Roy S. Williams.

American Airlines

2

ENGINEERING DEPT.

TECHNICAL DATA

◆

HANDBOOK OF INSTRUCTIONS

FOR THE

MAINTENANCE

OF THE

MODEL DC2-120 DOUGLAS TRANSPORT

◆

3-11-35

#6570

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Ft Worth Tex

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SECTION I

INTRODUCTION

In the design and construction of the Douglas Transport, the manufacturer has developed and incorporated a number of unique theories and devices new to the aeronautical industry. With these innovations in mind, he has endeavored to compile a handbook which will adequately describe and illustrate the construction, operation and maintenance of these devices and the airplane in general.

This handbook is divided into convenient sections such as fuselage, wing, landing gear, brakes, power plant, heating, etc., each of which contains descriptive data as to construction, operation, maintenance and other information essential to obtain the best results in operation and maintenance of the subject which it treats.

While the reduced scale drawings included in this handbook are sufficiently complete for purposes of routine inspection, installation of equipment and field overhaul, they should, in the case of any major overhaul of the airplane be supplemented by complete detail drawings. A thorough study of the drawings should precede any work on the airplane.

SECTION II

DIMENSIONS AND WEIGHTS

A. Characteristics

1. General Dimensions

Overall Span	85 ft.
Overall Length	61 ft. 11 3/4 in.
Overall Height, Flying Position	21 ft. 1 1/8 in.
Overall Height, at Rest	16 ft. 3 5/8 in.
Height Propeller Hub above Ground, Flying Position	6 ft. 10 3/4 in.
Height Propeller Hub above Ground, at Rest	104 inches
Clearance of Propeller Tips to Ground, Flying Position	16 3/4 in.
Clearance of Propeller Tips to Fuselage	11 inches

2. Wings

Center Panel

Airfoil Section	N.A.C.A. 2215
Chord	170 in.
Area (Projected Area)	255 sq. ft.

Outer Panel

Airfoil Section ... to	N.A.C.A. 2215 at Root N.A.C.A. 2209 at Tip
Dihedral (Measured at top surface)	5 degrees
Incidence	2 degrees
Area	684 sq. ft.
Total Wing Area (Including Ailerons)	939 sq. ft.
Area of Wing Flaps Included in Above	118 sq. ft.

3. Ailerons

Area aft Hinge Centerline (each)	34.85 sq. ft.
Area of Balance (each)	8.56 sq. ft.
Total Area (each).....	43.41 sq. ft.
Area of Aileron Flap (Right Aileron Only) Included in above on:	
Airplanes 1237 to 1256 incl. 1301, 1303, 1305, 1323, 1324.	1.25 sq. ft.
Airplanes 1257 to 1261 incl., 1286 to 1300 incl., 1302, 1304, 1306 to 1322 incl., 1325 to 1335 incl., and subsequent	1.85 sq. ft.

4. Vertical Stabilizer

Area	22.55 sq. ft.

5. Rudder

Area aft Hinge Centerline.....	36.27 sq. ft.
Area of Balance	6.23 sq. ft.
Total Area	42.5 sq. ft.
Area of Rudder Flap (Included in Above).	2.98 sq. ft.

6. Horizontal Stablilzer

Overall Span	25 ft. 8 in.
Area	92.2 sq. ft.

7. Elevators

Area aft Hinge Centerline	26.69 sq.ft.
Area of Balance (each)	2.61 sq.ft.
Total Area (each)	29.3 sq.ft.
Area of Elevator Flaps (each)	3.9 sq.ft.

8. Landing Gear

Tread	18 ft.
Axle Centerline aft of Leading Edge of Wing	25 1/2 inches
Tire Size	42 x 15:00-16 (10 ply)

Revised 11-24-34

B. Weights (Normal loading)

Weight Empty	12,173 lbs.
Crew (2 at 170 lbs. each)	340 lbs.
Steward	170 lbs.
Fuel (265 gallons)	1,757 lbs.
Oil (24 gallons)	180 lbs.
Passengers (14 at 170 lbs. each)	2,380 lbs.
Cargo and Baggage	1,200 lbs.
Full Gross Weight	18,200 lbs.
Wing Loading	19.2 lbs./ sq. ft.
Power Loading	12.7 lbs./h. p.

NOTE: A Department of Commerce approved loading schedule is shown on page 5 so as to enable the ground personnel to familiarize themselves with the proper distribution of weights when loading the DC2-120.

UNITED STATES DEPARTMENT OF COMMERCE

AERONAUTICS BRANCH
LOADING SCHEDULE

DOUGLAS DC-2 SERIAL 1307 NC-14274

Weight Empty 12173 Lbs. Gross Weight 18200 Lbs.

