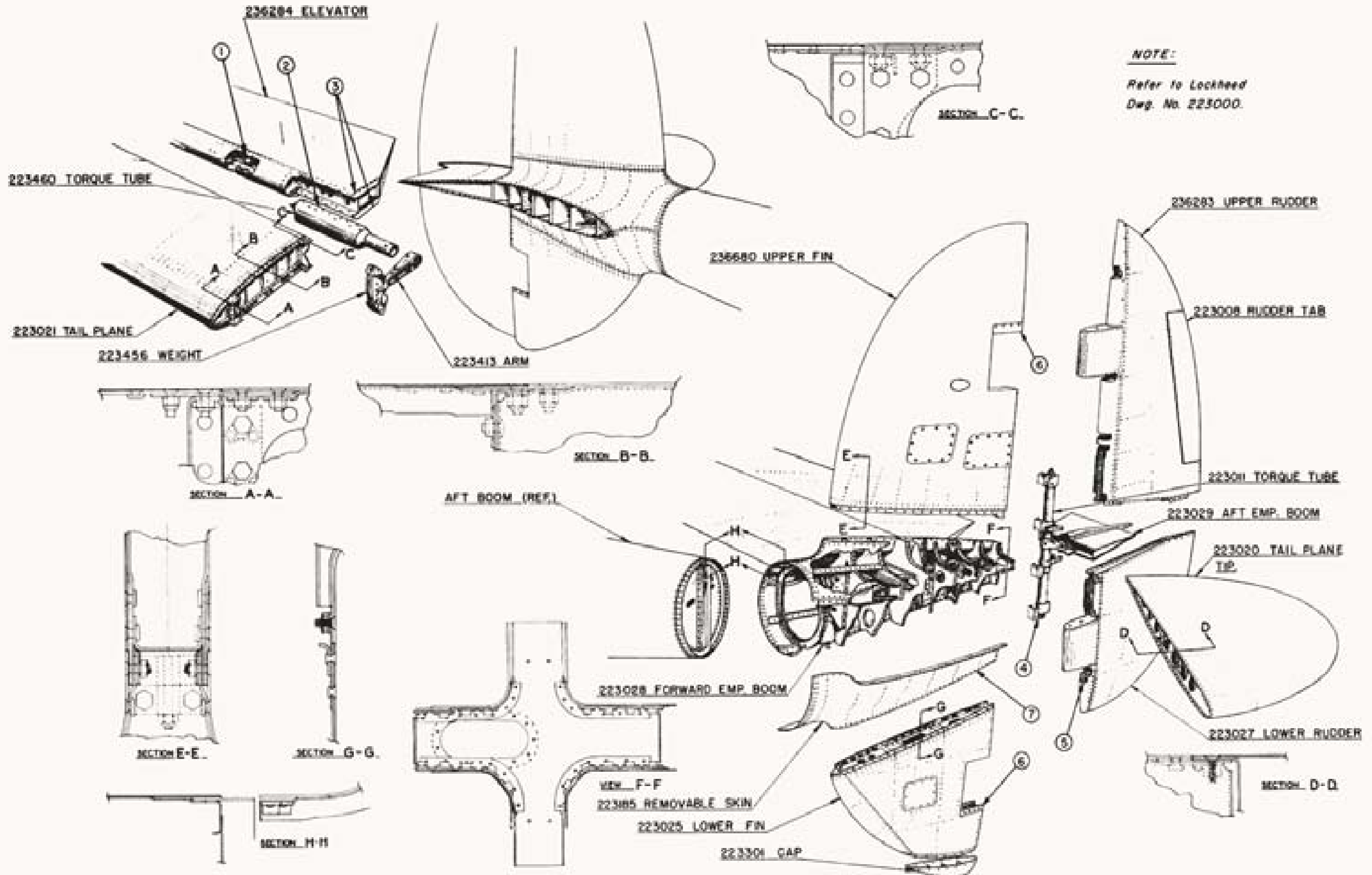
CAUTION: Care should be used when removing or installing the cannon in order to prevent damaging the machine gun parts or aeroplane structure.



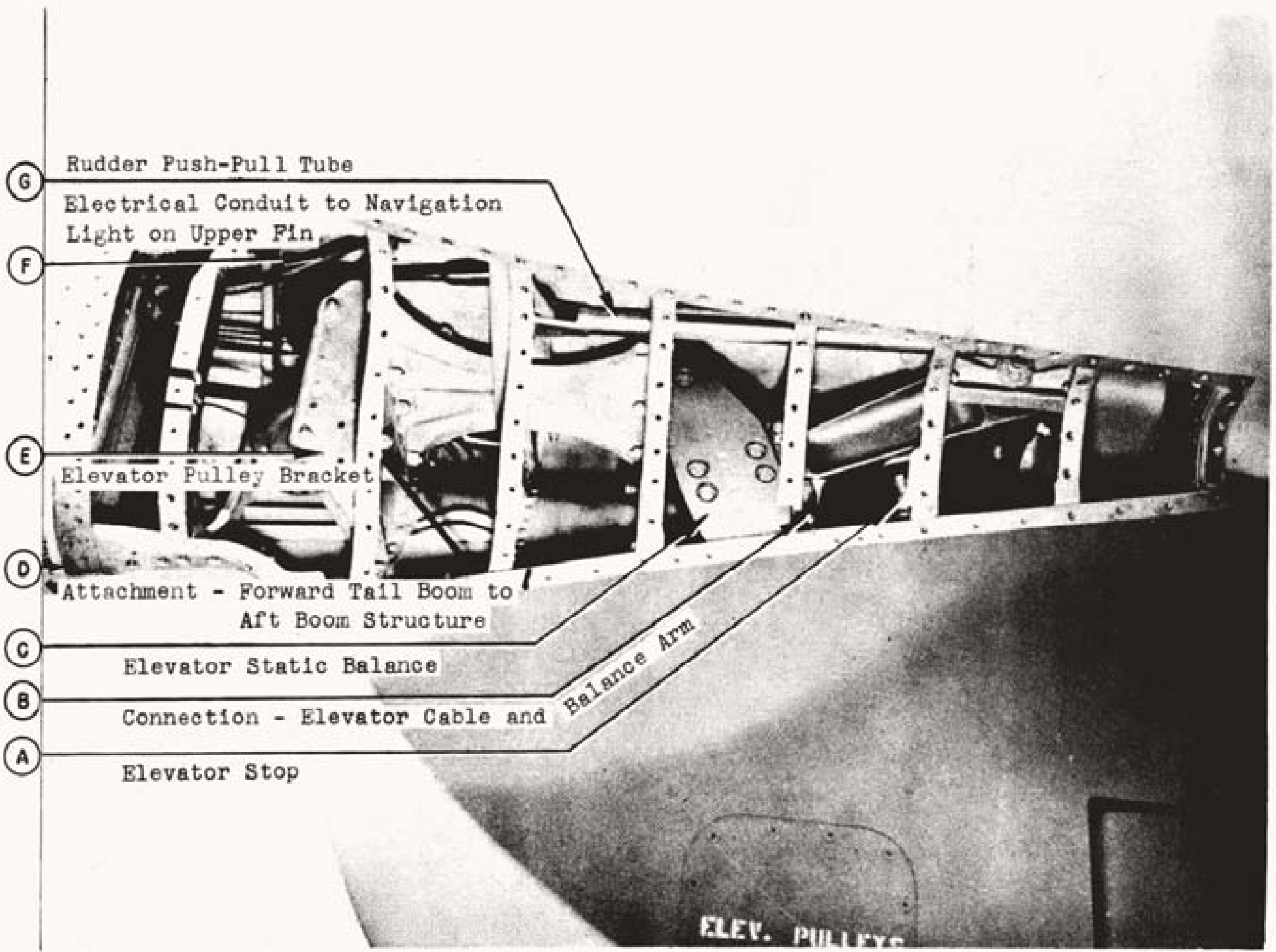
ATTACHMENT - OUTER MAIN PLANE TO CENTER PLANE



FUEL SYSTEM INSTALLATION - AFT FUSELAGE



NOTE:
 Refer to Lockheed
 Dwg. No. 223000.



G Rudder Push-Pull Tube
 F Electrical Conduit to Navigation Light on Upper Fin

E Elevator Pulley Bracket

D Attachment - Forward Tail Boom to Aft Boom Structure

C Elevator Static Balance

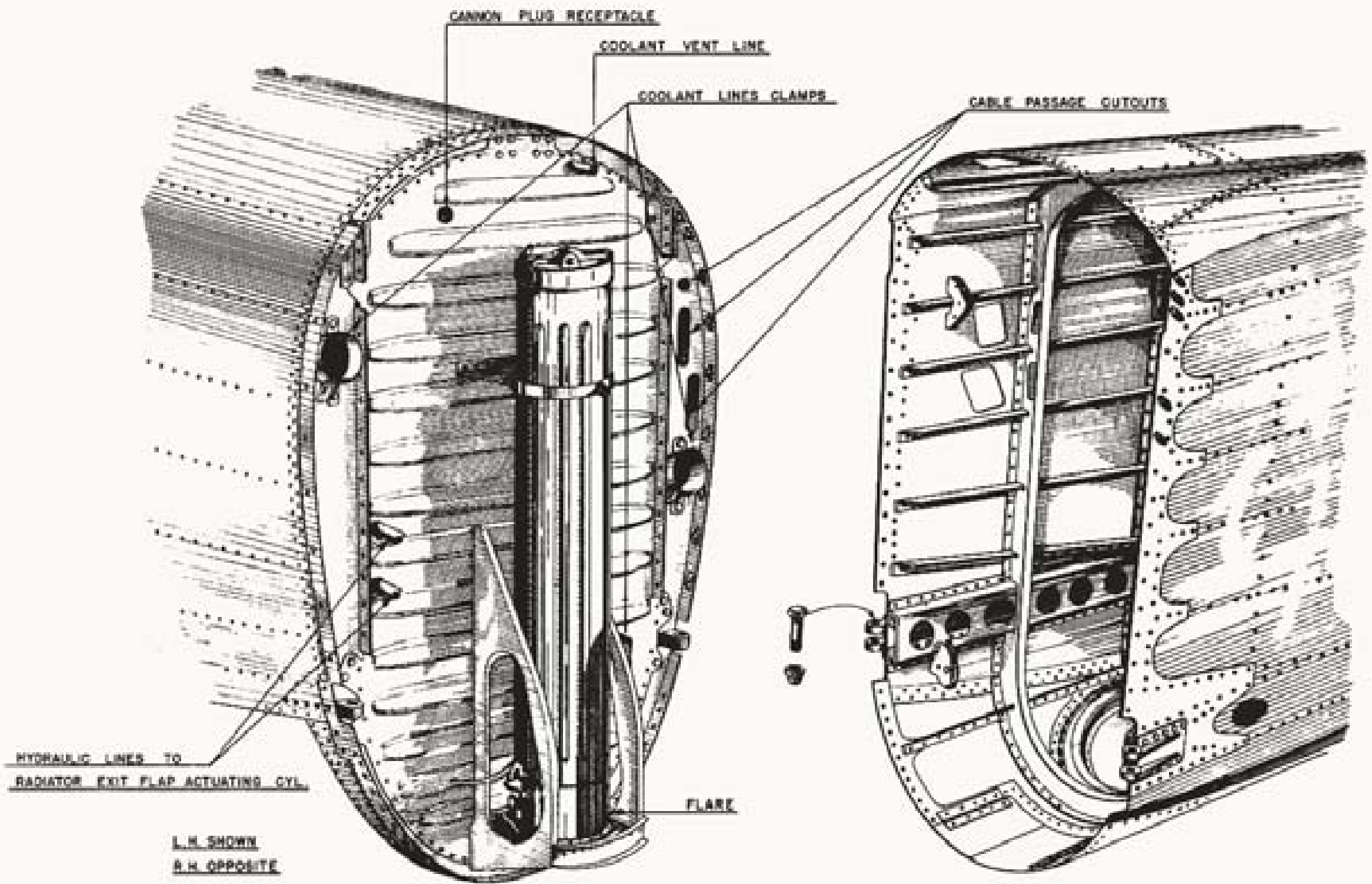
B Connection - Elevator Cable and

A Elevator Stop

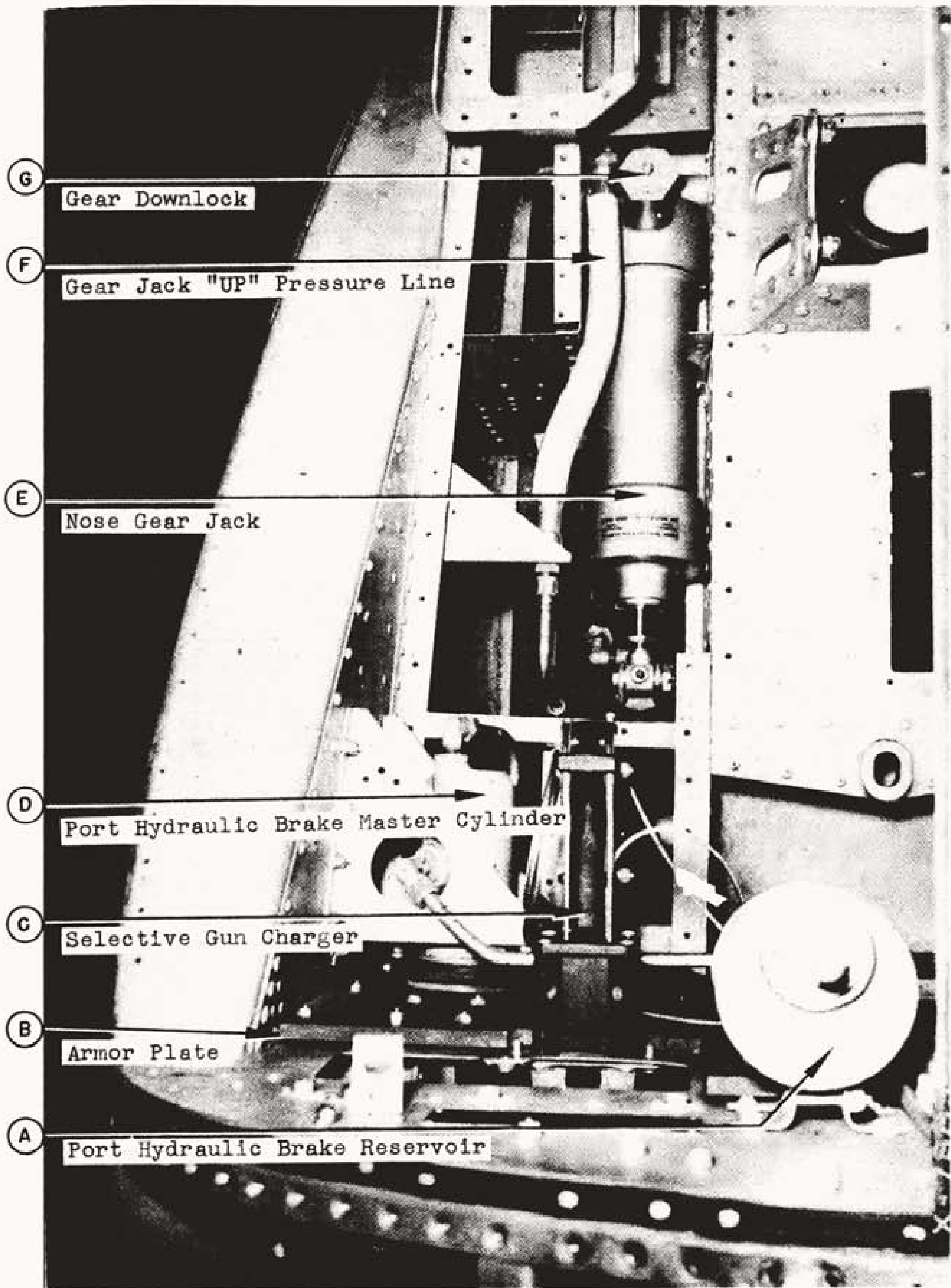
Balance Arm

ELEV. PULLEYS

FORWARD TAIL BOOM - LOWER QUADRANT OF SKIN REMOVED



BOOM JOINT AT STATION 265



NOSE GEAR JACK INSTALLATION — FUSELAGE

SECTION 6
ELECTRICAL INSTALLATION
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SECTION 6

ELECTRICAL INSTALLATION

1. General - The electrical system is of the single-wire type, with the aircraft skin and structure serving as earth. Rockbestos Aircraft Cable (600 volt, low tension copper conductor) is used throughout, installed in solid and flexible conduit. Cannon plug connectors are used at appropriate points in the system to facilitate disassembly.

2. Electrical power is supplied by an Exide 12TAS9A, 34 ampere hour, 24 volt accumulator connected in parallel with an Eclipse 314MOD5 generator which is mounted on the port engine. The accumulator is mounted in the baggage compartment in the port aft boom. The generator control box (in the port wheel well) contains an Air Ministry type E-1 accumulator plug-in socket, for connection to an auxiliary external power supply when the airplane is on the ground. The junction box locations, shown on Figure 3, are accessible through the removable panels shown in Figures 1 and 2, Section 4, Chapter 2.

3. Electrical Equipment - The following equipment is operated by the electrical system. See wiring diagram for types of equipment. For service and maintenance instructions see the vendors manuals except as noted below:

- a. Airscrew and airscrew filter (see Section 8 and relevant airscrew manual).
- b. Airscrew governor (see Section 8 and airscrew manual).
- c. Airscrew selector, feathering and safety switches (see Section 8 and airscrew manual).
- d. Starters (See Section 8 and Eclipse manual).
- e. Booster coils (see Eclipse manual).
- f. Oil cooler exit flap operators - The oil cooler exit flaps are operated by Dumore type El-Y motors which are controlled from the cockpit by switches. Each operating mechanism also includes a G.E. transmitter which is connected to a dual indicator on the instrument panel. Cannon plugs at the operator and indicator facilitate disconnection. Cam operated micro-limit switches automatically shut off the motors at the full open and closed positions of the flaps. Clearance between the cam and the switch should be $.031 \pm .010$.
- g. Carburettor air temperature bulbs and indicators.
- h. Coolant temperature bulbs and indicators.
- i. Ignition system - Scintilla dual magnetos are installed on the engines. The cables from the magnetos to the switches can be broken at Station 67 at a plug which automatically earths the magnetos when it is disconnected. The ignition switch contains a master switch which operates the accumulator solenoid, and two selector switches which close the magneto circuits.
- j. Auxiliary fuel pumps (see Section 8).
- k. Free air temperature indicator.
- l. Tachometer generators and indicators.
- m. Pitot tube heaters.
- n. Undercarriage and flap position transmitters and indicators.
- o. Fuel quantity gauge transmitters and indicators (see Section 8).
- p. Undercarriage warning horn and light (see Section 7, Chap. 6).
- q. Cockpit fluorescent lights, including inverter (see Paragraph 4 following).
- r. Flight instrument lights - The directional gyro and gyro-compass are illuminated by rim lights operated by a switch on the main box.
- s. Operating lights.

(1) Navigation lights: Are installed in the upper and lower surfaces of each outer

plane tip and on the outboard side of each vertical fin. They are controlled by a switch on the control column.

(2) Landing Lights: A retractable type landing light assembly is installed in each outer plane. The switch is mounted on the control column.

(3) Identification Lights: A downward identification light is located in the starboard outer plane lower surface just inboard of the landing light, and an upward light is installed in the canopy aft of the pilot. The lights are operated by a key (type BAM 50/372) in the cockpit.

(4) Gun blinkers: A light on the instrument panel is connected so that it flashes each time a machine gun is fired. A switch is provided on the main switch box to make the lights inoperable.

(5) Formation keeping light: A formation keeping light is installed in the canopy aft of the pilot and is controlled by a rheostat on the web junction box.

t. Oil dilution solenoid (see Section 8).

u. Armament switches and firing solenoids (see Section 11).

v. Gun camera controls and heater.

w. Throttle switches - A switch operated by a pin on the throttle control pulley closes the circuit of the undercarriage warning horn in case the throttles are closed while the undercarriage is retracted. The switch should be adjusted to close the circuit when the throttle is 1/4 inch from the closed position.

4. Fluorescent Lighting - The instrument panel in the cockpit is illuminated by two fluorescent ultra-violet lamps located on the control column. The intensity of ultra-violet light may be varied by rotating the shutter knobs; visible light is also available by turning the outer lamp housing. The lamps operate on 110 volt A.C. which is supplied by an inverter from the 24 volt system in the airplane.

The inverter is of the vibrator type (Electronic Type S-664, Electronics Laboratories, Inc.). The vibrator element, operated by an energizing coil in the D.C. supply circuit, produces pulsating D.C. which is transformed to 110 volts A.C. by a transformer of the leakage reactance type. The transformer functions also as a lamp reactor. Radio interference is reduced by filters for both radio and audio frequencies; however, flexible conduit is used on the input and output lines to eliminate interference more completely. Three volt A.C. is also available from the inverter, but is not used in the present installation.

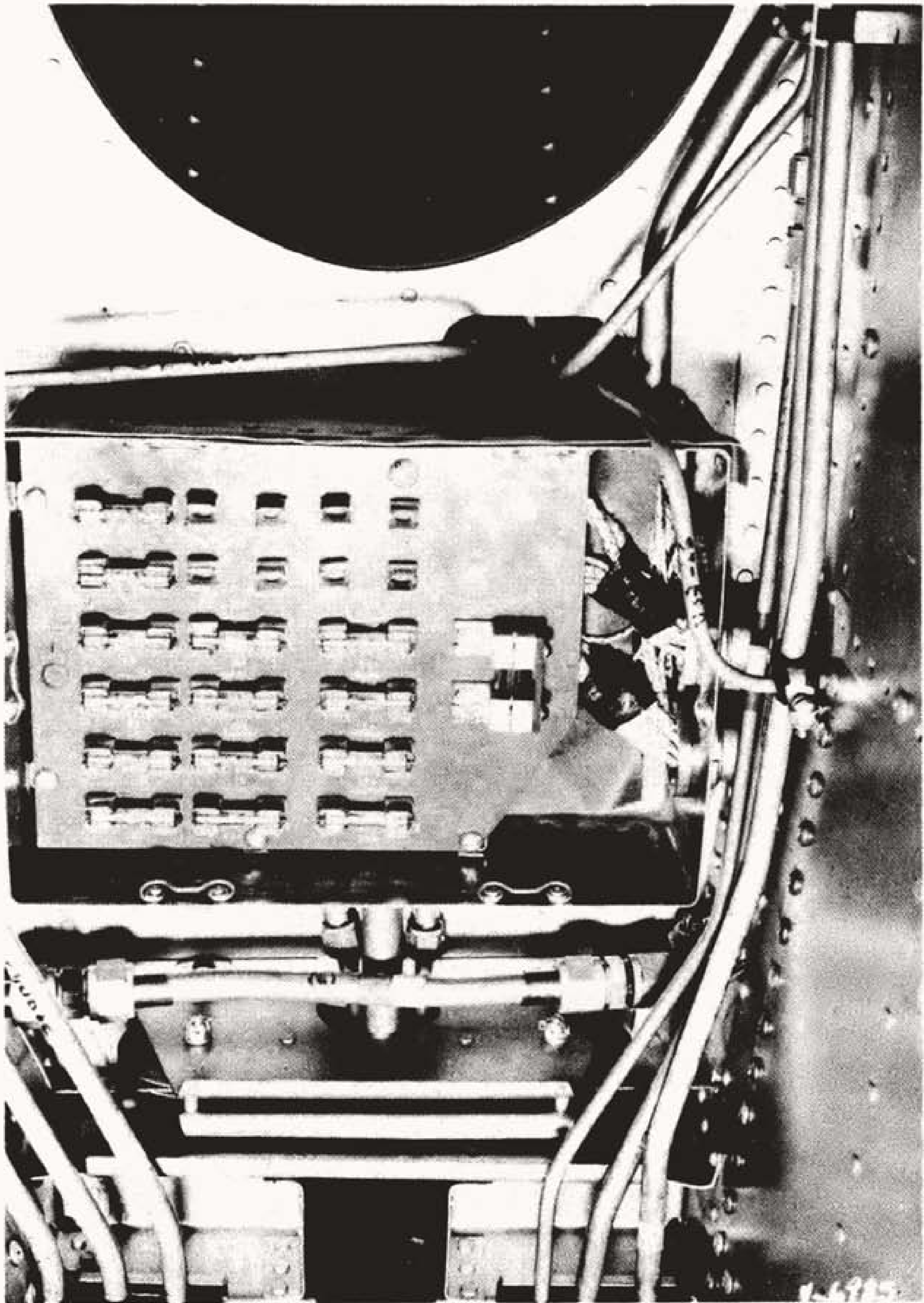
The lighting system should be inspected at the end of 250 hours of operation of the system. The lamps and starting switch should be checked for satisfactory operation. The inverter output should be checked. The vibrator fuses, and all soldered joints and leads should be inspected.

After 500 hours operation of the lighting system, the lamps should be replaced, and the starting switch changed if its action is sluggish. The vibrator in the inverter should also be replaced.








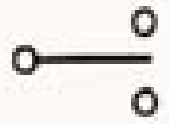







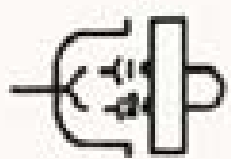







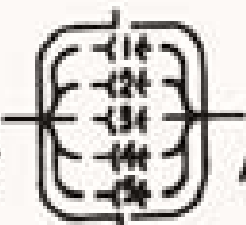

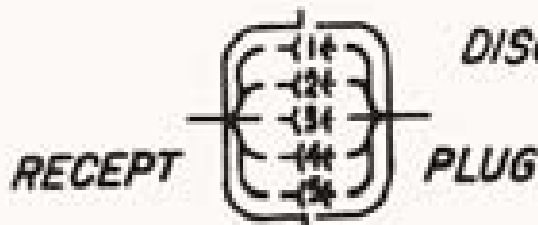

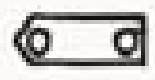
In case the lamps or circuit or both are inoperative, the following probable causes should be investigated.

- (1) Fuses blown.
- (2) Vibrator not clamped in socket.
- (3) Poor connections.
- (4) Defective vibrator.
- (5) Improper connections (see circuit diagram).
- (6) Insufficient accumulator voltage.

5. Electrical Circuits - All circuits are shown in the wiring diagrams which follow. The numbers on the junction and terminal boxes on the circuit diagrams correspond to those on Figure 3, which shows the location of the boxes in the airplane. The wire numbers on the diagrams correspond to those on the wires themselves and to those on the main electrical diagram which is furnished with the airplane. All switches, fuses, connectors, boxes, etc., are shown schematically on the drawings, using the symbol code given in Figure 2. The complete electrical wiring diagram is shown on drawing No. 246003.



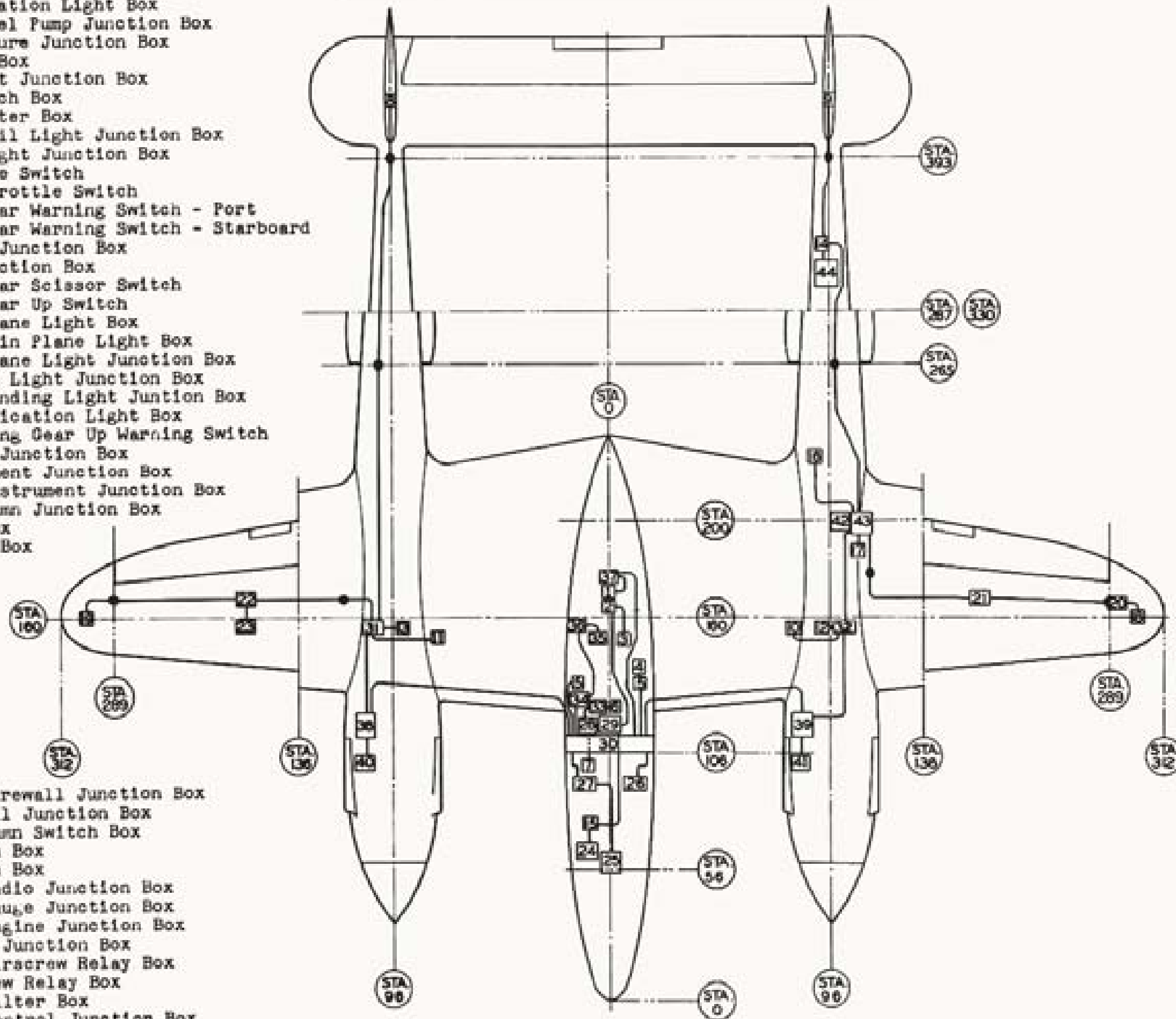
MAIN FUSE PANEL
- 127 -

	CAPACITOR (FIXED)		SWITCH (STD. "ON & OFF")
	FUSE		SWITCH (MOMENTARY "ON")
	MOTOR (D.C.)		SWITCH (STD. "ON" "OFF" & MOM. CONTACTS)
	LAMP (INITIAL FOR COLOR)		SELECTOR SWITCH (STD. "ON" "OFF" & "ON" CONT.)
	BUS		TRIGGER SWITCH OR KEY
	VOLTMETER		TERMINAL
	AMMETER		GROUND CONNECTION
	RELAY		TEMPERATURE RESISTANCE BULB
	SOLENOID		REVERSIBLE MOTOR
	COIL		BOX - NUMBER INDICATES TITLE
	RESISTOR		SHUNT
	RHEOSTAT		DISCONNECTOR
	RHEOSTAT		RECEPT PLUG
	ACCUMULATOR		
	PITOT		

ELECTRICAL SYMBOLS

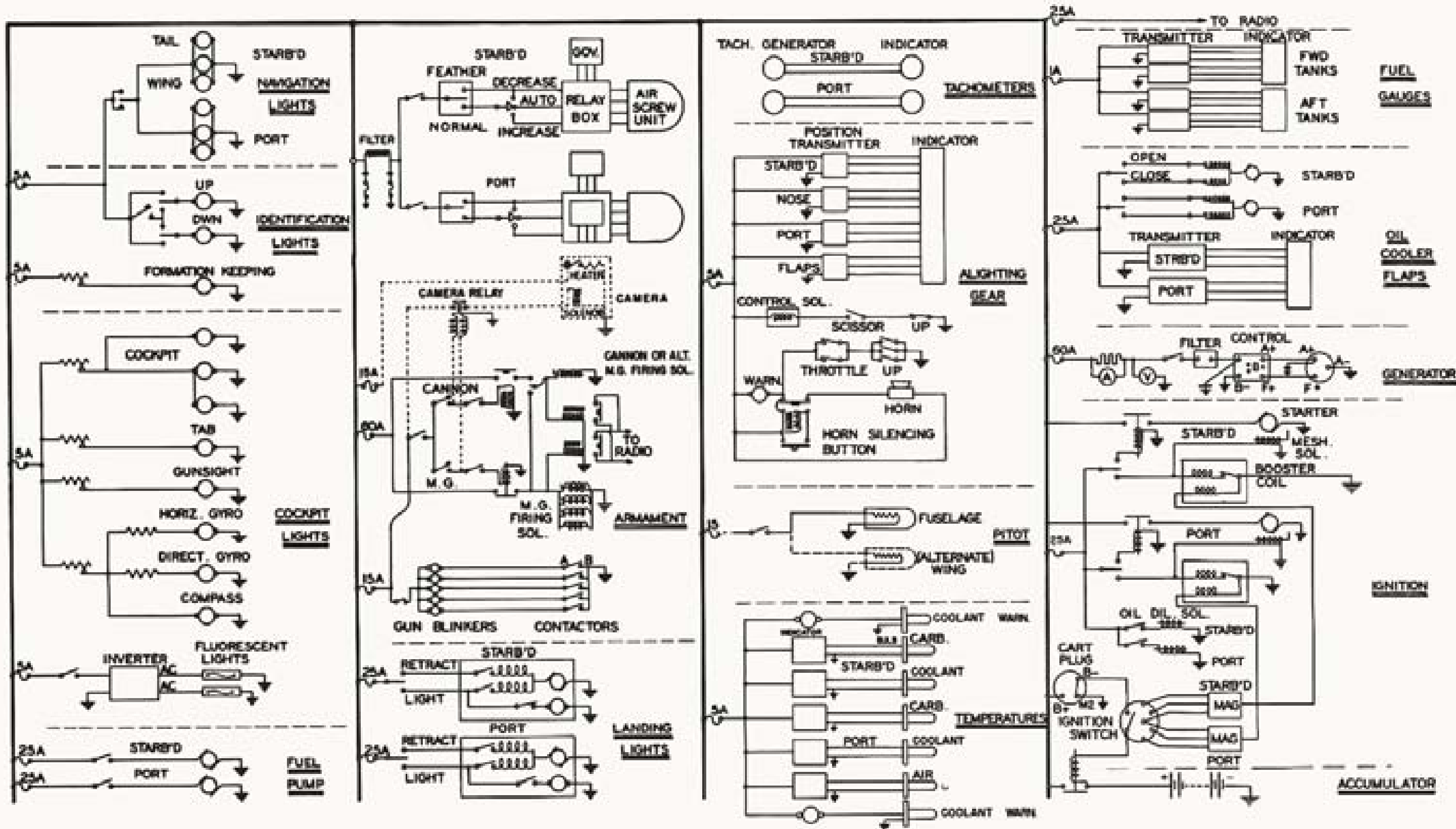
A.P. 2021 A VOL. I SECT. 6 FIG. 3

1. Up Identification Light Box
2. Auxiliary Fuel Pump Junction Box
3. Air Temperature Junction Box
4. Fuel Switch Box
5. Cockpit Light Junction Box
6. Trigger Switch Box
7. Airscrew Filter Box
8. Starboard Tail Light Junction Box
9. Port Tail Light Junction Box
10. Port Throttle Switch
11. Starboard Throttle Switch
12. Alighting Gear Warning Switch - Port
13. Alighting Gear Warning Switch - Starboard
14. Accumulator Junction Box
15. Inverter Junction Box
16. Alighting Gear Scissor Switch
17. Alighting Gear Up Switch
18. Port Main Plane Light Box
19. Starboard Main Plane Light Box
20. Port Main Plane Light Junction Box
21. Port Landing Light Junction Box
22. Starboard Landing Light Junction Box
23. Down Identification Light Box
24. Nose Alighting Gear Up Warning Switch
25. Machine Gun Junction Box
26. Port Instrument Junction Box
27. Starboard Instrument Junction Box
28. Control Column Junction Box
29. Main Fuse Box
30. Main Switch Box

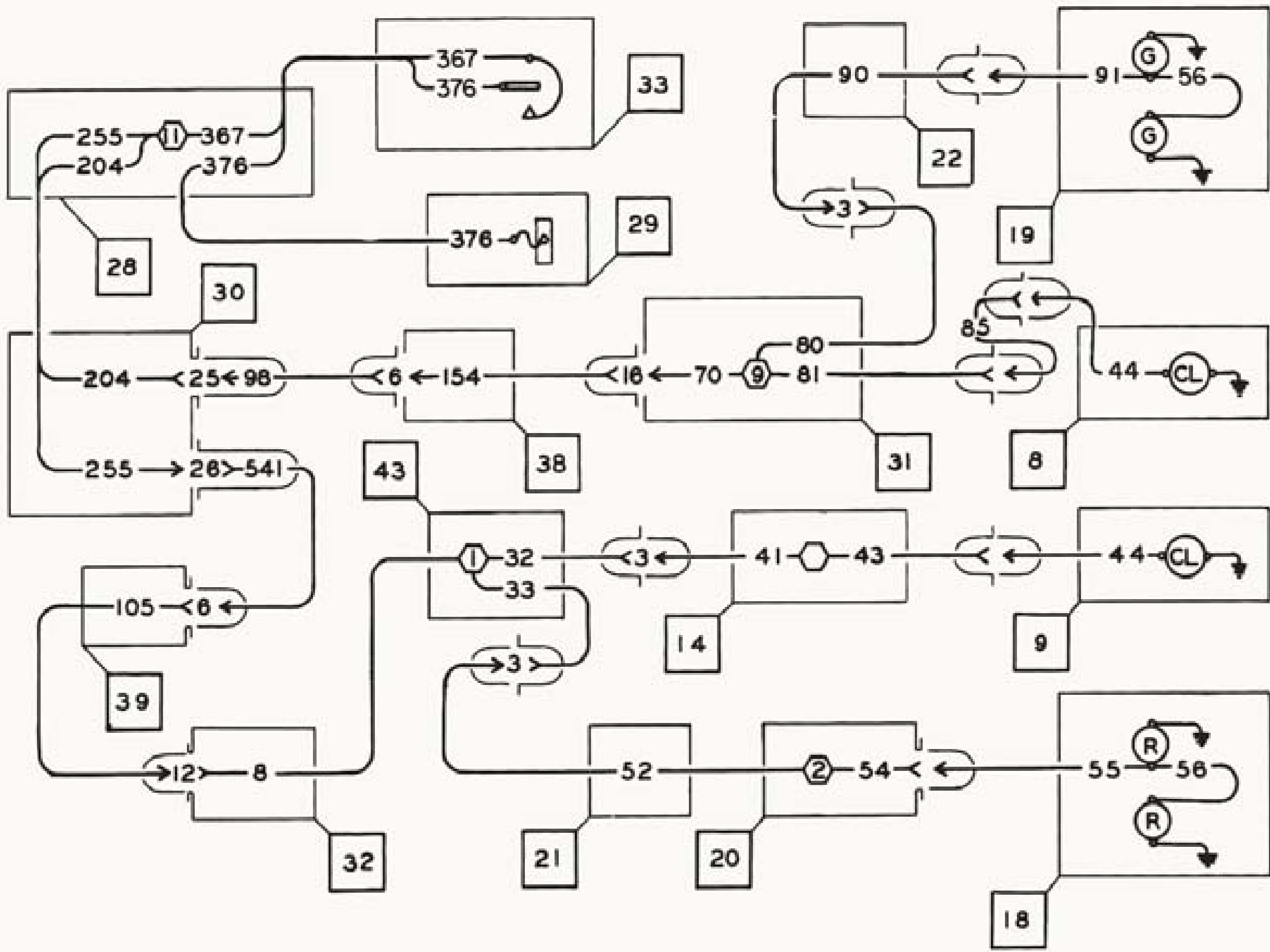


31. Starboard Firewall Junction Box
32. Port Firewall Junction Box
33. Control Column Switch Box
34. Web Junction Box
35. Warning Horn Box
36. Main Beam Radio Junction Box
37. Rear Fuel Gauge Junction Box
38. Starboard Engine Junction Box
39. Port Engine Junction Box
40. Starboard Airscrew Relay Box
41. Port Airscrew Relay Box
42. Generator Filter Box
43. Generator Control Junction Box
44. Accumulator Box