DISTRIBUTION OF CARGO TO REAR COMPARTMENT
(Remainder of Load to be Placed in Front Compartment

Total Cargo Load			100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
PASSENGERS	0	Max.	100	200	300	400	500	600	670	710	740	780	810	850	890	920	960	990	1000	1000	1000	1000
		Min.	90	120	150	180	210	250	280	310	340	380	410	440	470	500	540	600	700	800	900	1000
	1 or 2	Max.	160	200	300	400	470	500	540	580	610	650	680	720	750	790	820	860	900	930	970	1000
		Min.	160	170	210	240	270	300	330	370	400	430	460	500	530	560	590	620	700	800	900	1000
	3 or 4	Max.	200	200	290	330	360	400	430	470	500	540	580	610	650	690	720	760	800	830		
		Min.	200	200	230	260	290	320	350	390	420	450	480	520	550	580	610	650	700	800		
	5 or 6	Max.	190	190	230	260	300	330	370	400	440	470	510	550	580	620	650	690	720			
		Min.	190	190	210	250	280	310	340	380	410	440	470	510	540	570	600	640	700			
	7 or 8	Max.	110	160	190	230	270	300	340	370	410	440	480	510	550	580	620	650	690			
		Min.	110	140	170	200	230	260	300	330	360	390	430	460	490	520	560	600	690			
	9 or 10	Max.	100	160	190	230	260	300	330	370	400	440	470	510	550	580	620	650	700			
		Min.	30	60	90	120	150	190	220	250	280	310	350	380	410	440	500	600	700			
	11 or 12	Max.	100	190	230	260	300	330	370	400	440	470	510	550	580	620	650	690	720			
		Min.	0	0	0	10	40	70	100	140	170	200	230	260	300	400	500	600	700			
	13 or 14	Max.	100	200	290	330	360	400	430	470	500	540	570	610	650	680	720	750	790	820		
		Min.	0	0	0	0	0	0	0	0	20	50	100	200	300	400	500	600	700	800		

Note: For total cargo loads of less than 200 Lbs. Ballast rear compartment to minimum load required unless passengers are seated from the rear.

Approved: O. J. Kolstad
Engineering Inspector
U. S. Dept. of Commerce

Approved: [illegible]
Airline Inspector
U.S. Dept. of Commerce

SECTION III

GENERAL INSTRUCTIONS

A. Towing

1. Attachment for towing may be made on the landing gear axles and on the tail wheel axle.

B. Leveling

1. Pins upon which to place a spirit level are located under the center wing section, near and approximately in line with the front landing gear strut attachments and on the right side of the fuselage between the third and fourth cabin windows.

C. Hoisting

1. Complete Airplane

(a) The airplane is provided with attachments for three point suspension. Two fittings are located on the wing front spar within each nacelle. Access to these fittings is gained by removing the two cover plates from the top of each nacelle. The third point of attachment consists of a cable permanently secured within the fuselage structure just forward of the vertical stabilizer. Access to this cable is gained by removing a cover plate at this point. Figures 1a and 1b, Pages 10a and 10b, give information on the hoisting slings and fittings necessary for handling.

2. Tripods

(a) Wing stands or tripods are to be used for supporting the airplane while work is being done on the landing gear. Fittings for the attachment of the tripods are located on the center wing panel just outboard of each nacelle.

(b) To attach the tripods jack up the airplane. Two jack pads are provided on each landing gear unit. Remove the cover plates from the inner rear attachment fittings. Place the tripods in position and attach with 3/8 x 24 standard aircraft bolts. These bolts are carried, along with a socket wrench, in a leather bag attached to one of the tripods. The 2 1/8 inch long bolts are for the front fittings, and 1 inch long bolts for the inner rear fittings and the 1 1/4 inch long bolts for the outer rear fittings.

3. Wings

(a) Remove screws from the upper surface of the outer wing panel and attach the four hoisting fittings and the four strand sling. Figure 1, Page 10, shows the points of attachment.

4. Fuselage

(a) In hoisting the fuselage alone or the fuselage and center wing panel as a unit, the sling shown in Figure 1a, Page 10a, should be secured to the front spar wing-to-fuselage attachment fittings. Access to these fittings is gained (when the wing is in place) by removing the wing-to-fuselage fillets. The cable, located forward of the vertical stabilizer, forms the third point of support for this operation as well as that of hoisting the complete airplane. Note: When using this sling to hoist the fuselage and center wing panel as a unit, each engine section and the outer wing panels must be removed and all fuel drained from the tanks.

5. Power Plant

(a) The engine section complete, except for the propeller and oil, may be hoisted by attaching a sling to the lugs provided on the engine cylinder heads. Access to the lugs may be gained through the two holes in the anti-drag ring.

D. Lashing Down

1. The airplane may be lashed down at three points; namely, each wing tip and the jury tail skid. Tie down cables are stowed in a leather bag on the rear wall of the baggage compartment. The cables may be attached to eyebolts on the lower surface of each outer wing panel and to a bolt in the jury tail skid.

E. Engine Covers

1. A cover for each engine is stowed in the rear fairing of each nacelle. These are accessible by removing the inboard circular cover plate marked "engine cover".

F. Starting of Engines

1. Suggested procedure for starting is as follows:

(a) Set tank selector valve to tank required.

(b) Set engine fuel selector valve to "both-on". (The primer takes off the right fuel pressure gauge line.)

(c) Work the wabble pump until pressure shows on both gauges.

(d) Give about two full strokes of the throttle of engine desired. (If engines are not cold, two full strokes will be unnecessary.) Note: Do not start the engines when carburetor heat control is in the "hot" position.

(e) Set main switch to airplane's battery or to battery cart. (This switch is located on the mail compartment wall aft of the co-pilot.)

(f) Push main ignition switch "on".

(g) Set engine switch for engine desired.

(h) Set starter selector switch for engine desired.

(i) Push starter button.

NOTE: The spark is retarded automatically by a special solenoid working in unison with the starting solenoid when the starter button is pushed. The booster ignition also goes on automatically when the starter button is pushed.

2. For starting either engine with the handcrank it is necessary to push the starter button in order to get booster ignition and spark retard. (The handcrank is stowed in the rear baggage compartment.)

G. Identification of Lines

1. All lines are painted with a 1 inch wide colored band near each joint and connection, and at such intermediate points as necessary. The following colors are used for identification:

(a)	Gasoline lines and connections	RED
(b)	Oil lines and connections	YELLOW
(c)	De-icer air lines	GREEN
(d)	Vacuum air lines	BLUE
(e)	Retracting lines	BLACK
(f)	Supercharger Pressure	ORANGE
(g)	Fire extinguisher	BROWN
(h)	Brake lines	PURPLE
(i)	Airspeed static tubes	WHITE & BLUE
(j)	Airspeed pressure tubes	WHITE & GREEN

H. Walkways

1. The center wing section between the nacelles and the fuselage is reinforced for walkway purposes. If, at any time, it is necessary to walk on the outer wing panels or on top of the fuselage, padded boards should first be laid down.

I. Door Keys

1. One key will unlatch all doors with the exception of the lavatory door.

J. Tire Pressure

1. The proper air pressure of the landing gear tires is 40 pounds each and that of the tail wheel 55 pounds.

K. Cargo and Baggage Tie Down

1. The cargo and baggage compartments are equipped with permanently anchored brackets for the attachment of tie down straps. The tie down straps are easily adjustable in length in order to accommodate varying quantities of cargo and baggage.