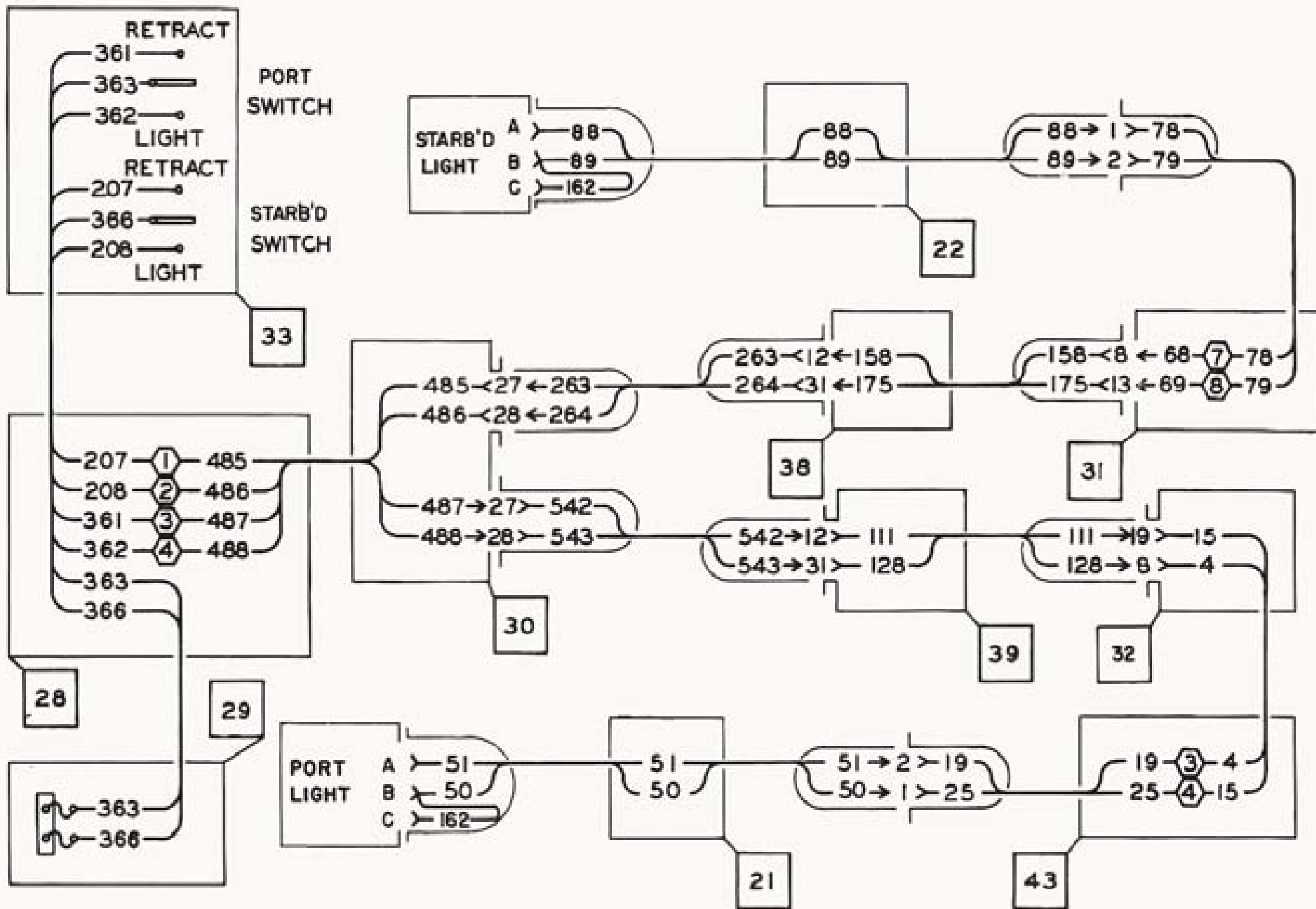
LOCATION DIAGRAM



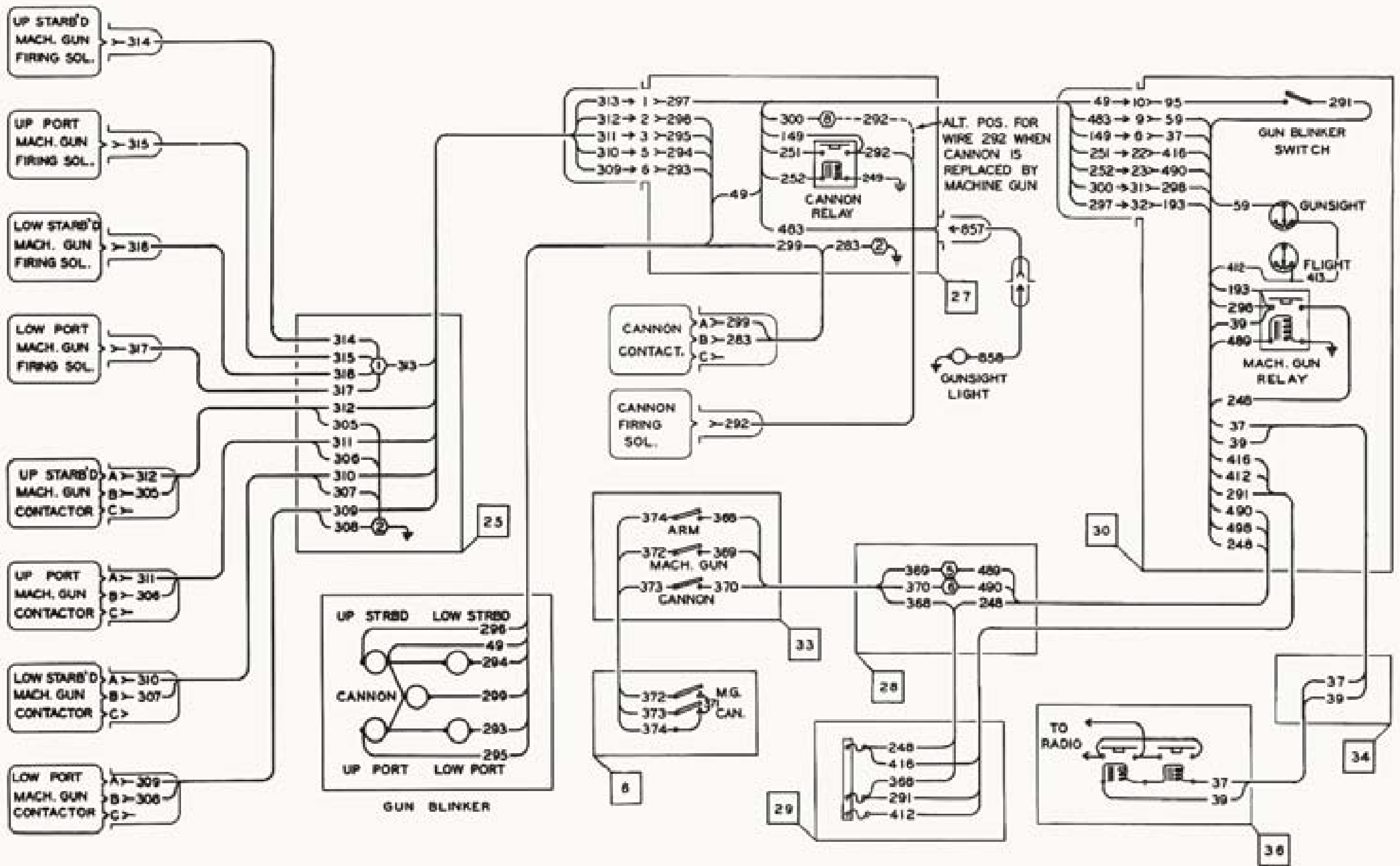
SCHEMATIC DIAGRAM OF ELECTRICAL CIRCUITS



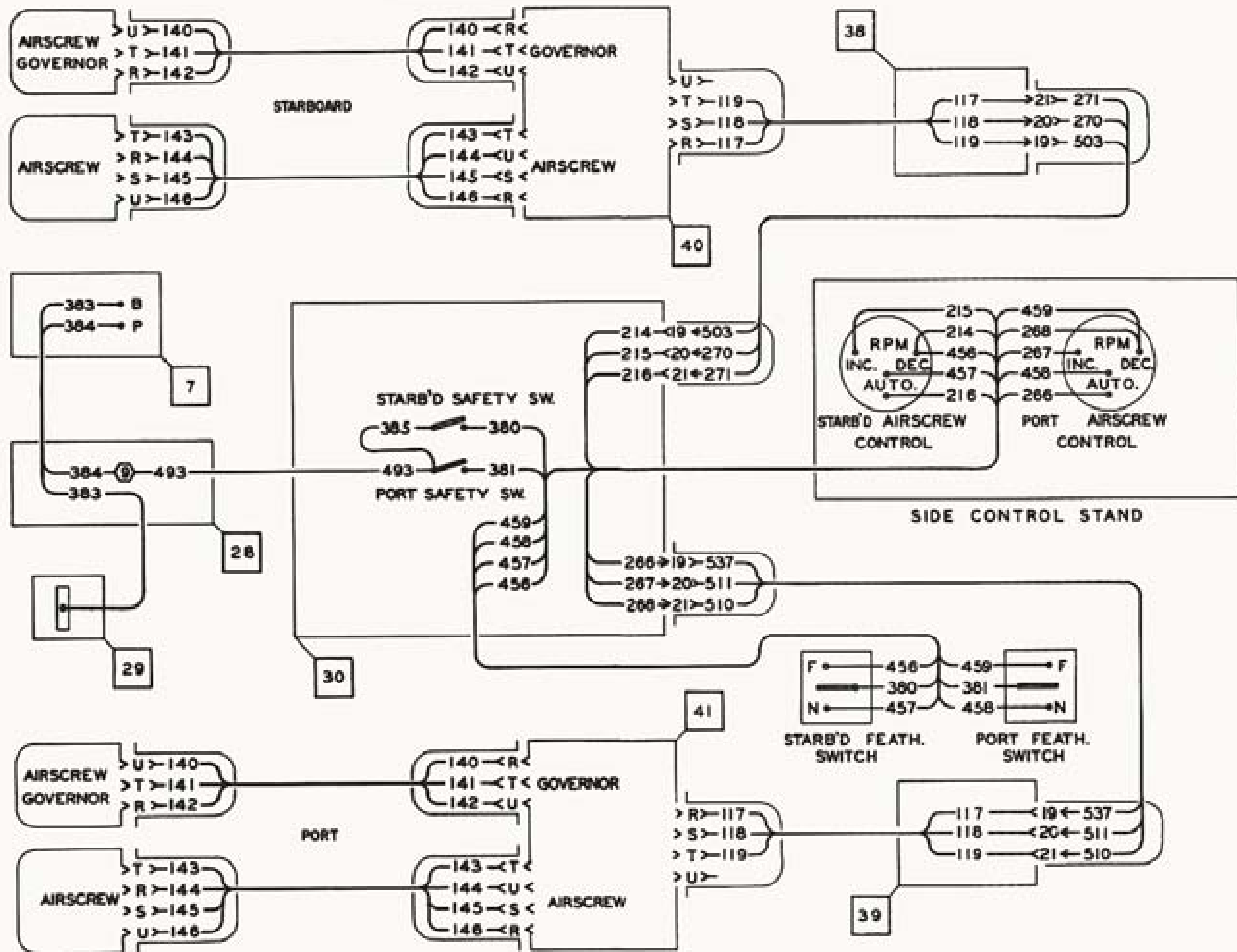
NAVIGATION LIGHTS CIRCUIT



LANDING LIGHTS CIRCUIT

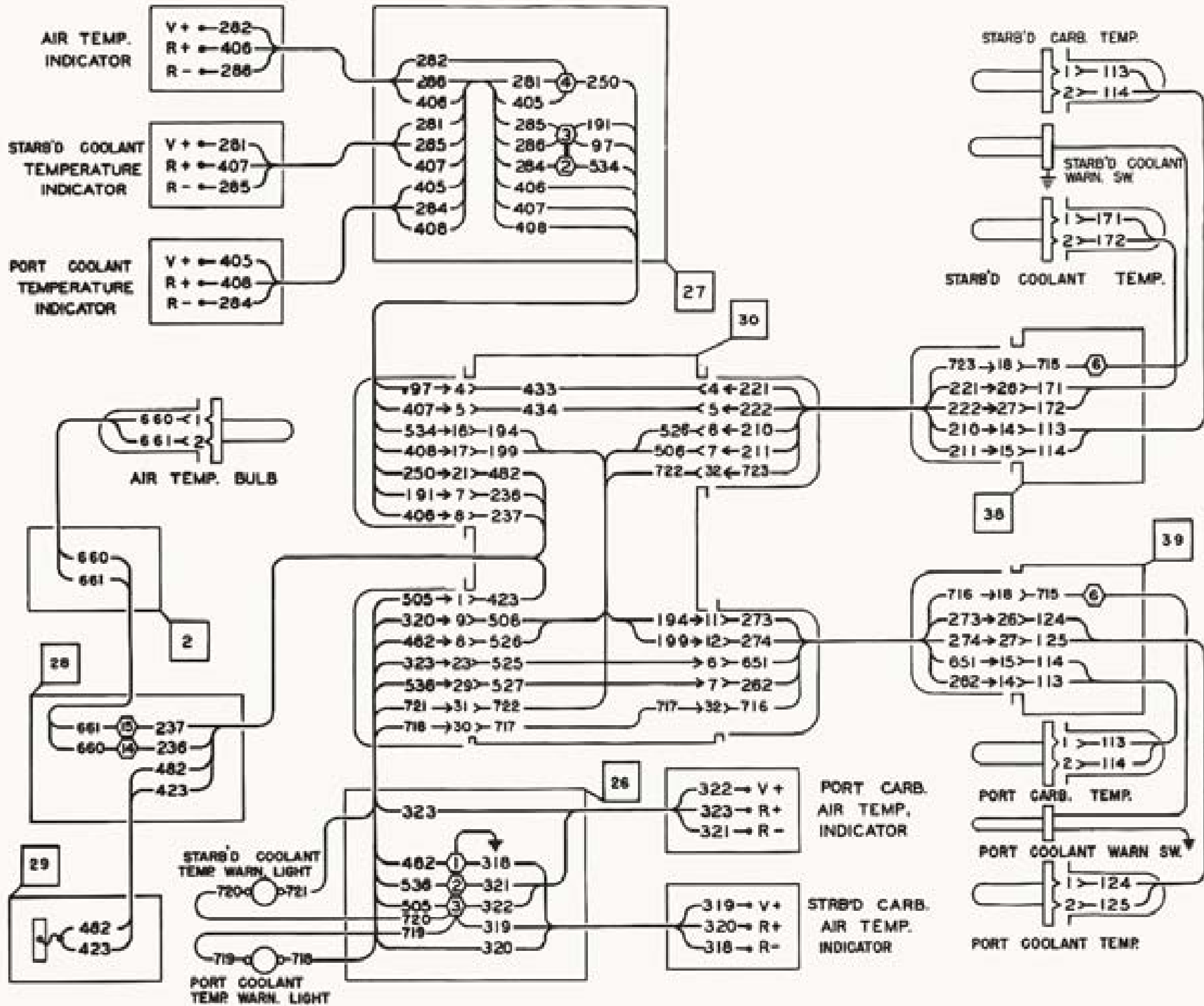


ARMAMENT CIRCUIT

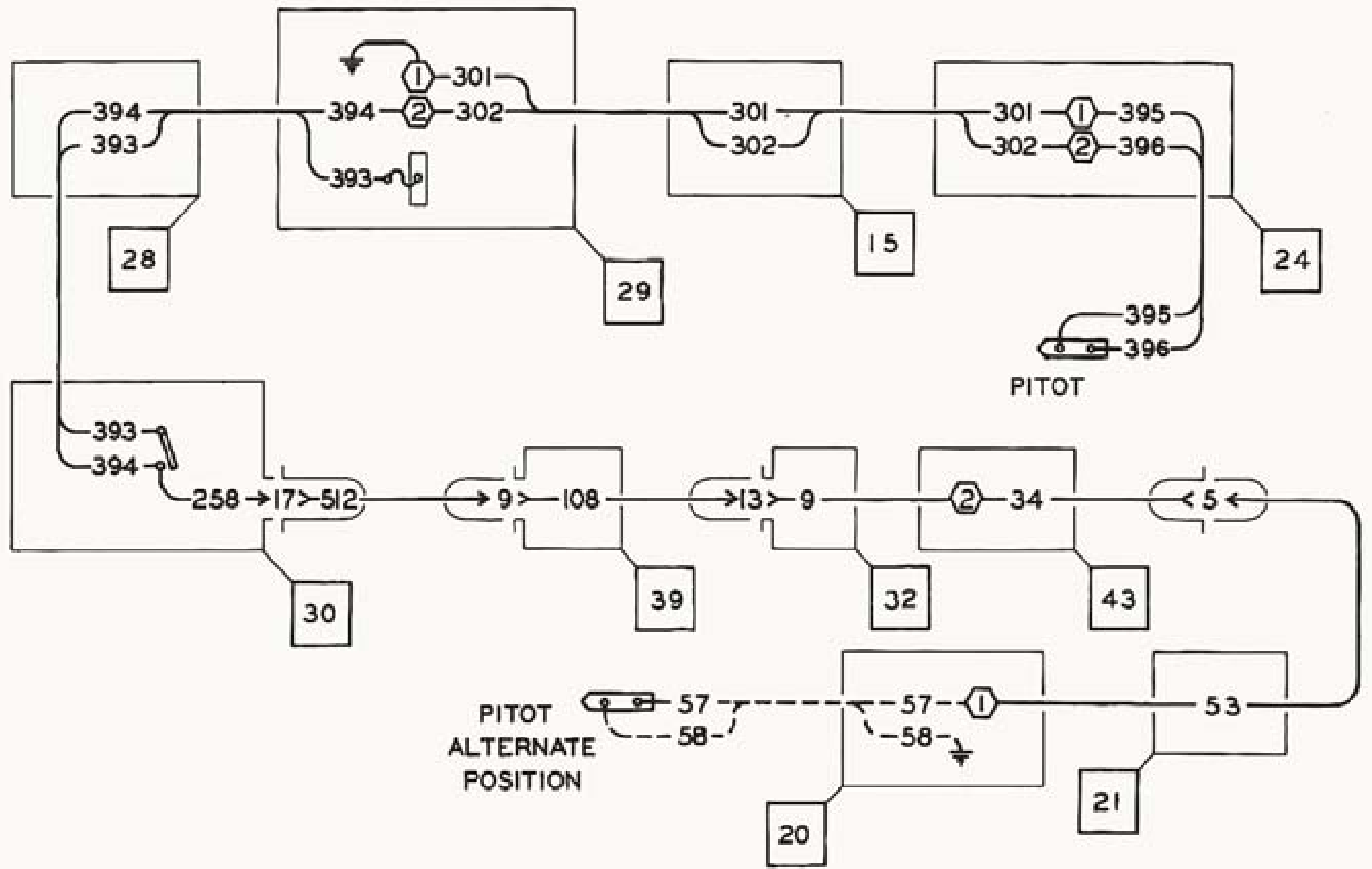


AIRSCREW CONTROL CIRCUIT

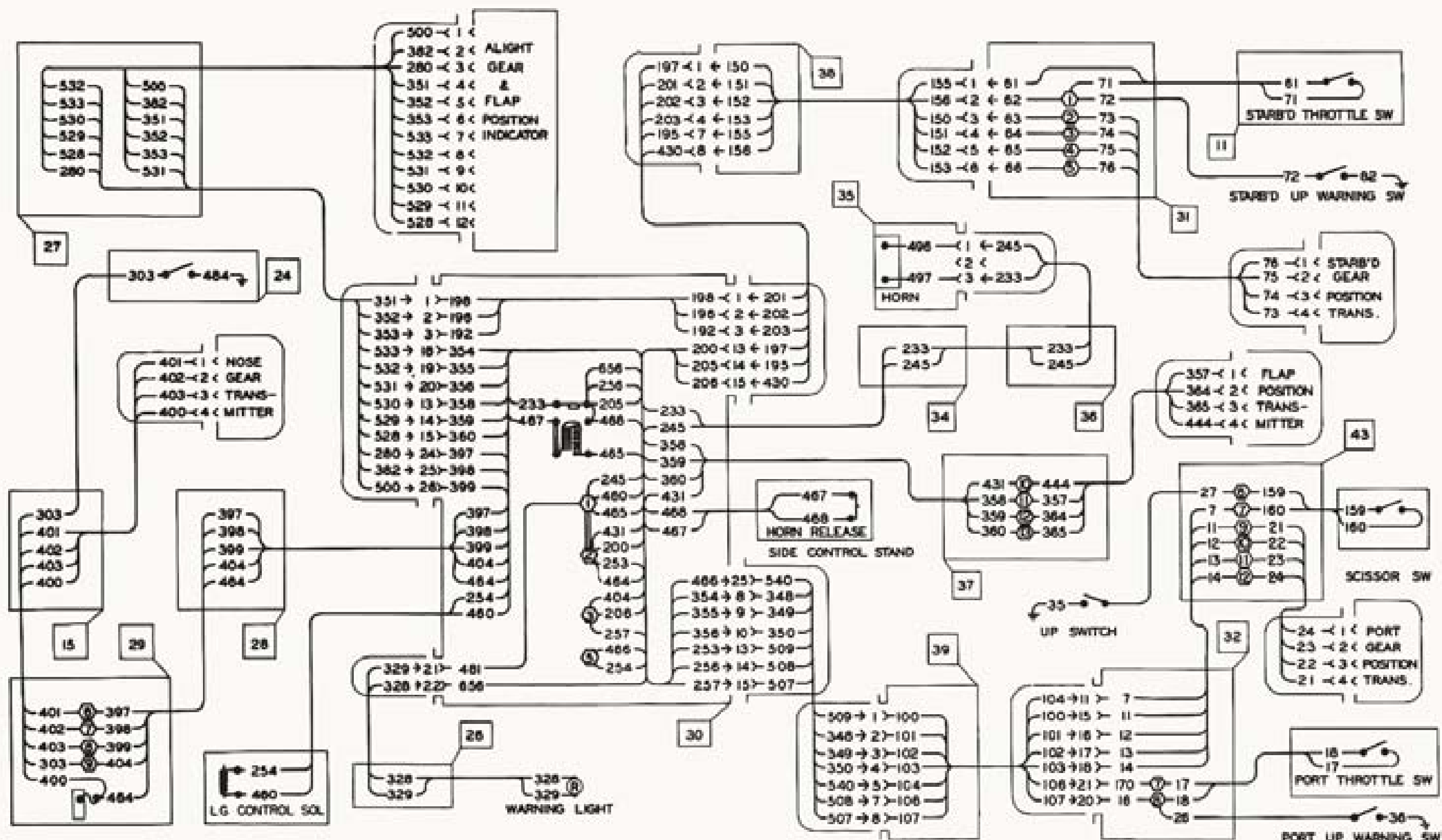
A.P. 2021 A VOL. I SECT. 6 FIG. 9



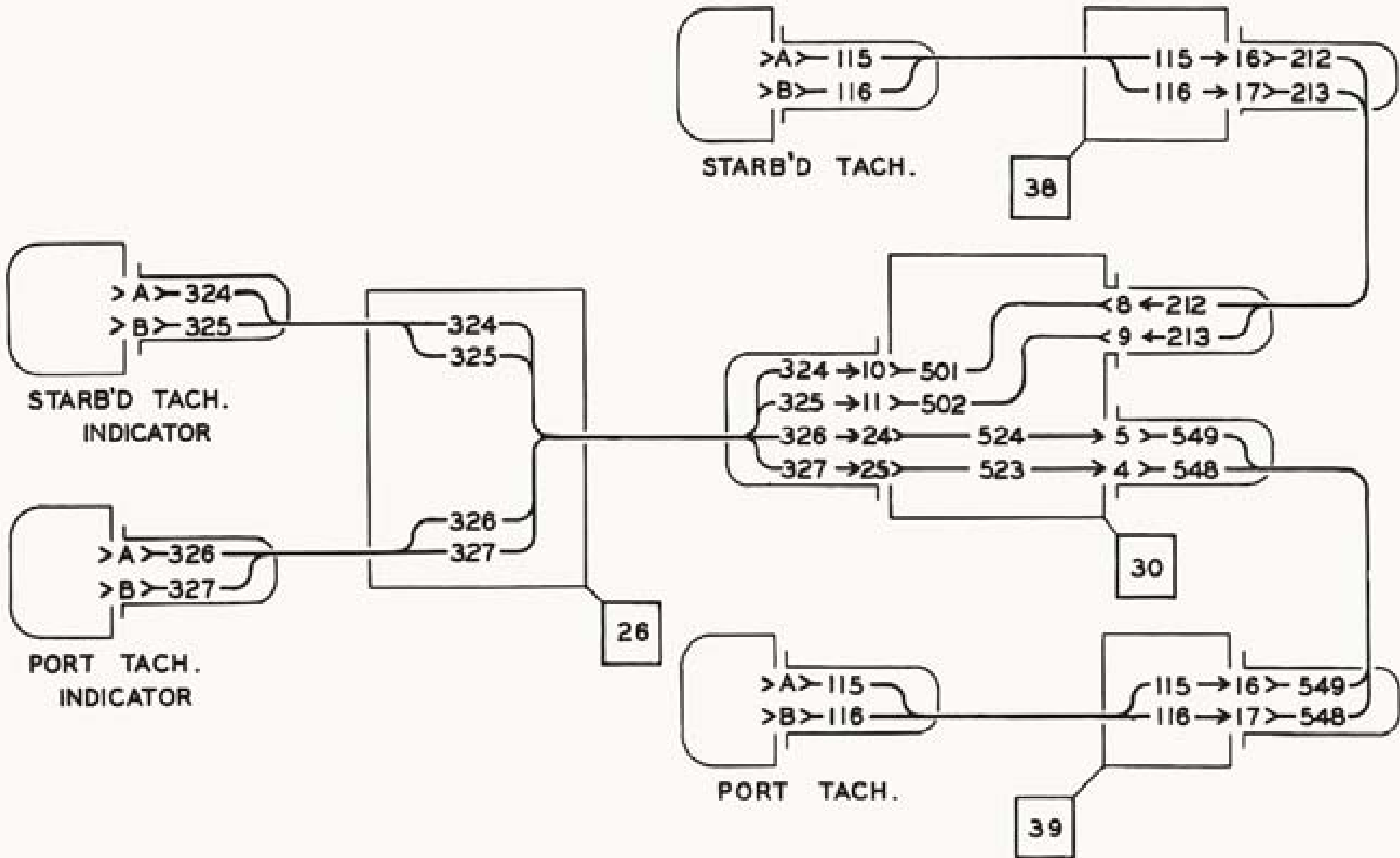
TEMPERATURES CIRCUIT



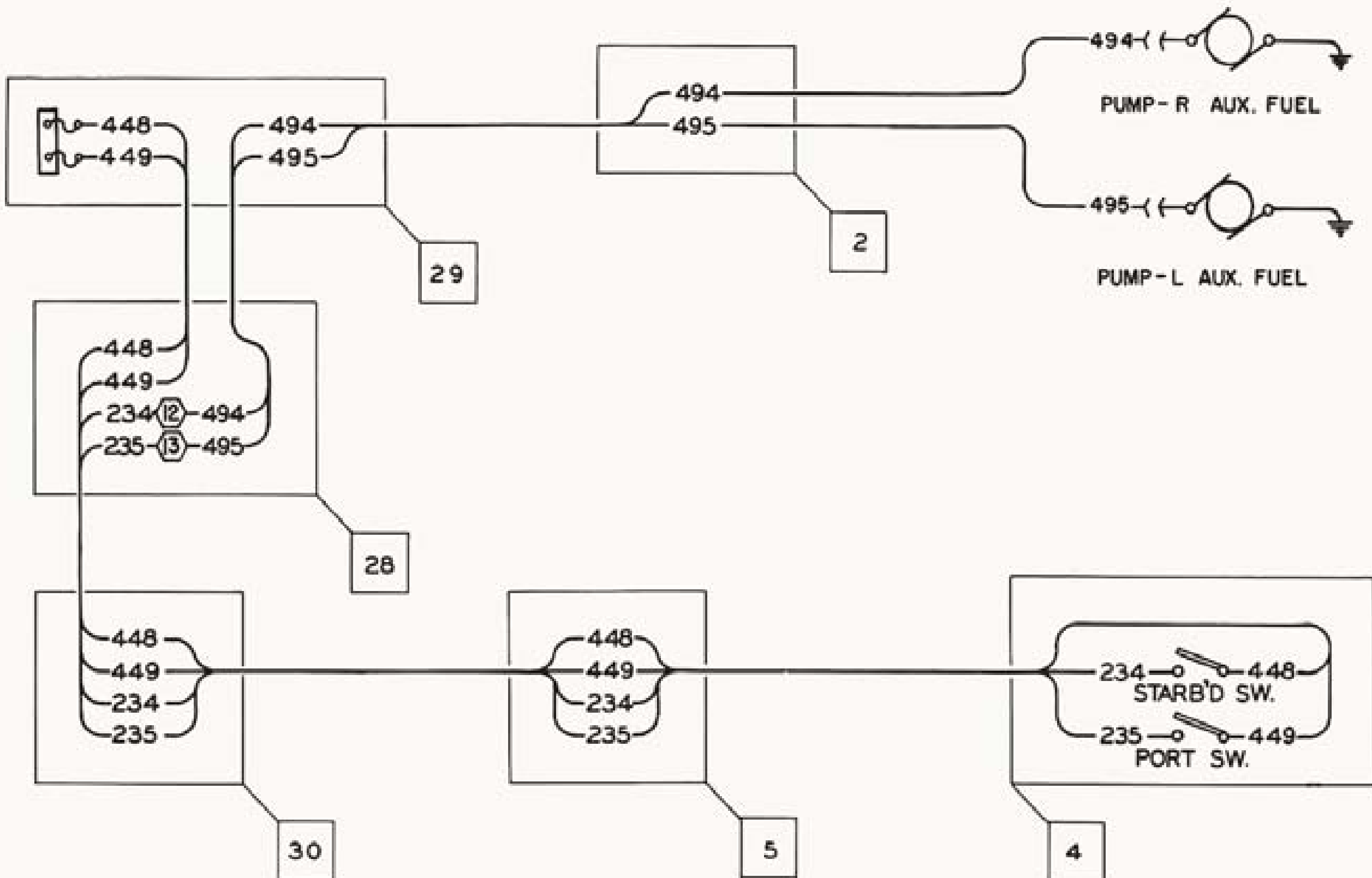
PITOT CIRCUIT



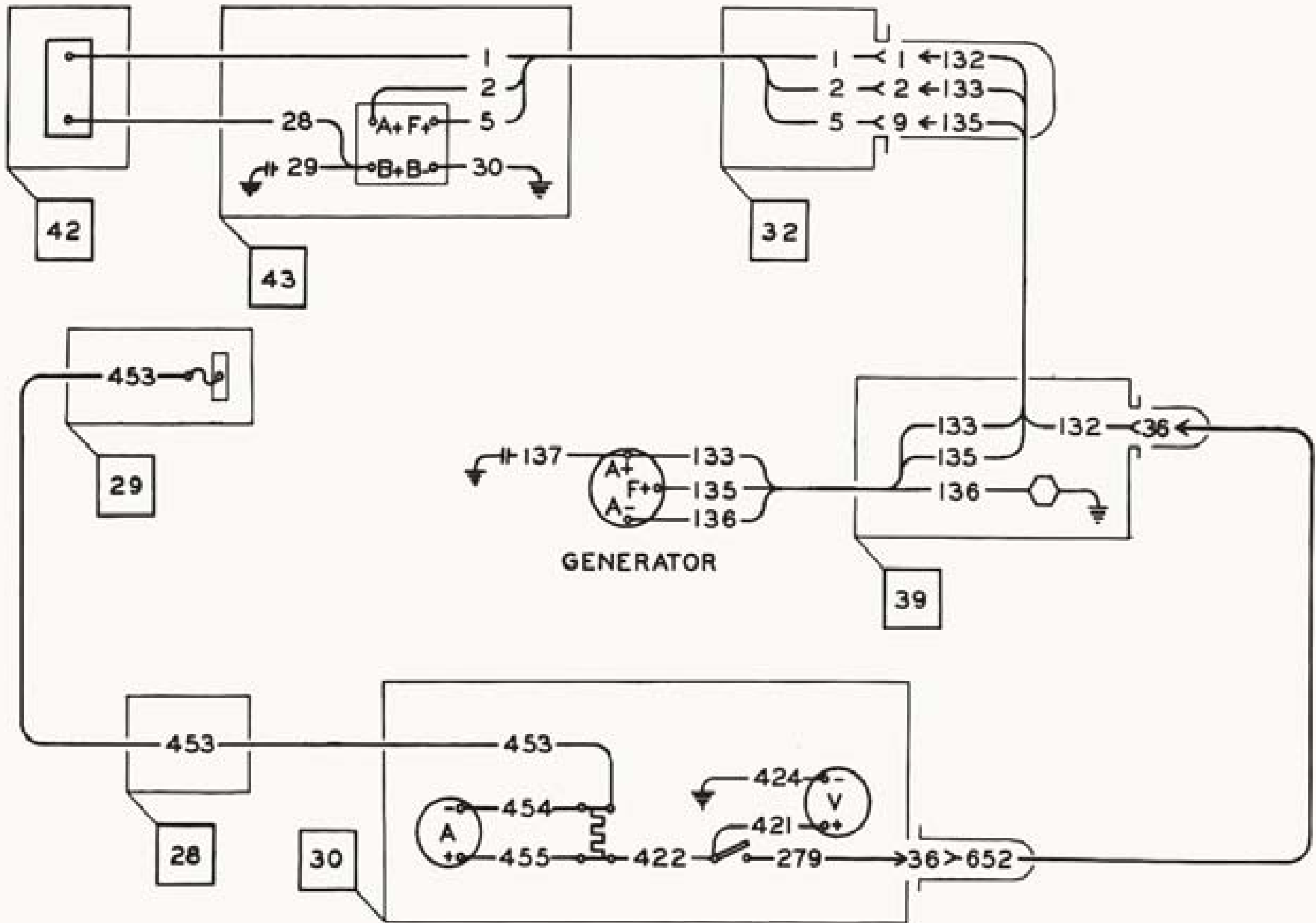
ALIGHTING GEAR CIRCUIT



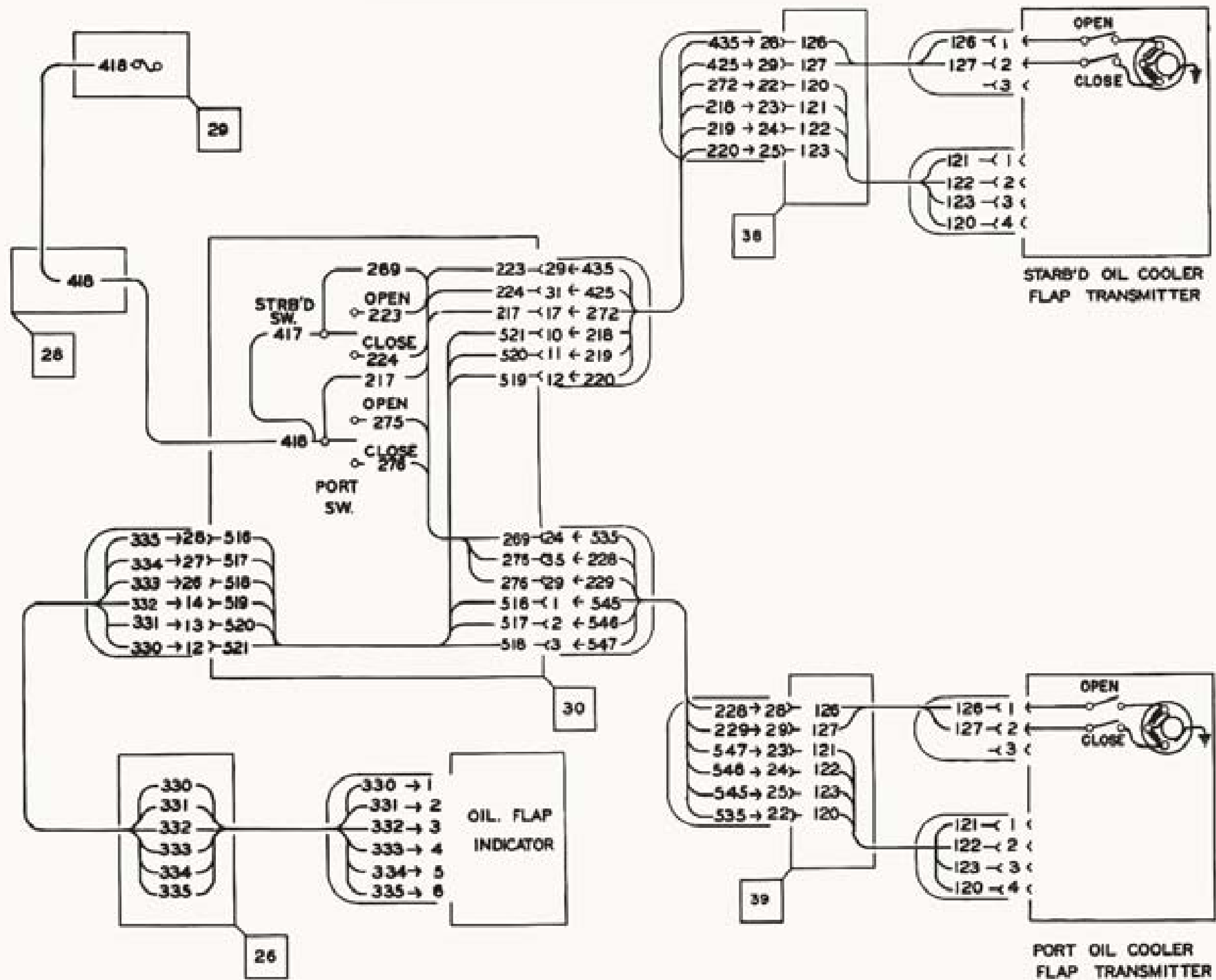
TACHOMETER CIRCUIT



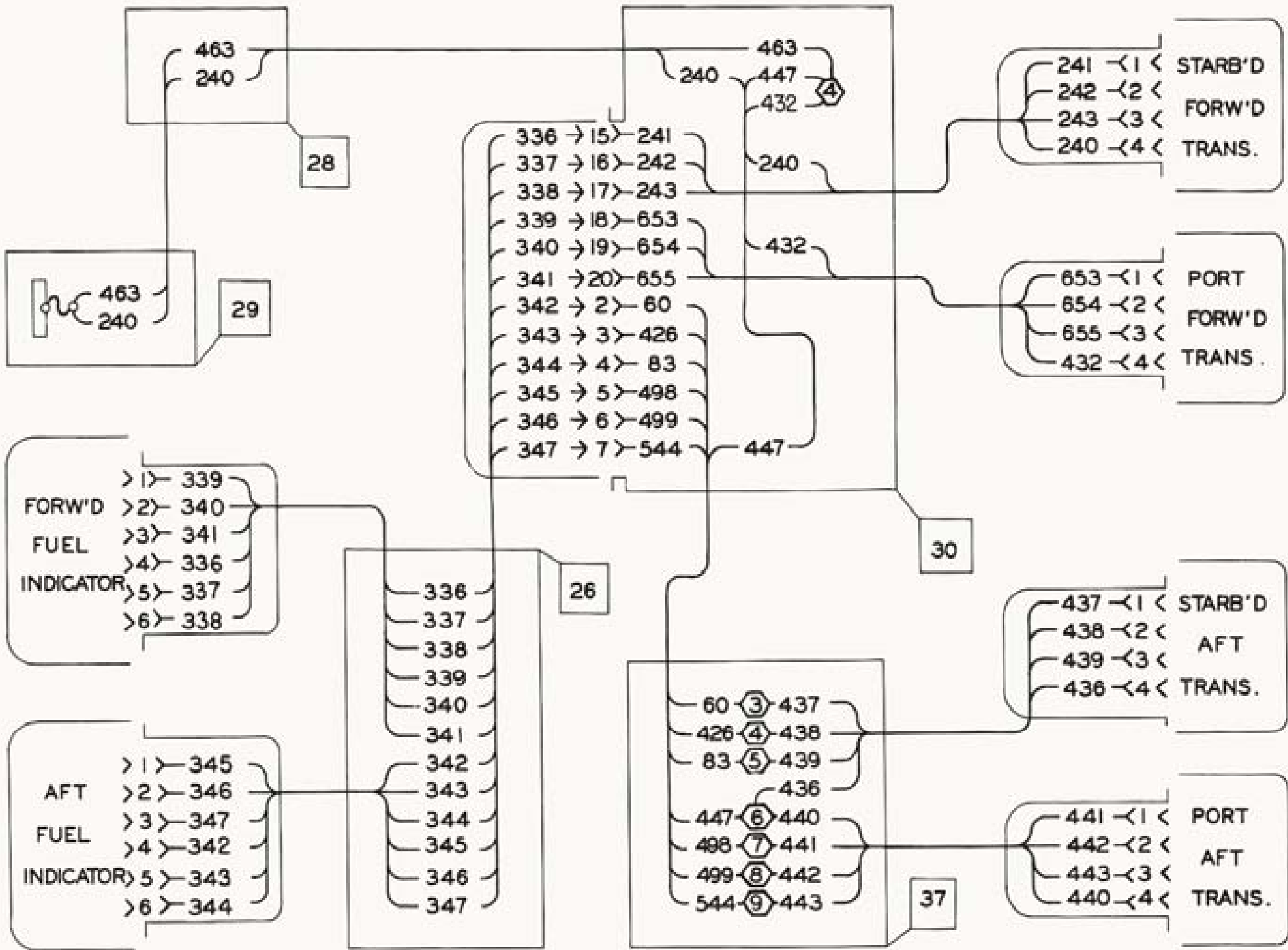
AUXILIARY FUEL PUMP CIRCUIT



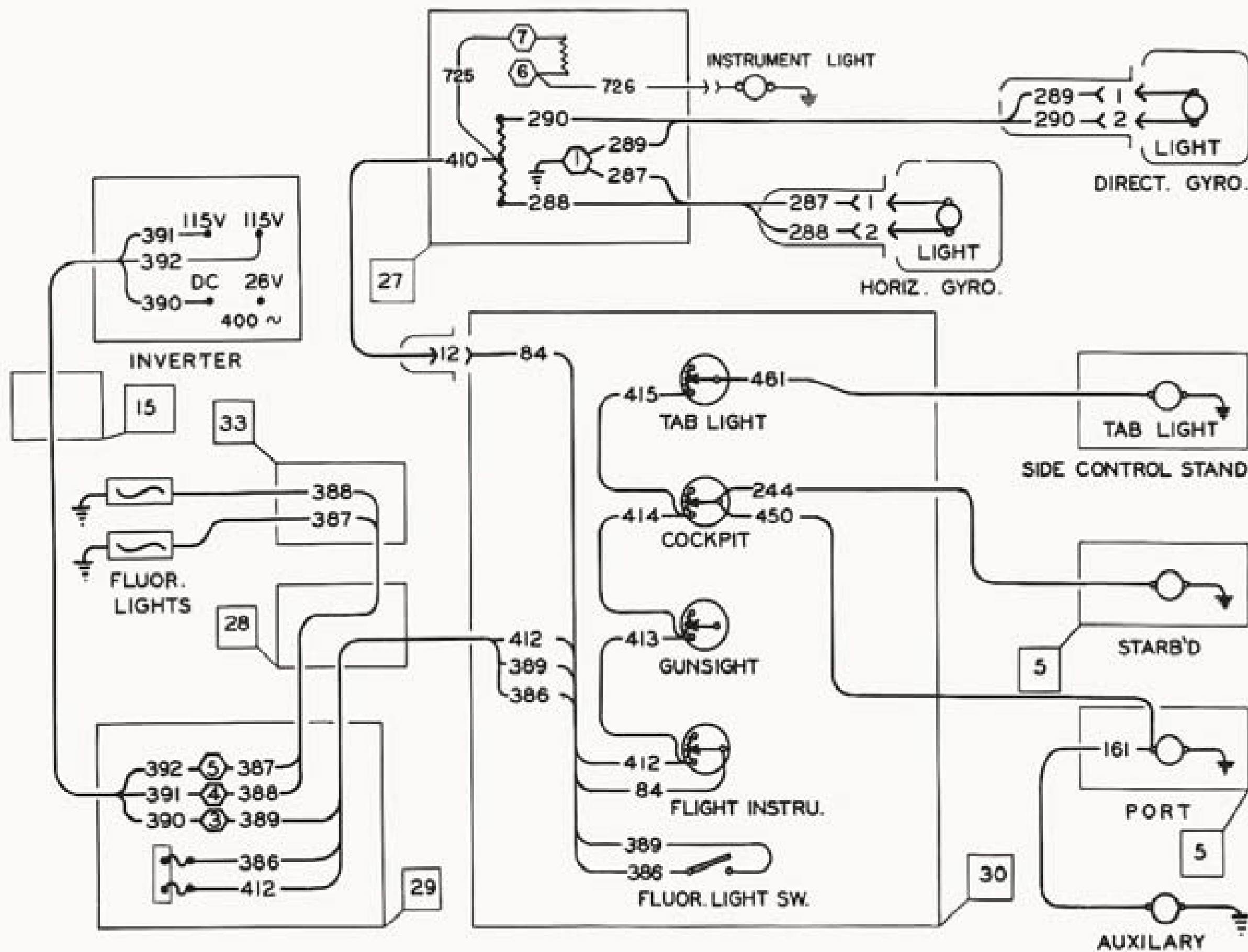
GENERATOR CIRCUIT



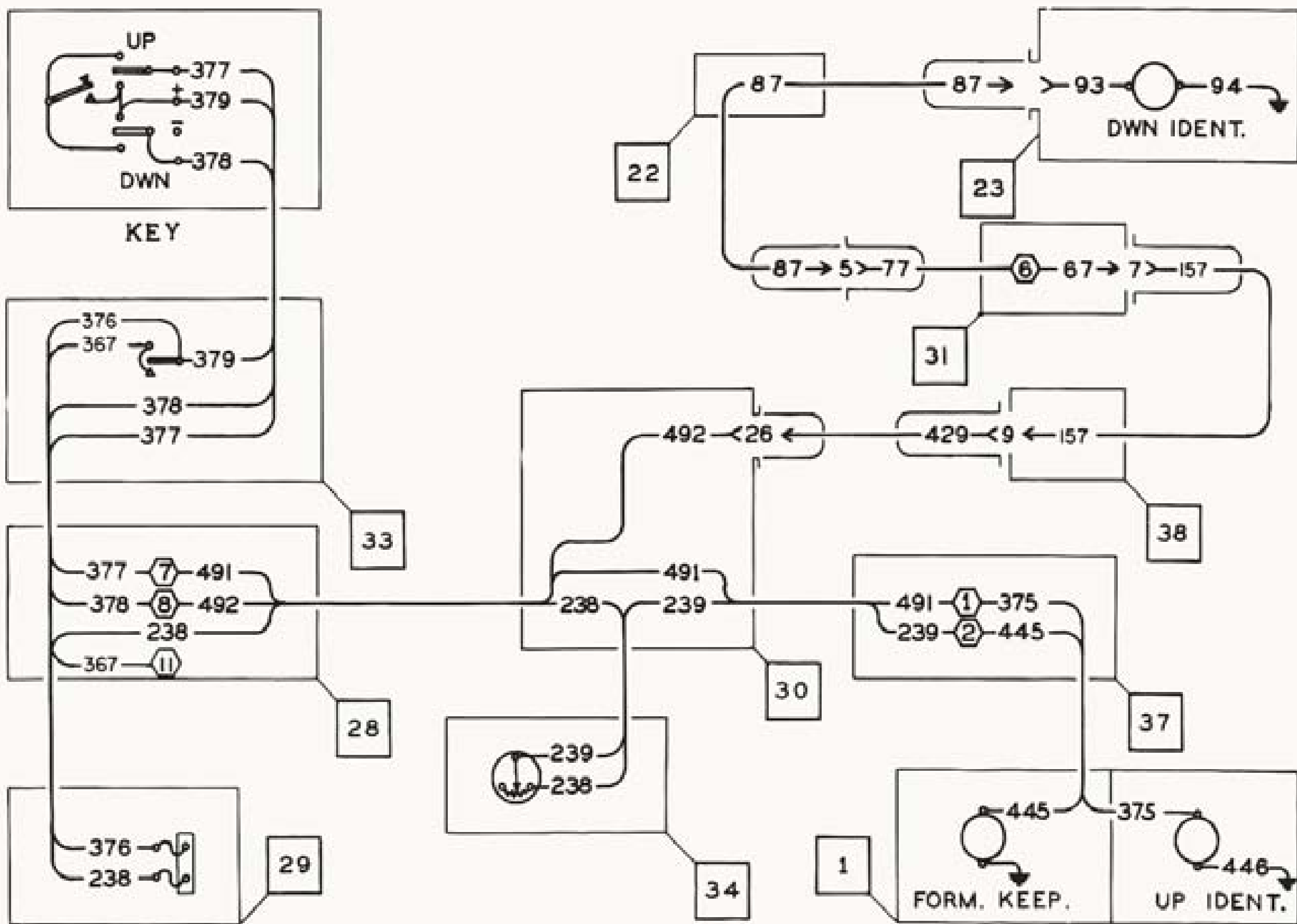
OIL COOLER FLAPS CIRCUIT



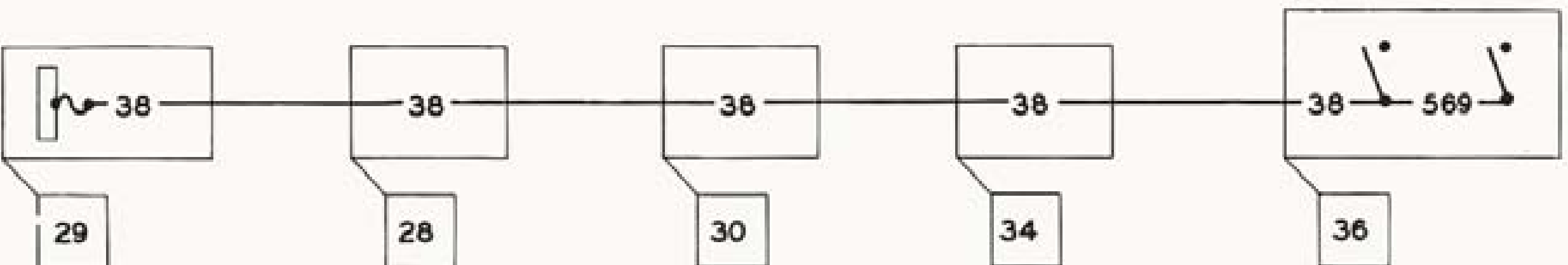
FUEL GAUGE CIRCUIT



COCKPIT LIGHT CIRCUIT



IDENTIFICATION LIGHTS CIRCUIT



RADIO POWER SUPPLY

SECTION 7

DESIGN AND CONSTRUCTION OF AIRFRAME

- Chapter 1 - Fuselage
- 2 - Booms
- 3 - Main Planes
- 4 - Tail Unit
- 5 - Alighting Gear
- 6 - Flying Controls

FUSELAGE

CHAPTER 1

CONTENTS

	Paragraph
General Construction	1
Nose Wheel Door.	3
Armament Hood.	4
Windshield and Cockpit Enclosures.	5

LIST OF ILLUSTRATIONS

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Fuselage Structure	1

CHAPTER I

FUSELAGE

As shown in Figure 2, Section 4, stations are identified by their distance in inches from Station 0, the foremost point on the fuselage nose.

1. The gondola type fuselage, extending forward from the centre main plane trailing edge, is symmetrically located about the centre line of the aeroplane and is a semi-monocoque type structure, with formers, stringers, and bulkheads of Alclad. The stressed skin is butt-joined, being secured to the understructure by flush rivets. The portion of the fuselage ahead of Station 95, contains the armament, the brake master cylinders, and brake fluid reservoirs. Aft of Station 95 is found the pilot's cockpit, where all controls are located. To the rear of the cockpit is the hydraulic fluid reservoir and the hydraulic flap drive motor and actuating mechanism. The lower portion of the fuselage, below the floor line, contains the nose wheel and its retracting mechanism, the major controlling units for the hydraulic system, the fuel valves, strainers and pumps, control cables, main fuse box, and the compartment for receiving the ejected cannon cases.

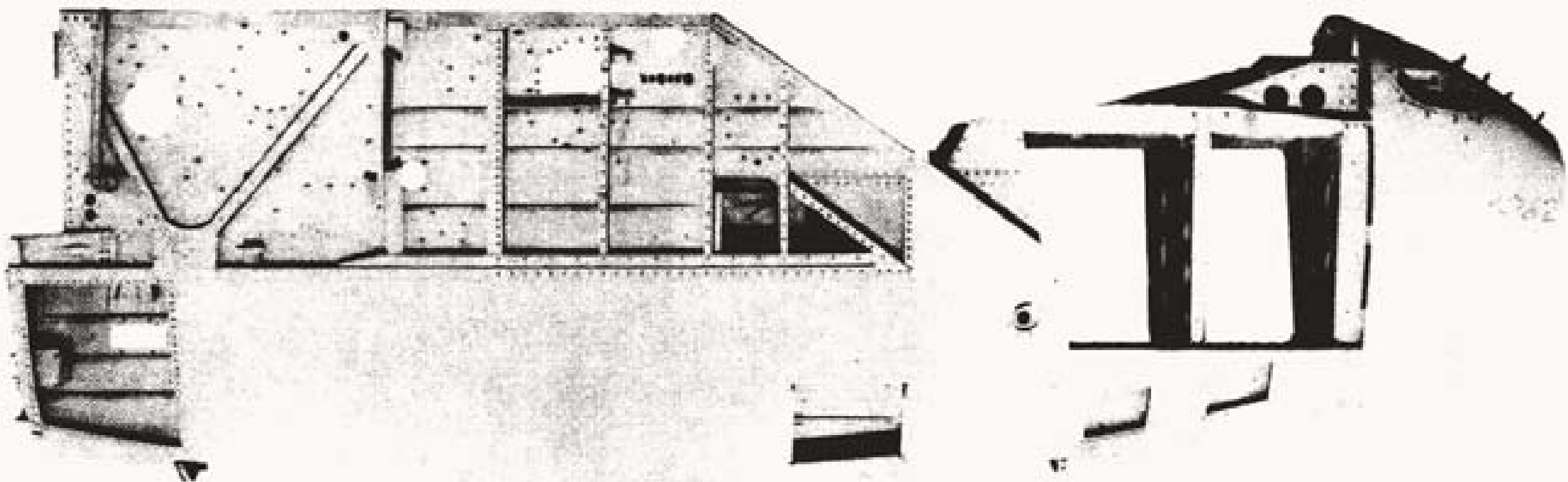
2. The fuselage is jig-mated with the centre main plane at the factory, joined by rivets aft of the main spar and by screws and bolts forward of the main spar. Longitudinal keelsons furnish support for floors and provide additional strength to the fuselage. Most parts are of 24ST Alclad aluminum alloy or of 24SO Alclad heat treated to the desired condition.

3. Nose wheel door: A flush type door, formed to fit the fuselage contour, covers the nose gear well when the gear is retracted. Actuated by a hydraulic jack at the aft end, the door swings on four 'Studebaker' type stainless steel hinges, opening outward to starboard. In closing, a roller at the forward end of the door engages a latch, which is locked when the door is closed, by a small hydraulic jack.

The door is constructed of ribs and formers, to which is riveted an inner and outer skin. The outer skin is butt-joined and flush riveted. The inner skin contains dimpled lightening holes, covered by doped fabric patches.

4. Armament hood: A door on each side of the armament compartment from station 38 15/16 to station 95 opens outward and upward to give complete access to the armament section for servicing. The doors swing on stainless steel "Studebaker" spring loaded hinges, and are secured in the open position by arms clipped to the inside of the doors. When closed, the doors are fastened by 'Dzus' type fasteners. Door structure consists of a formed waffle type frame spot-welded to the outer skin.

5. Windshield and Cockpit Enclosure: The windshield is of laminated shatterproof glass enclosed in an extruded aluminum alloy frame, the glass sealed and cushioned in the frame by a moulded rubber channel and held in place by aluminum alloy retainer strips attached with flush screws. A 1 1/2 inch thick piece of bulletproof glass is installed just aft of the windshield, sloping aft at approximately 45°. The remainder of the cockpit enclosure is of transparent plastic held in aluminum frames and consists of a sliding panel on each side, a removable top canopy, and the rear section. The sliding panels, controlled from the cockpit by a crank geared to a drum and cable mechanism, lower into a slot provided between the front shear spar and the main spar. The operating cable is accessible for inspection and adjustment through the lower centre plane fillet. The top canopy, which serves also as the emergency exit, is held in place by four sliding pins. The pins on the left side are operated by a shaft having handles on both the interior and exterior of the cockpit, while the pins on the right normally serve as hinge pins about which the canopy is raised when entering or leaving the cockpit. The rear section of the enclosure is moulded in one piece, including the integral reinforcing ribs. It is held in its frame by a retaining strip and attaches to the fuselage by flush head screws.



FUSELAGE STRUCTURE

BOOMS
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Aft Tail Boom	5

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Forward Boom (Starboard).	1

CHAPTER 2

BOOMS

1. The booms, whose centre lines lie on wing stations 96 on either side of the aeroplane, consist of semi-monocoque structures, faired from the firewalls aft to, and supporting, the tail. The engine nacelles contain the complete power plant unit, airscrew, oil system, etc., forward of the firewall and are not considered to be a part of the booms. The structure of the booms is principally of Alclad aluminum alloy, stainless steel being used where elevated temperatures are encountered adjacent to the engine exhaust systems. Butt-joining is used at all exposed skin joints. Construction of the booms is in four sections, as follows:

- a. Forward Boom - Sta. 155 1/4 to 265
- b. Aft Boom - Sta. 265 to 393
- c. Tail Boom - Forward - Sta. 393 to 430
- d. Tail Boom - Aft - Sta. 430 Aft.

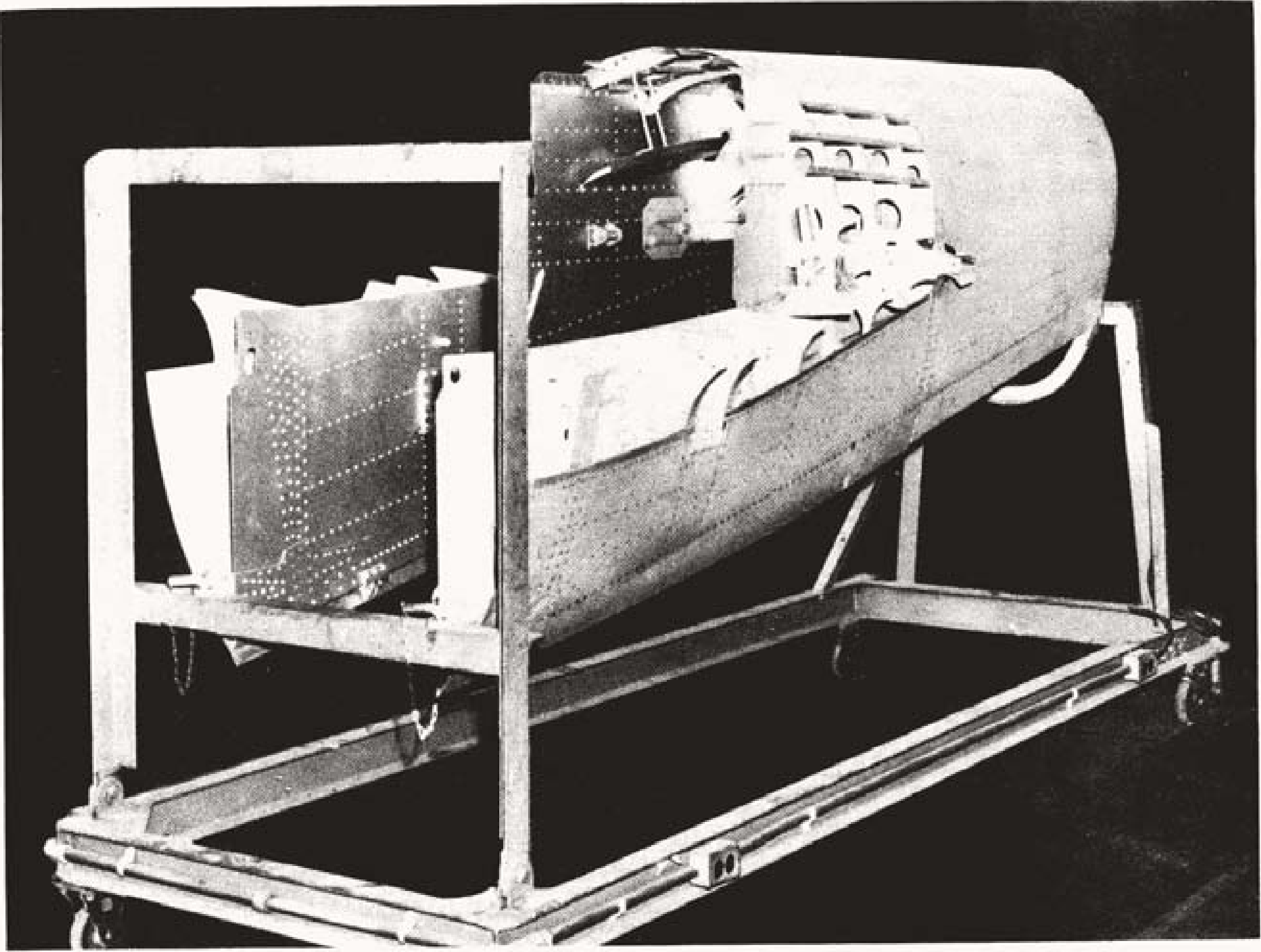
The booms contain some of the major units of the aeroplane such as the main alighting gear and actuating mechanisms, engine coolant radiators, flares, accumulator and control cables.

2. Forward Boom: The forward boom is jig-mated with the centre main plane at the factory and attached with rivets and bolts. The main alighting gear wheel well extends nearly the whole length of the forward boom, the pivot point of the oleo leg being at Station 179 7/8, and the hydraulic actuating jack extending into the engine nacelle. A pair of clam shell type doors cover the wheel well entirely, when the wheel is fully retracted, and are operated by a single hydraulic jack located vertically on the aft wheel well bulkhead, through a system of cables and push-pull rods. The doors, carrying none of the structural load of the boom, are of double construction, having an inner and an outer skin, and longitudinal and transverse formers between. Lightening holes in the inner skin are covered with doped patches. Five stainless steel "Studebaker" type hinges are provided for each door to swing on and spring loaded latch pegs on the outboard door fit into mating holes on the inboard door, when closed. The upper door hinge brackets are carried by the lower channels of the forward boom, as are the forged fittings which mate with the engine mount support bay and the aft boom attachment fittings.

3. Aft Boom: The aft boom is attached to the forward boom by screws and stopnuts through the skin and the webs, and by bolts through two forged fittings that mate with fittings on the forward boom channel. The aft face of the bulkhead web at Station 265 supports the flare rack immediately above a pair of spring loaded clam shell type doors through which the flare is discharged. Access to this portion of the boom is gained through a manhole between Stations 274 5/8 and 295. Brackets supporting the Prestone radiator frames are attached to formers at Stations 282 3/4 and 295. The baggage compartment is located between Stations 325 and 366 and is accessible through a door on the port side of the starboard boom. The top lining panel, attached by Dzus fasteners, is removed to inspect the control cables and pulleys above. Each end of the compartment is sealed by an aluminum alloy bulkhead attached by Dzus fasteners. A similar compartment in the port boom houses the accumulator.

4. Tail Boom - Forward: The tail boom, which supports the tail surfaces and attaches them to the boom proper, is joined to the aft boom at Station 393 by screws, hex and plate nuts. The lower outboard quadrant of skin is removable to give access to the surface controls.

5. Tail Boom - Aft: This section forms the tail cone of the boom from Station 430 aft. On its outboard side the boom supports the rear portion of the stabilizer tip. It is attached to the forward tail boom by screws and plate nuts.



FORWARD BOOM (STARBOARD)

MAIN PLANES

CHAPTER 3

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General	3
Spars	4
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Ribs	6
Engine Mounting Structure	7
OUTER MAIN PLANE	
General	8
Ribs	9
Tips	10
Ailerons	11
Tabs	12
FLAPS	
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Flap Position Indicator	14

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Port Aileron - Top and Bottom View	5
Main Plane Flap Installation	6
Main Plane Flap Carriages and Tracks	7
Main Plane Flap Drive Screw	8

CHAPTER 3

MAIN PLANES

1. The main plane consists of three sections, namely: the centre main plane and the port and starboard outer main planes. The centre main plane, supporting the fuselage at the aeroplane centre line, and the nacelles, booms, and main alighting gear at its outboard ends, also contains the four fuel tanks. The outer main planes are equipped with retractable landing lights on their under surfaces, while the starboard plane only is equipped with a downward identification light.

2. The centre main plane is fitted with flaps at its under trailing edge, one on each side of the fuselage. Each outer main plane also is fitted with a flap at its under trailing edge, inboard of the aileron. All four flaps are operated by a hydraulic motor through a screw and cable arrangement.

CENTRE MAIN PLANE

3. General - (See Fig. 1, 2) - This plane, in plan view, is symmetrical about its centre line, its ribs, corrugated stiffeners, and spar webs being of formed Alclad sheet, spar flanges of extruded aluminum alloy sections, and fittings such as spar ends, "Bathtub" fittings, etc. being of forged aluminum alloy. Skin is butt-jointed Alclad sheet. Large, removable panels in the under-surface, facilitate servicing and removal of the fuel tanks.

4. Spars: - The major unit of the main plane is the main spar, a box type beam which is the backbone of the aeroplane. It extends through the main plane aft of Station 155 1/4, going through the fuselage behind the pilot's seat. Enclosed in the main spar are the surface control, flare release, automatic recognition device cables and the heater tubes. The outboard ends of the main spar are terminated with forged attachment fittings on both the upper and lower flanges which mate with similar fittings on the outer main plane panels, being held in place by attachment pins. The rear shear spar is of single web construction and comprises the rear wall of the fuel tank compartment. No ribs or intermediate structure are found in this compartment or in the forward fuel compartment. The front shear spar is a single web spar, similar to the rear spar in construction and terminates, at the junction of the centre main plane and the engine nacelle, with a fitting which mates with the inboard engine mount support. Single lug forged fittings are located at the outer ends of the rear spar, for attachment of outer main plane.

5. Corrugations - For stiffness and strength, corrugated panels are installed just under the skin. "Bathtub" fittings, of forged 14ST aluminum alloy are installed at the outer end of the corrugation, making provision for attachment to similar fittings in the outer main plane panels. The corrugations are in the area between the main and rear spars.

6. Ribs - Few ribs are used in the centre plane. Aft of the rear shear spar are found ribs shaped to take the flaps in their retracted position. Ribs are found at the outboard ends of the centre plane and near the centre, all of which are fabricated of Alclad sheet, flanged and stiffened by extruded angles.

7. Engine Mounting Structure - (Refer to Section 8).

OUTER MAIN PLANE

8. Each outer main plane (See Figures 2, 3) consists of a main spar, two rear shear spars (one spar forward of the wing flap and the other one forward of the aileron), ribs, tip and skin. Both the main spar and the rear shear spar are of single web construction, the main spar terminating outboard at the plane tip junction and the rear spar at a point slightly beyond the inboard end of the aileron. The leading edge, forward of the main spar, consists of ribs, stringers and skin. The ribs aft of the rear spar in the flap vicinity are shaped to take the flap in its retracted position.

The end fittings of the spars mate with and are similar in construction to, the corresponding fittings on the centre main plane. "Bathtub" fittings are installed on the outer plane corrugations which mate with those on the centre plane. "J" section stringers, formed from sheet Alclad, run the length of the wing, tying into the ribs through cutouts in their flanges.

9. Ribs - All ribs are of formed Alclad sheet, flanged for attachment to the structure and skin. Stiffening is accomplished by means of beads formed in the webs, with the exception of the trailing edge ribs, which are of double construction, one flange in each direction, and are stiffened by extruded angles riveted diagonally to the webs. The inboard nose rib has an engine mount lug, together with a stiffening channel, incorporated on its inboard side.

10. Main Plane Tips - Each tip (See Figure 6) is fabricated of ribs and formers, and an upper and lower skin. The skins are joined by a riveted lap joint at the leading edge, while the trailing edges, both extending aft, are spotwelded together. The tip is secured to the outer main plane by flush head screws, and contain the conduit and fittings for the tip lights. All parts are of formed Alclad sheet.

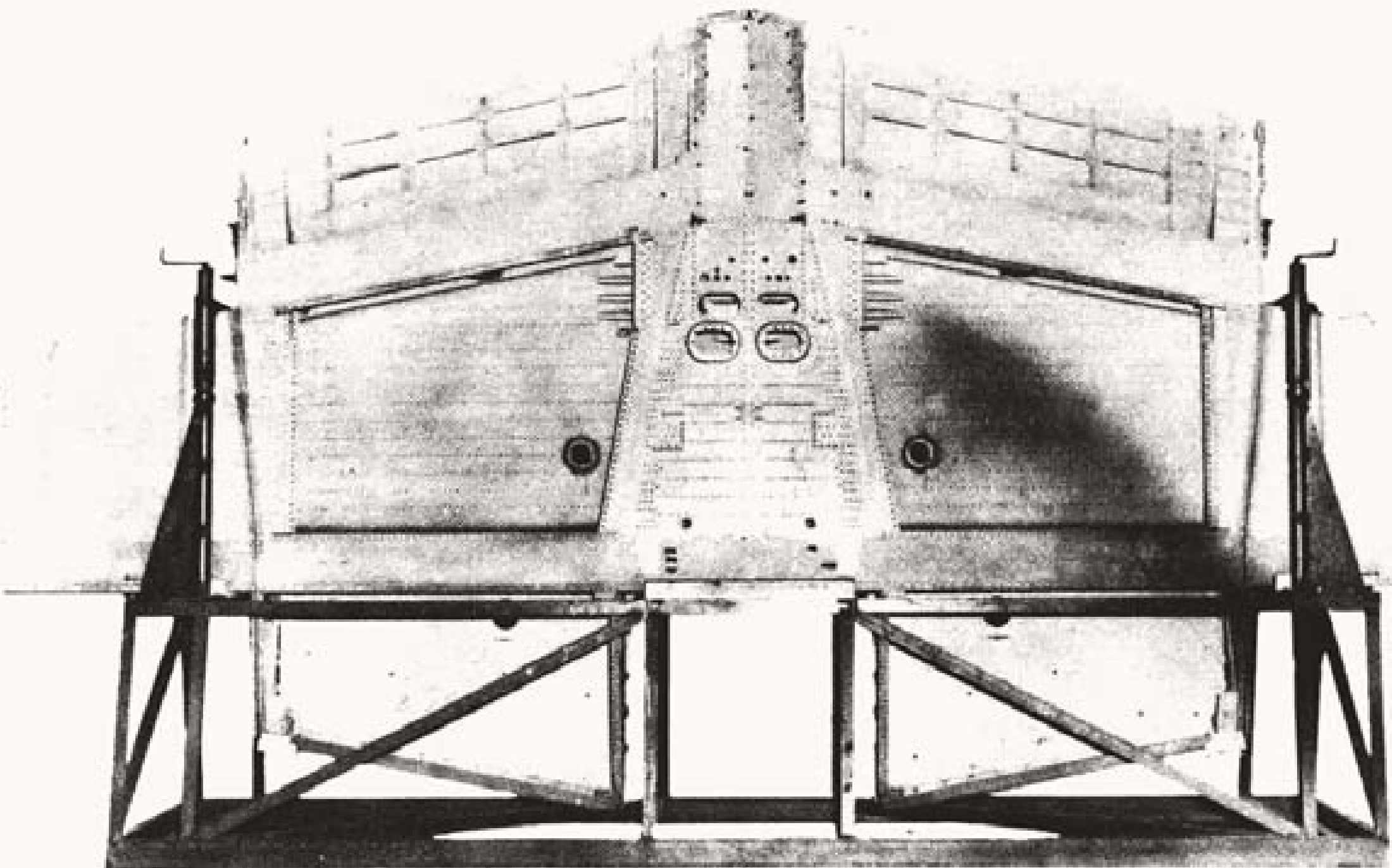
11. Ailerons - The ailerons (See Figure 7) are fitted in the outer main planes between Stations 182 and 289. The structure is similar to that of the main planes, in that a front spar runs the length of the aileron, and ribs and intercostals serve as formers. Parts are of formed Alclad sheet. The ailerons are statically and dynamically balanced, four counterweights being attached to the forward edge of each aileron. Piano hinges along the upper edge of the aileron provide for its movement. The upper and lower skins are riveted together at the trailing edge. The aileron trimming tabs are located on each aileron between Stations 212 and 230.

12. Aileron Tabs - (See Figure 7). These tabs swing about piano hinges at their lower edge, being actuated through cable controlled drum and screw units. Construction is of sheet Alclad, with the exception of the fittings of machined extrusions which connect the push-pull rods to the tabs.

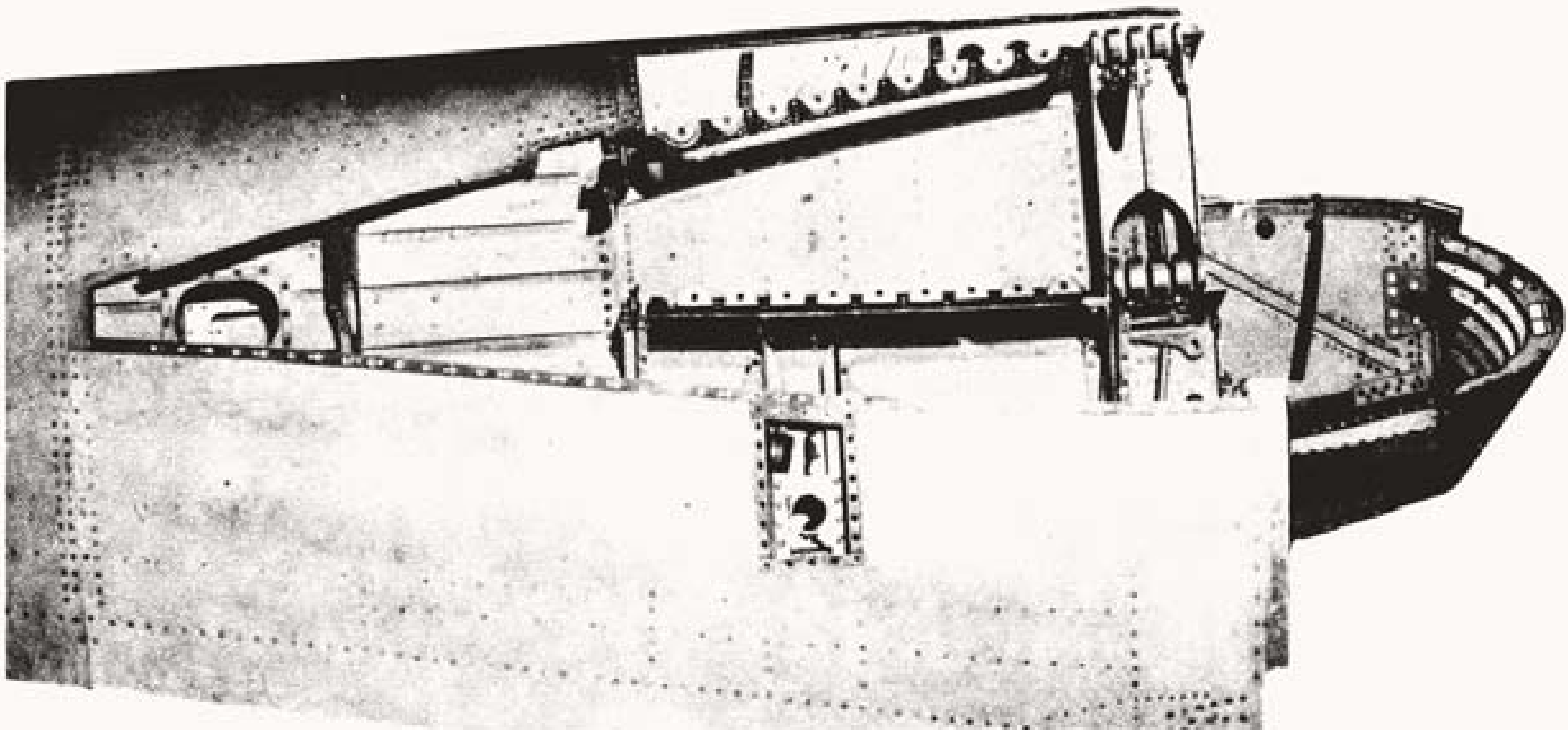
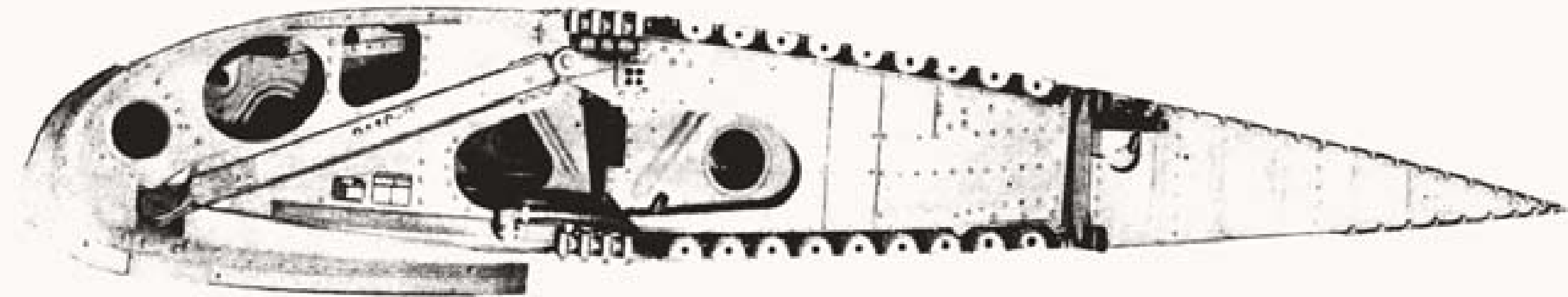
FLAPS

13. The hydraulically actuated flaps (See Figures 4, 5, 8) are in four sections, the port and starboard centre main plane flaps, and the port and starboard outer main plane flaps, all the flaps being simultaneously operated. They are of the Fowler type, each end of each flap being attached to carriages which roll on tracks built into the plane structure. The carriages are linked by cables to push-pull tubes traveling in brackets on the rear shear spar. The push-pull tubes are actuated by long screws which are driven by a hydraulic motor housed in the upper rear fuselage section. The flaps are fabricated from Alclad sheet, fittings being of forged aluminum alloy. In their retracted position the flaps form an integral part of the main plane, offering a smooth surface to the airflow. See Chapter 6, Paragraph 10, for controls and operation.

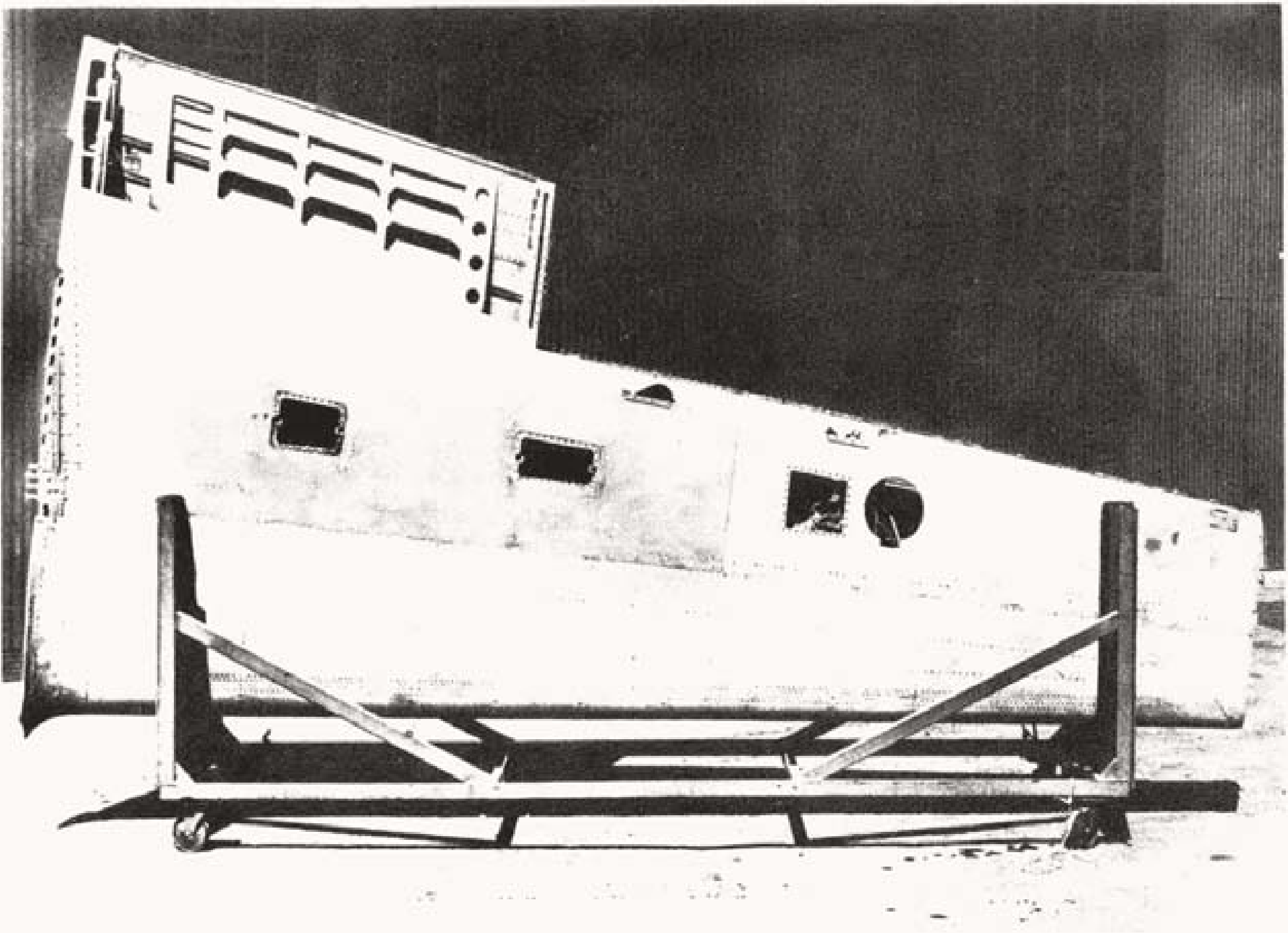
14. Position Indicator - A position indicator, located on the instrument panel and combined with the undercarriage position indicator is connected to a transmitter geared to the port actuating screw. The circuit is directed through the master switch. The indicator gives the position of the flaps in increments of the full open position.



GENTRE MAIN PLANE - BOTTOM VIEW



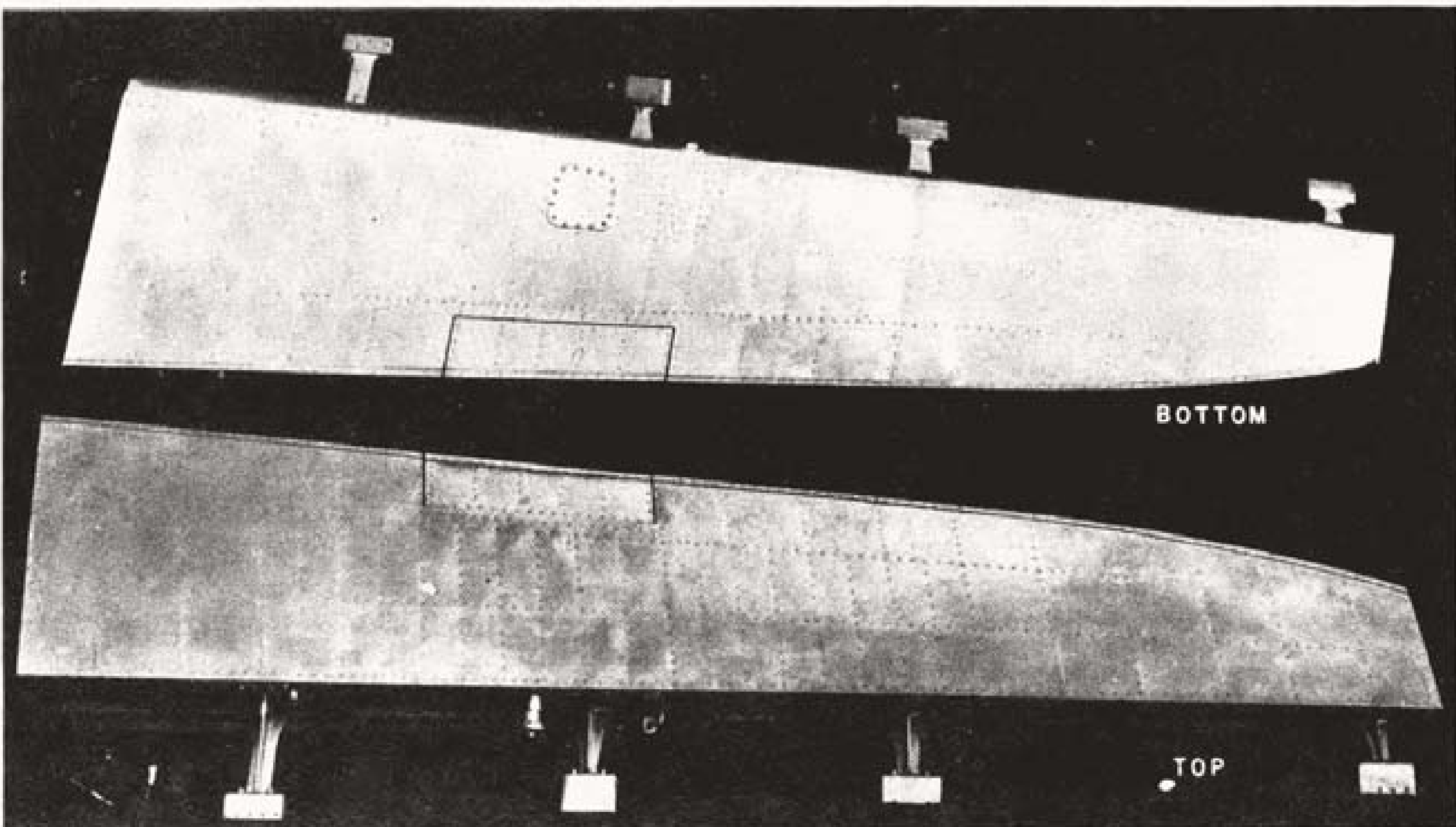
CENTRE AND OUTER MAIN PLANE JUNCTION (STARBOARD)



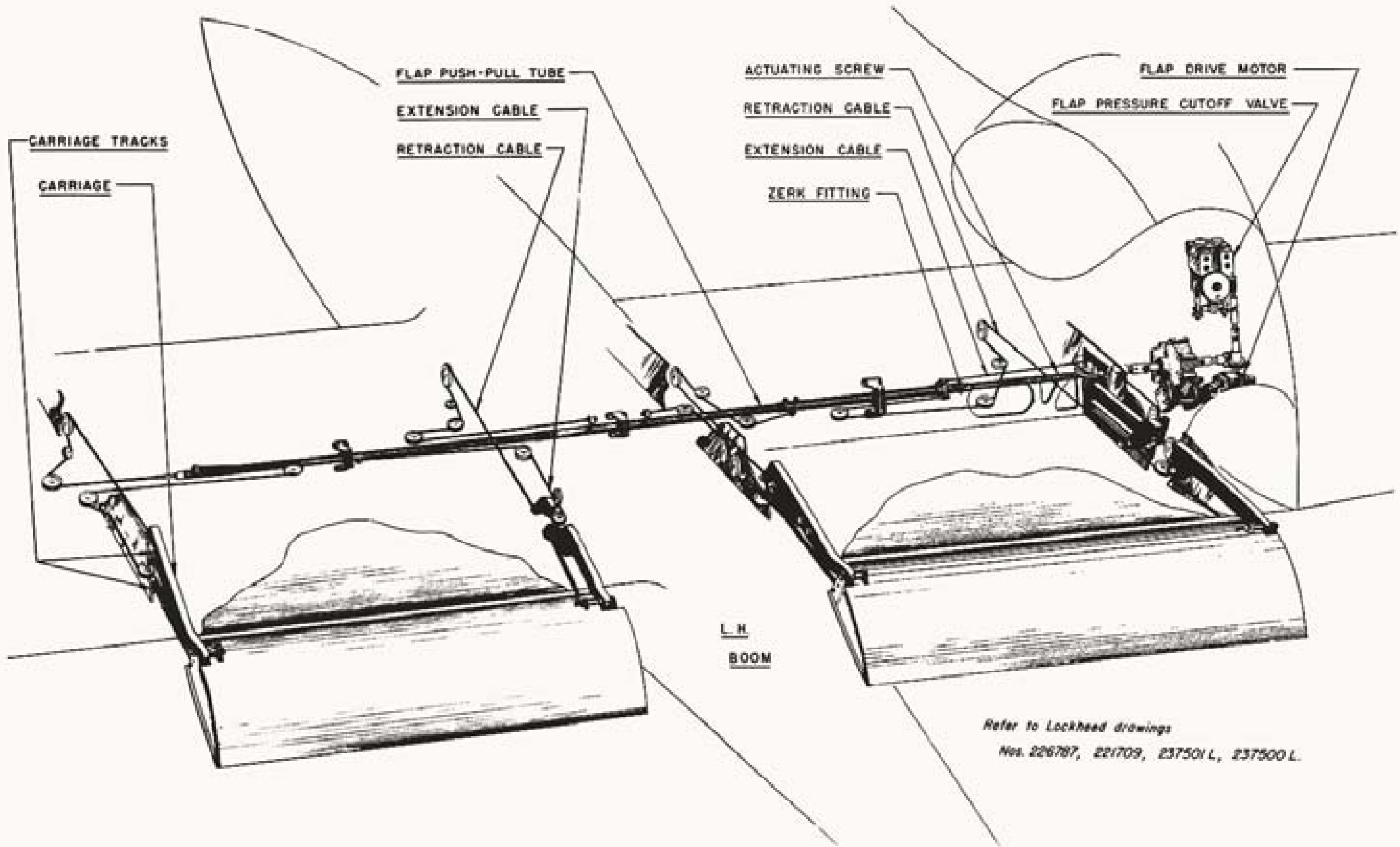
STARBOARD OUTER MAIN PLANE BOTTOM VIEW



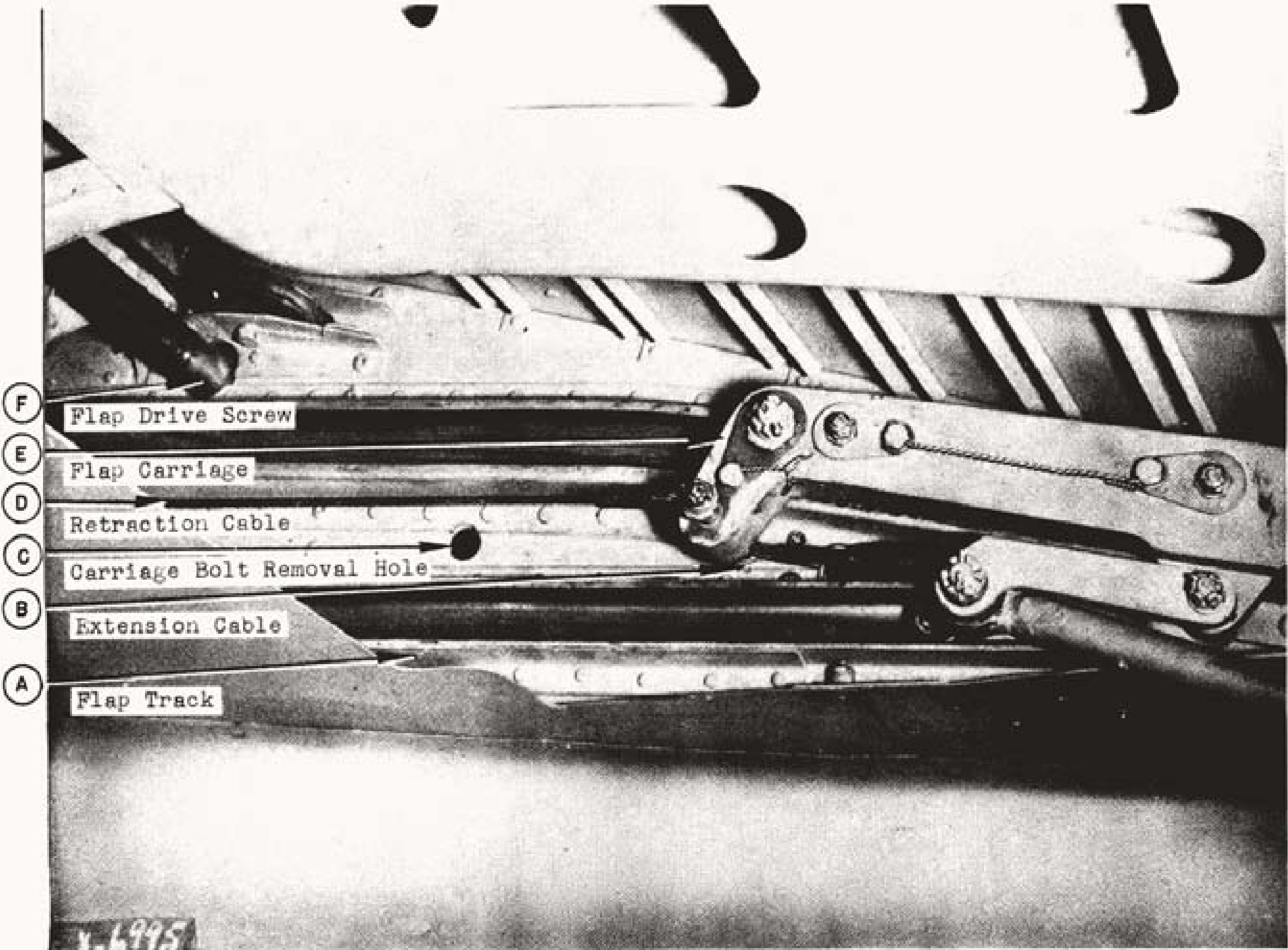
PORT WING TIP



PORT AILERON - TOP AND BOTTOM VIEW

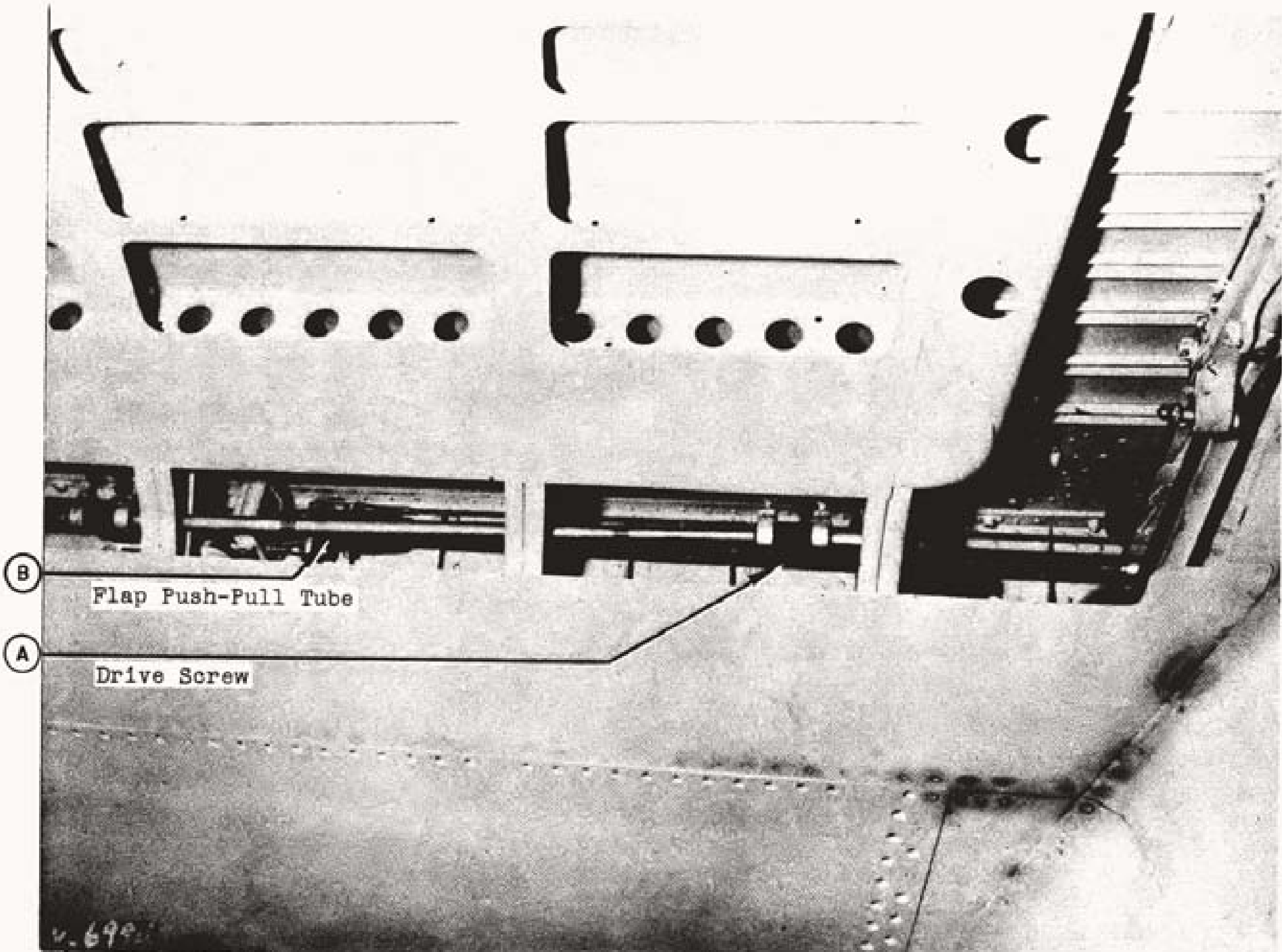


MAIN PLANE FLAP INSTALLATION



- (F) Flap Drive Screw
- (E) Flap Carriage
- (D) Retraction Cable
- (C) Carriage Bolt Removal Hole
- (B) Extension Cable
- (A) Flap Track

MAIN PLANE FLAP CARRIAGE AND TRACKS



MAIN PLANE FLAP DRIVE SCREW

TAIL UNIT

CHAPTER 4

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Tail Plane Tips.	3
Elevator	4
Elevator Trimming Tab.	5
Pins	6
Rudders.	7
Rudder Trimming Tabs	8

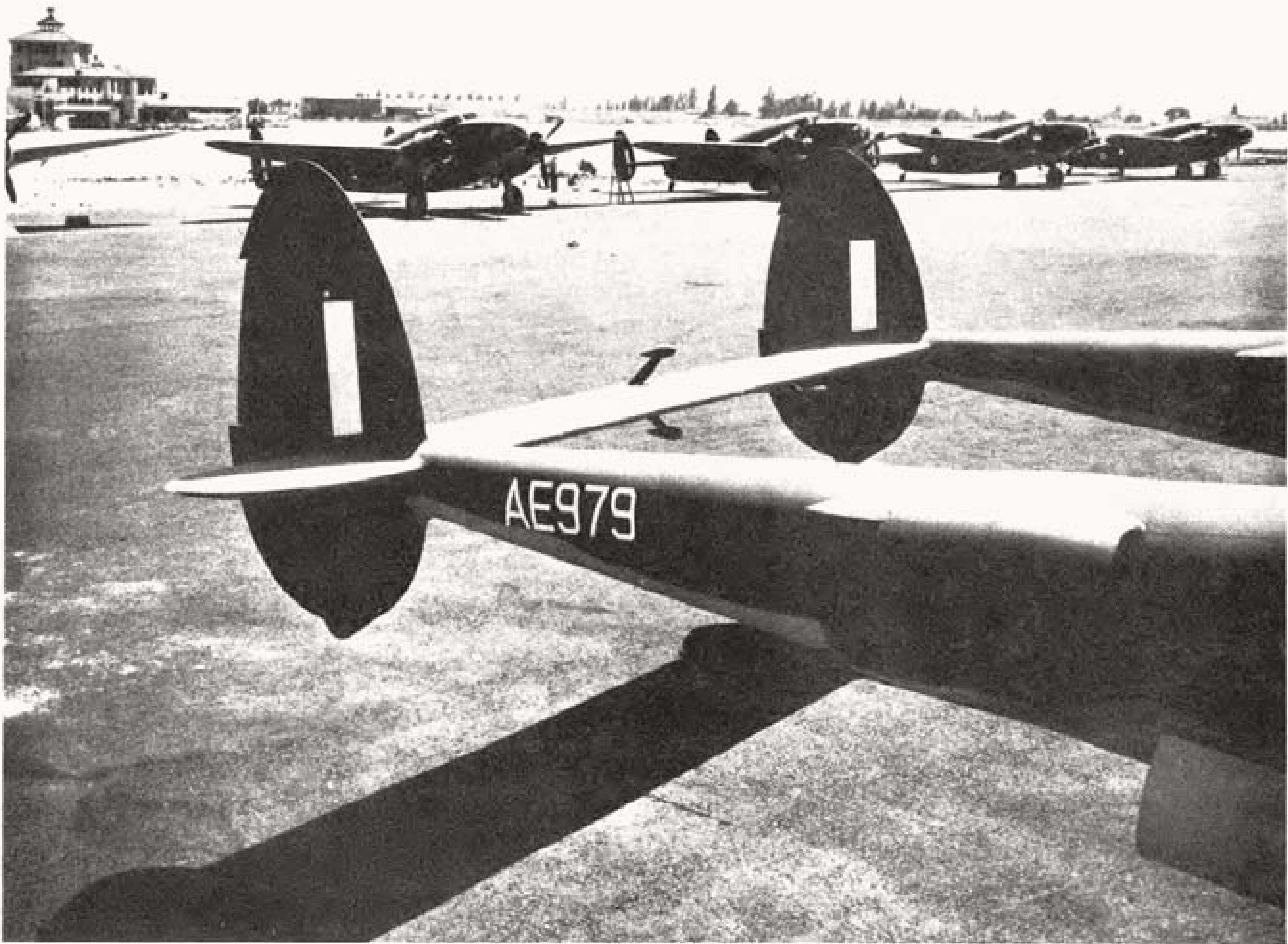
LIST OF ILLUSTRATIONS

	Figure
Tail Unit - Three Quarter Front View.	1

TAIL UNIT

CHAPTER 4

1. General - The tail unit (Figure 1) consists of a fixed tail plane between the booms, two tail plane tips, an elevator, two vertical fins, and two rudders. The elevator and rudders are each equipped with trimming tabs operable from the cockpit, and are statically balanced.
2. Tail Plane - The tail plane is composed of two spars, ribs, stringers, and skin, all of Alclad aluminum alloy. It ties into the inboard side of each forward tail boom, being attached with flush head screws and plate nuts. The rear spar carries the elevator hinge brackets and bearings, one end of each elevator torque tube, and the elevator tab actuating unit. A plate nut for plumb bob attachment is jig located on the under surface $3 \frac{7}{8}$ inches to the port side of the center line and is identified by a red circle. An eye is provided for attaching the radio antenna on the leading edge at the center line.
3. Tail Plane Tips - The tip panels, interchangeable port and starboard are built up of Alclad ribs, intercostals, and skin similar to the main plane tips. They attach to the outboard side of each tail boom with flush head screws and plate nuts.
4. Elevator - The elevator is a single panel structure, similar in structure to the tail plane. It attaches to the torque tubes by screws and to the tail plane by hinge pins operating in anti-friction bearings. It is statically balanced by counterweights acting on the outboard ends of the torque tubes, swinging in a space provided in the forward tail boom, and by external streamlined lead counterweights, one above and one below the elevator, which are located at the center line, supported by arms of streamlined cross section. The arms which support the internal counterweights also serve as control horns in that the elevator cables are connected to them. The elevator trimming tab is located at the trailing edge, disposed symmetrically about the center line.
5. Elevator Trimming Tab - The elevator tab swings about a stainless steel piano type hinge. The hinge pin is safetied by a screw and clip which secures the hinge pin to the elevator at its port end. A push-pull tube links the tab with its actuating unit in the tail plane.
6. Fins - The fins are constructed in upper and lower sections, interchangeable port and starboard. In the upper sections are the rudder tab actuating units, navigation light showing on the outboard side only, one elevator control pulley, and two rudder tab control pulleys. Each lower section carries one elevator control pulley and a steel shoe to protect the lower tip against tail down landings. The rear spars carry the rudder hinge brackets and the rudder torque tube. Construction is of Alclad ribs, spars, and skin, similar to that of the tail plane.
7. Rudders - The rudders are constructed in upper and lower sections, interchangeable port and starboard. Their structure consists of Alclad ribs, spars, and skin. Each section is fastened to the fin by hinge pins, to the torque tubes and to each other by screws. A counterbalance extends forward of the hinge line on each section and each rudder is provided with a trimming tab on its trailing edge.
8. Rudder Trimming Tabs - Each rudder tab is secured to the upper rudder section by a stainless steel piano type hinge, the hinge pin being safetied to the rudder at the lower end of the upper section. A push-pull tube links the actuating unit in the fin to the tab.