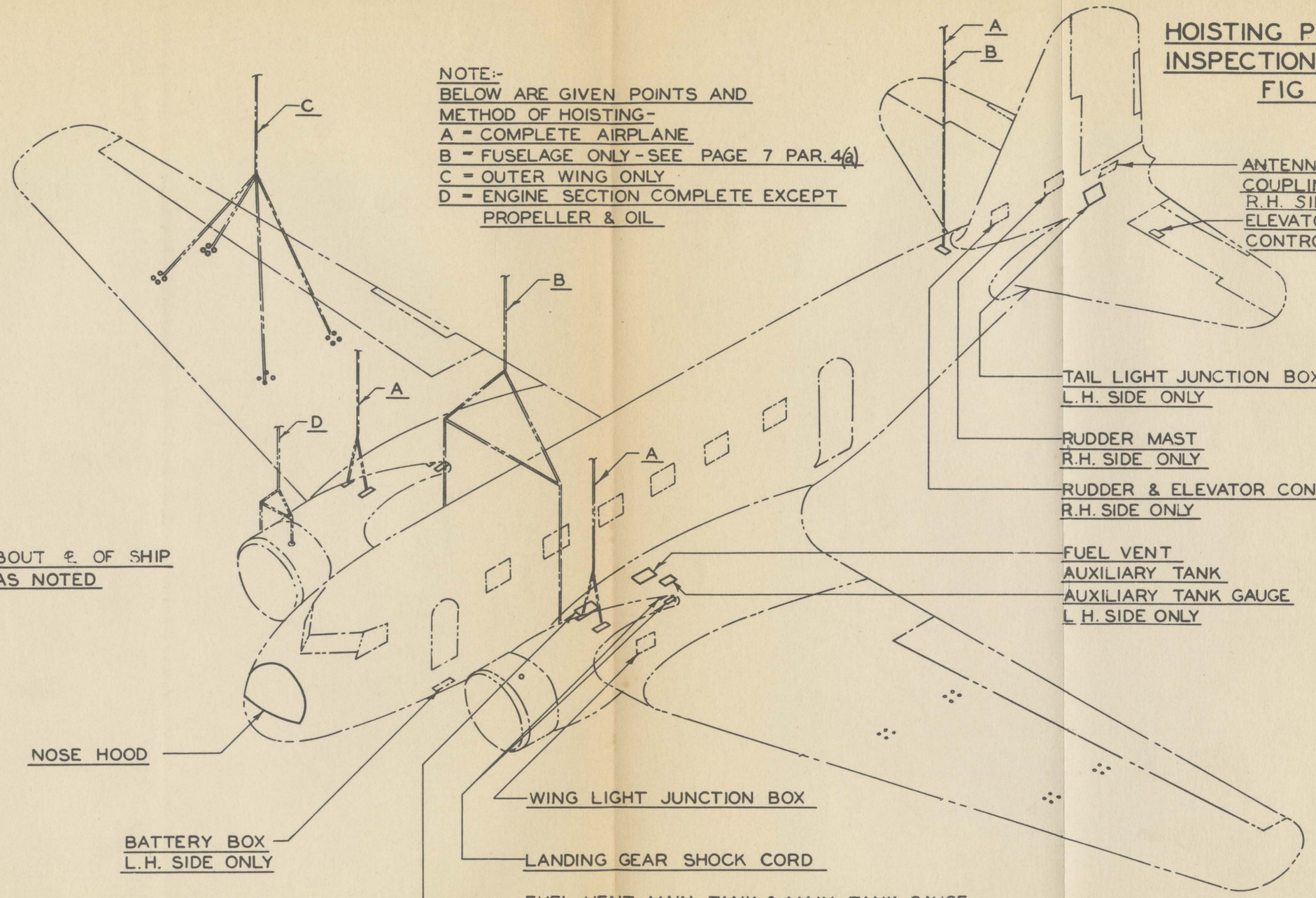
L. Surface Control Locking Strap

(Refer to Paragraph 1 (a), Page 38.)

1. To lock the surface controls, move the pilot's control column to its full forward position. Hook the locking strap on the spoke of the wheel and wrap one turn around the column and wheel spoke; then buckle to the pedal strap. The pedal lock strap is applied by placing the provided channel across the pilot's foot rests with the strap loop around the pedals. Wrap the strap around each foot rest and buckle to the control column strap.

HOISTING POINTS & INSPECTION DOORS FIG 1

NOTE:-
BELOW ARE GIVEN POINTS AND METHOD OF HOISTING-
A = COMPLETE AIRPLANE
B = FUSELAGE ONLY - SEE PAGE 7 PAR. 4(a)
C = OUTER WING ONLY
D = ENGINE SECTION COMPLETE EXCEPT PROPELLER & OIL