TAIL UNIT — 3/4 FRONT VIEW

ALIGHTING GEAR

CHAPTER 5

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ALIGHTING GEAR

CHAPTER 5

1. General - The alighting gear is of the tricycle-type, consisting of the main undercarriage and the nose undercarriage, each retractable by hydraulic pressure supplied by the engine pump or in emergency by the hand pump. When retracted, the gear is fully enclosed by flush, faired, automatically operated doors. Landing shock is absorbed by an oleo leg in each of the three assemblies. Independent hydraulic braking systems are provided for each of the main gear wheels, controlled by toe pedals on the rudder pedal assemblies.

2. Emergency Extension System - This system provides a reserve supply of fluid and the necessary piping from the dual hand pump to the gear jacks for extending the alighting gear in the event of failure of the main hydraulic system. In order to operate the system, the retraction by-pass valve, located on the cockpit floor in front of the hand pump, must be closed, the undercarriage control valve placed in the 'Down' position, the transfer valve on the hand pump placed in the emergency position and the hand pump operated.

NOTE: Refer to 'Pilot's Notes' and instruction plate in cockpit for operating limitations. Refer to Sec. 9, Hydraulics, for description of hydraulic operation.

3. Oleo Legs - (See Figures 12, 13, Section 4) - Landing loads are taken by the three oleo legs, one on each main wheel and one on the nose wheel. Each leg consists of a cylinder closed at the top and sealed at the bottom by chevron packings, spacers, a bearing, a gland nut and the piston tube. The cylinder containing oil and compressed air is divided into two chambers by the orifice plate. The piston tube assembly carries the wheel and axle, and moves up and down in the lower chamber, of the cylinder. When a force such as a landing load is applied to the wheel the piston moves upward in the lower chamber of the cylinder, forcing oil through the metered orifice, into the upper chamber where the shock is cushioned by compressed air. The orifice is so designed that, on the rebound, the oil is restricted in returning to the lower chamber thus damping the rebound motion. The piston is kept from rotating by torque arms or 'scissors links' attached to the lower ends of the piston and cylinder.

MAIN UNDERCARRIAGE

4. General - The main undercarriage (See Figure 1) consists of two assemblies, located in wells in the lower part of each forward boom, each made up of a cross head fulcrum, an oleo leg, a side brace strut, two torque arms, an axle, a drag strut, two drag links, an actuating cylinder including a "Down" lock, a brake and wheel assembly complete with tyre, a position indicator, and an "Up" lock.

5. The forged aluminum alloy cross head fulcrum is pivoted at each end in a bearing mounted in the vertical wheel well webs. The oleo leg is attached to the inboard end of the fulcrum and is braced against side loads by a tubular steel strut extending from a lug on the lower end of the leg to the outboard end of the fulcrum. The wheel axle and brake mounting flange are carried on the piston of the leg. The piston, which has a ten inch stroke, is connected and kept in alignment with the cylinder by scissors-type torque arms. The tubular steel drag strut is pivoted at one end at a fitting on the lower part of the leg and at the other end between the two drag links, which are triangular aluminum alloy forgings with bronze bearings at each apex. The lower bearing at (C) (See Section 4, Figure 14, Chapter 2) is the pivot point of the links. The upper bearing at (A) is pinned to the upper end of the drag strut and the forward bearing at (B) is pinned to the piston rod of the actuating cylinder. The actuating cylinder is in the engine nacelle, fastened by a clevis to the forged aluminum alloy engine mount support bay, the piston rod extending aft through a cutout in the firewall to connect to the drag links. A rubber bellows secured to the actuating cylinder and to the firewall closes the piston rod cutout in the firewall.

6. Retraction - Force applied at point (B) by the extension of the piston rod causes the drag links to rotate about the point (C), thus moving the upper end of the drag strut in an arc at point (A). This motion is transmitted to the oleo leg at point (D), causing it to swing about the fulcrum and retract upward and aft into the wheel well. Extension of the gear is accomplished by the forward movement of the actuating piston. For complete information concerning the operation of the actuating cylinder and locks, refer to Section 9, Hydraulics.

BRAKES

7. General - Each main undercarriage wheel is equipped with an independent hydraulic braking

system, control of which is maintained by toe pedals mounted on the rudder pedals. Each system consists of a master cylinder, a fluid reservoir, the brake assembly, and the necessary piping to connect the units.

8. Fluid Reservoirs - Two reservoirs, one for the port and one for the starboard brake system, are mounted on the forward side of the bulkhead at Station 95. Accessibility for checking and filling is provided by raising the armament hood. A tube connects each with its master cylinder.

9. Master Brake Cylinders - Two Goodyear barrel type, compensating cylinders are mounted in a fixed horizontal position on brackets outboard from and below the fluid reservoirs on the forward side of the bulkhead at Station 95. The piston rods are connected directly to the bell-cranks linking them with the toe pedals. Design of the cylinder is such that the correct amount of fluid is in the brake system at all times, the fluid in the reservoir compensating for volume changes due to temperature variation and automatically replacing fluid lost through leakage. Fluid is fed downward from the reservoir by gravity. The master cylinders are accessible by raising the armament hood.

10. Brake Assemblies - Each brake assembly consists of a group of bronze discs keyed to rotate with the wheel, interspaced by steel discs keyed to the anchor bracket and a brake cylinder which acts on hydraulic pressure to force the discs together, thereby obtaining brake action from the resulting friction. Springs, acting on the brake piston, return the piston to the "Brake Off" position when the hydraulic pressure is released, thus allowing the bronze discs to rotate freely. The brake piston is insulated from the heat produced by the brake action by an asbestos disc, thereby removing the hazard of volatilization of the hydraulic brake fluid.

11. Operation of Brake Systems - Force on the brake pedal causes the master brake cylinder piston to move forward. A slight forward movement blocks the compensating port and hydraulic pressure begins to build up in the entire system, thereby causing the wheel brake piston to actuate the brake discs. When the force is removed from the toe pedal, the return springs in the brake assembly cause the wheel brake piston to return and displace the hydraulic fluid back through the system to the master cylinder. Any excess volume of fluid is passed through the compensating port (which is open when the master cylinder is in the "Off" position) back to the reservoir. This insures against the possibility of dragging or locked brakes being caused by the master cylinder. If due to leakage, any fluid is lost back of the front piston seal, it is replaced by gravity from the reservoir. Fluid lost in front of the front piston seal is replaced by fluid passing through the holes in the piston head and around the lip of the front piston seal when the piston makes the return stroke. Consequently, if proper level of fluid is maintained in the reservoir, the master cylinder, connecting line, and brake cylinder are always full of fluid and ready for operation.

12. Parking Brake - The parking brake consists of ratchet pawls held normally out of engagement with the bell-cranks by springs. The brake is set by depressing the pedals and pulling the handle on the center control stand which overcomes the springs and brings the pawls into engagement with the ratchets. The brakes are released by depressing the pedals until the springs disengage the pawls.

NOSE UNDERCARRIAGE

13. General - The nose undercarriage, (See Figures 2, 3), mounted in a well in the fuselage, consists of a cross head fulcrum, an oleo leg, two side brace struts, two torque arms, a wheel fork, a wheel and tyre, a shimmy damper, two drag struts, a torque lever assembly, an actuating jack, a position indicator, an up-lock and a down-lock.

14. The forged aluminum alloy cross head fulcrum is pivoted in two bearings mounted in vertical webs in either side of the wheel well. The oleo leg fits through a hole in the centre of the fulcrum and is held in place by two steel tubes bolted to a fitting on the leg and to each end of the fulcrum. The piston of the oleo leg carries the wheel fork and axle. The fork is connected by the torque arms to the shimmy damper, which is mounted on the lower end of the oleo leg immediately below the drag strut fitting. The torque lever assembly, consists of a steel torque shaft mounted in bearings in the vertical webs aft of the fulcrum, and two steel levers, one centrally mounted on the torque shaft between the webs and pinned to the drag struts, the other lever mounted on the port end of the torque shaft, between the web and the outer skin, and connected to the piston rod of the actuating jack.

15. Retraction - In the retracting operation the gear jack piston rod moves the upper and lower torque levers about the torque shaft axis. The lower torque lever connected to the drag struts, lifts the pivot point between it and the drag struts, upward and slightly forward causing the oleo leg to swing aft and upward about the axis of the cross head fulcrum. As the leg reaches its fully retracted position, it opens the door control valve, allowing the door jack to actuate

the door. In closing, the door pin, mounted at forward end of the door, engages a hydraulically actuated latch which locks it closed.

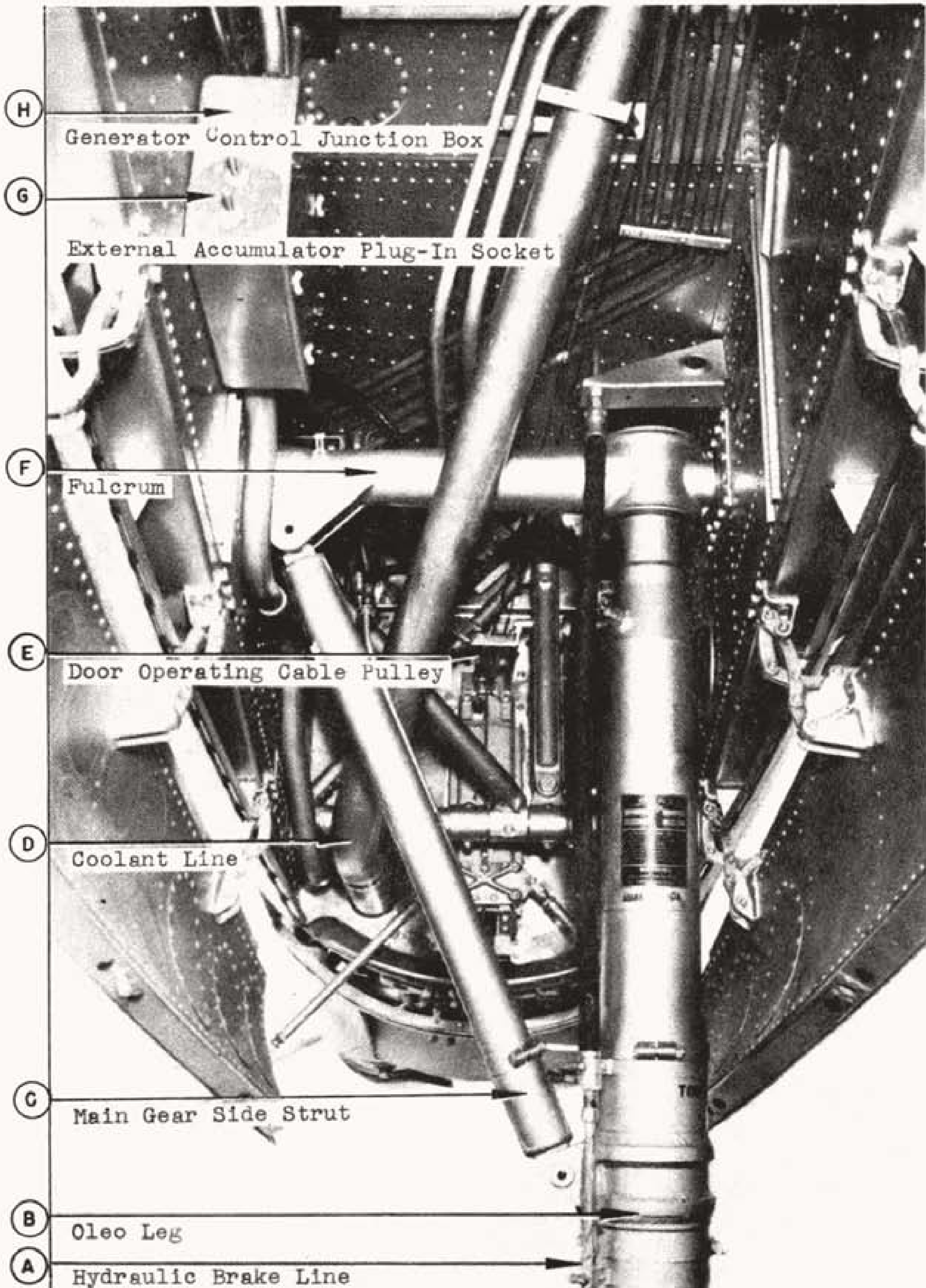
16. Shimmy Damper - The shimmy damper consists of a fluid reservoir, and two small spring loaded hydraulic cylinders (See Figure 2), mounted on the nose oleo so that their pistons straddle the leg on the port end and starboard sides. The supporting bracket encircles and is free to rotate about the leg immediately below the drag strut attachment fitting. The aft end of each piston bears on a roller that is carried on a lug integral with the drag strut attachment fitting. Turning the wheel fork forces the piston in on the side toward which the turn is made. The piston's forward stroke is resisted by forcing the hydraulic fluid through a small drilled passage in the check valve, while the return stroke is free and rapid, due to the strong extension spring and the automatic opening of the check valve. By this action, oscillating motion is resisted and progressively reduced. The bottoming of the pistons in the cylinders limit the swivel arc of the wheel fork to approximately 46° on each side of the centreline of the aeroplane.

INDICATING, WARNING, AND SAFETY DEVICES

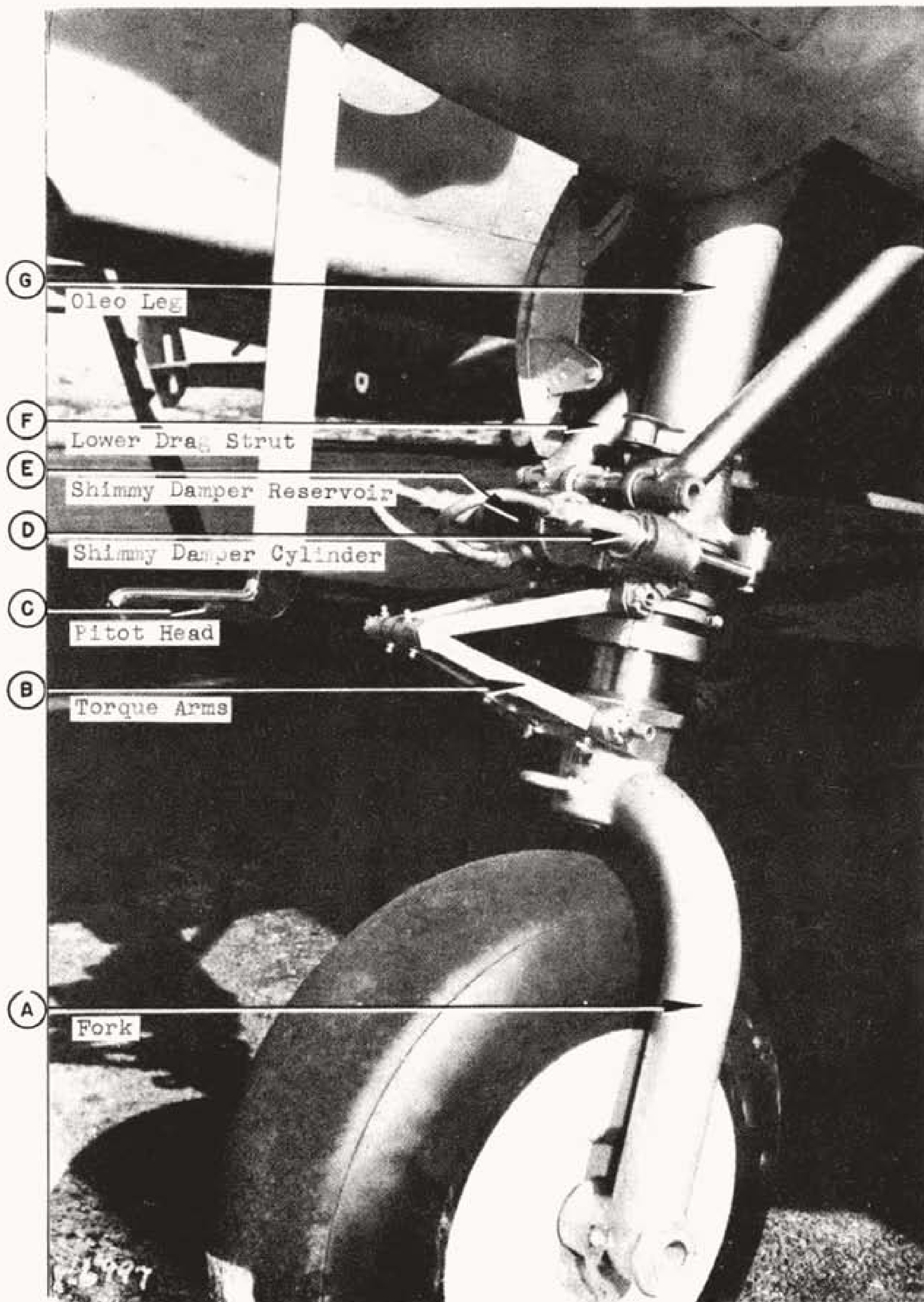
17. Position Indicator - A position indicator on the instrument panel is connected to a transmitter linked to each undercarriage fulcrum. The transmitters are of the rheostat type and allow an amount of current corresponding to the wheel positions to flow to the position indicating instrument. The circuit is controlled through the master switch.

18. Warning System - The circuit operating the warning light on the instrument panel and the horn behind the pilot's seat has a switch for each landing gear that is closed when the gear is retracted and a switch in each engine nacelle that is closed when the throttle is closed. Thus, if the throttles are closed before the landing gear is extended the lamp is lighted and the horn is sounded. A knob on the side control stand operates a relay that will cut out the horn circuit but which automatically resets itself when the throttles are opened again.

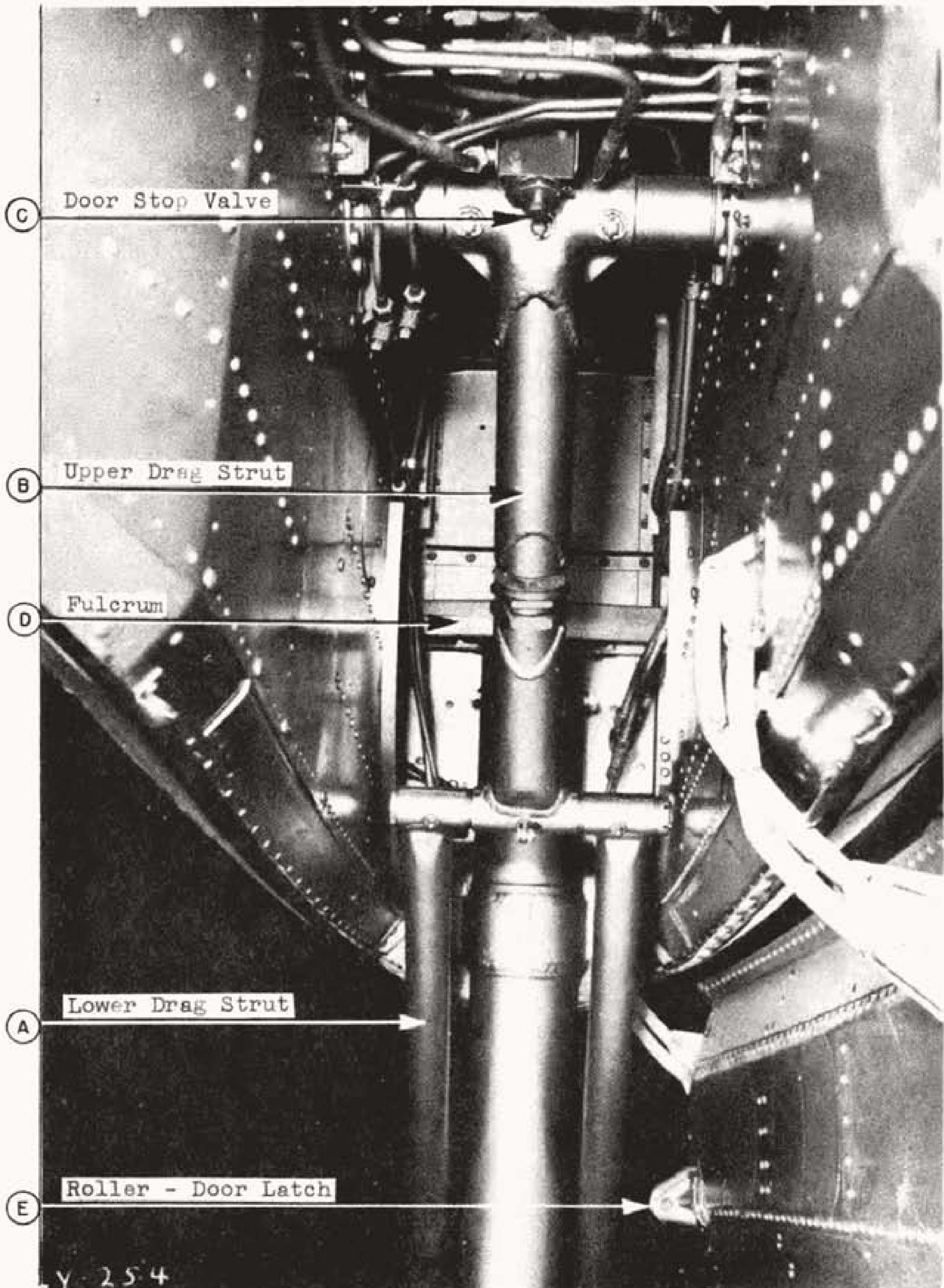
19. Safety System - When the gear control lever is in the "Down" position it is held thereby a spring engaged, solenoid released latch, as long as there is weight on the wheels. In this manner accidental retraction of the gear while the aeroplane is on the ground is prevented. A knob is provided on the side control stand for the emergency releases of the latch in the event the solenoid fails to function.



MAIN WHEEL WELL — FORWARD



NOSE ALIGHTING GEAR — 3/4 FRONT VIEW



NOSE WHEEL WELL - FORWARD

FLYING CONTROLS

CHAPTER 6

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CHAPTER 6

FLYING CONTROLS

1. General - The aeroplane is controlled from the cockpit through the control column, control wheel and rudder pedals. Tinned aircraft cable is used throughout the control system, $3/16$ inch 7×19 for the main flight control surfaces, $1/8$ inch 7×19 for the wing flaps, and $1/16$ inch 7×7 for the trimming tabs. All terminals are of the swaged type with the exception of some spliced eyes used in the flap cables. Sealed bearing anti-friction pulleys are employed exclusively. The cables are stretched prior to installation and are protected from corrosion by the application of a rust-preventive compound. Inspection plates in the aeroplane skin provide for the installation and maintenance of the control cables and fittings. (See Section 4, Chapter 2, Figures 1 and 2 for locations of inspection plates.)
2. Control Column - (Figure 1) - The control column is a hollow inverted "L" shaped member built chiefly of aluminum alloy tubing and one casting. It is mounted on the starboard side of the fuselage in two ball bearings located below the cockpit floor and between the outer skin and wheel well web. Threaded adjustable stops limiting the fore and aft motion of the column are built into the fuselage structure. The aileron control wheel, mounted at the upper extremity of the "L", is limited to $144^\circ \pm 5^\circ$ travel in either direction from its neutral position by adjustable stops. The aileron cable, secured around a drum in the castings, is carried over pulleys at the angle of the "L", extends downward to a second set of pulleys where it leaves the column on the centre line of the column pivot bearings. The aileron tab control unit is mounted at the angle of the "L" and consists of a knob and shaft keyed to a cable drum inside the casting. From the drum the cable extends downward, leaving the control column at the same location as the aileron cable. A geared position indicating dial is mounted concentric with the control knob. The lower extremity of the control column contains the bearings to which are attached the elevator control cables. In addition to flight controls the column carries the gun selector switch box, landing light, navigation and signal switches and identification light tapping key.
3. Aileron Control - (See Section 4, Chapter 2, Figure 4) - After leaving the control column the aileron cable runs aft to a pair of pulleys under the main spar, upward through holes in the lower spar cap and around the larger circumference of a reduction drum mounted inside the spar. From this drum out to each aileron the port and starboard systems are independent, and either side may be disabled without affecting the operation of the other. Cable to the port aileron is secured around the smaller circumference of the drum, one passing over and one under pulleys mounted at the aeroplane centre line, through a fairlead near Sta. 89 and another at Station $118 \frac{3}{4}$ near the rear face of the outer panel main spar and is secured around a differential drum at Station 230. The pivot connection of the push-pull rod to the drum is so located that the rotation of the drum causes aileron movement. Cable to the starboard aileron is secured around the smaller circumference of the reduction drum. The lower cable leaving the drum passes over a pulley at Station 15 and from this point outboard the system is similar to the port side. Turnbuckles for adjusting the cables and for breaking them when removing the outer main plane are accessible through an inspection plate in the lower wing surface aft of the main spar between Stations 146 and 158. The outboard drum and rod are reached through plates in the lower surface.
4. Aileron Trimming Tab Control - After leaving the control column the tab cables follow the same general path of the aileron cables, into the main spar, passing over pulleys near the lower spar cap and extending outboard each way, over a pulley near Station 89, through a fairlead at Station $118 \frac{3}{4}$ around a pulley at Station 182, aft and around a pulley at the aileron hinge line, outboard over a pulley on the aileron spar and around the actuating drum. The return cable follows the same path inboard, connecting directly through from one tab unit to the opposite and passing under a small pulley on the same shaft as the aileron reduction drum. Sleeves on the cable and stops in the wing limit the tab travel.
5. Elevator Control - (See Section 4, Chapter 2, Figure 5) - One pair of cables lead forward from the lower end of the control column, around pulleys at fuselage Station 95 and aft to pulleys under the main spar; another pair of cables travels aft to a similar set of cables in the same location. All four cables enter the main spar and pass over pulleys near the lower spar cap. One "Up" and one "Down" cable travel outboard in each direction through the spar to pulleys near Station 89 (those going to the port boom pass over two pulleys at Station 15 on the port side); here the cables turn aft through the spar web, over pulleys at Station 220 and again at Station 265, diagonally outboard to pulleys on the boom centre line at Station 295, up over pulleys at Station $334 \frac{9}{16}$, one over and one under a pulley at Station 336, and between two pulleys at Station $401 \frac{7}{8}$. Here the "up" cable goes down into the lower fin, around a pulley and up to the lower eye of the elevator horn and the "down" cable goes up over a pulley in the upper fin and down to the upper eye of the same horn. The travel of the elevator is limited by adjustable stops built into the tail boom and acting on the elevator horn.
6. Elevator Trimming Tab Control - The tab control unit is mounted on the side control stand, the operating hand wheel being attached to the drum shaft which protrudes through the inboard face of the side control stand, while the cable drum is located behind the panel. Cables from

the drum go down around pulleys under the floor, aft, up into the main spar, outboard on the port side to Station 89, aft through the port boom in a direction similar to the elevator cables, diagonally inboard through the horizontal tail plane and around the actuating drum on the aeroplane centre line. Sleeves on the cable and stops in the tail plane limit the rotation of the drums.

7. Rudder Control - (See Section 4, Chapter 2, Figure 6) - Rudder control is maintained from the cockpit by means of the rudder pedals. The rudder cables are bolted in pairs to forked masts that extend forward, one on each outboard side of the pedal assemblies. From these masts the cables pass through the cockpit floor, around pulleys at fuselage Station 105 and extend aft between pulleys under the main spar, upward through holes in the lower spar cap, outboard each way through the spar and aft in booms. At Station 401 7/8 the cables are attached to the outer ends of a walking beam pivoted in the tail plane. On the outboard side of each walking beam a push-pull tube connects with the rudder torque tube arm. Rudder travel is limited by adjustable stops acting against the walking beam.

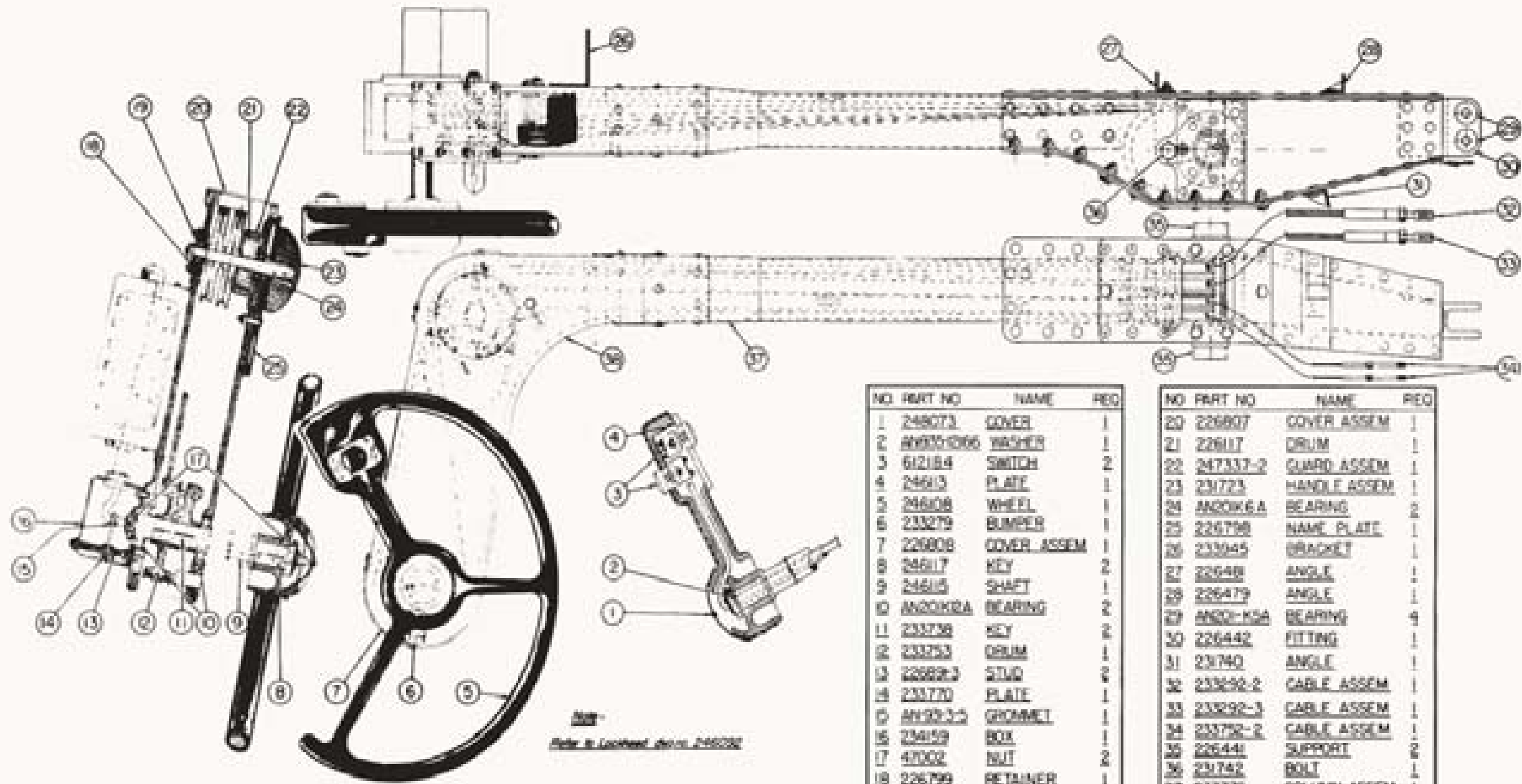
8. Rudder Trimming Tab Controls - The rudder tab control unit is mounted in the sloping face of the centre control stand. The cable from the drum travels forward in the control stand, down through the floor, outboard each way to the outside of the wheel well webs, aft to pulleys under the main spar, up into the spar and outboard each way to Station 89, aft in the booms accompanying the rudder cables, around a pulley mounted with the upper elevator cable pulley at Station 401 7/8, up into the fin over a pulley and downward to the actuating unit. The return cable reverses this path to Station 401 15/16 and connects across through the tail plane to the opposite system. The cable travel is limited by sleeves on the cable and adjustable stops in the fin.

9. Flying Control Parking Lock - The control column, wheel, and rudder pedals may be locked against movement when the aeroplane is parked, by a tube assembly located on the starboard side of the cockpit. The forward end of the tube is linked by a universal joint to a system of levers and rods that operate the rudder pedal lock. With the rudder pedals in neutral, raise the arm rest from the clip that holds it in place on the upper fuselage channel and push forward until the rudder locking pin engages, then swing the rest across the cockpit to the clip on the port side channel and fasten the strap around the control wheel. To unlock, reverse the preceding.

10. Flap Controls - (See Section 7, Chapter 3, Figure 6) - The four sections of the flaps (two on the centre main plane and one on each outer main plane panel) are operated simultaneously by a hydraulically-driven motor acting through actuating screws, push-pull rods, and cables. A control lever on the starboard cockpit wall, just below the window line, is connected through a cable to the flap control valve located aft of the nose wheel well on the starboard fuselage web. Plumbing lines carry hydraulic fluid from the control valve to the motor, which is located on the rear face of the rear shear spar. On the starboard side of the motor a hydraulic pressure shut-off is geared to the drive shaft, while the transmitter for the flap position indicator is located on the port side.

11. The flap screws extend outboard in each direction from their driving mechanism and into the threaded push-pull tubes, which are carried in roller assemblies. Cables attach to lugs on the push-pull tube, one extension and one retraction cable being provided for each flap carriage, one on each end of each flap. From its attaching lug on the push-pull tube, each cable extends through pulleys and is connected to the flap carriage, which rolls along flap carriage tracks built into the wing. The tracks are of such a shape and the flap is carried in such a manner, that as the carriage rolls aft, the flap moves aft and extends downward. In flight, the flap assumes an angle of approximately 35° in the fully extended position (for flap adjustments, see Section 4, Chapter 2).

12. Operation of Flaps - By moving the cockpit flap control lever to attain the desired flap position, the hydraulic flap drive motor is correspondingly actuated (see Section 9, paragraph 4). Through the flap motor drive, the actuating screws are rotated and cause the push-pull tubes to move inboard or outboard, depending upon the direction of motor rotation. The push-pull tubes cause the flap carriage actuating cables to move the flap carriages on their tracks, thus extending or retracting the flaps. The hydraulic pressure shut-off unit is so synchronized with the flap actuating mechanism that as the flaps reach their limit of travel, the hydraulic fluid flow to the motor is stopped.



NO.	PART NO.	NAME	REQ.
1	249073	COVER	1
2	AN9351006	WASHER	1
3	612184	SWITCH	2
4	24613	PLATE	1
5	24608	WHEEL	1
6	233279	BUMPER	1
7	226908	COVER ASSEM	1
8	24617	KEY	2
9	24615	SHAFT	1
10	AN20K2A	BEARING	2
11	233738	KEY	2
12	233753	DRUM	1
13	226893-3	STUD	2
14	233770	PLATE	1
15	AN931-3-3	GROMMET	1
16	234159	BOX	1
17	47002	NUT	2
18	226799	RETAINER	1
19	AN20K4	BEARING	1

NO.	PART NO.	NAME	REQ.
20	226907	COVER ASSEM	1
21	226117	DRUM	1
22	247337-2	GUARD ASSEM	1
23	231723	HANDLE ASSEM	1
24	AN20K6A	BEARING	2
25	226798	NAME PLATE	1
26	233945	BRACKET	1
27	22648	ANGLE	1
28	226479	ANGLE	1
29	AN20-K2A	BEARING	4
30	226442	FITTING	1
31	231740	ANGLE	1
32	233692-2	CABLE ASSEM	1
33	233292-3	CABLE ASSEM	1
34	233792-2	CABLE ASSEM	1
35	226441	SUPPORT	2
36	231742	BOLT	1
37	233779	COLUMN ASSEM	1
38	233795	HEAD CASTING	1

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ENGINE INSTALLATION

SECTION 8

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SECTION 8

ENGINE INSTALLATION

1. The aircraft is powered by two Allison liquid cooled engines, Type V.1710 C.15, R. H. rotating, installed in nacelles at the front ends of the forward booms, and supported by the engine mounts which are attached to the front shear spar and main spar. For a complete description of the engines and operating instructions, refer to A.P.2048A. Photographs of the engine installation are at the end of this section.

2. Each engine mounting is a composite structure consisting of two triangular, forged aluminum alloy trusses which form the lower half of the mounting, and a pair of inverted Vee struts of tubular steel welded to forged steel end fittings, which form the upper half. The two halves are rigidly bolted together. The engine mounting pads and oil cooler support lugs are incorporated in the trusses, and the engine is secured to the pads by 8 bolts. The load on the rear truss fittings is carried by a forged aluminum support bay which is in turn supported by the forward ends of the main wheel well channels and by diagonal tubular steel struts attached to the main beam. The upper fitting on the inboard inverted V-strut is bolted to a fitting on the front shear spar in the centre main plane, the outboard attachment being made to a similar fitting on the outer plane braced by a strut from the main spar. The short arm of the V-strut and the support bay diagonals are adjustable by means of turnbuckles.

3. Engine Cowling and Airscrew Spinner - The cowling for each engine is made in 18 panels exclusive of the carburettor air scoop panel, the airscrew spinner and the leading edge fillet panel. Each panel is attached to the cowling formers and support by Dzus fasteners. The scoop panel is similarly mounted. The formers and supports are bolted to the engine and to clips and fittings on the engine mounting. The airscrew spinner is in two sections, attached to two supports which are bolted to flanges on the airscrew hub. The rear section is made in three segments which fit around the airscrew blade shanks and are fastened with screws to the spinner supports. The nose section is a one piece cone-shaped panel and is riveted to the forward support. The spinner is dynamically balanced.

4. Engine Accessories - The following accessories are mounted on each engine except as noted:

STARTER - Eclipse Series 11, Model 2087H

AIRSCREW GOVERNOR - Curtiss, Drawing No. 100006-1C

GENERATOR - Eclipse 314MOD5 (Port Engine only.)

HYDRAULIC PUMP - Pesco Model 466 (Starboard Engine only.)

FUEL PUMP - Pesco R600 CWB Type D

VACUUM PUMP - Pesco Type B-6

TACHOMETER GENERATOR - Weston Model 752 Type J-4

5. Engine Controls - Figure 8 (Sect. 4, Chap. 2) shows diagrammatically the arrangement of the engine controls. The throttle and mixture control levers for both engines are mounted in pairs on the aft spindle in the side control stand, while the airscrew pitch and heat control levers are mounted on the forward spindle (see Sect. 11, Figs. 9, 10.) A knob is provided on each spindle for adjusting the drag on the levers. Cables running through a tube on the lower leading edge of the main spar connect the control levers in the cockpit to cranks at the engine firewall. Push-pull tubes carry the control into the engine compartment.

6. Engine Starting Equipment - Each engine is equipped with an Eclipse Series 11, Model 208H, combination hand and electrical inertia starter with booster coil, starting solenoid, and meshing solenoid. The wiring of the starting system is included on Fig. 13, Sect. 6. The switches are mounted on the main switch box below the instrument panel. Each switch contains a "START" "MESH" and "OFF" position. (See Sect. 11, Fig. 9). The forward (start) position actuates the starter solenoid, the aft position actuates the mesh solenoid, and the central position is "OFF". An extension shaft for the hand starting crank is accessible through a small door in the right-hand side of each nacelle. A hand crank is stowed in the starboard wheel well just below the automatic recognition device. The ignition (magneto) switches are mounted on the main switch box. The priming system is described under Fuel System. For starting instructions, refer to A.P. 2048A or section of this manual issued separately as "Pilot's Notes".

7. Induction System - The carburettor cold air is brought in through a scoop which is built into the top panel of the cowling over the accessory section of the engine. From the scoop a short duct containing the carburettor air temperature bulb leads straight down to the carburettor. Warm air is supplied to the system by ducts which lead air from shrouds around the exhaust manifolds to the top of the engine, where it mixes with the cold air in the mouth of the scoop. A shutter in the scoop actuated by the cockpit control regulates the amount of heated air thus supplied.

8. Exhaust System - The exhaust gases are collected from the ports by short stacks leading into manifolds extending horizontally along each bank of cylinders to the tail pipes which pass over the main spar on either side of the oil tanks, exiting through the top of the nacelle. Heated air for the cockpit and armament compartment is derived from a muff type heater which leads from the scoop in each cowling, through the exhaust manifold shroud to the firewall, where it enters the main spar and runs inboard to the cockpit.

AIRSCREWS

9. General - Curtiss Full-Feathering Controllable Pitch three-bladed metal airscrews are fitted to the engines and are driven through reduction gears having a ratio of 2 to 1. The pitch changing is accomplished through gears driven by an electric motor which derives its energy from the aircraft's electrical power supply through brushes and slip-rings mounted on the airscrew hub. Both constant speed (automatic) and manual selective control are available. For constant speed, the airscrew is controlled by a governor which is mounted on the forward accessory drive of the engine. For electrical circuit see Sect. 6. For detailed service information refer to the relevant airscrew manual.

10. Airscrew Controls - (See Sect. 11, Figs. 9, 10) - A combination selector switch and manual control switch for each airscrew is installed on the port side control stand. When the switch is in the "Automatic" position, the governor controls the pitch, and the engine r.p.m. may be varied by use of the airscrew control levers. For manual control, the selector switch, normally in the "OFF" position, is thrown to the forward or aft position as desired, to increase or decrease the airscrew pitch.

11. Airscrew Safety Switches - An airscrew safety switch for each airscrew is mounted on the port side of the main switch box and functions automatically in case an overload condition on the airscrew is attained when manual control is used. The switch may be re-set after being opened by throwing it to the full "OFF" position and then to "ON". It should be kept in the "ON" position at all times, whether the airscrew is being operated by manual or automatic control.

12. Airscrew Feathering Switches - The airscrew feathering switches, mounted on top of the channel on the port side of the cockpit, have hinged covers to prevent accidental operation. For further details of operation and circuit layout see the relevant instruction manual, and the aircraft electrical circuit diagram, Fig. 7, Sect. 6.

FUEL SYSTEM

13. General - (See Fig. 12) - Two independent fuel systems are provided, one for each engine, with cross-suction lines for emergency use. Each system is equipped with an engine-driven fuel pump which delivers fuel to the carburettor at the required pressure. Electrically driven booster fuel pumps are also incorporated, one in each system. These pumps may be used for starting and may be operated continuously at altitude if necessary, to maintain proper pressure. A flapper check valve by-passes the fuel around these pumps when they are inoperative.

14. Fuel System - Tanks - Fuel is carried in four self sealing rubber tanks mounted in the centre main plane. Two main tanks of 77 Imp. gals. capacity each, are installed aft of the main spar, and two reserve tanks of 50 Imp. gals. capacity each, are installed forward of the main spar. The normal fuel load is 62 Imp. gals. in each main tank and 31 Imp. gals. in each reserve tank. Both tanks are filled to capacity in the fuel overload condition. The tanks are fastened to the structure with bolts and screws at the fittings for the filler caps, sumps, and quantity gauge transmitters. Panels on the underside of the centre plane are removable for access to the tanks. (See Sect. 4, Chap. 2, Fig. 1). Manholes are located in the bottom of each tank, the one in the reserve tank containing the sump. An additional manhole is located in the top of the reserve tank, accessible only when the tank is removed. Each tank is vented to the outside bottom skin of the fuselage through tubes which connect to the flanges at approximately the highest points on the outboard walls of the tanks.

15. Fuel System - Anti-Surge Tanks - In addition to the four supply tanks, a small anti-surge tank is installed between each main tank and the tank selector valve. Each anti-surge tank is

separated from the main tank by the removable diagonal rib at Wing Station 17-22 1/2, and the two are connected by 1 1/4" O.D. tubes, one at the upper portion of the tank wall and two at the lower portion, the latter having flapper valves at their inboard ends to prevent the return of fuel to the main tanks. A manhole is provided in the outboard side of each anti-surge tank. An anti-surge chamber in the reserve tank is formed by a chord-wise rubber bulkhead, inboard of the center, with two holes over which flapper valves are attached.

16. Fuel System - Filler caps - The filler caps are mounted flush with the main plane surface just fore and aft of the main spar on each side of the fuselage. The caps are installed in fittings which are attached to the tanks and skin in a manner similar to that used in installing the fuel quantity gauge transmitters.

17. Fuel System Sumps - (See Sect. 4, Chap. 1, Figs. 2,3) - Sumps are located in the anti-surge tanks and in the reserve tanks. The sump flange in the anti-surge tank is attached to a well which is supported by the bottom skin of the centre main plane. The sump contains the main tank fuel outlet, including a strainer and standpipe, and a drain cock. The strainer screen is made accessible by removing a plug in the bottom of the strainer assembly. The sump itself is reached through an inspection plate in the bottom of the fuselage. The reserve tank sump consists of a stainless steel plate and a valve for draining the tank. The plate is attached to the lower main plane skin by Phillips head steel screws, and sealed by a leak-proof rubber pad. This opening also provides a manhole for inspection of the reserve tank.

18. Fuel System - Quantity Gauges - The fuel quantity gauges are of the remote indicating electrical type, General Electric transmitters being installed in each tank. The indicators are located at the top of the instrument panel in the cockpit, one showing the fuel quantity in each of the forward (reserve) tanks, the other indicating the amount of fuel in each of the rear (main) tanks. The mounting flange on the forward tank transmitter is secured by bolts to the web of the rib at Wing Sta. 19 1/2 and to a ring moulded into the rubber of the tank wall. The main tank transmitters are mounted vertically in the anti-surge tanks. The mounting flange on each of the latter units is bolted to the top of a spool type fitting in the upper skin structure of the centre plane, a ring in the tank wall being attached to the bottom of the fitting.