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FUSELAGE HOISTING SLING

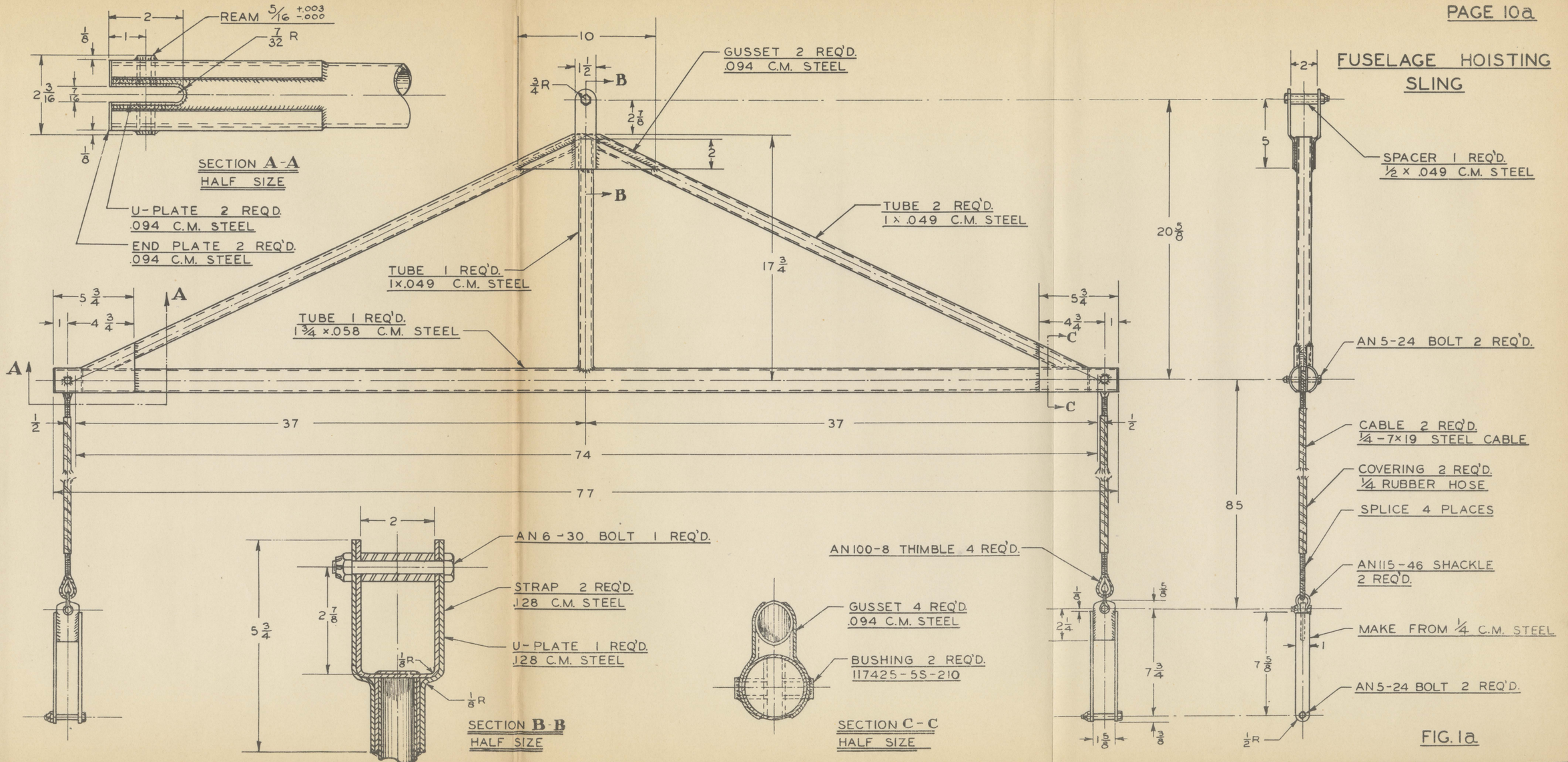