19. Fuel System - Tank Selector Valves, Engine Primer, Booster Pumps - The tank selector valves, accessible by removing the skin panel beneath the aft fuselage (see Sect. 5, Fig. 2), are operated individually by mechanical remote controls located on the port side of the cockpit. By use of these valves, an engine may be fed from either the main or the reserve tank of its own system, or from the tank in the opposite system which is feeding the other engine. The engine primer, mounted on the centre control stand, draws fuel from one side of the system only, and may be used to prime either engine through the use of the selector valve. Switches controlling the electrically driven booster pumps are also mounted on the port side of the cockpit. The pumps are accessible by removing the skin panel beneath the aft fuselage.

20. Fuel System - Strainers (See Sect. 5, Fig. 2) - The fuel strainer in each system is a United Aircraft Products, Inc. Type C-4 unit, mounted below the selector cock between the latter and the electrically driven fuel pump. The strainers are accessible through removable panels in the bottom of the fuselage.

21. Fuel System - Piping - The piping circuits (Fig. 12) of the two sections of the fuel system are virtually identical. Pipes from the main and reserve tanks lead to the tank selector cock from which the fuel passes through the strainer to a "Tee" fitting from which it is drawn through a by-pass pipe or through the electric fuel pump when the latter is operating, and from there to the engine-driven pump and to the carburettor. The dual engine primer draws fuel through a pipe from the strainer on the starboard side. From the port strainer, a 3/8" O.D. tube leads to a jettison valve located on the forward port side of the fuselage. The cross-suction lines lead from the upper forward port of each tank selector cock to a "Tee" connection in the pipe in the opposite system between the selector cock and the fuel strainer. The main tank vent lines lead from the outboard end of the tanks rearward to the aft side of the rear shear spar, and inboard to the fuselage, where they are directed downward to the bottom side of the fuselage. The reserve tank vent lines run forward through the front shear spar inboard along its forward face to the fuselage, whence they turn downward to the fuselage skin. Vapor return lines vent the carburettors to the reserve tanks. All lines containing fuel are marked with red encircling bands 1/2 inch wide at each terminal and at other appropriate points.

OIL SYSTEM

22. General - (See Fig. 13) - Each engine has an independent oil system with provisions for partial circulation and dilution of cold oil to aid in starting. Dual oil temperature regulators (coolers with thermostatic by-pass valves) are located in the lower part of each engine cowling.

23. Oil System - Tanks - The oil tanks are fastened to the firewall and the main spar by Dural straps backed with pads of composition rubber. The tanks are of welded aluminum alloy construction and are interchangeable, port and starboard. Each tank is composed principally of two parts, a vertical section which lies along the forward face of the firewall, and a horizontal section which extends aft over the main spar. The capacity of the tank is 10 Imp. gals. plus 1.2 Imp. gals. foaming space. Normal load is 7 Imp. gal. per tank, and in the overload condition, full tanks (10 Imp. gals. each) are used. A leveling cock on the left-hand side of each tank may be opened to determine the normal load. The warm-up hopper is a cylindrical shell which extends through the vertical section, to the sump which is located at the bottom of the tank. It is riveted to the tank section at the front and rear, where the hopper and tank are tangent. The filler cap is on the port side of the upper surface of the vertical tank section, recessed in a well in the surface. An aluminum alloy tube is provided as a guide for a dip stick for measuring oil quantity. The tank is vented at the front and rear to the crankcase of the engine.

24. Oil System - Coolers - The oil coolers, two for each engine, are United Aircraft Products units, 10" in diameter, with thermostatic by-pass control valves, and are installed in a duct in the lower cowling. The passage of air through the cores is regulated by electrically actuated exit flaps which are controlled from the cockpit by a toggle switch. An oil cooler flap position indicator of the selsyn type is installed on the instrument panel. The operating mechanism incorporates a gear box, electric motor, selsyn transmitter, and two micro limit switches which stop the motor automatically as the flap reaches either end of its travel. The flap is fastened to the operating mechanism by bolts which are reached through cover plates on the inside of the flap. The operating mechanism is attached by screws to two webs between the coolers.

25. Oil System - Partial Circulation - The oil return line nozzle is located in the centre of the top of the forward tank section, so that the oil returning from the engine is discharged directly into the hopper. Thus a warm oil supply is available within a short time after starting the engine.

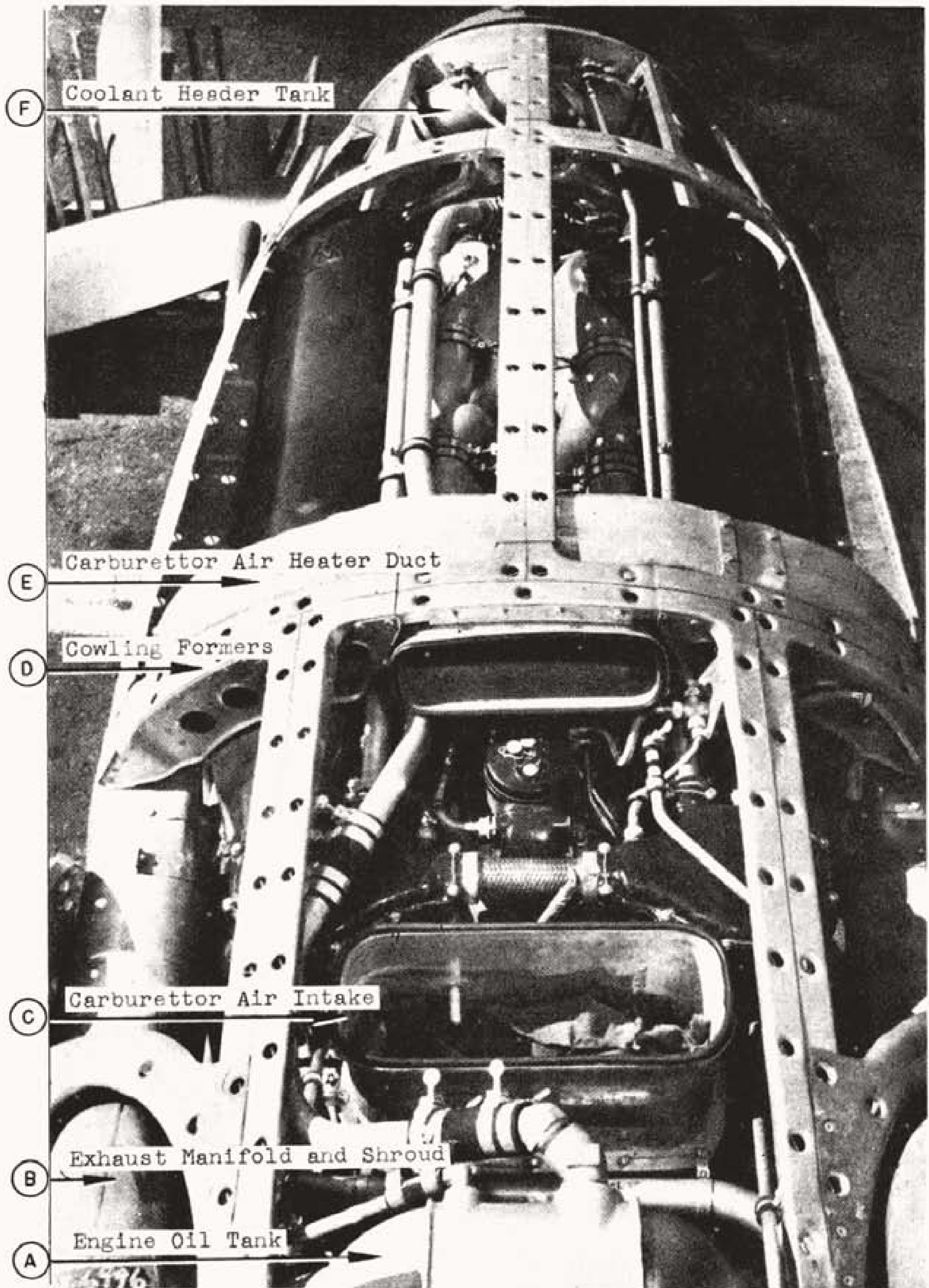
26. Oil System - Dilution - An oil dilution system, to assist in circulating cold oil, is provided for each engine. The system consists of a line from the fuel pressure gauge tube to the "Y" drain cock in the oil inlet line. The flow of fuel to the oil line is controlled by a valve, operated by a solenoid which in turn is controlled by a switch on the centre control panel in the cockpit. For the electrical circuit, see Fig. 12 in Section 6.

27. Oil System - Pipe Lines - The oil piping is shown in Figure 13. The oil leaves the tank through a sump and flows to the pump through a line containing a "Y" drain cock, the oil temperature thermometer well, and the oil dilution line connection. After circulation through the engine, the oil leaves via two lines which lead to the oil temperature regulators, from which it is conducted back to the tank, where it empties into the hopper. The oil pressure gauge line is connected at the oil pump and runs from there through fairleads along the forward face of the forward spar, to the instrument in the cockpit. The temperature line is routed in a similar manner. All oil lines are marked with yellow bands 1/2 inch wide.

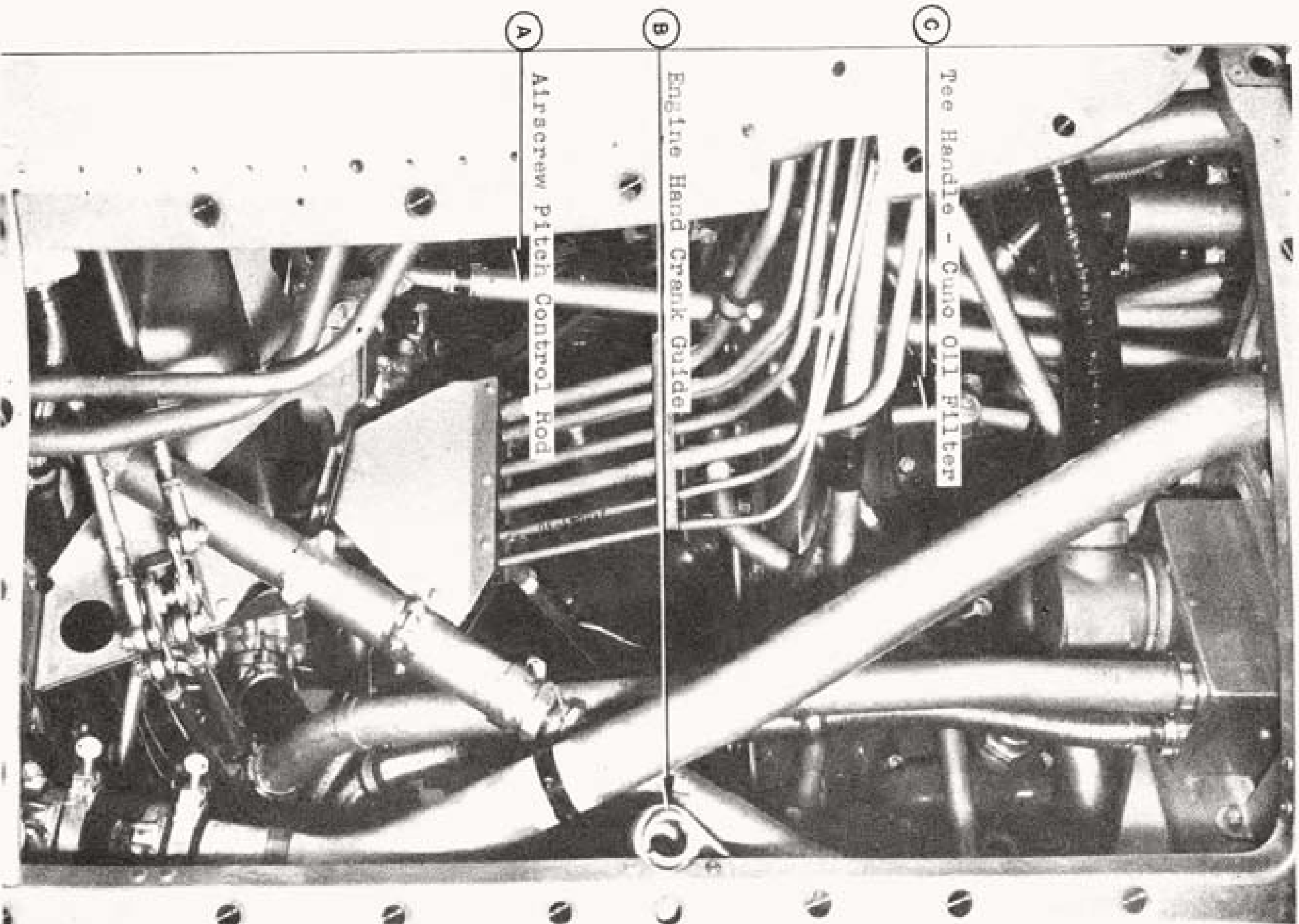
COOLING SYSTEM

28. General - An independent cooling system is provided for each engine. (See Fig. 14.) Each system has a capacity of approximately 17 Imperial gallons and Ethylene Glycol, Spec. D.T.D. 344 is used for coolant. The header tank contains vent and overflow connection, a snuffle valve, and the filler cap. The overflow line runs from the top of the tank to an opening in the skin on the inboard side of the cowling. The snuffle valve provides a balance between internal and external pressure, relieving when the pressure difference exceeds 2 pounds. A tube connects the tank to the main circulation system just aft of the coolant pump, which is located at the bottom of the accessory section of the engine. The pump circulates the coolant in the jackets of the two banks of cylinders whence it leaves via the connections at the forward end of each bank and is carried through tubes, which pass between the webs and outer skin of the boom, to the radiators which are located, one on each side of each aft boom, between Stations 282 3/4 and 295 (see Fig. 11). From the radiators, the liquid is piped to a "Y" from which a single line runs forward to the pump. The outlet lines are vented from their high points to the header tank, and the return line contains two drain plugs at the low points and a cock for bleeding the high point. The well for the coolant thermometer is contained in one of the outlet lines. An air scoop in front of each radiator directs air to the core, and the flow of air is regulated by exit flaps which are hydraulically actuated. The four-way control valves, one for each pair of radiators, are located in the fuselage wheel well at Station 100 and are connected by push-pull remote controls to the knobs on the port cockpit sill (see Sect. 4, Chap. 2, Fig. 9; and Sect. 11, Fig. 10). The radiators are clamped in Neoprene lined cradles which are supported by frames attached to the boom structure with Lord bushings. The lines in the system are marked with 1 1/2 inch white-black-white bands.

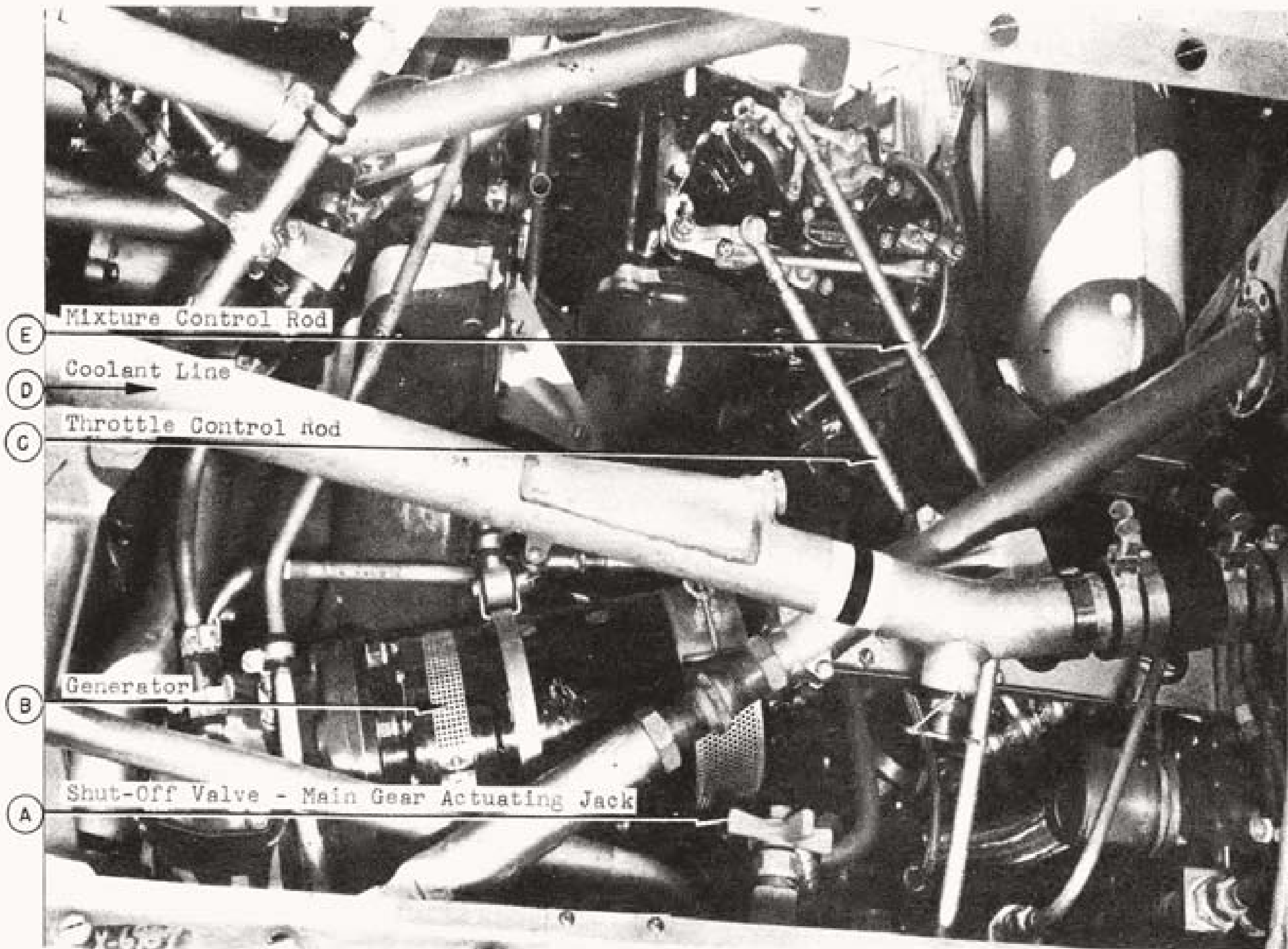
29. Accessory Cooling Tubes - A special spark plug cooling tube replaces the tube supplied with the engine. An extension from the aft end of the starboard tube carries cooling air to the magneto, and on the port side an extension carries air into the tachometer generator drive on the engine. Another special tube receives air from the oil cooler intake ducts and exhausts on the airscrew relay box, engine junction box and rear accessory compartment.



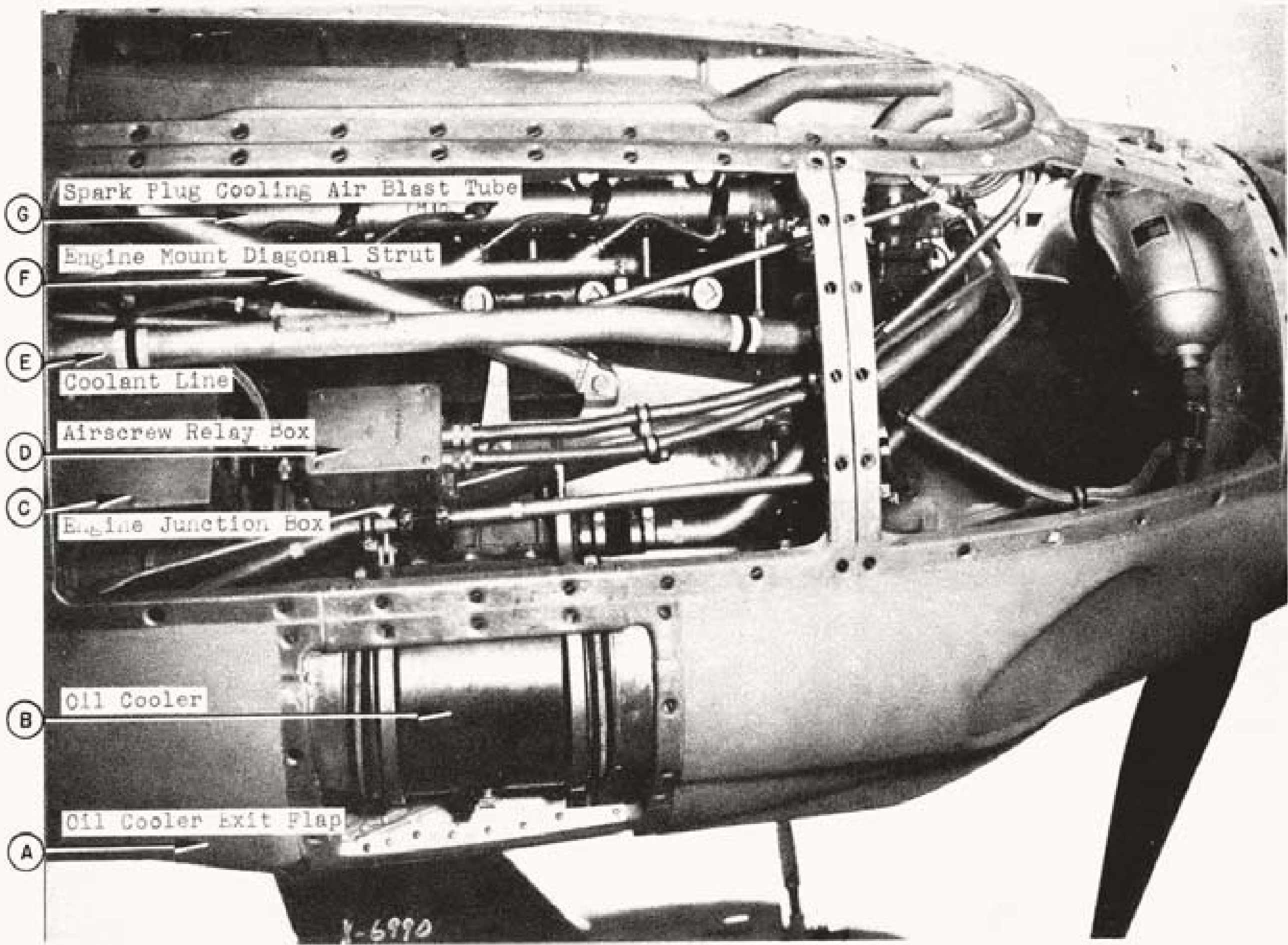
PORT ENGINE — TOP VIEW



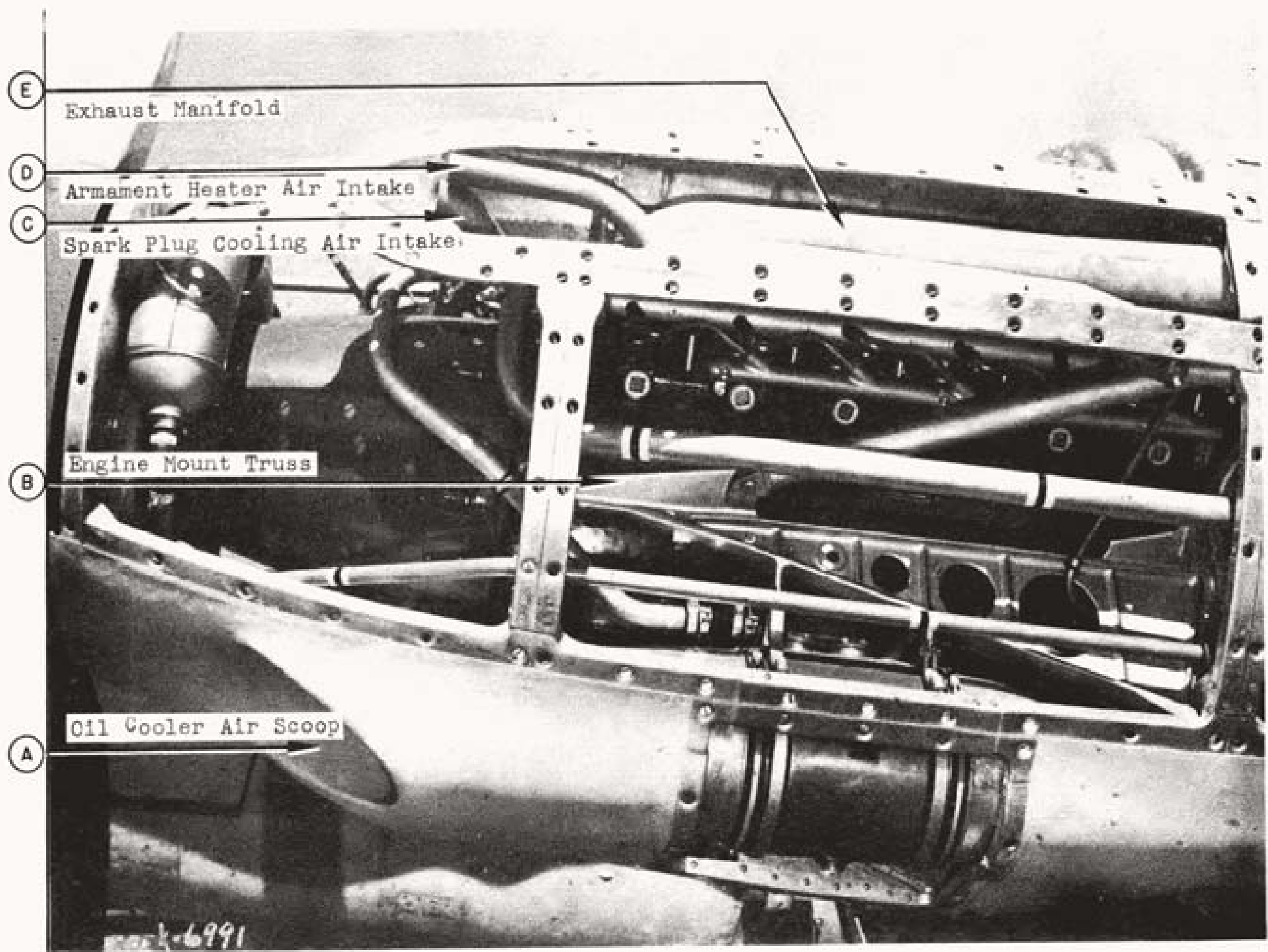
PORT ENGINE ACCESSORY COMPARTMENT — INBOARD



PORT ENGINE ACCESSORY COMPARTMENT — OUTBOARD



PORT ENGINE - INBOARD



E Exhaust Manifold

D Armament Heater Air Intake

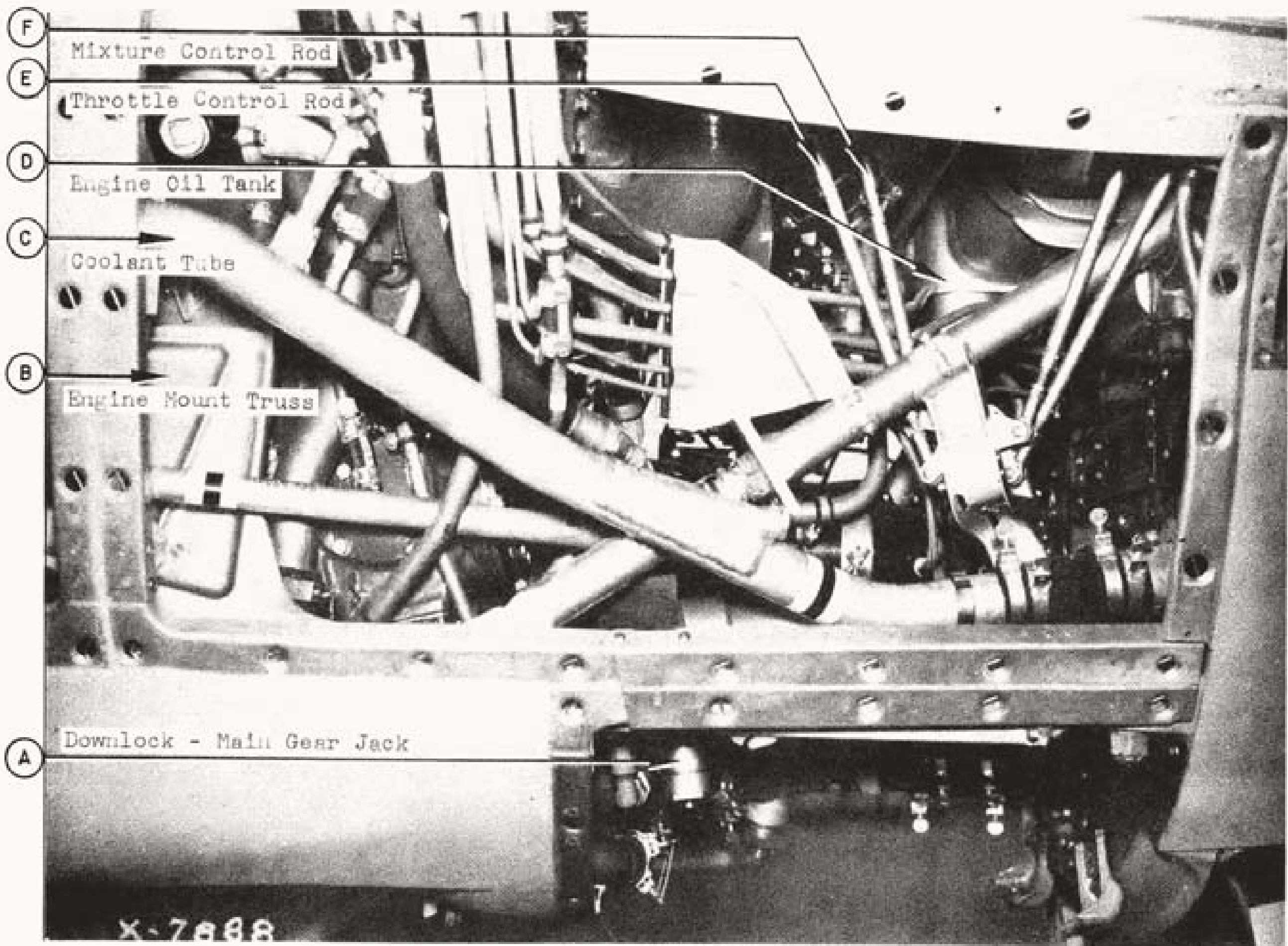
C Spark Plug Cooling Air Intake

B Engine Mount Truss

A Oil Cooler Air Scoop

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PORT ENGINE — OUTBOARD



F Mixture Control Rod

E Throttle Control Rod

D Engine Oil Tank

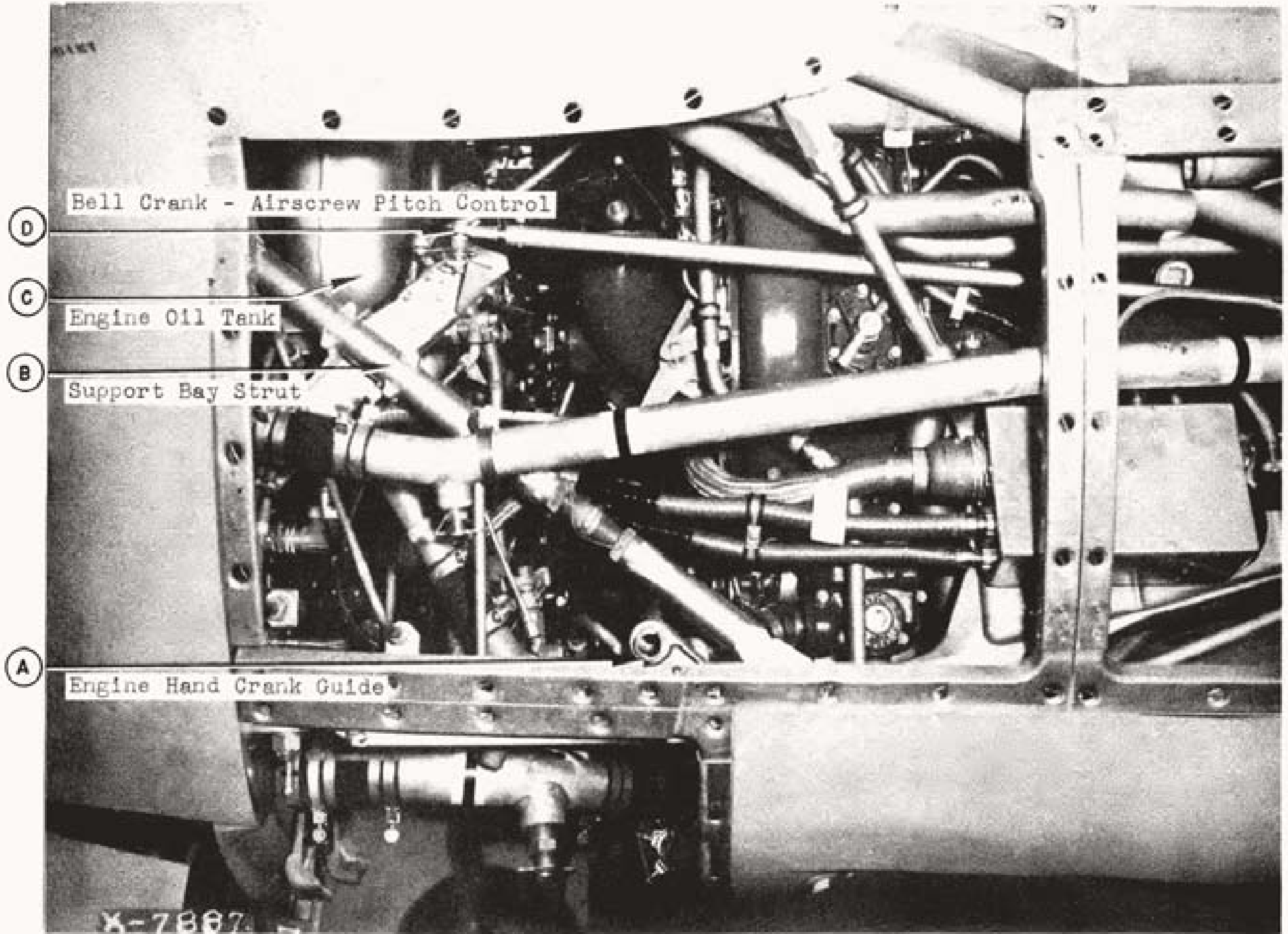
C Coolant Tube

B Engine Mount Truss

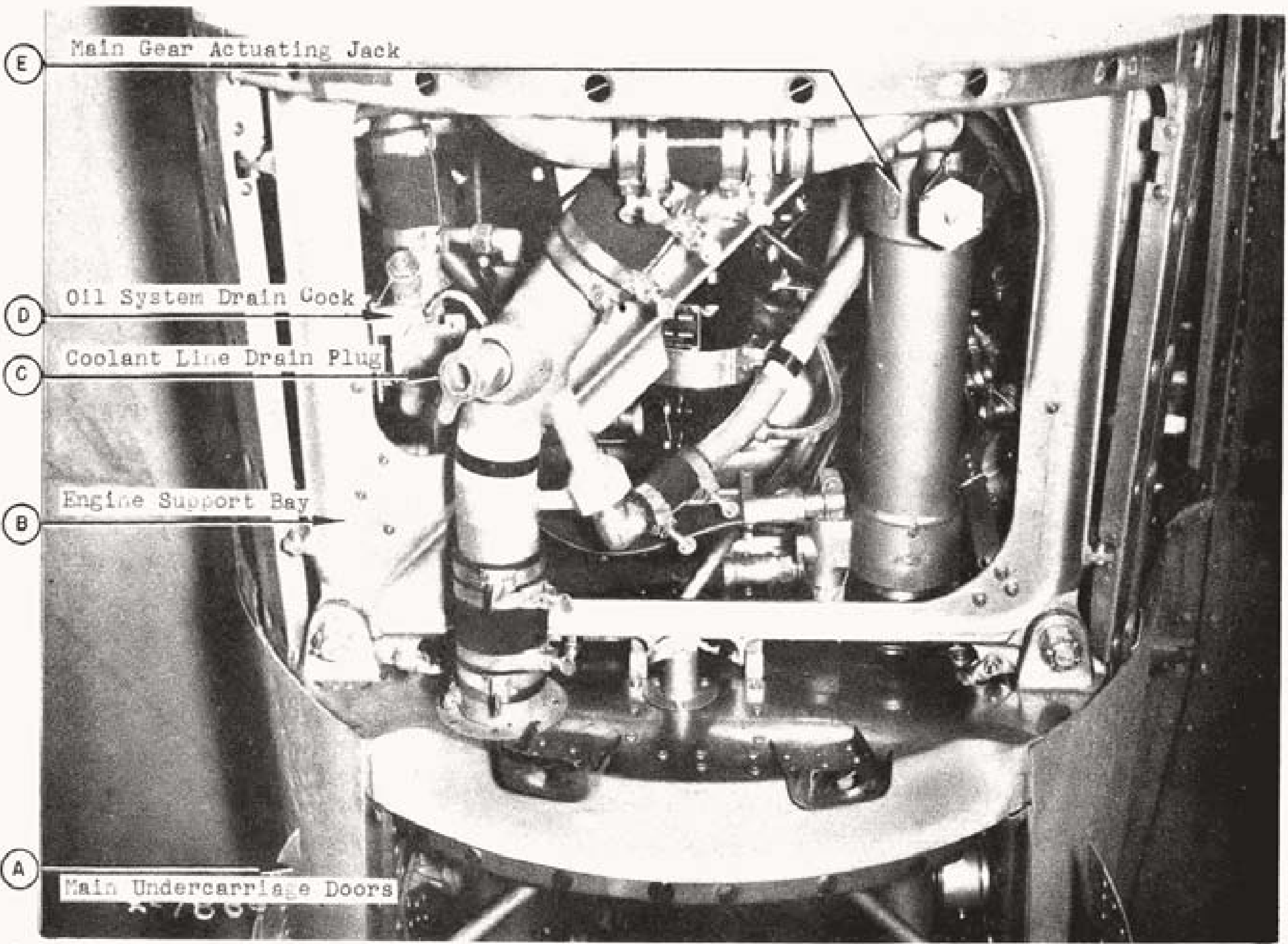
A Downlock - Main Gear Jack

X-7688

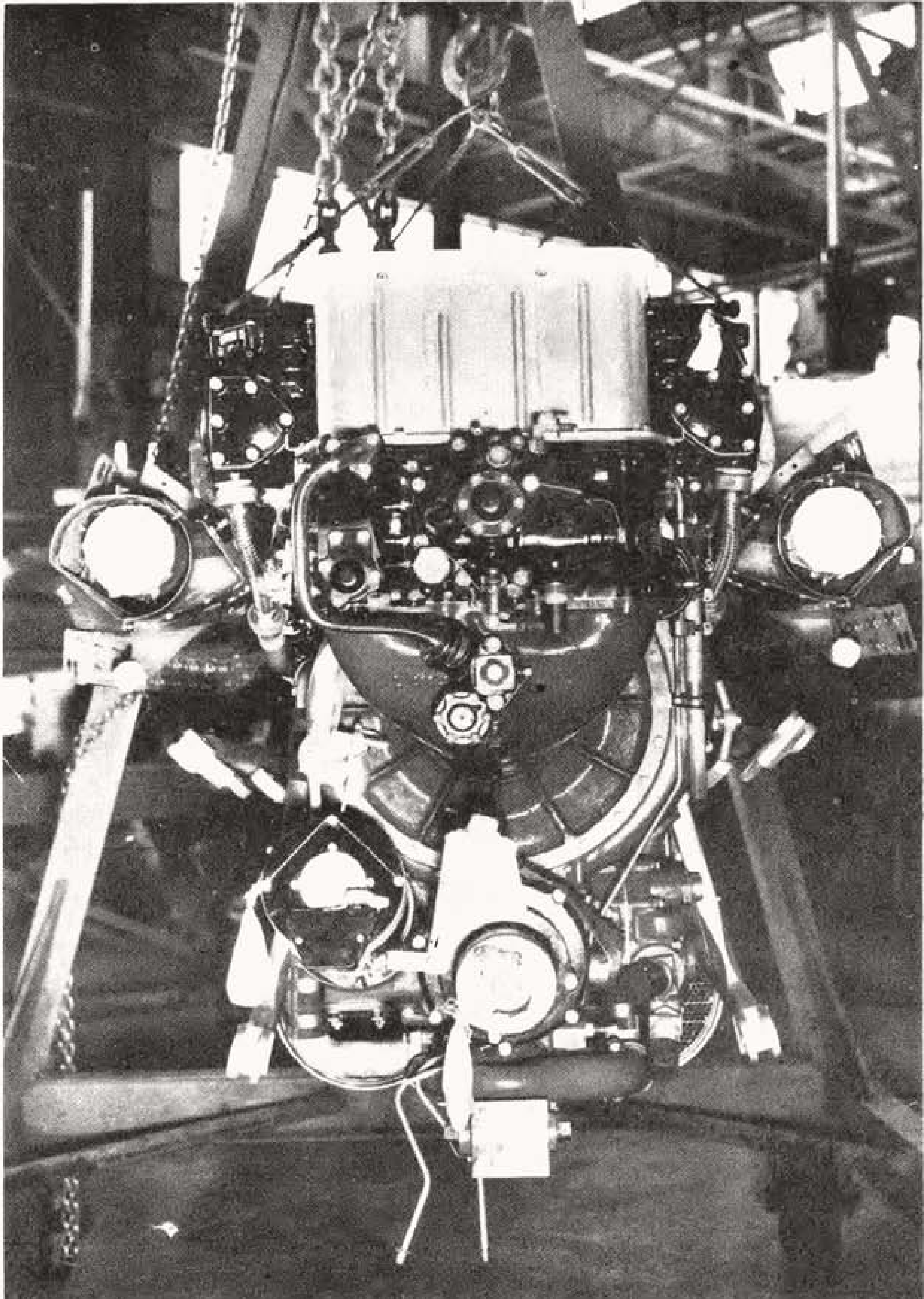
STARBOARD ENGINE ACCESSORY COMPARTMENT — INBOARD



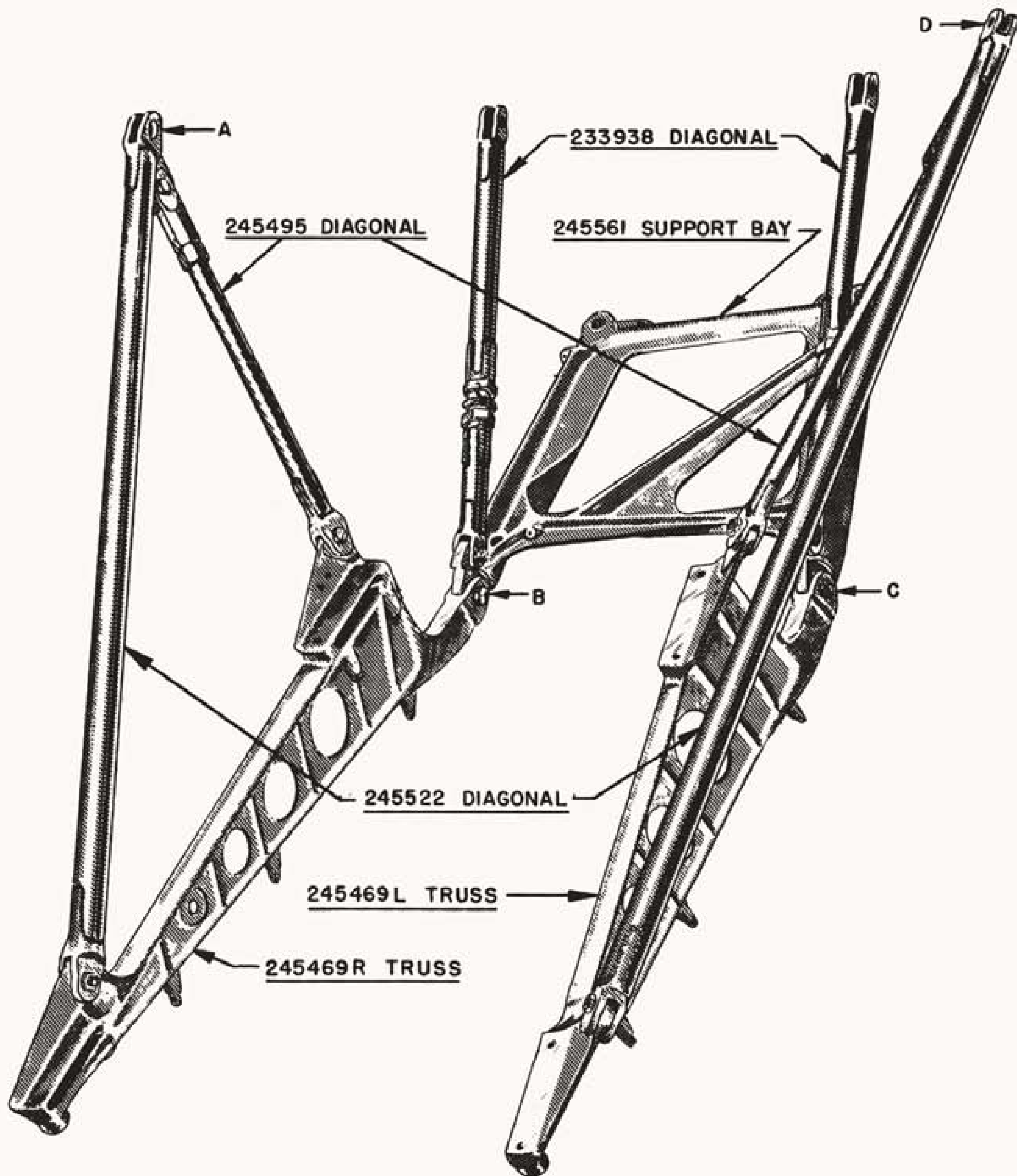
STARBOARD ENGINE ACCESSORY COMPARTMENT - OUTBOARD



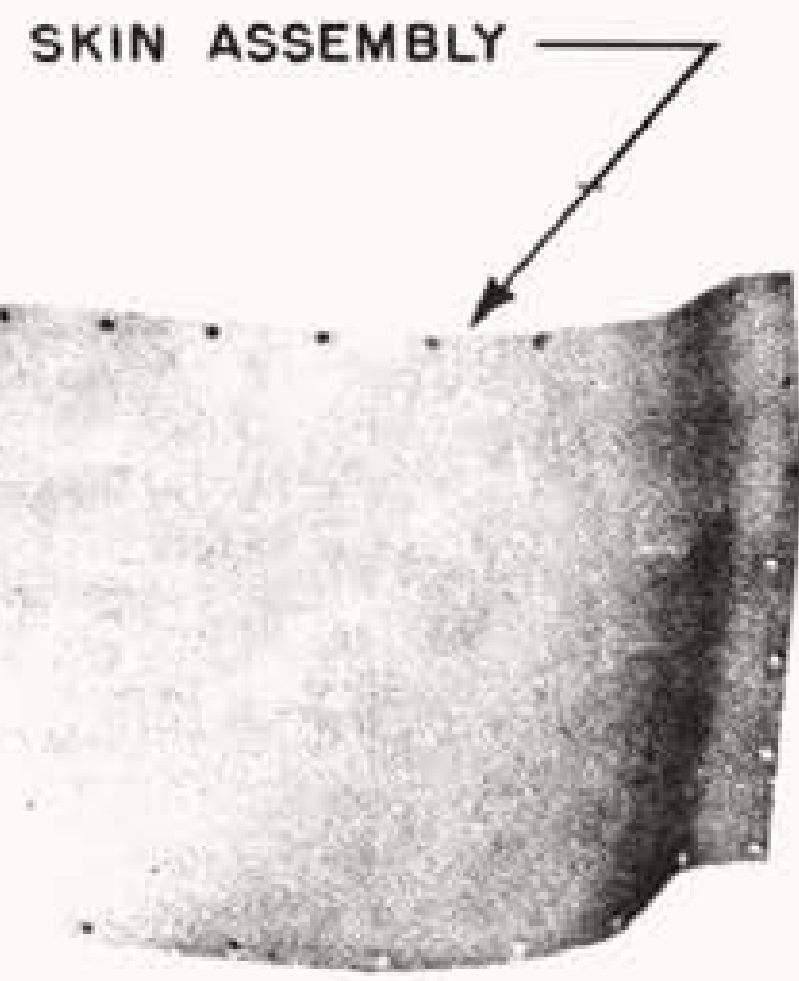
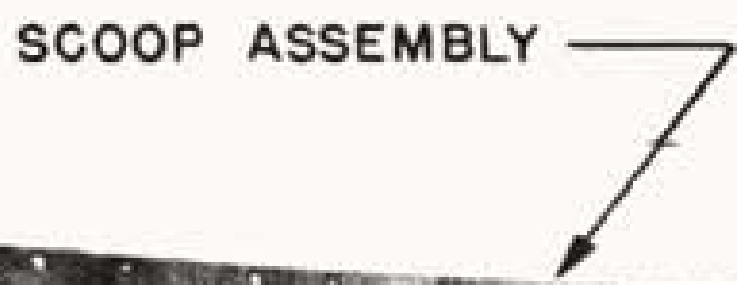
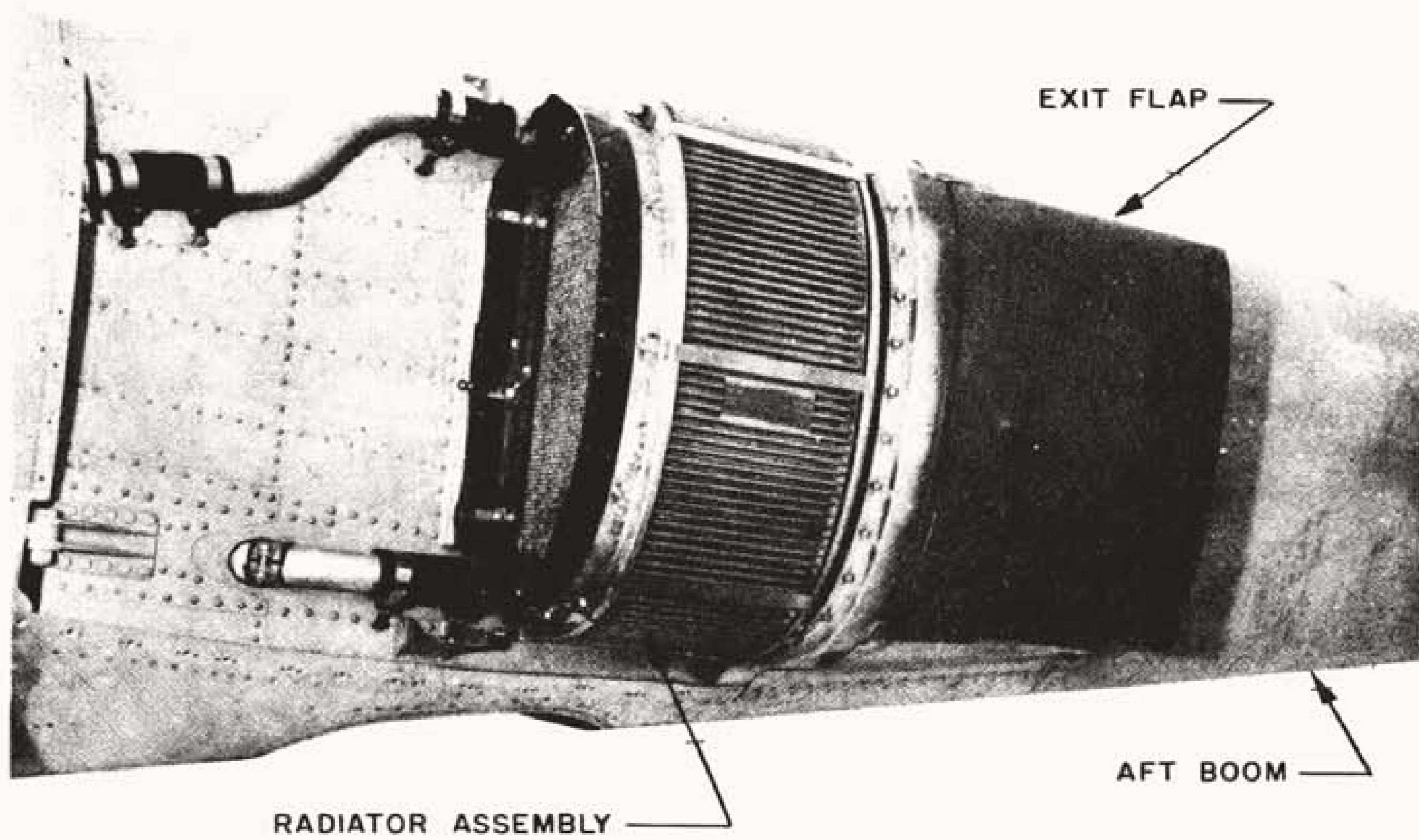
STARBOARD ENGINE ACCESSORY COMPARTMENT - BOTTOM VIEW



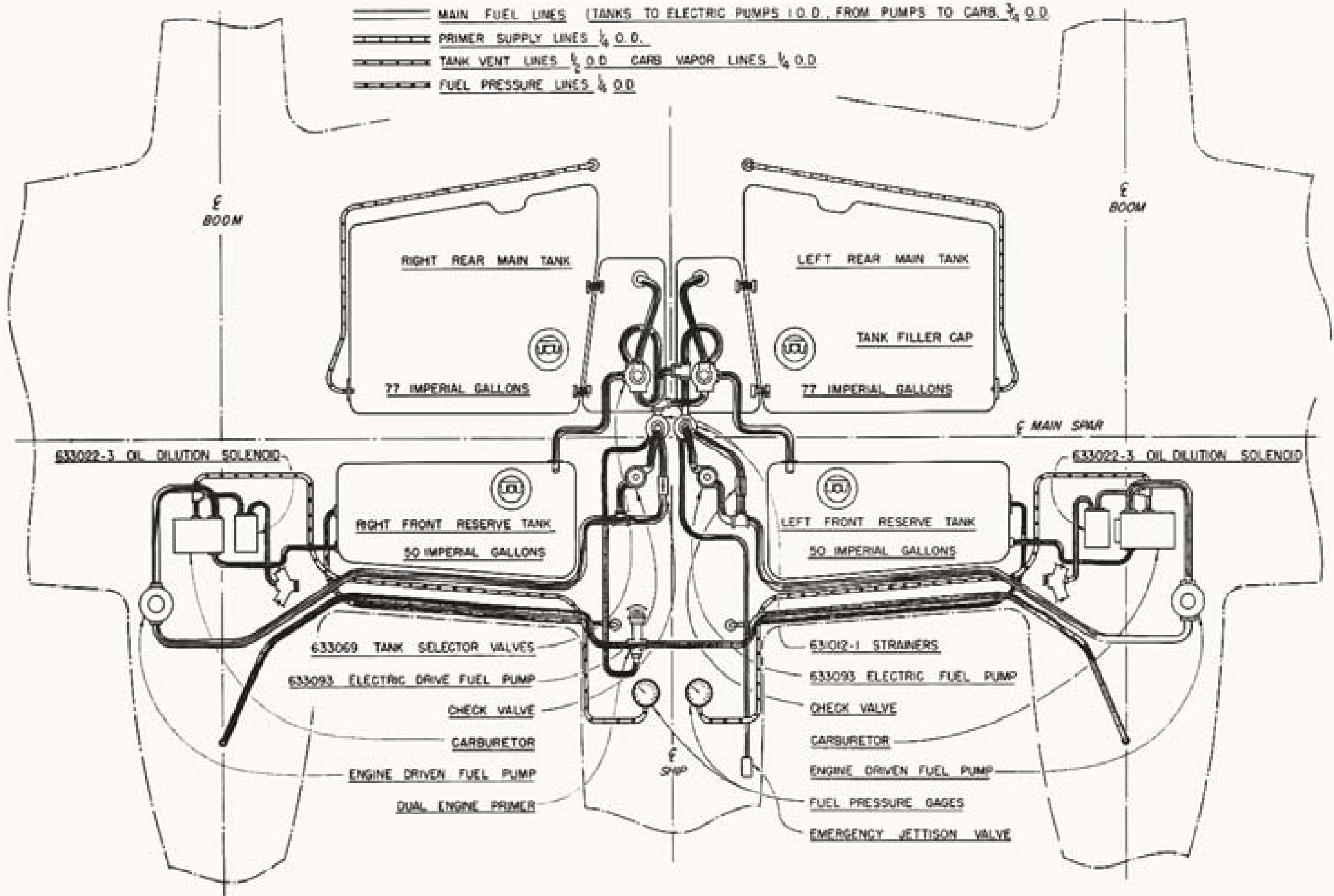
PORT ENGINE - REAR VIEW



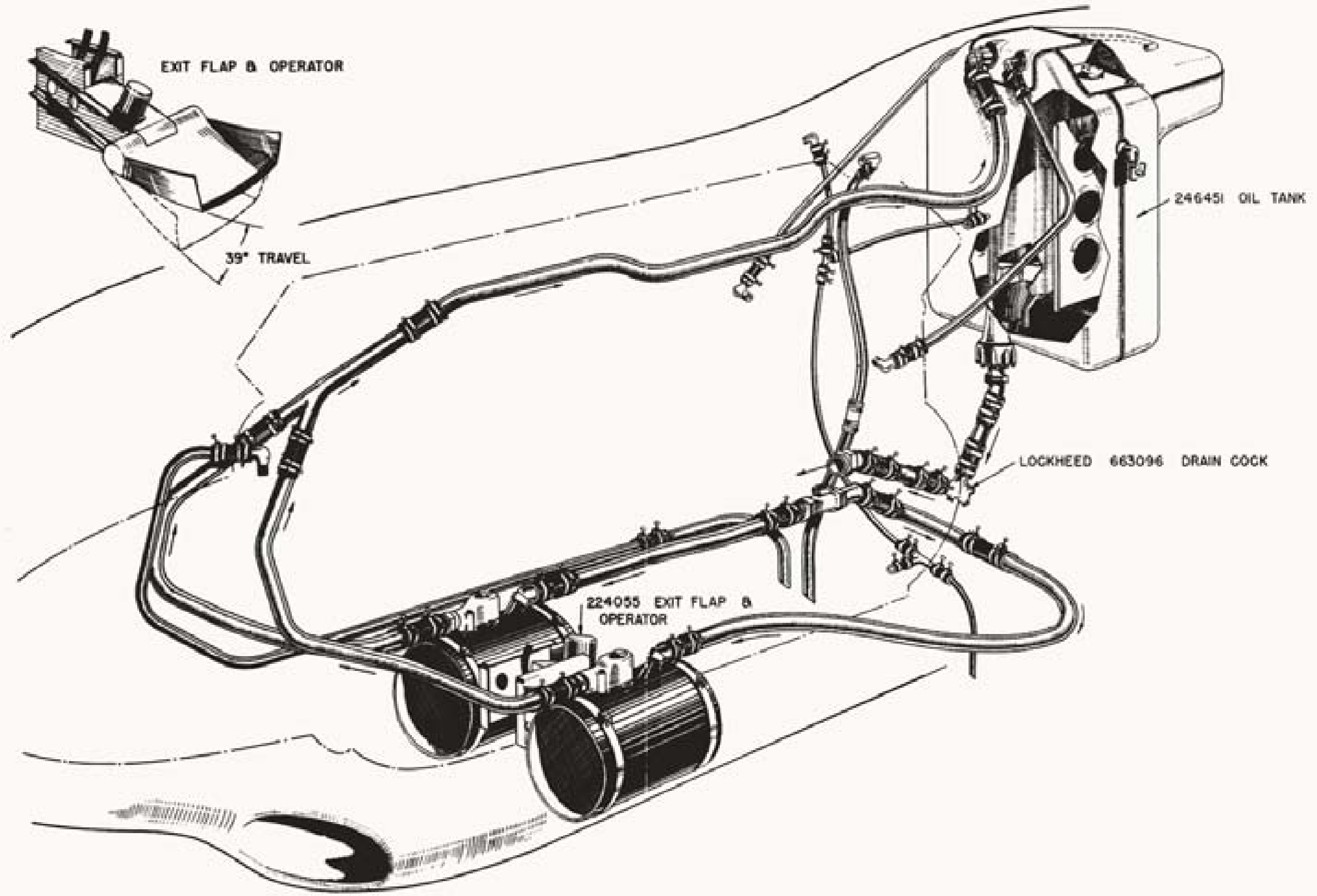
PORT ENGINE MOUNT

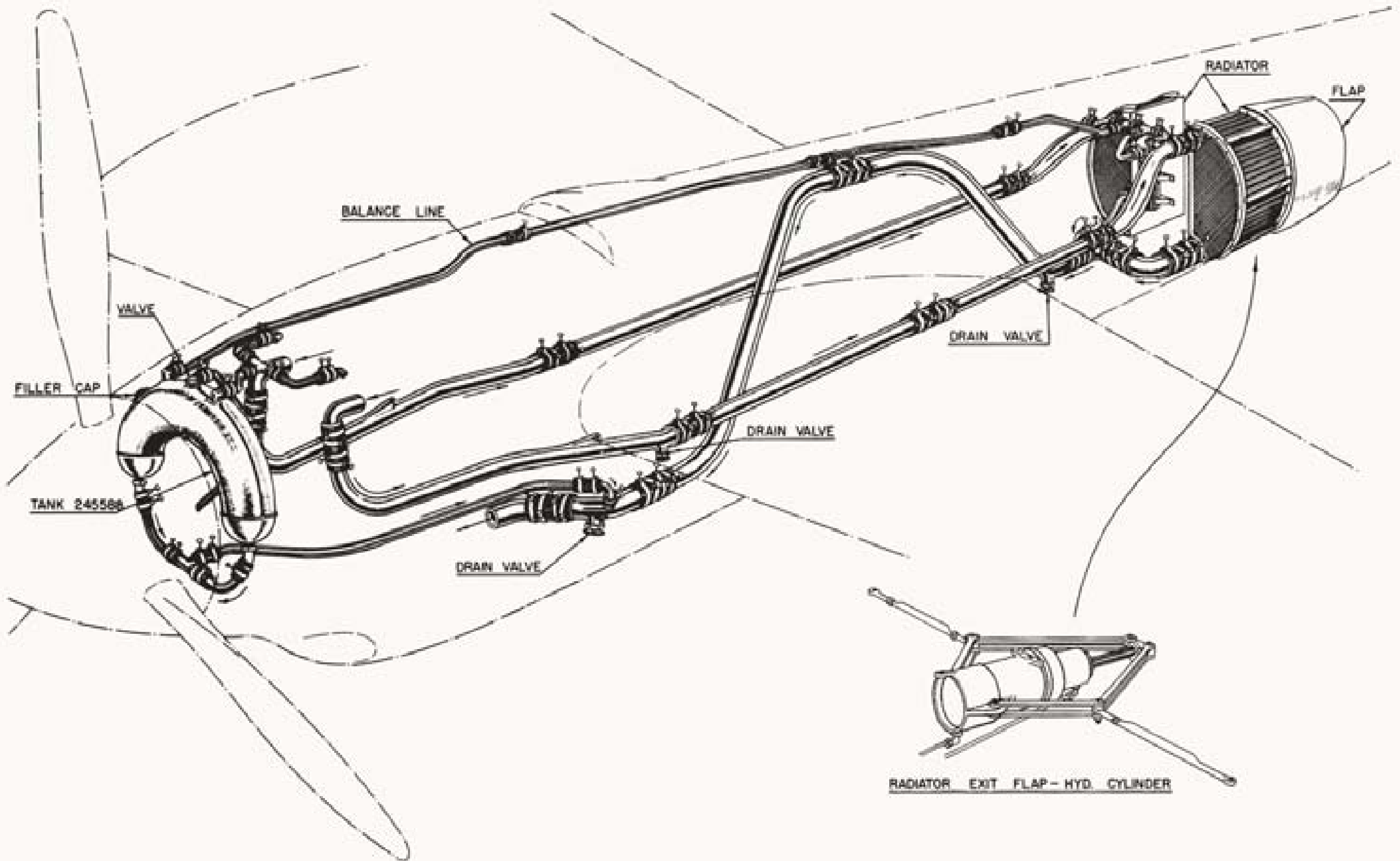


COOLANT RADIATOR - PORT BOOM OUTBOARD



FUEL SYSTEM DIAGRAM





COOLANT SYSTEM

HYDRAULICS

SECTION 9

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SECTION 9

HYDRAULIC SYSTEM

1. Operation of System - The hydraulic system provides a method of transmitting power in the form of hydraulic pressure, supplied by the engine driven pump, or the hand pump. Pressure is directed to the following mechanisms as desired, by operation of the control levers and valves. See Fig. 1.

- a. Alighting Gear Jacks
- b. Flap Motor
- c. Cannon Charger
- d. Cannon Firing Equipment
- e. Cannon Case Ejection Door
- f. Coolant Radiator Exit Flaps

2. Power Supply - (Pump to Control Valves) See Fig. 2. Fluid is drawn from the reservoir by the engine driven pump, mounted on the starboard engine and forced through the pump check valve and the filter to the main pressure regulator. The pressure range is controlled by the regulator, which is set to operate between 1150 and 1350 p.s.i. When the system pressure reaches the upper limit, the regulator by-passes the pump pressure to the reservoir with no load on the pump, until the system pressure drops to the lower limit, when the cycle is repeated. Should the regulator fail to function, relief valves in the undercarriage and flap selector valves, set to open at 1500 p.s.i. will protect the system from excessive pressure. From the regulator, pressure is delivered through a distributing line to the accumulator, and to the alighting gear control valve, flap control valve, system pressure gauge, coolant radiator exit flap control valve, cannon charger control valve, cannon firing solenoid valve and the cannon case ejection door control valve. The hand pump pressure line is connected to the pressure distribution line in normal operation. When the emergency lines are used to extend the alighting gear the hand pump is supplied with fluid from the emergency reservoir and delivers pressure into the emergency lines through a check valve.

3. Alighting Gear - Fig. 3

a. Retracting Operation - Selection of the desired operation of the alighting gear is made through a control valve having two positions "UP" and "DOWN" thus pressure is maintained on one side of the actuating pistons at all times. When the control lever is placed in the "UP" position, pressure is directed into the "UP" line and the "DOWN" line becomes a return line. Fluid passes through the "UP" line to the down locks at the gear jacks, and to the door stop valve which is closed except when the gear is fully retracted. As fluid enters the down lock, the pressure lifts the pin from its groove in the piston head before entering the cylinder and moving the piston. When the gear has traveled to within 1/4" of its fully retracted position, a thumb point on the oleo-leg engages the pressure rod on the door stop valve, opening the valve and allowing pressure to reach the door jack. Immediately after the door jacks operate, pressure builds up sufficiently to overcome the 750 pound relief valve in the line and operate the nose door locking jack. The gear is held up by hydraulic pressure, allowing 3/16" clearance between the up-lock plunger and the inside diameter of the axle, as long as the control lever is left in the "UP" position.

b. Extension - When the control lever is placed in the "DOWN" position, pressure is directed into the "DOWN" line and "UP" line becomes the return line. Fluid passes through the down line to the up-locks, nose door locking jack and the door jacks. The nose door locking jack operates immediately due to its low operating pressure, followed by the door jacks, which require less pressure than the up-locks. After the door jacks operate, pressure increases in the up-locks sufficiently to withdraw the plunger from the landing wheel axle and to pass into the gear jacks, thus extending the gear. When the emergency extension system is used pressure travels through separate lines from the hand pump to the gear jacks through the up-locks.

4. Main Plane Flaps - See Fig. 4 - The flap control lever has three positions, "UP", "DOWN" and "CLOSED". The "UP" and "DOWN" positions control the direction of flap movement while the "CLOSED" position enables the pilot to stop the motion and lock the flaps hydraulically, in any desired intermediate position. Fluid from the four-way valve flows to the hydraulic motor through a dual, mechanically operated cut-off valve, which automatically cuts off the pressure to the motor at either extremity of flap travel. Fluid is returned from the motor to the hydraulic reservoir. The drain line at the motor returns any leakage past the bearing, to the reservoir.

5. Armament Units - Hydraulic pressure is used for charging and firing the cannon and for operating the cannon case ejection door. A schematic diagram of the plumbing is shown on Fig. 1. Refer also to Section 11, Armament.

6. Coolant Radiator Exit Flaps - Fig. 1. The radiator flaps are actuated by hydraulic jacks in each boom controlled by a manually operated four-way valve.

HYDRAULIC EQUIPMENT - POWER SUPPLY

7. General - Illustrations and instructions for maintenance of hydraulic equipment are contained in Section 4, Chapter 2 of this manual. Following is a brief description of the hydraulic units:

8. System Reservoir - An aluminum alloy reservoir of approximately 1 3/4 Imp. gals. capacity is mounted in straps on the rear face of the bulkhead at Station 192 1/4 in the upper aft portion of the fuselage. The filler neck, at the top of the reservoir, is screened by a removable finger strainer held in place by the cap. A plug assembly in the bottom of the reservoir, to which the drain line and flap motor drain line attach, carries a screen that strains the fluid as it circulates through the system. Pipe lines connected to the reservoir are as follows: - Top - vent lines, Port side - outlet to pump, Starboard side - System return line, Bottom rear - Hand pump, Bottom centre - Flap motor drain and reservoir drain outlet.

9. Engine Driven Pump - A NO. 466 Pesco pump is mounted on the accessory drive on the starboard engine. Pump capacity is approximately 4 Imp. gals. per minute. Refer to the vendors manual for detailed service information.

10. Pump Check Valve - A check valve is installed in the pump pressure line, between the engine pump and the Cuno filter.

11. Pump Pressure Gauge - A U.S. Gage Co., Type AW-1 7/8-3-A, pressure gauge is connected into the pump pressure line between the pump check valve and the Cuno filter.

12. Filter - A Cuno 11171 filter is installed in the pump pressure line between the pump check valve and the pressure regulator, to remove grit and foreign matter from the hydraulic fluid. The filter employs the principle of edge filtration plus positive mechanical cleaning.

13. Pressure Test Connection - A fitting for connecting an outside source of pressure for ground testing is installed in the line between the filter and the pressure regulator.

14. Suction Test Connection - A suction test fitting is installed in the suction line near the lower aft portion of the fuselage.

15. Suction Check Valve - A check valve is installed in the pump supply line near the suction test connection.

16. Pressure Regulator - A Vickers No. AAL4501 hydraulic unloading valve is installed in the fuselage, aft of the nose wheel well. It connects the pump pressure line to the system pressure and return lines. The regulator is set to maintain a pressure range of 1150 to 1350 p.s.i. in the system.

17. Accumulator - The Vickers No. AAL4000 accumulator, mounted aft of the pressure regulator is a spherical shaped chamber divided by a diaphragm. The upper chamber is connected to the hydraulic system. The lower chamber, provided with an air valve is initially charged with compressed air to 500 p.s.i. This hydro-pneumatic accumulator will provide hydraulic system pressure by means of compressed air when the pump is stopped or unloaded, and will supply auxiliary oil volume during intermittent peak demands.

18. System Pressure Gauge - A U.S. Gage Co., Type A.W. 1 7/8-3A pressure gauge is connected into the pressure line on the system side of the regulator.

19. Emergency Extension Reservoir - The emergency reservoir located behind the pilot's seat is of welded aluminum alloy construction. The capacity is 1.33 Imp. gallons. From the top connection, a vent line is carried to the outside of the fuselage skin and from the bottom, a line extends to the hand pump.

20. Hand Pump - (See Fig. 8) The hydraulic hand pump is mounted on a bracket on the cockpit floor starboard of the seat. The integral four-way valve is connected into the main system and the emergency extension system, normally being safetied in the former position.

21. Hand Pump Check Valves - A Parker No. 9-1839-8 check valve is installed in each outlet port of the hand pump.

22. Emergency Relief Valve - A Parker No. 9-1839-6-2 relief valve set to open at 1000 p.s.i. is installed in the emergency extension line for protection against expansion of the fluid in the emergency line due to temperature rise or in case the retraction by-pass valve is closed, and a normal retraction attempted. The relief valve by-passes the fluid into the emergency reservoir.

23. Retraction By-Pass Valve - A Parker No. 6 ANVDD-D-2339-3 needle valve is installed in the floor in front of the hand pump. THIS VALVE IS TO BE CLOSED ONLY DURING OPERATION OF THE EMERGENCY EXTENSION SYSTEM. The function of this valve is to by-pass any pressure in the emergency line (which might be caused by leakage at the shuttle valves on the gear jack) into the main reservoir.

HYDRAULIC EQUIPMENT - ALIGHTING GEAR

24. Control Valve - An Aircraft Accessories Corp. valve, No. 62046, is mounted aft of the nose gear well on the port fuselage web. The control shaft extends above the cockpit floor and is connected by cable to the operating lever in the side control stand.

25. Return Line Check Valve - A Parker No. 475-HT-10D check valve is installed in the return line from the control valve to the hydraulic reservoir.

26. Shut-Off Valve - A Parker No. 201-1GG-8D valve is installed in the alighting gear "up" line just forward of the firewall in each engine nacelle.

27. Restriction Valve - A Parker No. 5-740-9 restrictor is installed between the shut-off valve and the main gear actuating cylinders. The needle must be opened approximately 5/8 of a turn from the closed position.

28. Main Gear Jack - Aircraft Precision Products, No. 51227. This jack consists of an aluminum alloy cylinder with a steel piston. The cylinder is attached to the engine mount support bay and the piston rod is pinned between the drag links. The down lock and shuttle valve are part of the assembly.

29. Nose Gear Jack - Aircraft Precision Products, No. 51229. This jack is similar to the main gear jack in construction and is mounted in the fuselage nose section between the web and the outer skin. The cylinder is attached to the web and the piston is attached to the torque lever.

30. Down Locks - The down locks are built integral with the jack cylinder and caps (Aircraft Precision Products No. 41271.) As fluid enters the cylinder port through the "UP" lines, the pressure raises filler, "H" (Fig. 26, Sect. 4, Chap. 2) lifting the spring loaded pin from the recess in the piston head. After the pin retracts from the piston head, a ridge on the pin opens the valve "N" allowing fluid to enter the cylinder.

31. Shuttle Valve - The shuttle valves are built integrally with the gear jack (See Fig. 26, Sect. 4, Chap. 2). The "DOWN" line is connected to port "A", the emergency extension line is connected to port "B". The spring "HH" holds the piston "DD" against the seat closing the emergency extension port. When the landing gear control valve is put in the "DOWN" position and fluid is pumped through the emergency lines, the pressure forces the piston "DD" against the seat at port "A" thus closing the main system line and allowing pressure from the emergency system to enter the jack and extend the gear.

32. Up-Locks - Refer to Figures 27 and 28, Section 4, Chapter 2.

a. Operation - The function of the up-locks is to delay the extension of the alighting gear until the doors have opened and to hold the gear retracted in case of loss of hydraulic pressure. The up-lock contains two chambers, "A", is used during normal operation, "B" is used for emergency operation. In normal extension of the gear, fluid enters chamber "A" at port "A" extending stem "K" and withdrawing pin "P" from the landing wheel axle. After pin "P" has moved 7/16" nut "M" engages and opens valve "L" allowing pressure to pass through port "C" to the gear jack. In retracting the gear, the flow through chamber "A" is reversed.

b. Main Gear Up Locks - Bendix No. 10569. The up-lock is mounted on a removable plate on the inboard side on the inboard wheel well web. The locking pin "P" extends through a hole in the web and engages the landing wheel axle.

c. Nose Gear Up Lock - Bendix No. 10614. The up-lock is mounted on the outboard side of the port wheel well web. The locking pin extends through a hole in the web and engages the landing wheel axle.

33. Main Gear Door Jack - Bendix No. 10455 - The door jack is mounted on the bulkhead at the aft end of each main wheel well. The piston rod is attached to the cars which operate the doors.

34. Shut-Off Valve - A Parker No. 6-AN-V-DD-D angle needle valve is installed in the "opening" line near each door jack. When the valve is closed the doors will remain open while the gear is retracted. The valves must be safetied "open" at all times except when it is desired to inspect the retraction of the gear.

35. Nose Door Jack - Vard Mechanical Laboratory No. P-250500. The nose door jack is mounted at the aft end of the wheel well, the piston rod is attached to the door.
36. Door Stop Valves - (Fig. 31, Sect. 4, Chap. 2) Bendix No. 10474. These valves are installed in the "CLOSING" or "UP" line to each door jack and are open only when the undercarriage is fully retracted. Their function is to prevent the doors from closing before the gear is fully retracted. The ball "K" is unseated by plunger pin "C" when buffer "A" is engaged by a thumb point on the oleo-leg.
37. Door Holding Valves - Parker No. 9-1839-6-3 relief valves are installed in each undercarriage door down line to hold the doors open against the air load in flight until the gear is fully retracted. The valves are set to open at 250 p.s.i.
38. Door Check Valves - Parker No. 11-1339-17-6-2 check valves are installed in each undercarriage door down line to by-pass fluid around the door holding valves during extension of the gear.
39. Nose Door Locking Jack - Bendix No. 401319. This jack is used to operate the latching mechanism to secure the front end of the nose door.
40. Nose Door Lock Holding Valve - A Parker No. 9-1839-6-4 relief valve adjusted to open at 750 p.s.i. is installed in the "UP" line to prevent the locking jack from operating until the door has closed.
41. Nose Door Lock Check Valve - A Parker No. 11-1339-17-6-2 check valve is connected into the line with the holding valve to by-pass the fluid around the holding valve during extension of the alighting gear.

HYDRAULIC EQUIPMENT - MAIN PLANE FLAPS

42. Control Valve - An Aircraft Accessories Corp. valve No. 62047 is mounted aft of the nose gear well on the starboard fuselage web. The control shaft extends above the cockpit floor and is connected by cable to the operating lever on the starboard side of the cockpit.
43. Pressure Cut-Off Valve - Dwg. No. 225421. The pressure cut-off valve, located on the rear face of bulkhead 206 $\frac{3}{8}$ in the upper rear portion of the fuselage, automatically cuts off hydraulic pressure to the flap motor as the flaps reach either extremity of their travel.
44. Flap Operating Motor - A Vickers No. AA15000A hydraulic motor, installed on the rear face of the rear spar under the pressure cut-off valve actuates the flaps through a gear box and screw mechanism.

HYDRAULIC EQUIPMENT - ARMAMENT UNITS

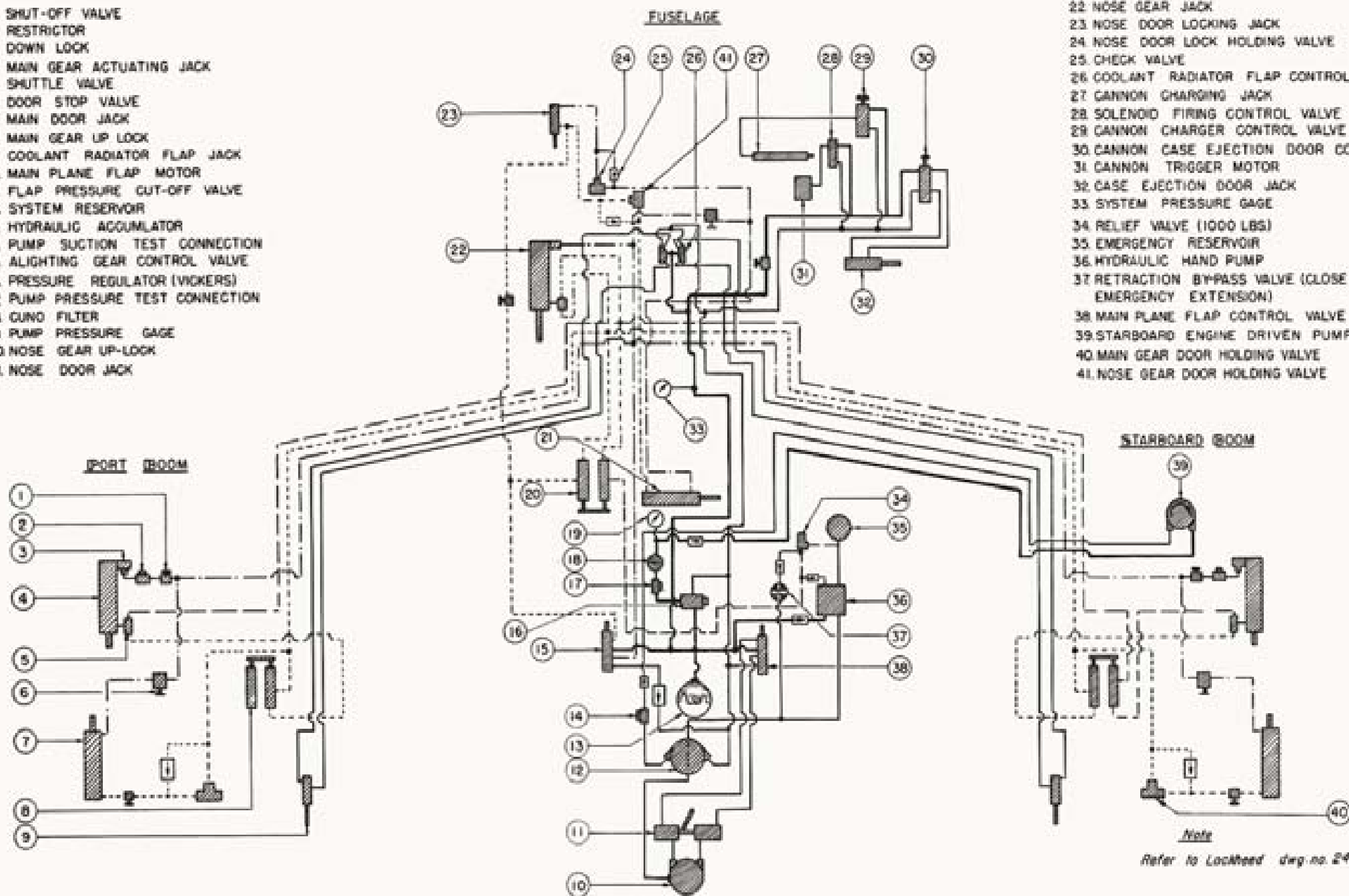
45. Shut-Off Valve - A Parker No. 201-1GG-8D valve is installed in the pressure line to the armament units.
46. Solenoid firing Control Valve - Bendix No. 78595 - A solenoid operated hydraulic valve is used, when the cannon is installed, to control the hydraulic trigger motor.
47. Trigger Motor - Bendix No. 78594 - The trigger motor mounted on the cannon, moves the sear lever from its breech block locking position while the solenoid valve is opened.
48. Cannon Charger Control Valve - Bendix 76861. The cannon charger control valve is mounted on the starboard side of the cockpit when the cannon is installed, for operating the hydraulic cannon charger.
49. Cannon Charger - The cannon charger consists of a spring loaded hydraulically operated cylinder mounted on the cannon and controlled from the cockpit.
50. Cannon Case Ejection Door Control Valve - Aircraft Precision Products No. 41088 - This valve, mounted on the centre control stand in front of the pilot is used to open and close the cannon case ejection door.
51. Cannon Case Ejection Door Jack - Bendix No. 10501 - This jack, mounted in the starboard side of the fuselage nose section, between the web and the outer skin, and controlled from the cockpit, actuates the cannon case ejection door.

HYDRAULIC EQUIPMENT - COOLANT RADIATOR FLAPS

52. Control Valve - Adel No. B-92 01, Model 4V5D-2- The radiator flap four-way valves are mounted outboard of the port web in the nose wheel well at Sta. 100. The valves are actuated from the cockpit by means of a Simmonds-Corsey remote control mounted on the port cockpit sill (See Fig. 39, Sect. 4, Chap. 2).
53. Radiator Flap Actuating Jack - Aircraft Precision Products No. 40787. This jack is mounted horizontally in each boom aft of Station 295. The piston shaft is connected to rods that attach to the flaps. (See Fig. 40, Sect. 4, Chap. 2).

- 1. SHUT-OFF VALVE
- 2. RESTRICTOR
- 3. DOWN LOCK
- 4. MAIN GEAR ACTUATING JACK
- 5. SHUTTLE VALVE
- 6. DOOR STOP VALVE
- 7. MAIN DOOR JACK
- 8. MAIN GEAR UP LOCK
- 9. COOLANT RADIATOR FLAP JACK
- 10. MAIN PLANE FLAP MOTOR
- 11. FLAP PRESSURE CUT-OFF VALVE
- 12. SYSTEM RESERVOIR
- 13. HYDRAULIC ACCUMULATOR
- 14. PUMP SUCTION TEST CONNECTION
- 15. ALIGHTING GEAR CONTROL VALVE
- 16. PRESSURE REGULATOR (VICKERS)
- 17. PUMP PRESSURE TEST CONNECTION
- 18. CUND FILTER
- 19. PUMP PRESSURE GAGE
- 20. NOSE GEAR UP-LOCK
- 21. NOSE DOOR JACK

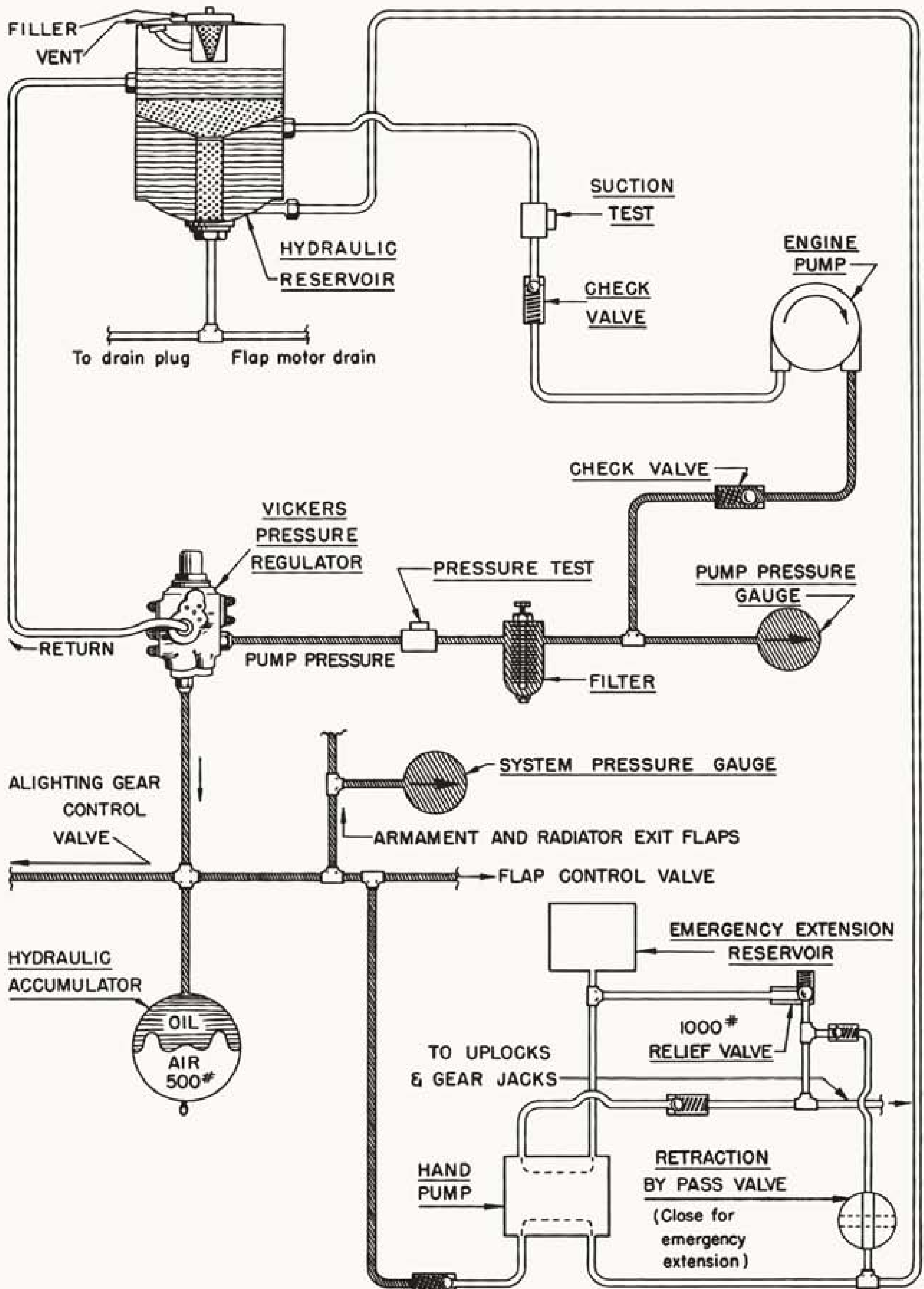
- 22. NOSE GEAR JACK
- 23. NOSE DOOR LOCKING JACK
- 24. NOSE DOOR LOCK HOLDING VALVE
- 25. CHECK VALVE
- 26. COOLANT RADIATOR FLAP CONTROL VALVES
- 27. CANNON CHARGING JACK
- 28. SOLENOID FIRING CONTROL VALVE
- 29. CANNON CHARGER CONTROL VALVE
- 30. CANNON CASE EJECTION DOOR CONTROL VALVE
- 31. CANNON TRIGGER MOTOR
- 32. CASE EJECTION DOOR JACK
- 33. SYSTEM PRESSURE GAGE
- 34. RELIEF VALVE (1000 LBS)
- 35. EMERGENCY RESERVOIR
- 36. HYDRAULIC HAND PUMP
- 37. RETRACTION BY-PASS VALVE (CLOSE ONLY FOR EMERGENCY EXTENSION)
- 38. MAIN PLANE FLAP CONTROL VALVE
- 39. STARBOARD ENGINE DRIVEN PUMP
- 40. MAIN GEAR DOOR HOLDING VALVE
- 41. NOSE GEAR DOOR HOLDING VALVE



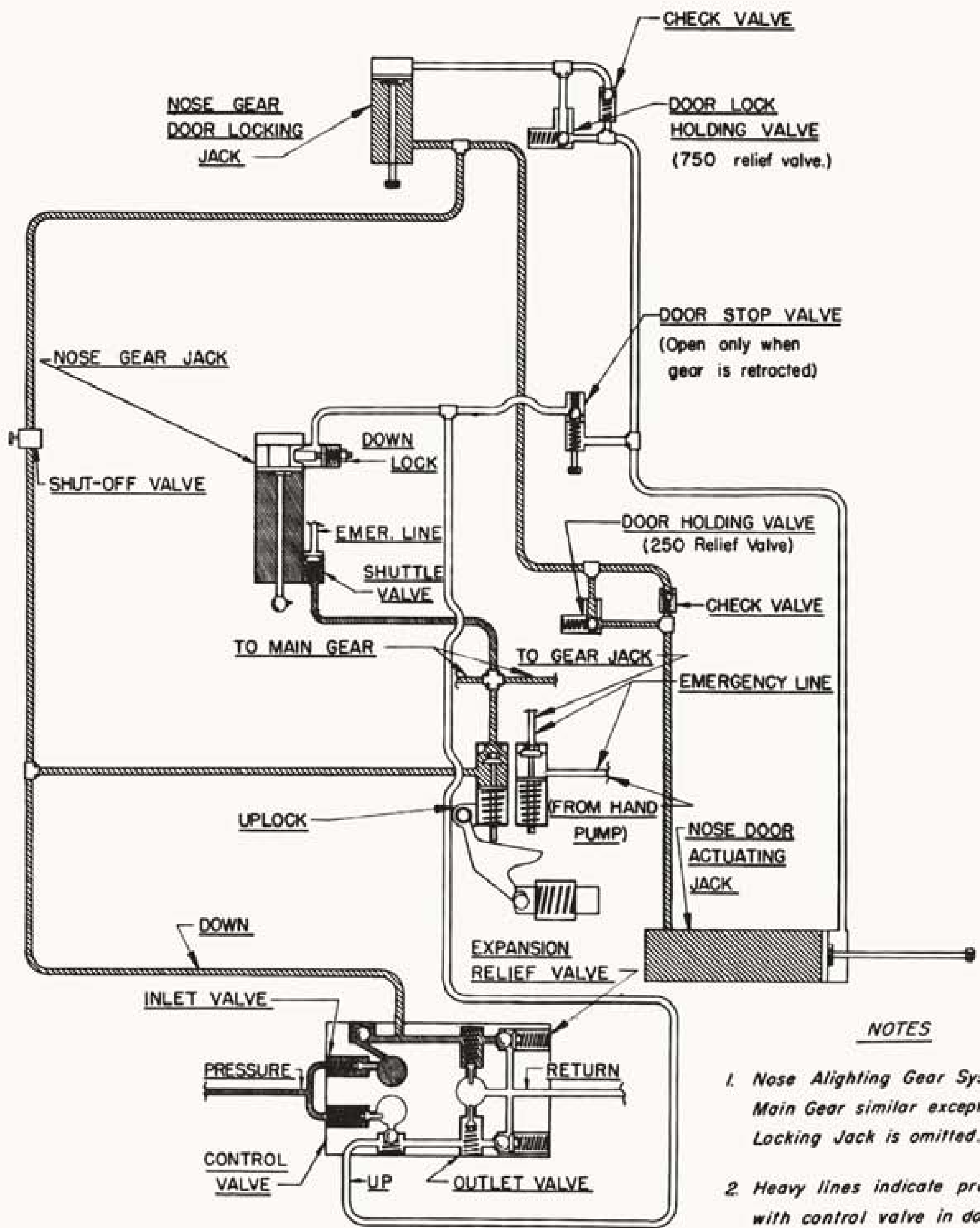
Note
Refer to Lockheed dwg no 246389

Notes: ———— Emergency Extension - - - - - Alighting Gear Down - · - · - Alighting Gear Up ———— Pressure ———— Alternate Pressure and Return

HYDRAULIC SYSTEM DIAGRAM



PRESSURE SUPPLY DIAGRAM



NOTES

- 1. Nose Alighting Gear System shown, Main Gear similar except Nose Gear Locking Jack is omitted.
- 2. Heavy lines indicate pressure flow with control valve in down position.