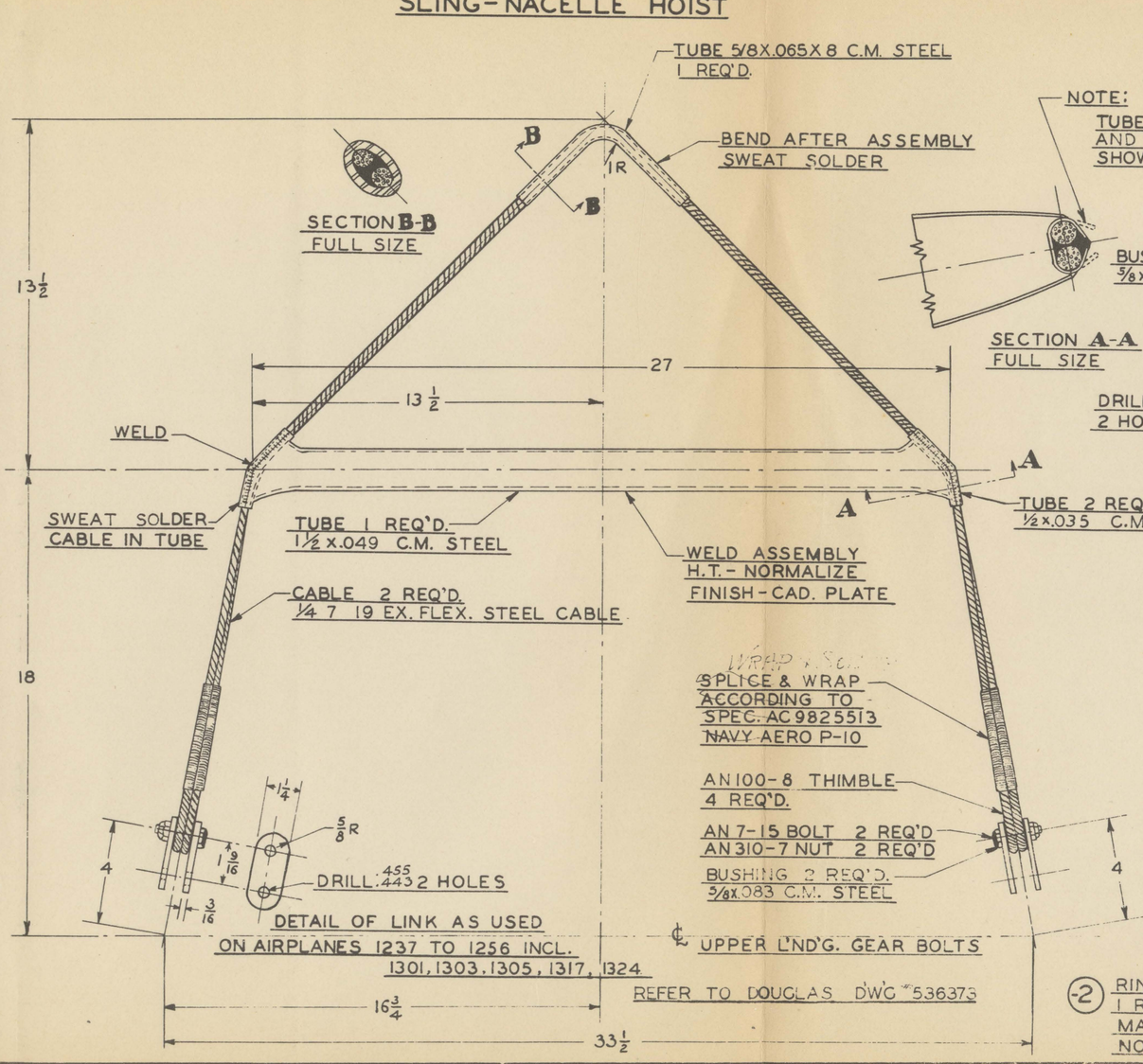
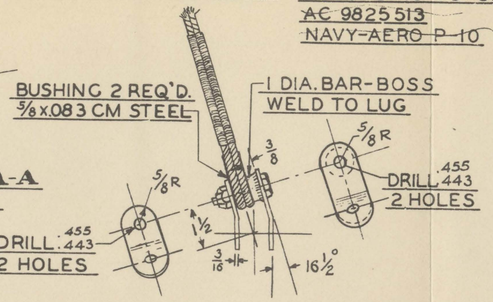
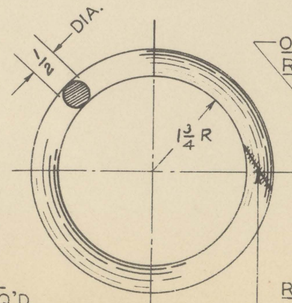