DIAGRAM - NOSE GEAR HYDRAULIC OPERATION

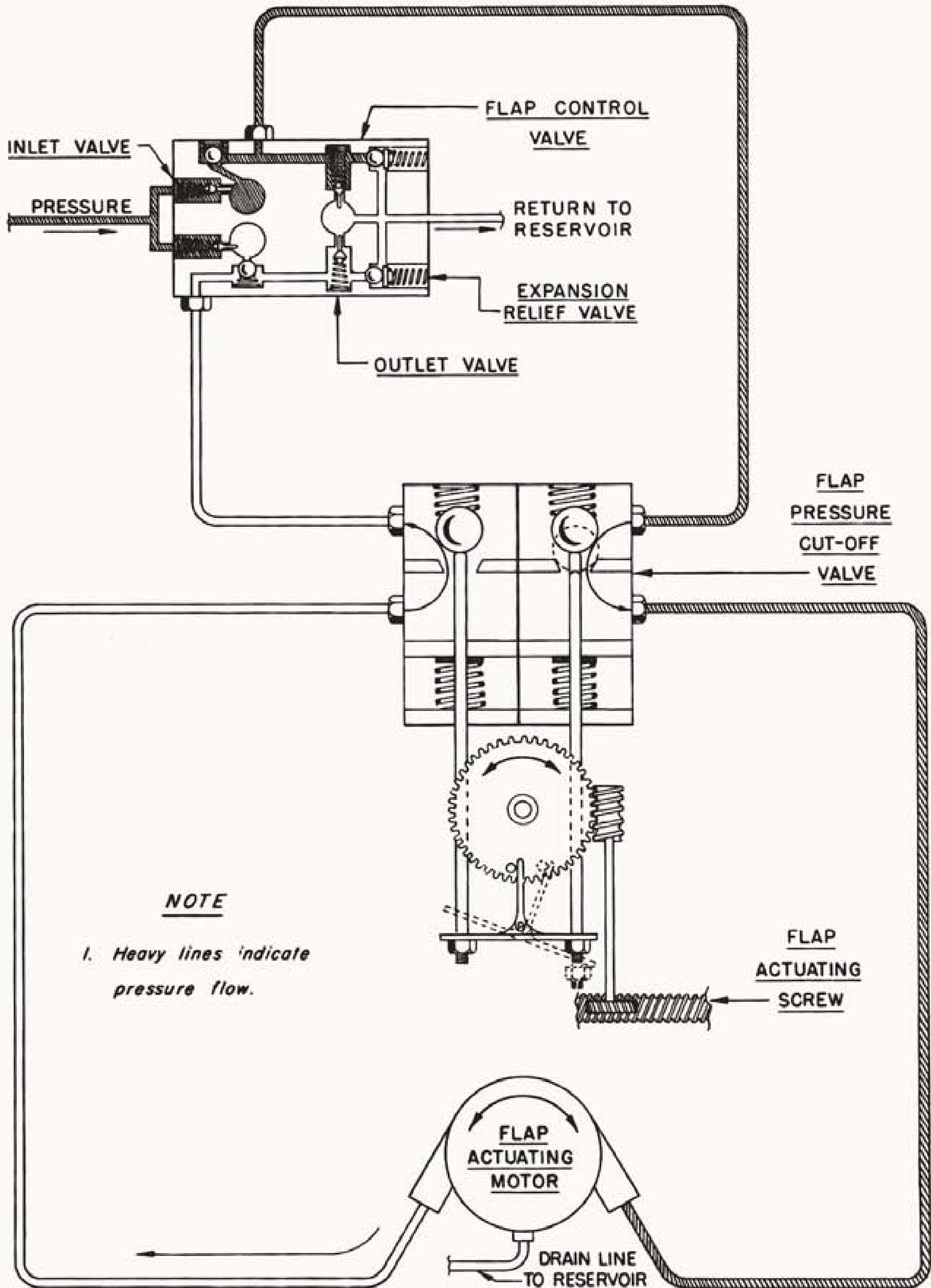
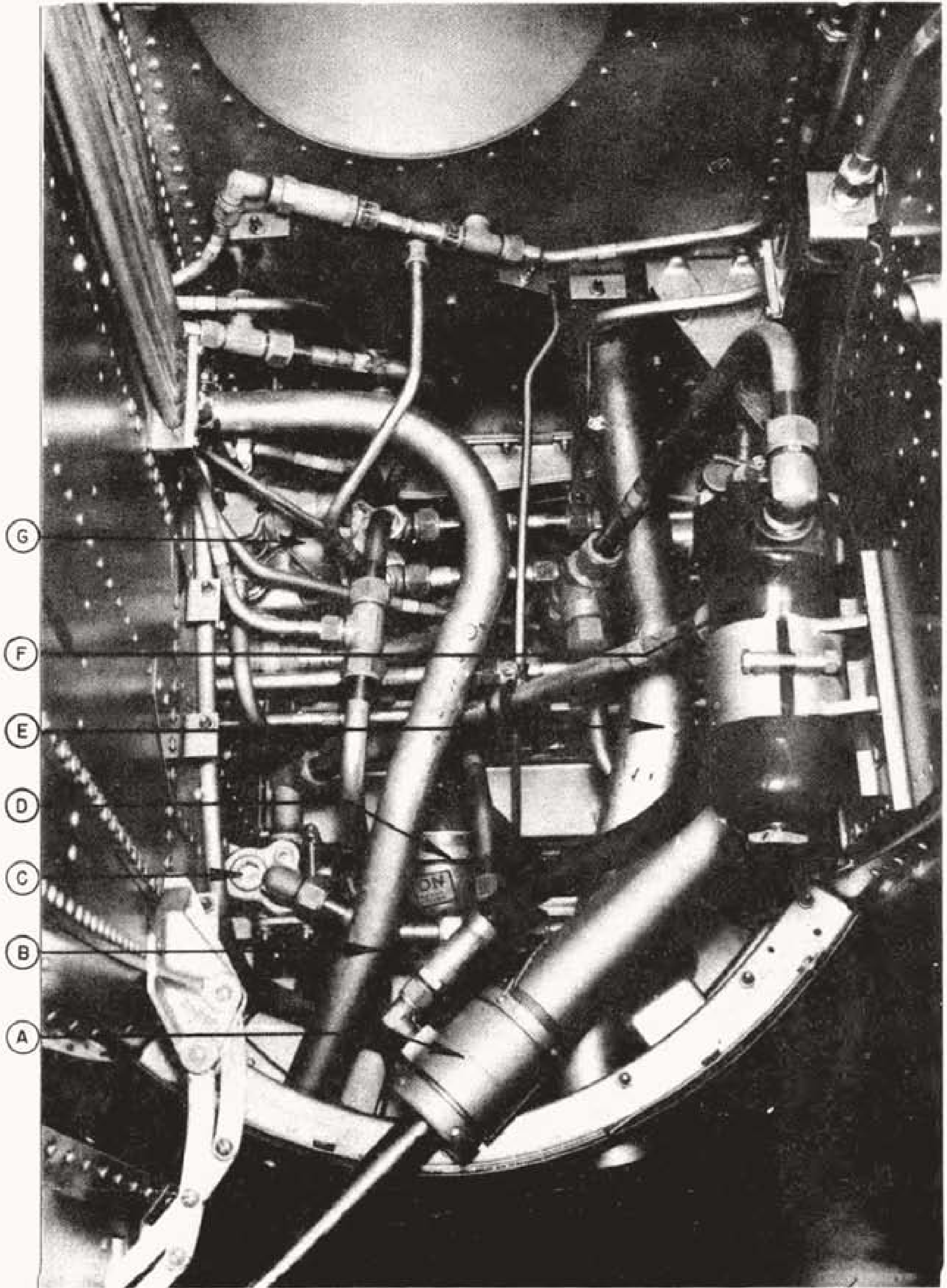


DIAGRAM - FLAP HYDRAULIC OPERATION

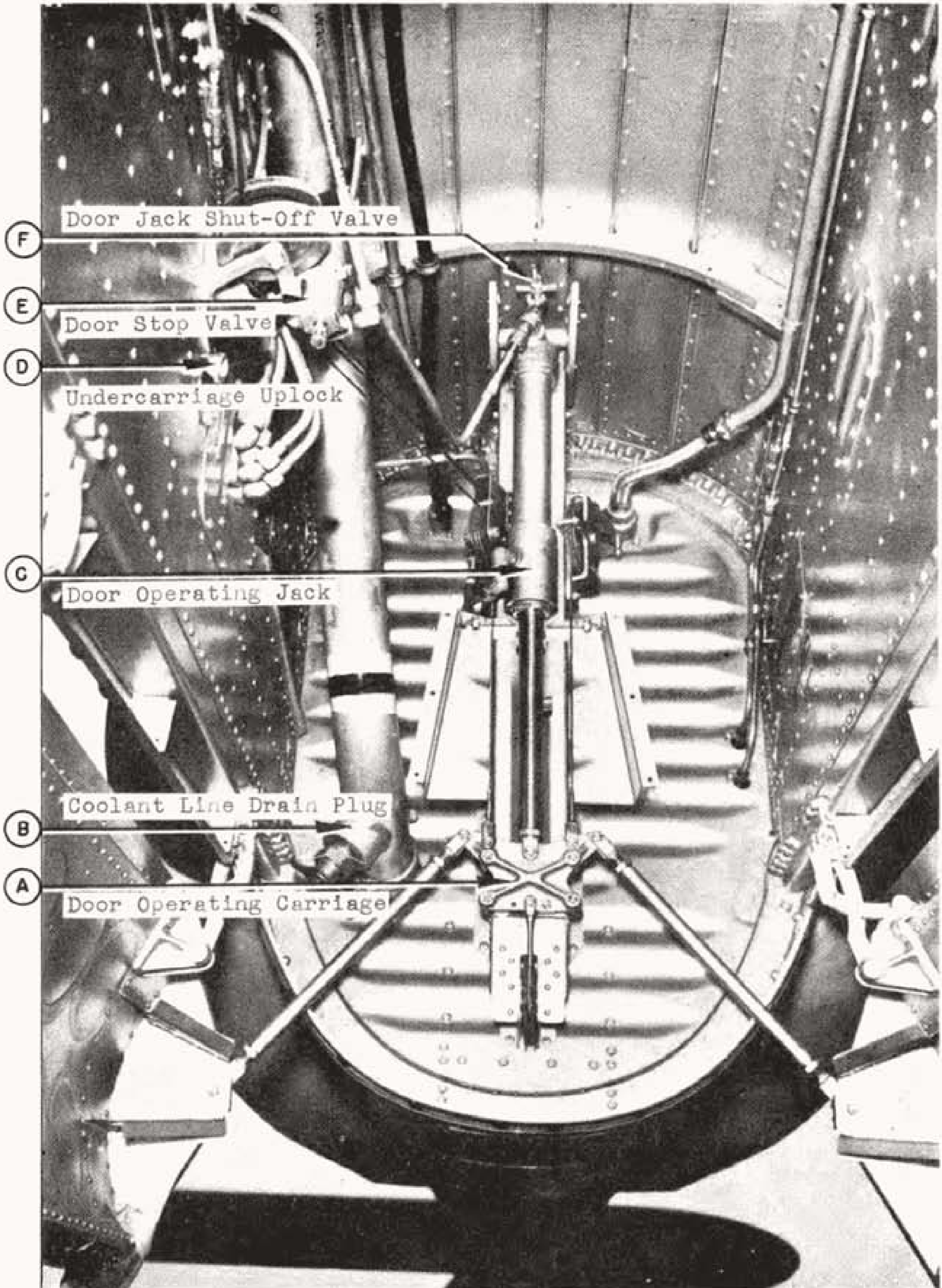
Key to Fig. 5

Nose Wheel Well - Aft

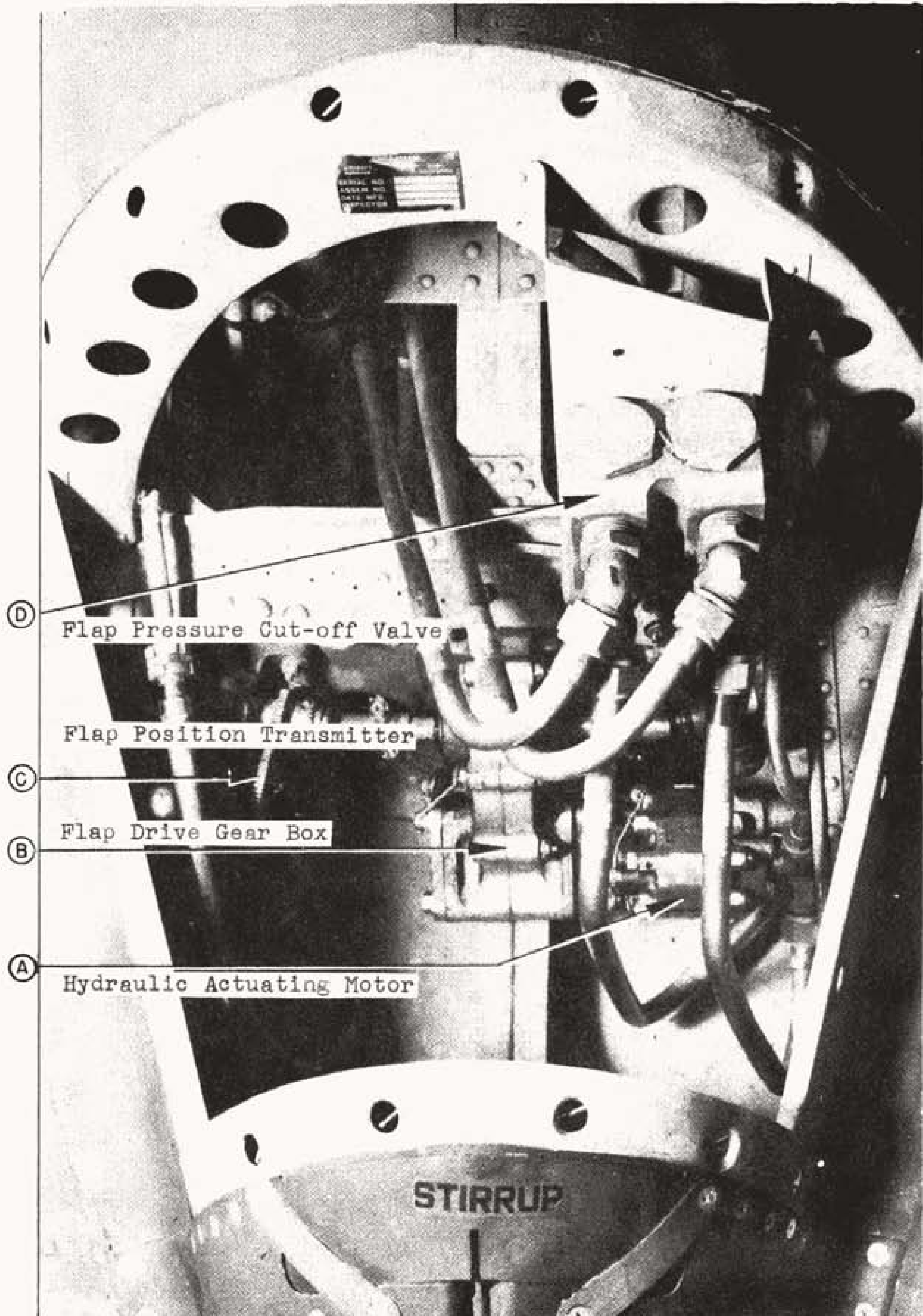
- A. Door Actuating Jack
- B. Cockpit Heating System By-Pass Duct
- C. Vickers Pressure Regulator
- D. Hydraulic Accumulator
- E. Armament Section Heater By-Pass Duct
- F. Cuno Filter
- G. Flap Control Valves



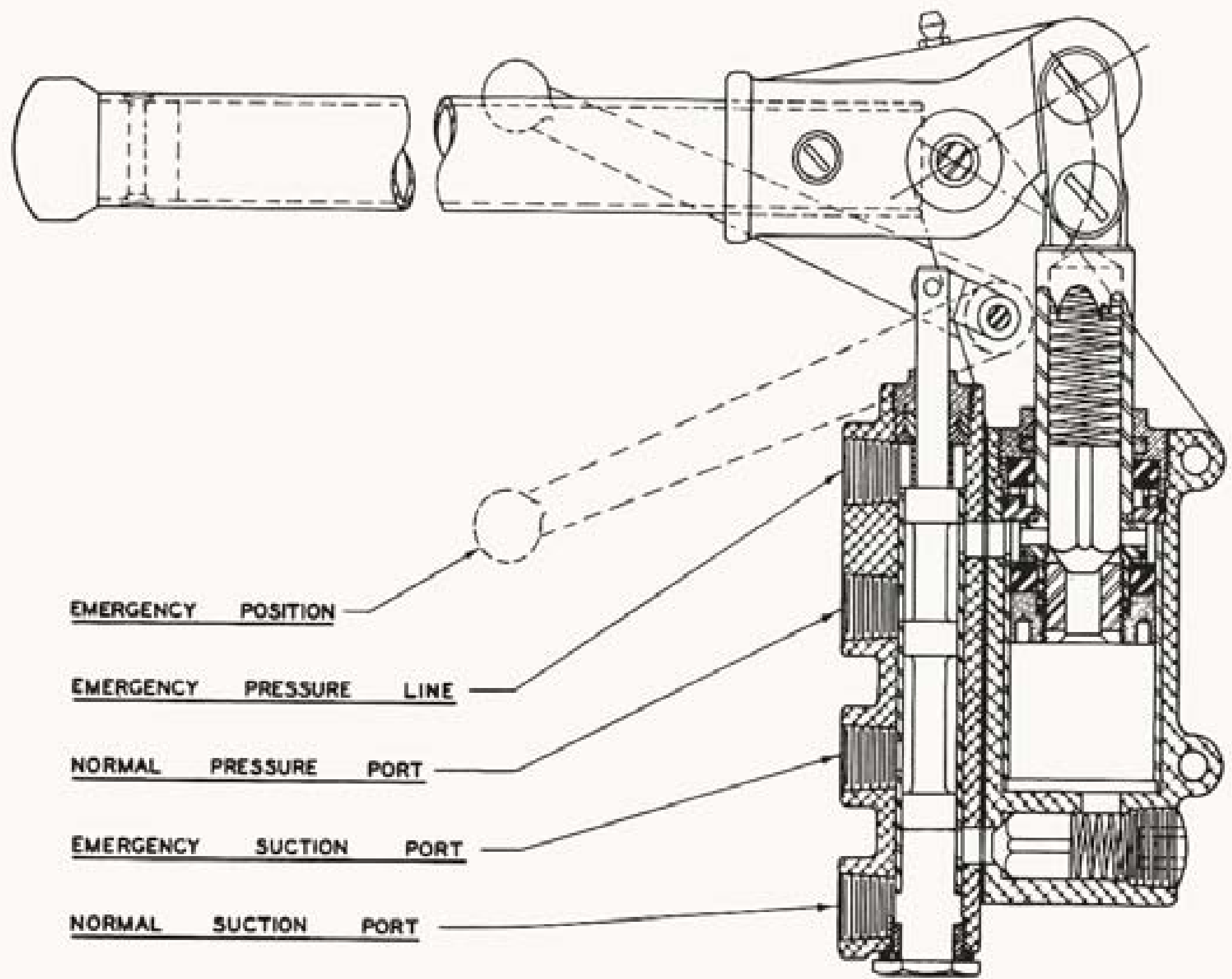
NOSE WHEEL WELL - AFT



MAIN WHEEL WELL — AFT



FLAP MOTOR INSTALLATION - AFT FUSELAGE



EMERGENCY POSITION

EMERGENCY PRESSURE LINE

NORMAL PRESSURE PORT

EMERGENCY SUCTION PORT

NORMAL SUCTION PORT

NOTES:

- 1. REFER TO LOCKHEED NO. 667048
ECLIPSE DWG. NO. D-80083

HYDRAULIC HAND PUMP

EQUIPMENT
SECTION 11
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SECTION 11

EQUIPMENT

ARMAMENT

1. General - Provisions are made for installation of five Colt MG53 .50 calibre fixed machine guns in the fuselage nose section. Four of the guns are grouped symmetrically above the centre gun (See Figs. 1-7). A Mark II 20 mm Hispano aircraft cannon may be mounted in place of the centre machine gun.
2. The armament compartment is located in the nose section of the fuselage above the nose gear well, and extends aft to Station 95. Lifting the armament hood gives access to the compartment for servicing. The armament hood is secured in the closed position by 'Dzus' fasteners and supported in the raised position by stay rods, which when not in use swing inward and clip on the hood.
3. Gun Sights - Two fixed gun sights are provided, the ring and bead type, and the optical type. The ring sight is mounted on a swivel type bracket on the windshield frame at Station 126. The bead is mounted forward of the windshield at Station 97 $\frac{3}{8}$. The mean line of sight through the ring and bead sight is at waterline 34.2, three inches to port of the fuselage centreline. The optical sight (type St-1A) is mounted in the windshield, so that the mean line of sight through the reflector is at waterline 34.2 on the centreline of the fuselage. A sun screen for the reflector is carried in a case mounted on the left side of the pilot's seat. A rheostat, located on the switch box below the instrument panel, provides control of the brilliance of the gun sight lamp.
4. Bullet-Proof Glass - Drawing No. 247256 - Protection is provided for the pilot by a rectangular piece of 1 $\frac{1}{2}$ inch bullet-proof glass which is mounted just aft the windshield. The lower end rests in a bracket which is carried by the two forward members of the windshield frame. The upper end is supported by two screws which fasten to brackets on the upper windshield frame. The glass is quickly removable by taking out the two screws and lifting out the glass, while the lower supporting bracket may be removed by unscrewing the two wing bolts which secure it.
5. Armor Plate - Drawing No. 246398 - Sections of $\frac{3}{8}$ inch bullet-proof steel plates are installed on the front and rear of the armament bulkhead at Station 95, inside the upper contour of the fuselage between Station 95 and 106 just ahead of the windshield, on the back and bottom of the pilot's seat and on the front of the overturn structure from the top of the headrest to just above the main beam. A yellow circle, 2 inches in diameter is painted on the visible side of the armor plate after installation. The word 'face' is stenciled on the impact side of the plates which are face hardened and not homogeneous.
6. Fixed Gun Mounts - The guns are supported at their forward attachment points by a trunnion assembly and at the rear by an adjustable mounting post. The mounts embody locking collars for quick removal and installation of the guns. When the guns are removed for repair or replacement, the detachable parts of the trunnion and rear mounting post should be removed from the gun and reinstalled on the mounts.
7. Cannon and Centre Machine Gun Mountings - A Mark II, 20 mm aircraft cannon or a .50 cal. MG53 Colt machine gun may be used in the centre gun position. A trunnion is provided for the cannon at Station 63 $\frac{23}{32}$ and a forward mounting post bracket at approximately Station 30. For the machine gun installation the cannon trunnion bracket is replaced by the machine gun bracket at Station 72 $\frac{1}{8}$, and a rear gun post is provided at Station 88 $\frac{3}{8}$.
8. Gun Level Lugs - Leveling lugs are installed on the starboard side of the armament compartment, one fixed lug at Station 63 and one adjustable lug at Station 45. (See Section 4, Chapter 1.)
9. Selective Gun Charger - Figure 8. A Universal selective gun charger control mounted in front of the pilot, and connected by cables to the four outer machine gun chargers (Interstate Aircraft and Engineering Type 611), mounted on the rear of the guns, is provided for charging or clearing any of the outer four machine guns. To operate proceed as follows:
 - (a) Turn the knob to indicate the desired gun.
 - (b) With the lever pull the head back to its stop where the flybolt will engage its latch.
 - (c) Return the lever to its original forward position.
 - (d) Strike the knob with the heel of the hand to release the flybolt latch.

(e) Repeat for each gun to be charged.

NOTE: Use this same procedure to clear a jammed gun or misfire.

10. Centre Machine Gun Charger - An Interstate Aircraft and Engineering Corp. type 611-L gun charger is mounted at the rear of the gun and is connected by 7 x 7 steel cable to the type 671 charging control mounted on the base below the instrument panel. To operate pull the handle back to its stop, then return to its original position, this holds the bolt retracted until the button on the control handle is depressed, releasing it.

11. Cannon Charger - The cannon charger consists of a spring loaded hydraulic cylinder mounted on the aft portion of the cannon and operated by a control valve on the centre control stand. Charging is accomplished by depressing the control handle through its 3/8" stroke. The handle will remain in this position until the breech block is fully retracted. When the breech block strikes the buffer spring, the handle will return to its original position and the valve will automatically close, allowing the hydraulic charger cylinder piston to return. The breech block, however is held in the retracted position, until the piston return stroke has nearly exhausted the hydraulic fluid in the charger cylinder, so that when released it will move forward under the full force of the driving spring, unimpeded by the charger. A safety feature is incorporated in the charging system whereby it is impossible to fire the gun, should the firing switch be inadvertently closed. To hold the gun safe, the control handle is turned counter-clockwise to the safety position and then depressed. The valve will automatically close in the manner previously described, but the hydraulic fluid will remain trapped in the line, holding the breech block retracted. Thus the gun will be safe until the control handle is rotated clockwise to the firing position.

12. Ammunition Boxes - Four .50 Calibre boxes of 500 rounds capacity each carried in the armament compartment feed the four outer machine guns. The boxes slide in guide tracks and are locked in place by engaging and turning the handle pins in slotted openings at the outer ends of the tracks. A .50 calibre box of 300 rounds capacity is mounted in the centre of the compartment and feeds the centre machine gun. When the cannon is installed in the centre gun position, the centre .50 calibre box is removed and a Hispano 20 mm. magazine of 60 rounds capacity, is mounted on the cannon. On later models a 150 round box and Chatellerault feed replace the 60 round magazine.

13. Ammunition Chutes - The feed chutes are pinned to the box covers, and are attached to the guns by quick release fittings. A vertical adjustment of the pins in the box covers is provided for movement required in gun leveling.

14. Link Ejection Chutes - The link ejection chutes, of spotwelded stainless steel construction, are fastened to the inboard side of each gun by quick release fittings, and discharge into the case ejection chutes.

15. Case Ejection Chutes - The case ejection chutes also of spotwelded stainless steel construction are fastened to the fuselage structure under each gun by piano hinges and quick removable pins, and discharge through removable panels in the lower portion of the fuselage skin.

16. Ejected Cannon Case Compartment - A neoprene lined compartment on the starboard side of fuselage between Stations 75 and 87 1/2, receives the ejected cases. A hydraulically actuated door, controlled by a push pull button on the centre control stand, permits dumping of the contents in flight.

17. Firing Controls - The outer four machine guns are controlled by type G-4 solenoid assemblies on each gun, operated by a button on the forward side of the control wheel through selector switches mounted on a box on the control column yoke. The extreme starboard lever operates the gun master switch, which must be placed forward on "GUN" to render the remaining switches effective. A bar pivoted at each end of the switch box, will return all of the levers to the "OFF" position. The centre machine gun is fired by the cannon button in the same manner as the outer machine guns. The cannon firing equipment consists of a solenoid valve and a hydraulic firing unit (trigger motor). The solenoid energized by the cannon firing button on the aft side of the control wheel through the selector switch on the yoke of the control column, opens the valve allowing hydraulic pressure to displace the piston in the trigger motor thereby withdrawing the sear. By releasing the firing switch the solenoid valve is closed to the pressure line and is opened to the return line, thus releasing the sear.

18. Gun Blinkers - A blinker light for each gun is mounted on the instrument panel. An electric contactor (Interstate Aircraft and Engineering Corp.), mounted on the aft end of each machine gun, closes the circuit to the respective blinker light each time a shot is fired. No contactor is provided for the cannon, the center blinker light being used only when the alternate machine gun is installed. (See Sect. 6, Fig. 7 for Wiring Diagram.)

19. Gun Camera - On later models provisions are made in the fuselage nose for installation of a Fairchild Type W-7 Gun Camera. The camera may be levelled using the gun levelling lugs. Access to the camera is obtained through a hinged door in the fuselage nose. The door is locked by means of a single Dzus fastener. When the camera is not in use a cover for the opening in the door is attached by four screws.

INSTRUMENTS

20. Instrument Panel - Fig. 9 - A central main instrument panel finished in dull black lacquer, is located aft of the armament compartment at Station 106. Access to the back of the panel is made through a removable skin panel just forward of the cockpit canopy. The instruments provided are as follows:

- 1 Fuel Gage - front tanks. G. E. Model 8DJ-12-LXA - (Lockheed 624070).
- 1 Fuel Gage rear tanks. G. E. Model 8DJ-12-LXB - (Lockheed 624072).
- Type 189-A 2 Coolant temperature gages (1 left engine and 1 right engine) Weston Model 606 (Lockheed 622063).
- 2 Coolant temperature warning lights.
- 1 Undercarriage warning light.
- 1 Airspeed indicator, Kollsman Type 657-K-0126 (Lockheed 620027).
- 1 Gyro horizon, Sperry Type 643720 (Lockheed 620126).
- 1 Clock, Jaeger Type 3650-X (Lockheed 620127).
- 2 Manifold pressure gages, Type 1919-1B (Lockheed 622061).
- 1 Altimeter, Kollsman Type 642K-05 (Lockheed 620120).
- 1 Rate-of-Climb Indicator, Pioneer Type 1633-1B (Lockheed 620117).
- 2 Tachometer Indicators, Weston Model 545-R Type 70E (Lockheed 622066-2).
- 2 Carburetor Air Thermometers, Weston Model 606 Type 128-A (Lockheed 622065).
- 1 Directional Gyro, Sperry Type 643715 (Lockheed 620002).
- 1 Turn and Bank Indicator, Pioneer Type 1700-1A (Lockheed 620059).
- 1 Undercarriage and Flap position indicator. G. E. Type 8DJ4-PXR (Lockheed 629057).
- 1 Free Air Thermometer, Weston Model 606 Type 190-A (Lockheed 626037).
- 1 Suction Gage, U. S. Gage Co. Bourdon Type (Lockheed 626040).
- 1 Oil Cooler Flap Position Indicator, G. E. Model 8DJ-12PXB (Lockheed 629059).
- AW-2 3/4-19-J 2 Engine Gages-(Oil Temperature - Oil Pressure & Fuel Pressure) U.S. Gage Co. (Type (Lockheed 622068).
- 1 Gun Blinker Lamp Assembly
- 1 Hydraulic Pump Pressure Gage, U. S. Gage Co. Type A.W. 1 7/8-3-A (Lockheed 626003).
- 626003). 1 Hydraulic System Oil Pressure Gage, U. S. Gage Co. Type A.W. 1 7/8-3-A (Lockheed
- 1 Vacuum Selector Valve
- 1 Type 1818-3 Pioneer Compass

21. Instrument Glare Shield - To prevent reflection in the windshield of the instruments on the panel, a shield of army duck is installed above the panel. A stainless steel support strip at the rear of the shield is attached at Station 125 to brackets on each side of the cockpit. Eight longitudinal ribs are inserted in pockets in the shield for stiffening and an additional pocket is provided in the upper centre to allow clearance for the gunsight. Snap fasteners hold the shield in place.

22. Pressure Head - The electrically heated pressure head (Kollsman Type 372C-02) is mounted on a mast extending below the fuselage, at Station 38 15/16 on the fuselage centreline. The pressure line is connected to the airspeed indicator. The static line is connected to the airspeed indicator, rate of climb indicator and the altimeter. The switch controlling the heating element is located on top of the main electrical switch box.

23. Vacuum System - Fig. 13. Two engine driven pumps type 347-B6 supply the suction required to drive the gyroscopic instruments. The air exhaust line from each pump is connected to an oil separator which returns any oil leakage to the engine crankcase and exhausts the air through a tube opening into the oil temperature regulator exit duct. A suction relief valve is attached by a nipple to the inlet port of each pump and from there the lines are carried inboard to the fuselage along the forward face of the front shear spar. Between fuselage Stations 135 and 145 9/16, on the outboard side of the starboard wheel well web, the lines are connected to a vacuum selector valve on the instrument panel, which permits the use of either one or both pumps. The control handle for this valve is on the cockpit floor to the right of the pilot's seat. The valve is accessible by removing the web panel. A Weatherhead combination check and backfire relief valve is installed in each pump line close to the selector valve. The line from the valve to the instruments divides at a reducing tee behind the instrument panel; the small line connecting to the bank and turn indicator through the throttle valve and the large line connecting to the flight and the bank and turn indicators. The suction gage is connected to the flight indicator.

24. Air Temperature Indicator - This instrument, mounted on the instrument panel shows the temperature of the air at the bulb. Air from the slip-stream passes over the bulb through a small scoop in the lower fuselage skin aft of the wheel well. (See Sect. 6, Fig. 9 for Electrical Circuit)

MISCELLANEOUS

25. Heating System - Two heating systems are provided, one for windshield and cockpit heating, another for heating the armament compartment. The windshield and cockpit heater is supplied with hot air from intensifier tubes attached to the exhaust manifolds on the starboard engine, and carried to the cockpit by tubing through the main spar. A two way valve on the starboard side of the cockpit at station 145 directs the desired proportion of hot air into the windshield and cockpit heater tube, by-passing any surplus through a tube open to the airstream at the bottom of the fuselage. The armament compartment heater receives hot air from the intensifier tubes on the port engine exhaust manifolds. Tubing through the main spar carries the hot air to a two-way valve at the port side of the cockpit, at station 149, controlled by a lever at station 139 5/8 which operates a door in the valve to divert any desired portion of the supply to the armament compartment by-passing the surplus to the outside air at the bottom of the fuselage.

26. Ventilating - A cold air inlet is located on the port side of the cockpit aft of the engine control stand. Air is taken in through a small duct on the fillet between the fuselage and the wing leading edge on the port side of the aeroplane. The rate of flow is regulated by turning the head of the ventilator. An adjustable exhaust vent is provided on the port side of the rear cockpit bulkhead.

27. Flares - International Flare Signal Type A-4 flares are installed one in each boom at Station 265. A cable release mechanism controlled from the cockpit releases the flares through spring loaded clam shell type doors in the boom directly beneath each flare. Removable panels in the boom provide access to the flare rack and release mechanism. The short cable connected to the release lever at the flare rack is rigged to contain 1/2" slack.

28. Oxygen Apparatus - Ref. Dwg. No. 246292 - Provisions are made for the installation of two Mark V oxygen bottles, one in a vertical position at Sta. 150, the other in a horizontal position at Sta. 166 both on the port side of the cockpit. 3/16 O.D. copper tubing connect the bottles with the Mark VIIIA oxygen regulator located on the starboard side of the cockpit at Sta. 150 25/32. A 5/16 O.D. aluminum alloy tube connects the regulator to a bayonet socket mounted on port side of the regulator support. Oxygen supply is controlled by the valve on the regulator. Shut-off valves are incorporated on each bottle. The oxygen lines are color marked light green.

29. Automatic Recognition Device - Provisions are made for installation of the Plessey Co. Type E-1262 Automatic Recognition device in the starboard wheel well at Station 203 1/2. Control cables are installed running parallel to the flare control cables to the cockpit. Both ends of the control cables are clamped to the structure pending installation of the automatic recognition device in the boom and the Type E-1262-C damped rate control in the starboard side of the cockpit just forward of the flare controls.

30. Data Case and Flight Report Holder - A data case and flight report holder are carried in the starboard boom baggage compartment being held in place by a bracket and a length of shock absorber cord.

31. Map Case - A map case (Part 247661) is installed on the engine control stand near the floor.

32. Pilot's Seat - A general fireproof type CR-6620 seat, provided with armor plate and a Type A3 cushion, is installed in the cockpit. A well in the bottom of the seat accommodates the pilot chute portion of the parachute, and a leather pad on the port side prevents chafing of the parachute ring. In addition to the safety belt, a spring loaded belt assembly to hold the pilot

against the back of the seat is provided, and is adjusted by a lever at the port side of the seat. A lever on the starboard side controls the vertical adjustment of the seat.

33. Radio Equipment - Figs. 14, 15 & 16 - Provisions are made for the installation of the R3003 radio in the port boom and for the alternate installation of either the TR1133A or the TR9D beneath the aft cockpit enclosure. Confidential aspects of these installations may be found in the relevant radio service manuals.

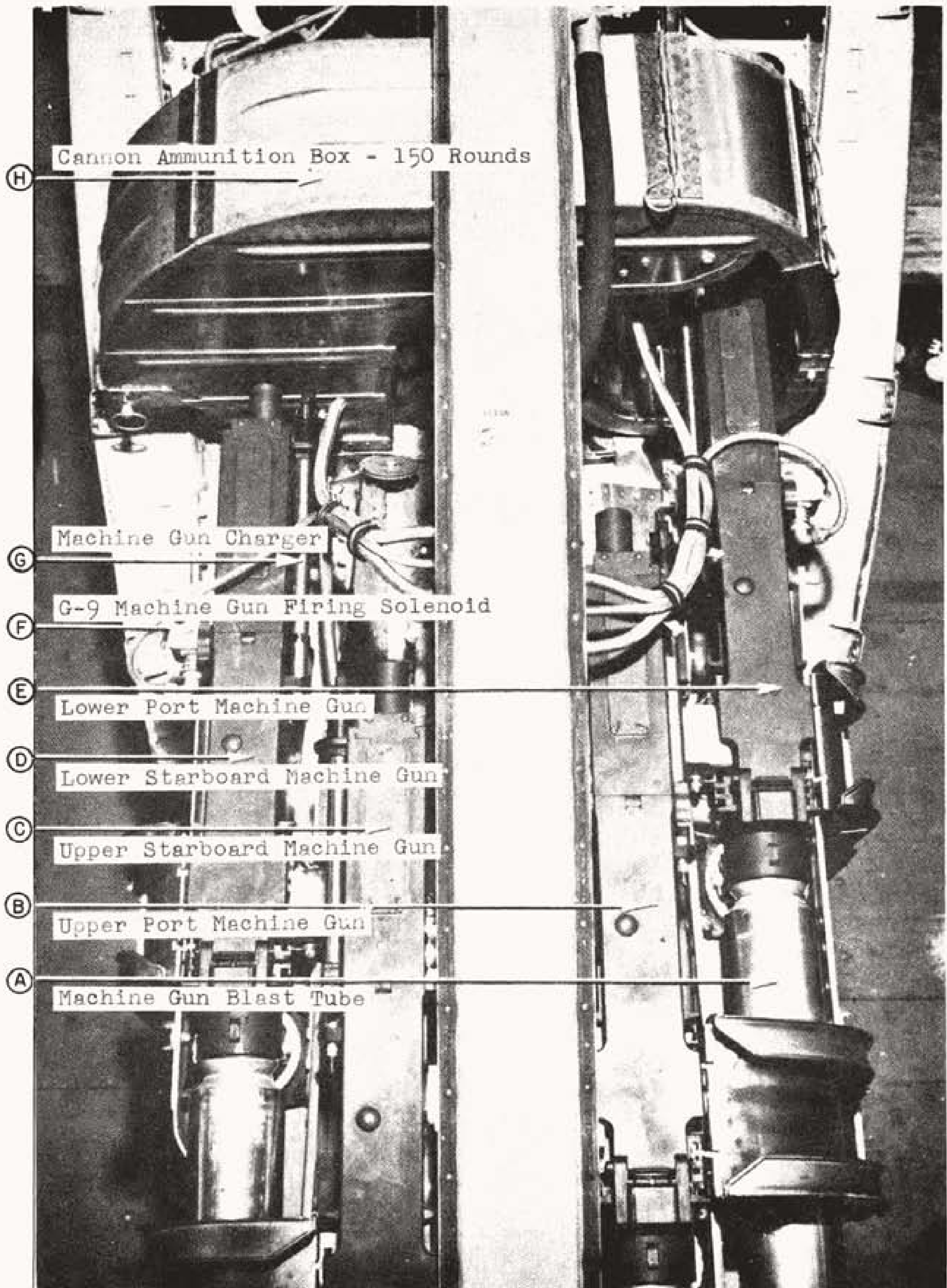
a. The main beam radio junction box (See Fig. 11), located behind the pilot's seat on the starboard side, contains fuses and master switches for the radios. A master fuse for all radio power is located in the main fuse box beneath the cockpit floor.

b. Remote controls for the R3003 radio are located on the port side of the cockpit, while those for the TR1133A and the TR9D are located on the starboard side.

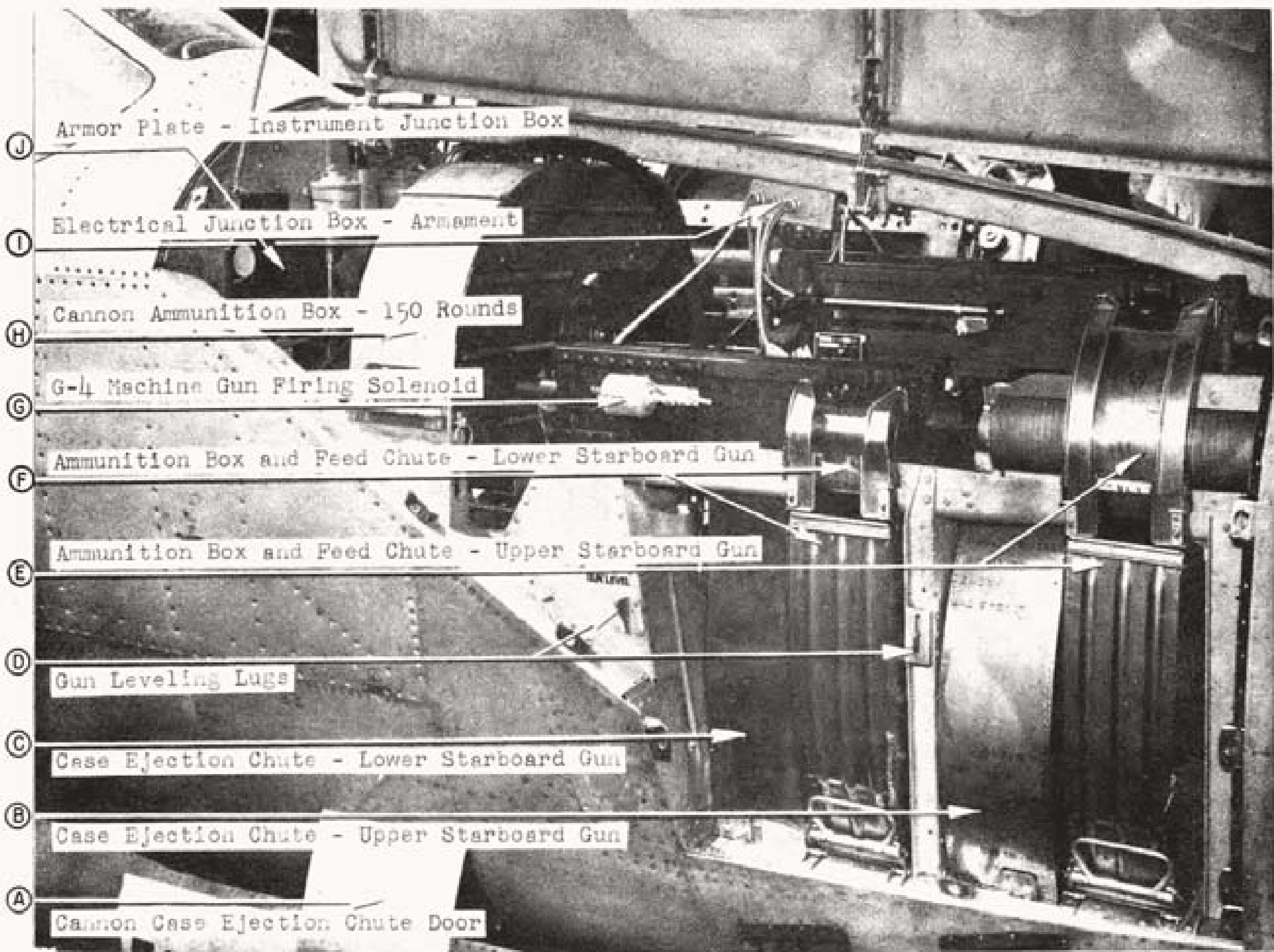
c. When the machine guns are to be fired, the abrasion boot must be carried to protect the Ultra High Frequency radio antenna beneath the fuselage.

NOTE: Considering the electrical characteristics and the effects of low temperatures encountered at high altitudes, substitutes for this boot are not recommended.

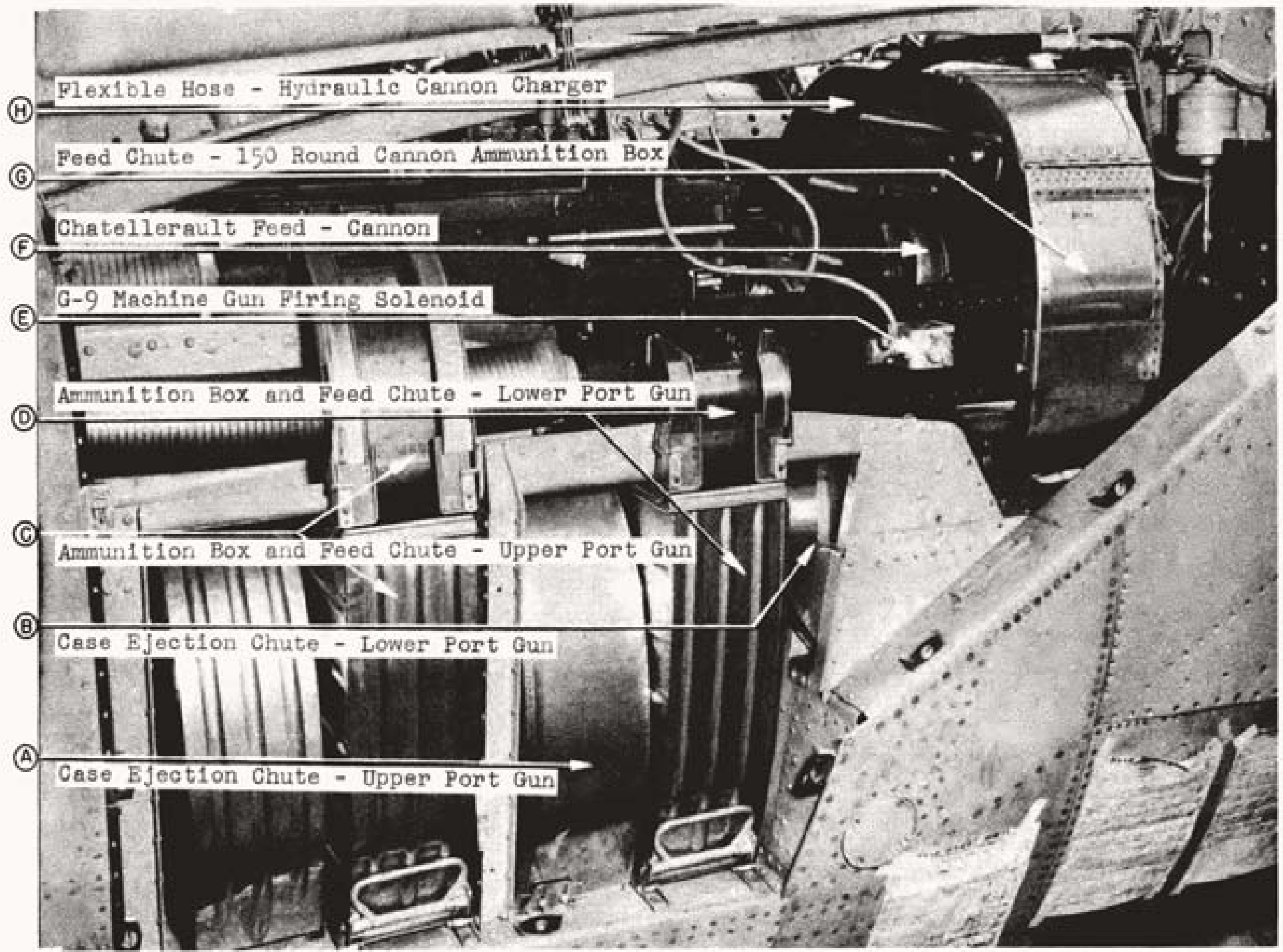
d. When the TR1133A radio is not installed the U.H.F. antenna should be removed and the opening filled with the plug provided.