FIG. 1a

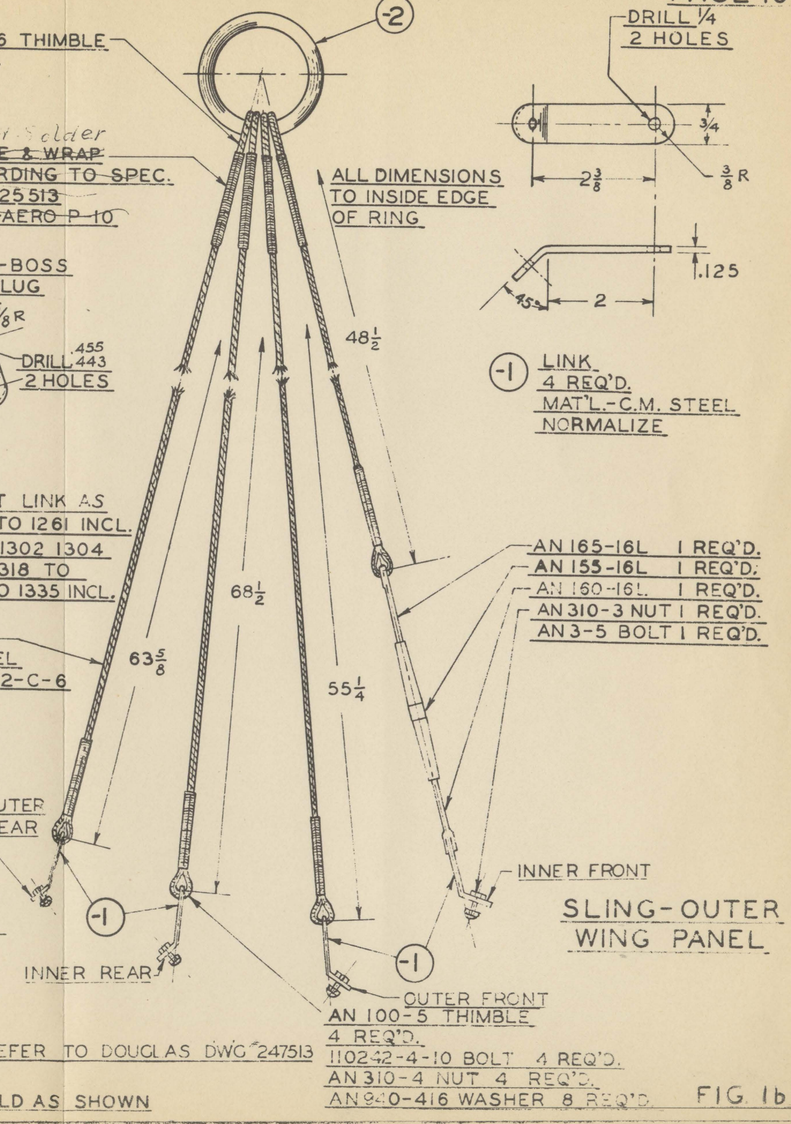
SLING-NACELLE HOIST







(-2) RING
1 REQ'D.
MAT'L.-C.M. STEEL
NORMALIZE



(-1) LINK
4 REQ'D.
MAT'L.-C.M. STEEL
NORMALIZE

SLING-OUTER
WING PANEL

FIG 1b

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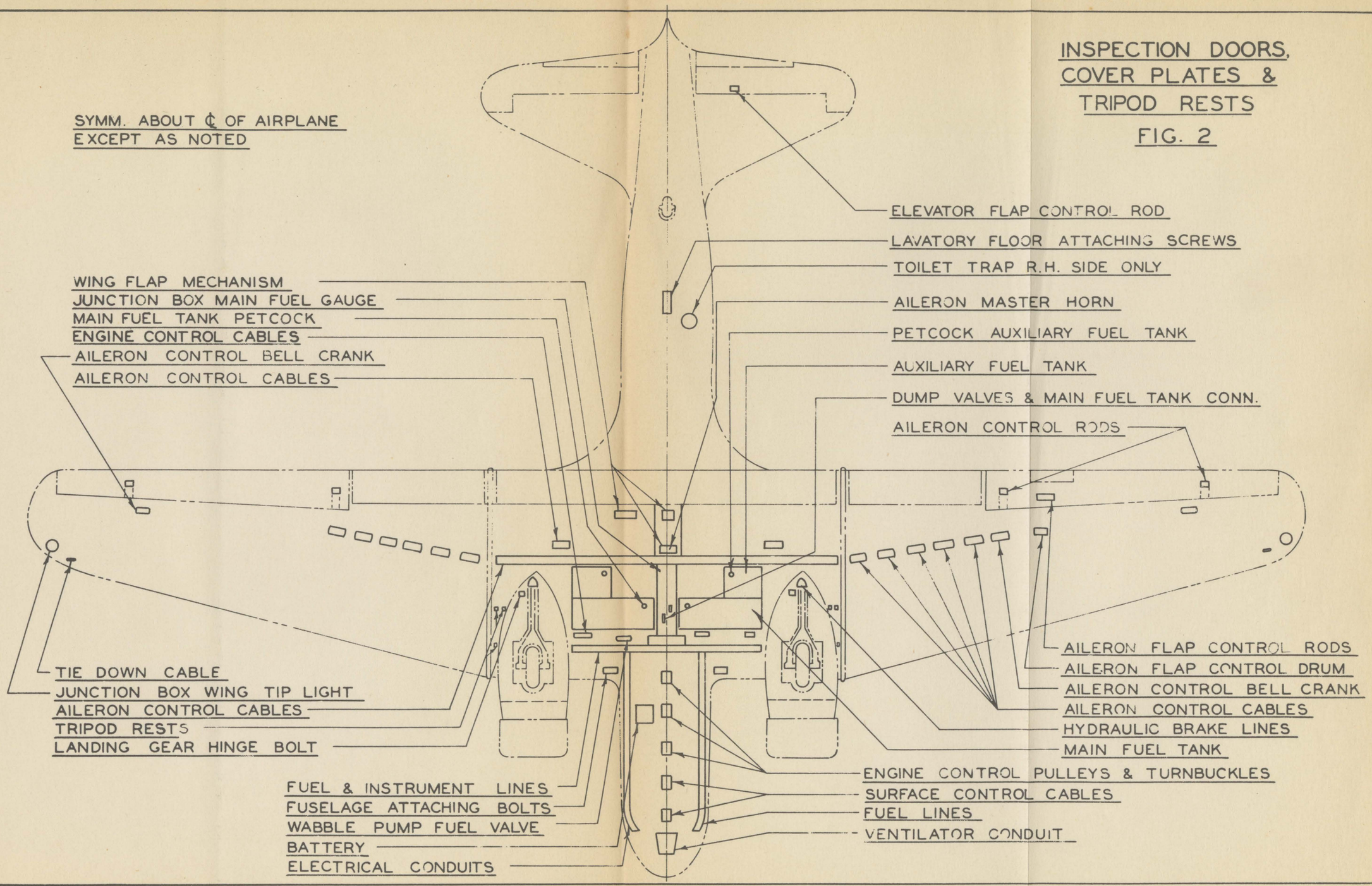
INSPECTION DOORS, COVER PLATES & TRIPOD RESTS