ARMAMENT - TOP VIEW



ARMAMENT - STARBOARD SIDE - 150 ROUND CANNON INSTALLATION

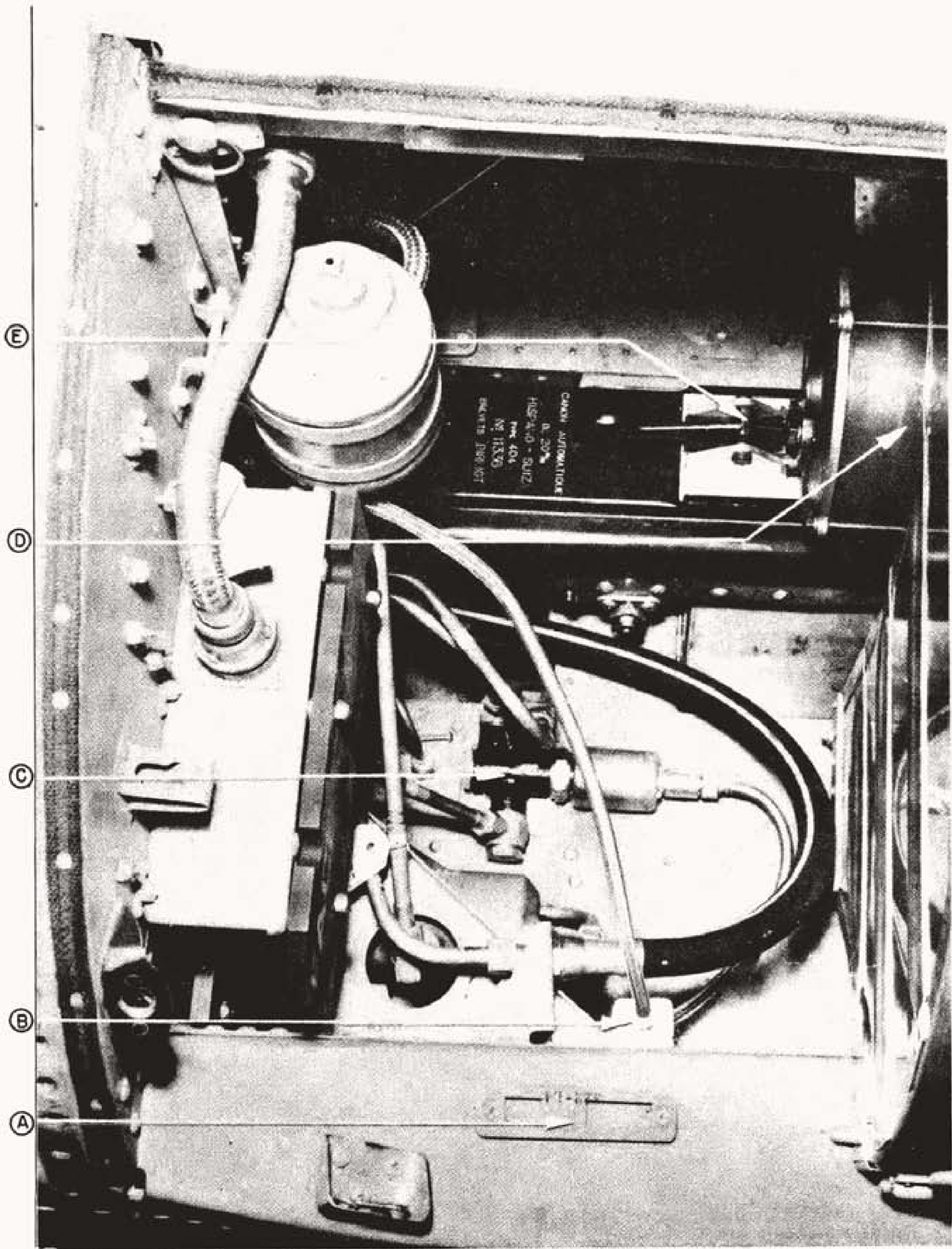


ARMAMENT - PORT SIDE - 150 ROUND CANNON INSTALLATION

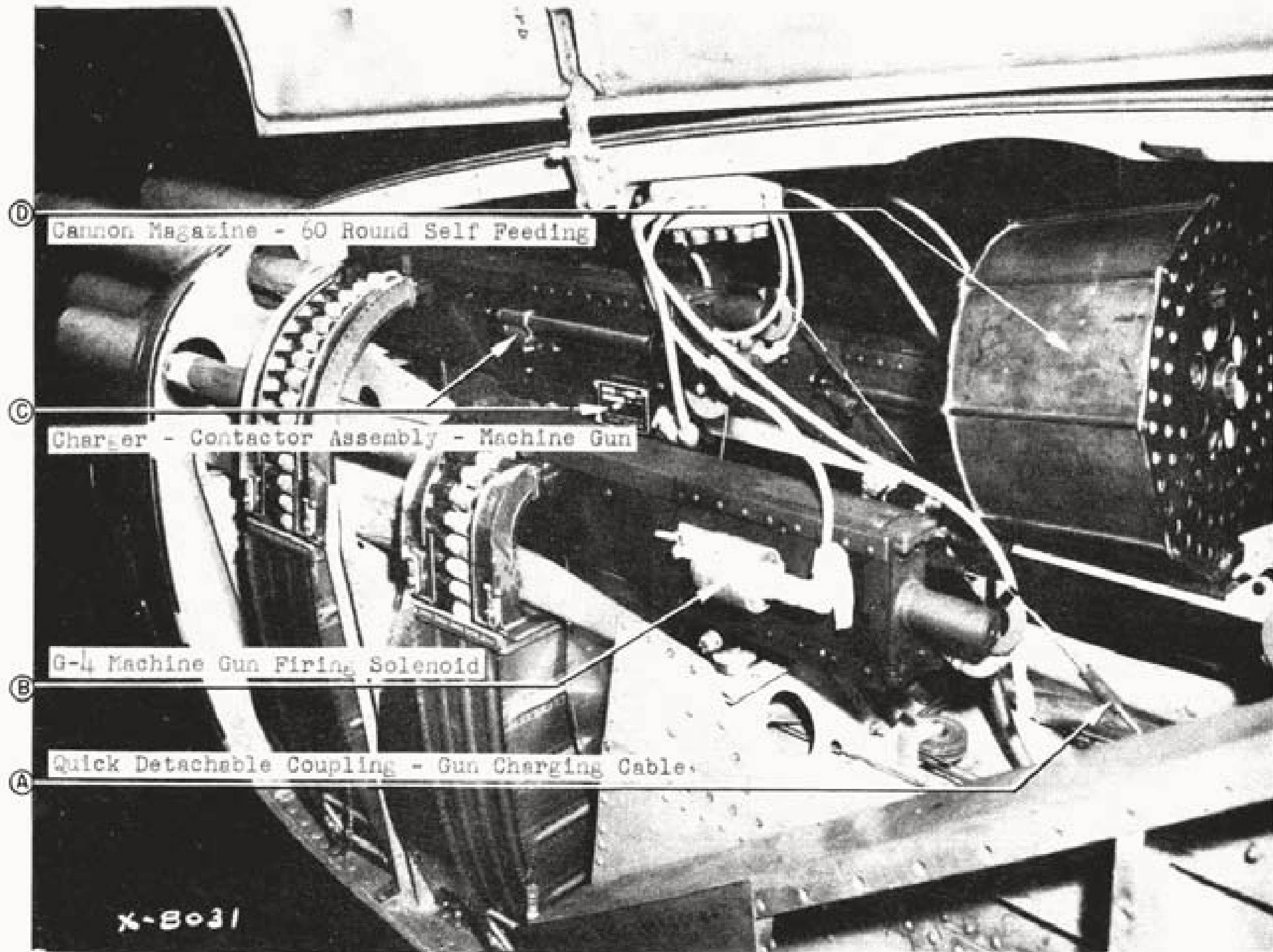
Key to Fig. 4

Armament - Starboard Side Aft

- A. Stowage Bracket - Gun Firing Solenoids
- B. Disconnecter - Alternate Machine Gun or 20 MM Cannon Firing Control. (Shown connected to Cannon Solenoid Control Valve. Upper wire is connected to machine gun firing solenoid when alternate gun is installed).
- C. Cannon Firing Solenoid Control Valve.
- D. Chatellerault Feed - Cannon
- E. Release Lever - Cannon Feed



ARMAMENT - STARBOARD SIDE AFT



④ Cannon Magazine - 60 Round Self Feeding

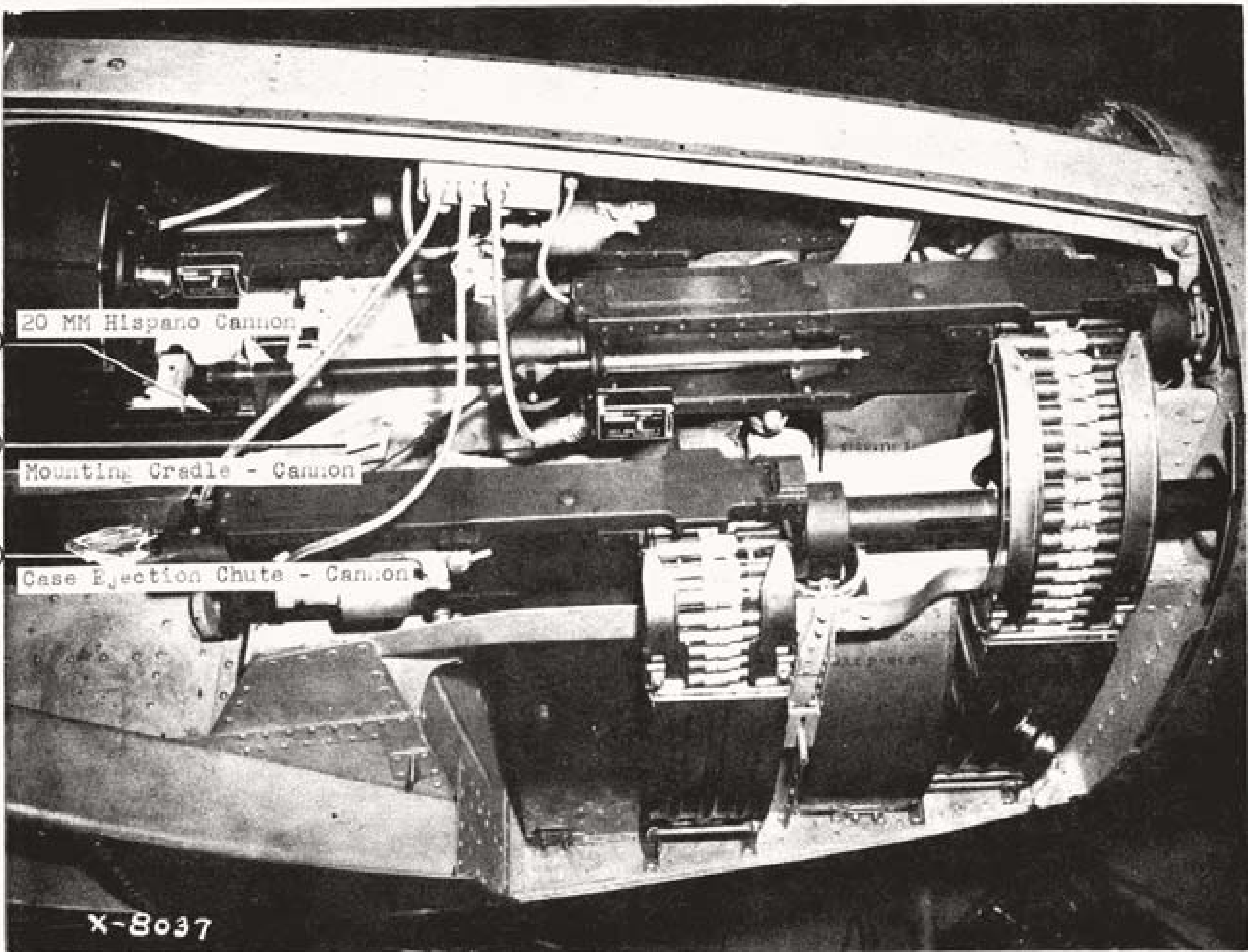
③ Charger - Contactor Assembly - Machine Gun

② G-4 Machine Gun Firing Solenoid

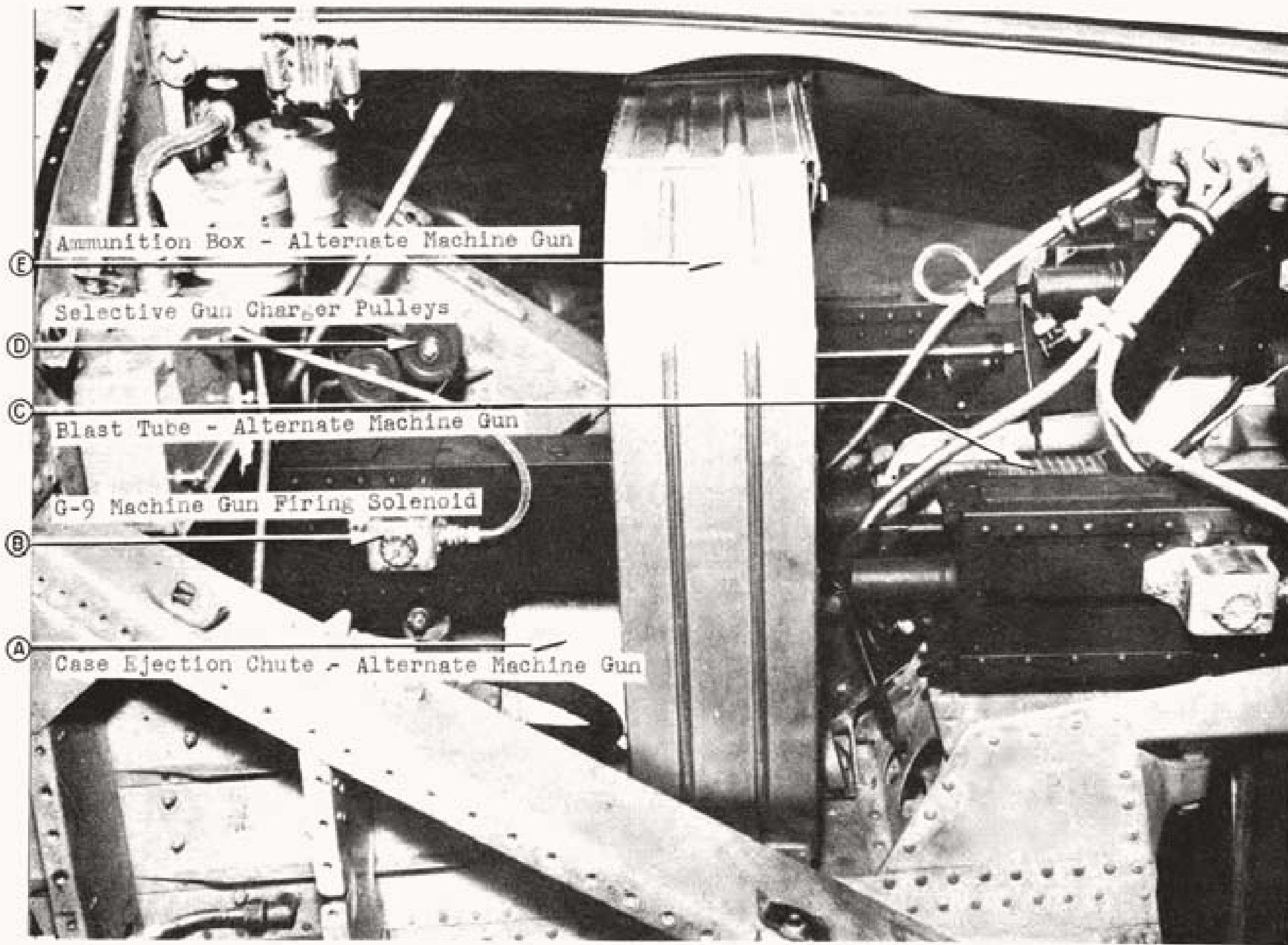
① Quick Detachable Coupling - Gun Charging Cable

X-B031

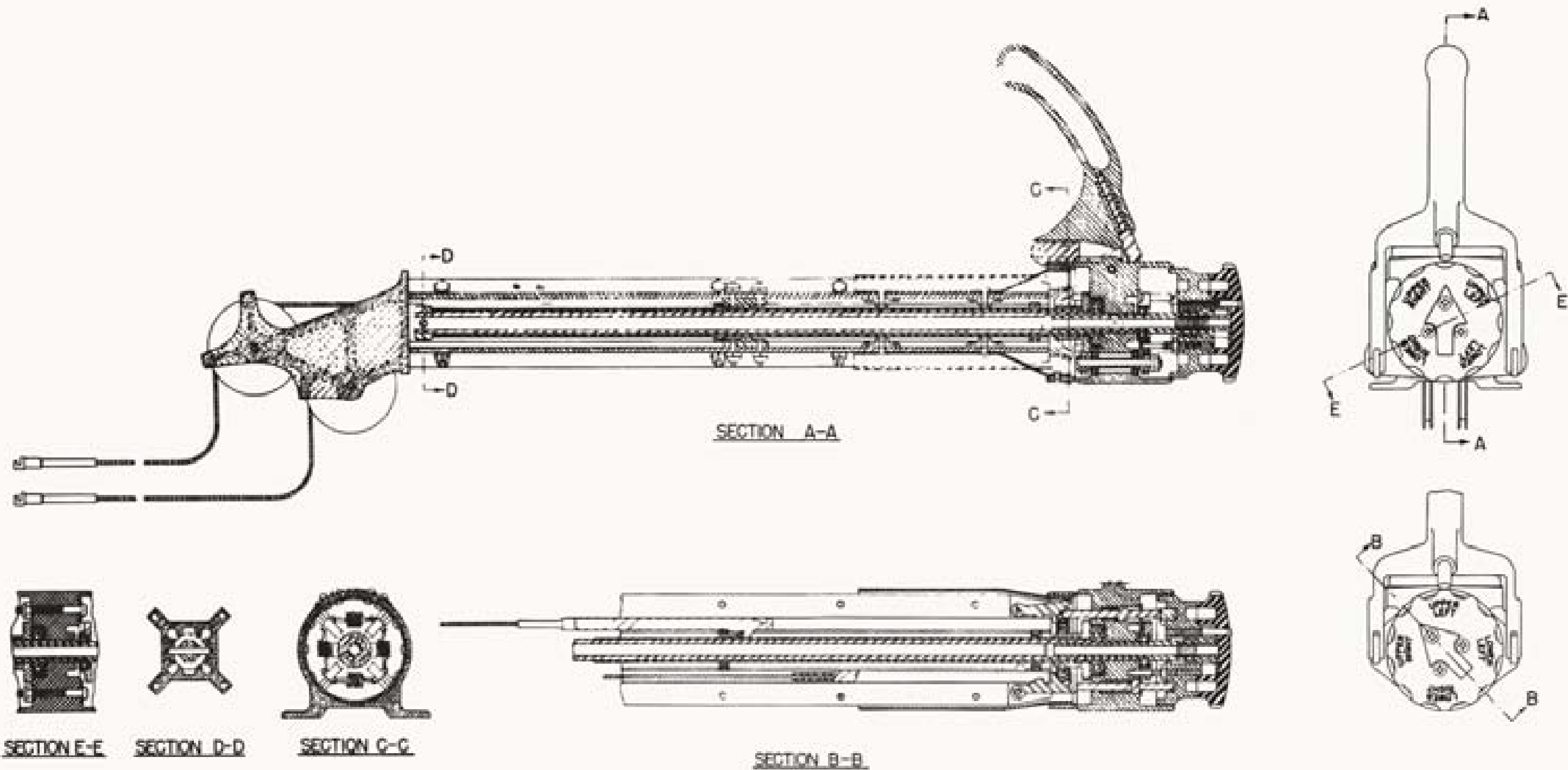
ARMAMENT - PORT SIDE - CANNON WITH 60 ROUND MAGAZINE



ARMAMENT - STARBOARD SIDE - CANNON WITH 60 ROUND MAGAZINE

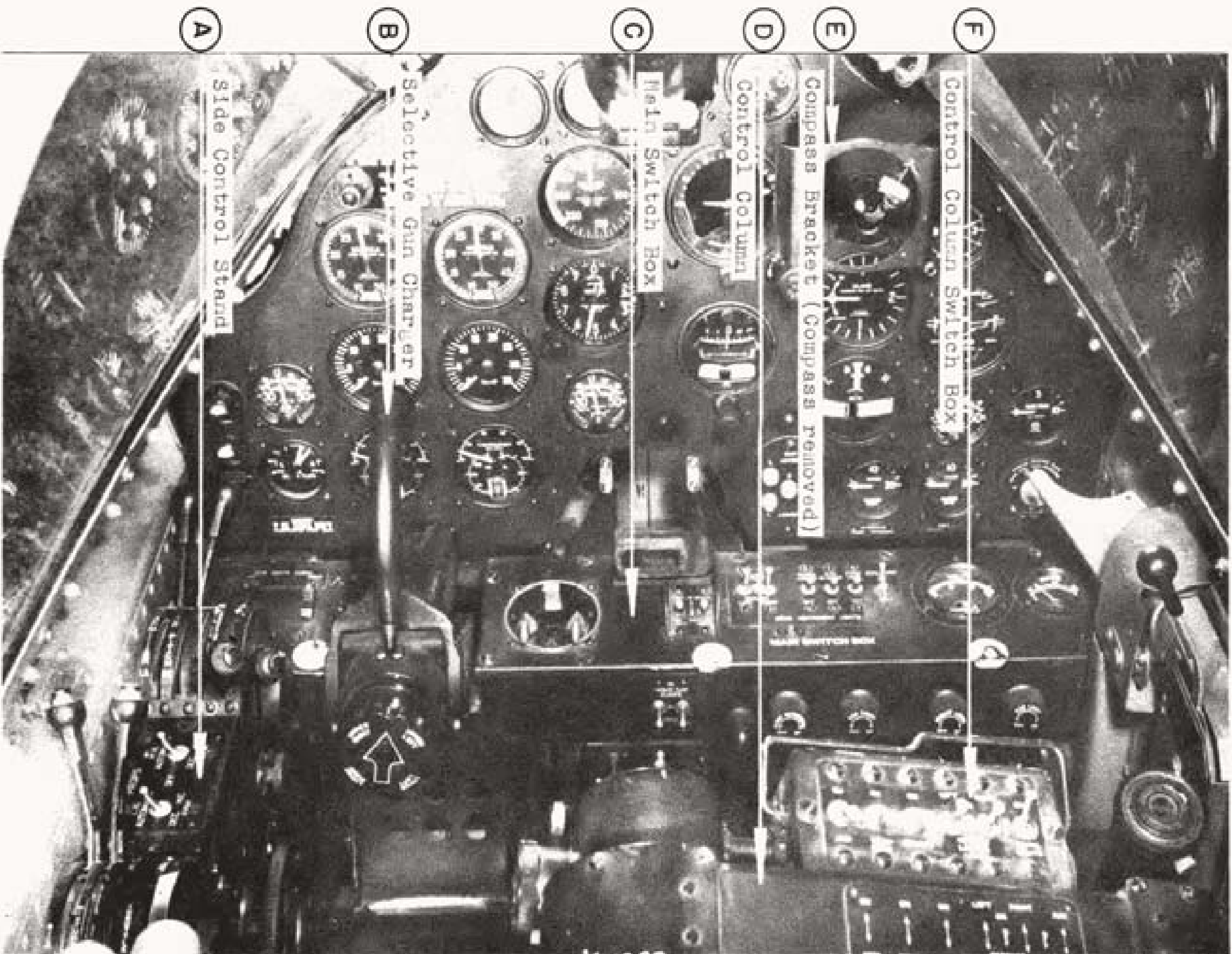


ALTERNATE .50 CAL. GUN INSTALLATION - STARBOARD VIEW

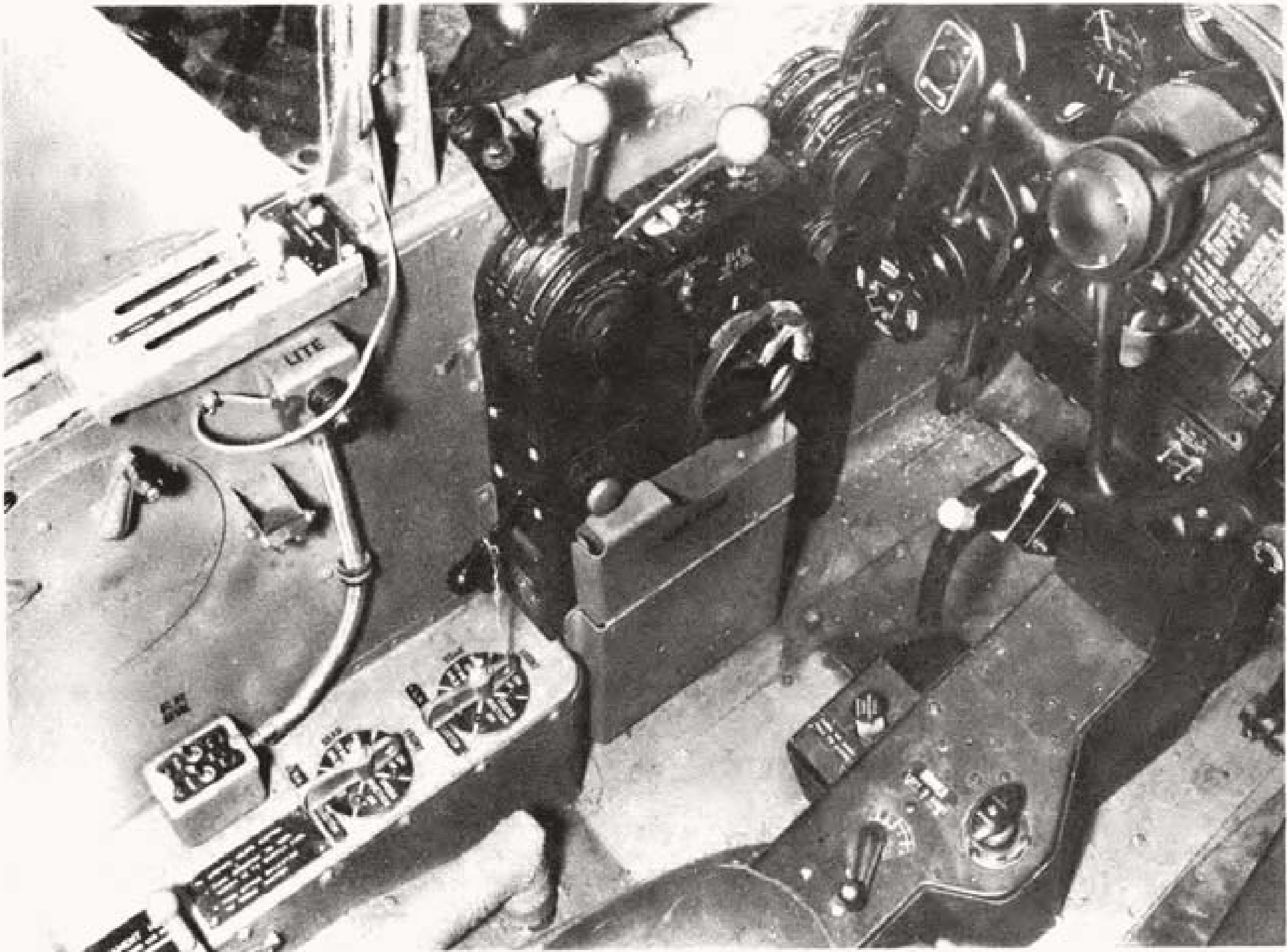


NOTE - REFER TO LOCKHEED DRAWING NO. 245096

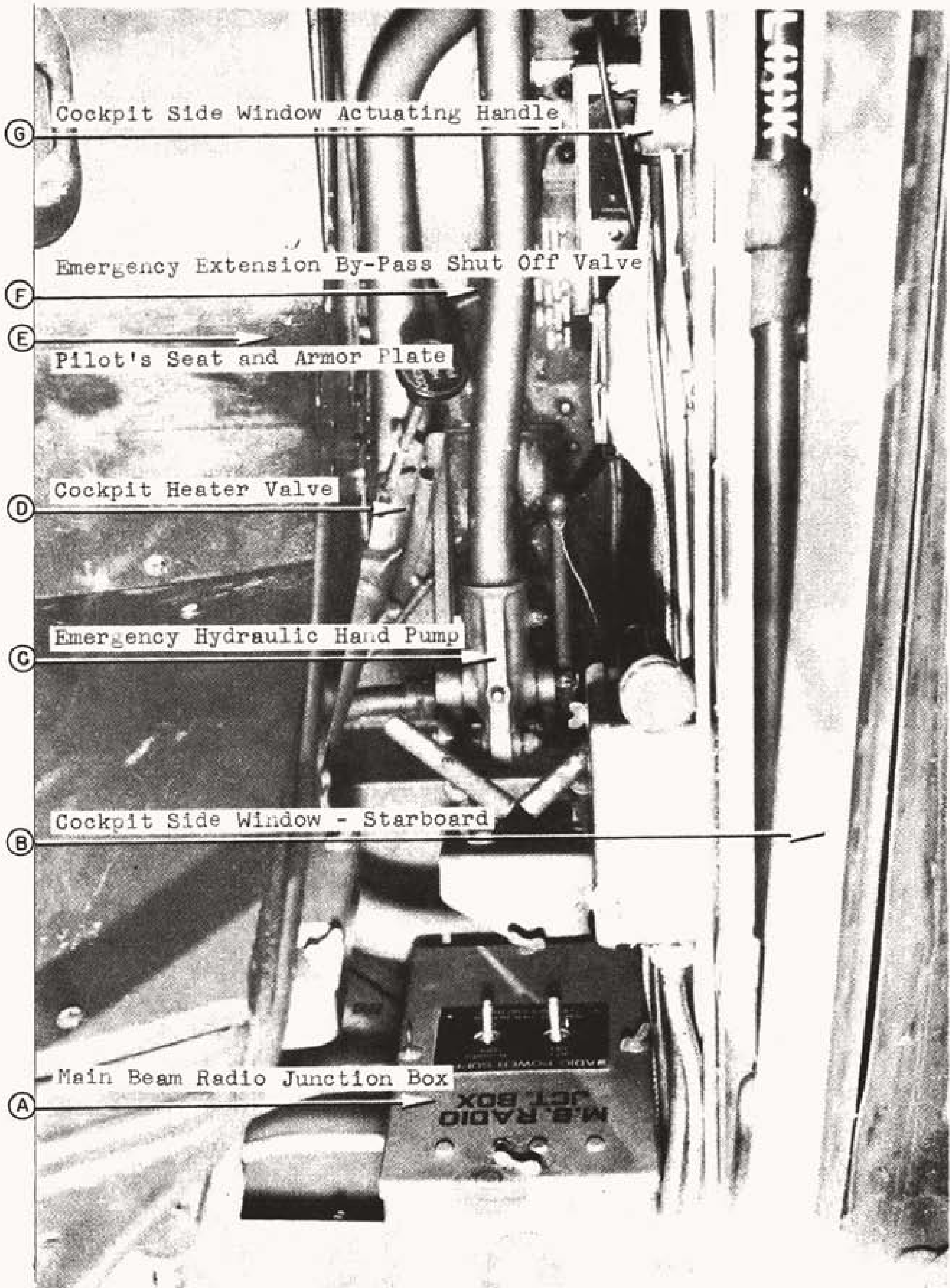
SELECTIVE GUN CHARGER



INSTRUMENTS AND CONTROLS



PILOTS COCKPIT - PORT SIDE FORWARD



PILOT'S COCKPIT - STARBOARD SIDE AFT

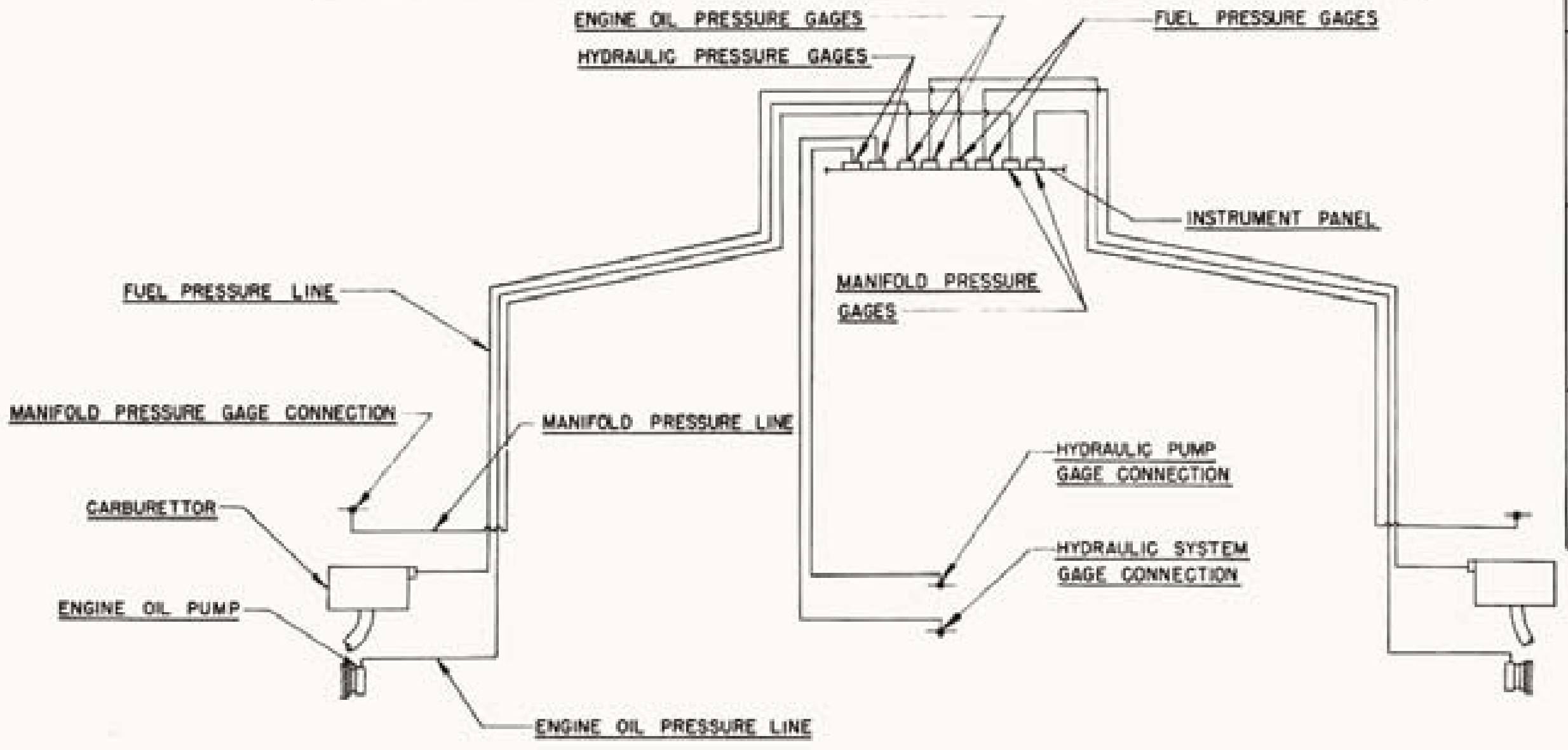
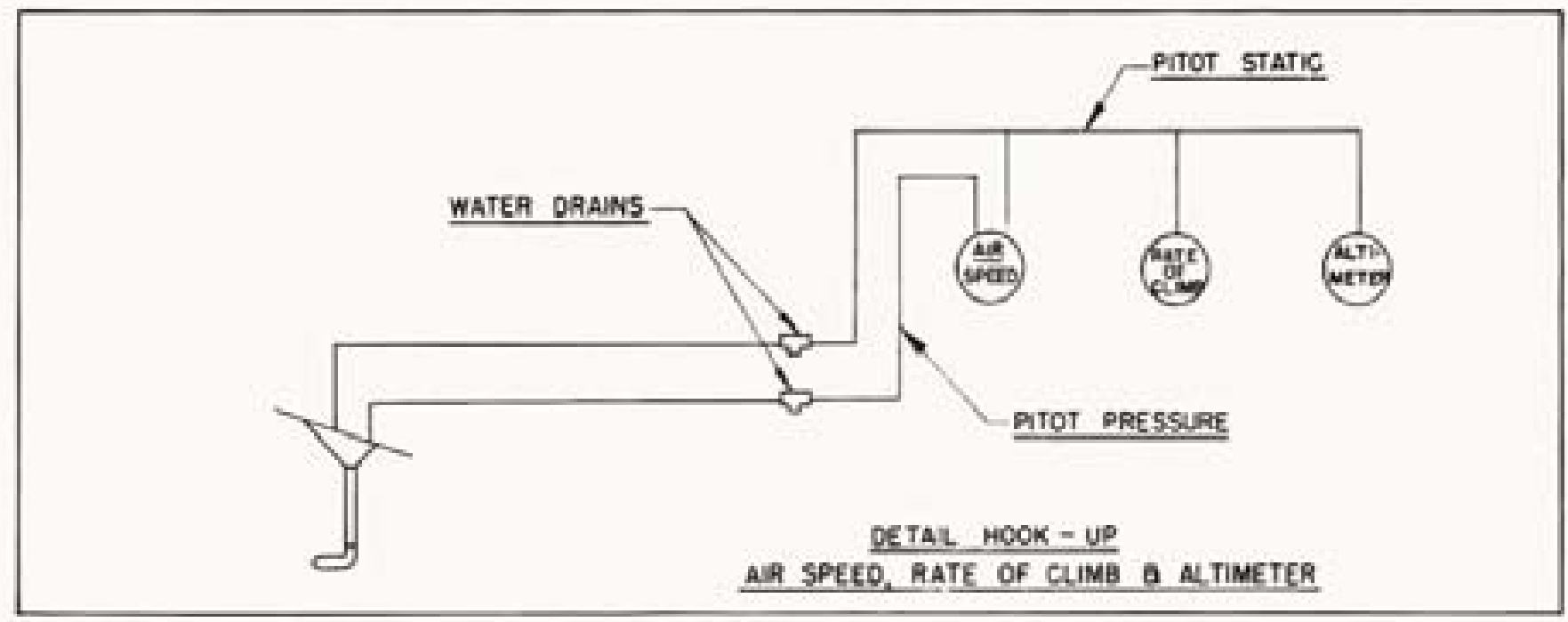


DIAGRAM - INSTRUMENT LINES

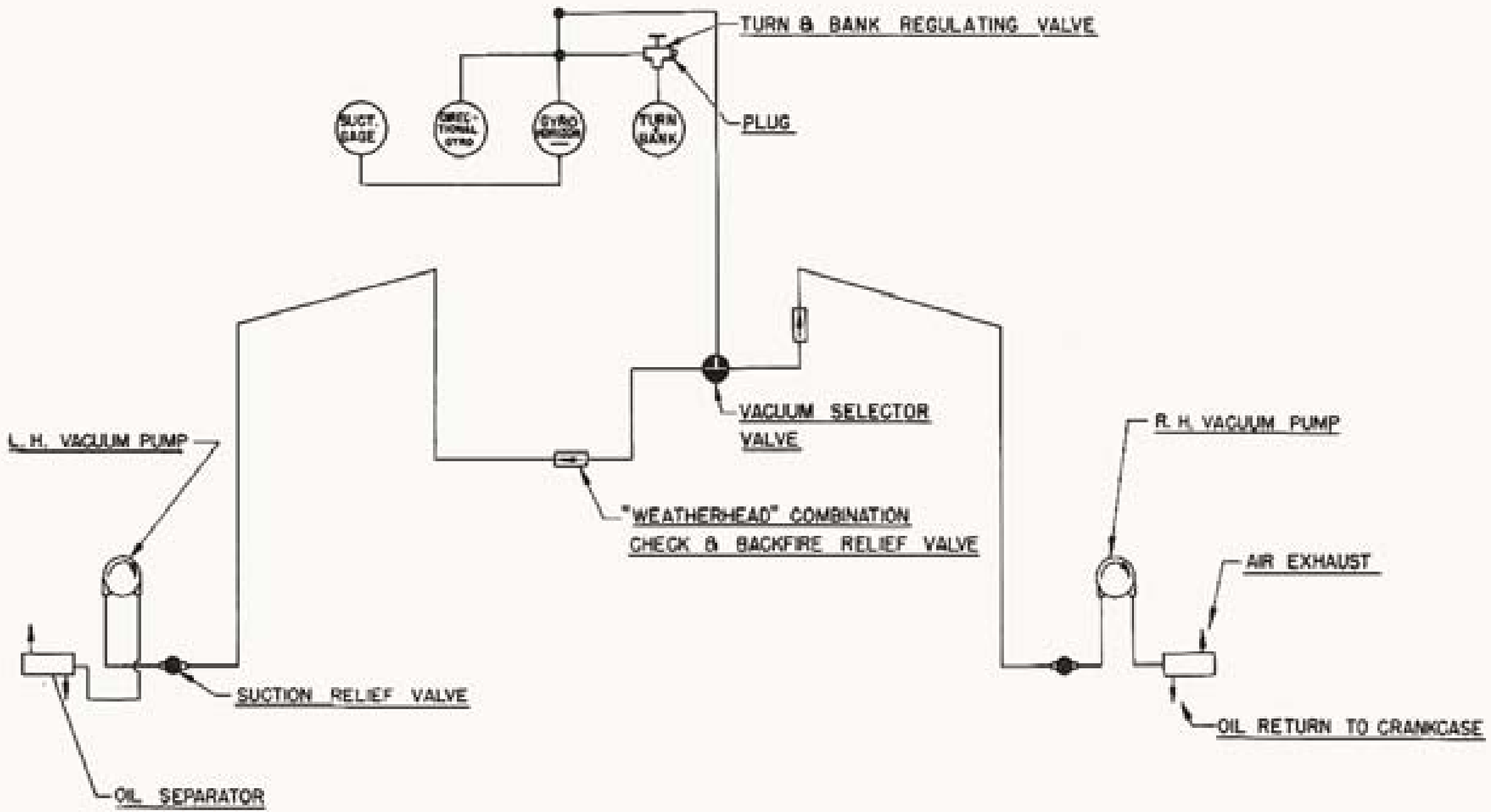


DIAGRAM - VAGUUM SYSTEM

AP 2021 A VOL. I SEC II FIG. 14

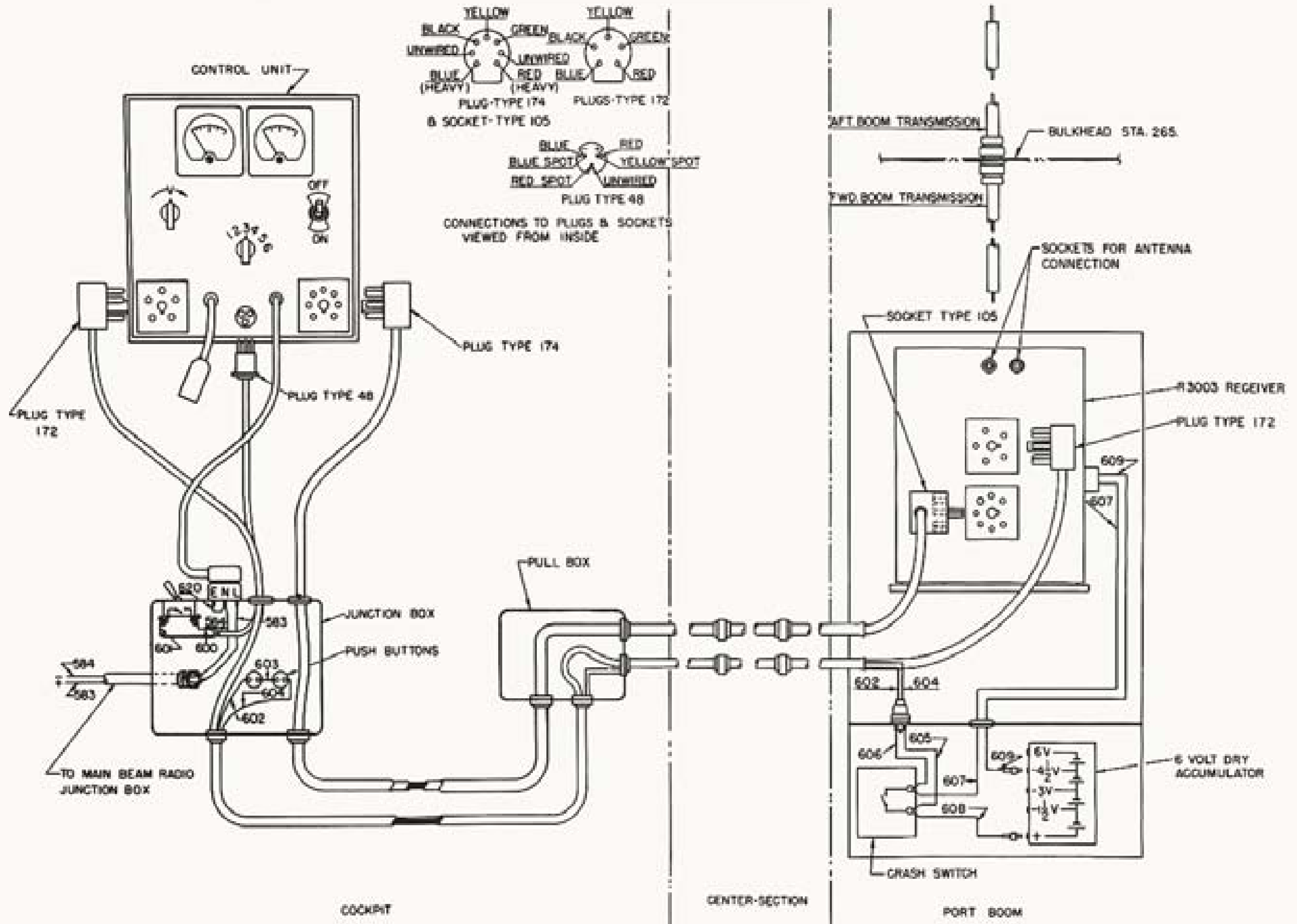


DIAGRAM- R 3003 RADIO

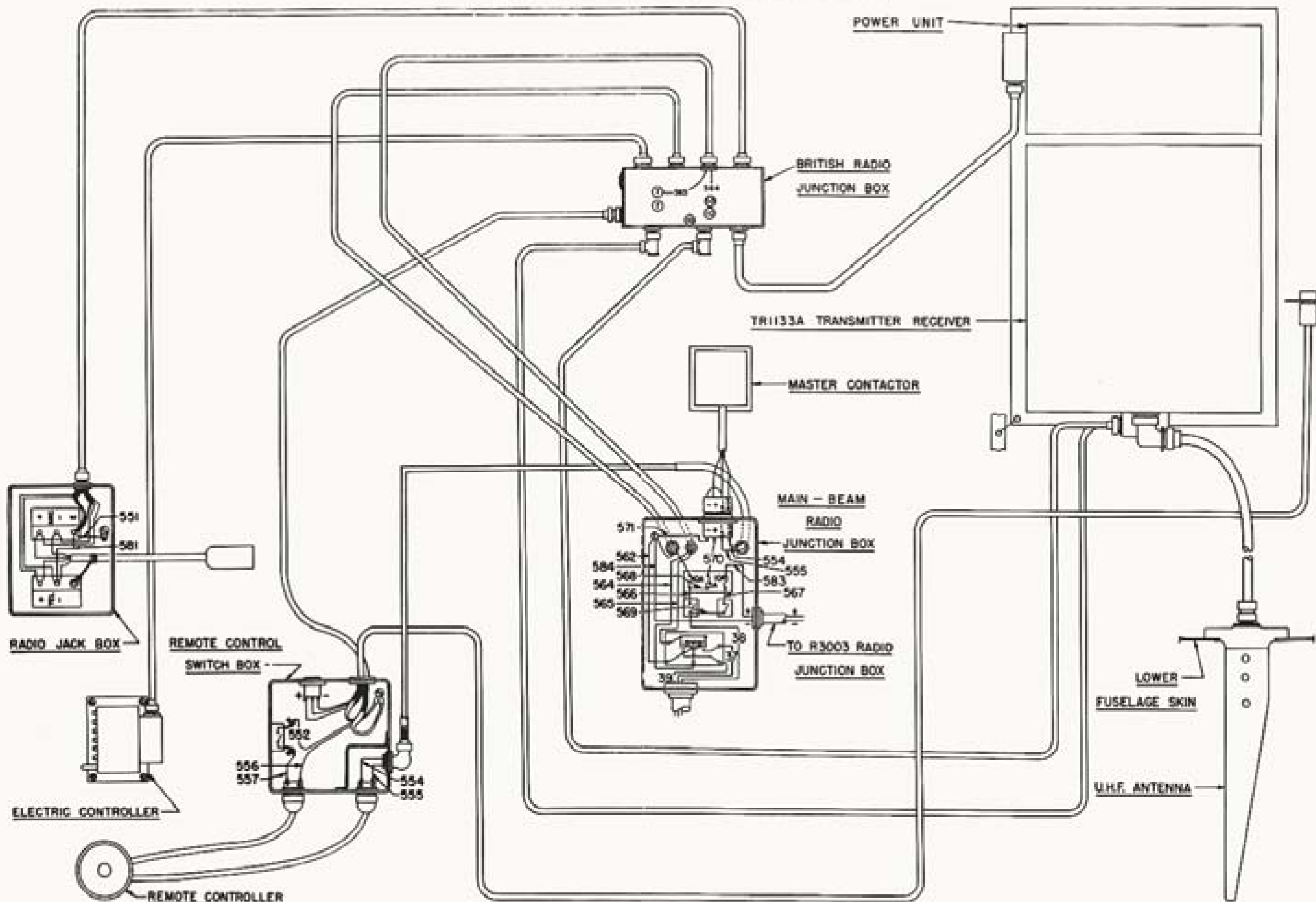


DIAGRAM - TR1133A RADIO