FIG. 2

SYMM. ABOUT ℄ OF AIRPLANE EXCEPT AS NOTED



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SECTION IV

FUSELAGE

A. Description

1. The fuselage is of semi-monocoque construction consisting essentially of transverse frames made of formed 24ST Alclad sheet, and longitudinal members of 24ST extruded bulb angle. Some special longitudinal members are made of 24ST Alclad sheet formed as channels. The fuselage covering is 24ST Alclad sheet.

2. In case of replacing structural members, such as transverse frames or longitudinals, it is important to follow the material specifications as noted on the detail frame drawings and the frame assembly drawing, #530545, which provides an index to the detail frame drawings. In replacing fuselage covering, follow the material specifications given on fuselage covering drawing #536766. NOTE: The Department of Commerce has approved the replacement of 24SRT with 24ST with the exception of all the spar webs and the center wing section corrugation.

3. For care and protective finishing of structural members and metal covering, refer to Section XXIV, Page 157.

B. Cabin Finish

(See Section XXI, Page 146, for soundproofing.)

1. The interior of the cabin from the bottom of the windows upward is lined with Grade A airplane cloth, stretched and doped. The forward wall is in one piece, attached by a dural strip which is secured by Parker Kalon screws. At the ceiling, it is sewed to the ceiling piece and both are held in place by a cloth strip. The side walls from the ceiling, down to the cold air duct, are of one piece held in place by a cloth strip at each end of the cabin. At each frame there is a dural strip which is adjusted into the curve of the ceiling by means of an adjustable fastener at each end. These fasteners are under the cold air ducts, which must be removed to detach or adjust the strips. Paragraph C, Page 144, outlines the procedure for removing the cold air duct. Around the doors the cloth is attached to a dural strip which is riveted to the forward door jamb and is attached with Parker Kalon screws to the other door jambs.

2. The spaces between the windows are covered by cloth panels. These panels are interchangeable and may be removed readily without disturbing any other cloth portion. Along the lower edge and around the windows thepanels attach to dural strips which are held in place by Parker Kalon screws and along the upper edge they are held by wires in the hem, which are attached at each frame. In order to replace one of these panels, it is necessary to remove the two adjacent window frames and the cold air duct. Paragraph K, Page 18, outlines the procedure for removing a window frame. The replacing of a panel may be greatly facilitated by the use of a simple jig, as shown in the window jig diagram, Figure 3, Page 14. Any slightly damaged part of the cloth covering may be repaired quickly by applying a cloth patch. The cloth is doped with acetate dope; under no condition use a nitrate dope.

3. Panels of Plymetal Haskelite, Grade UVU, are installed between the window line and the floor. The surface which faces the soundproofing material is perforated for the purpose of assisting in sound control. The panels are held in place by Parker Kalon Screws. A special washer is used under the head of each screw, and the trim strips snap over these washers similar to a glove snap. Do not attempt to slide the trim strips over the washers from the ends as this is liable to damage the aluminum sheet which forms the outside surface of the panel. The trim strips may be pried off with a screw driver or similar tool.

C. Cabin Floor

1. The floor is of 1/2 inch Plymetal Haskelite panels, Grade UVU, which are secured in place by special screws. These screws are fitted with shoulders which prevent them from coming out of the floor panel when detached from the structure. In removing any panel it is first necessary to detach the large headed screws and then raise the aft end and slip the panel rearward and out from under the adjacent forward panel. It is not necessary to remove the metal strips which form the edge of the panels. Each panel is butted against rubber strips. Care must be exercised when removing or replacing a panel as injury to the rubber strips may cause the floor to leak when washed. The work of replacing a panel may be greatly facilitated by placing a thin sheet of metal on top of the rubber when inserting under the warm air duct.

D. Cargo Compartment and Passageway Floors

1. The passageway floor consists of three panels of corrugated Alclad sheet, the forward and rear of which are secured by special screws fitted with shoulders that prevent them from coming out after the threads have been disengaged. Removal of the rear panel gives access to the battery terminals.

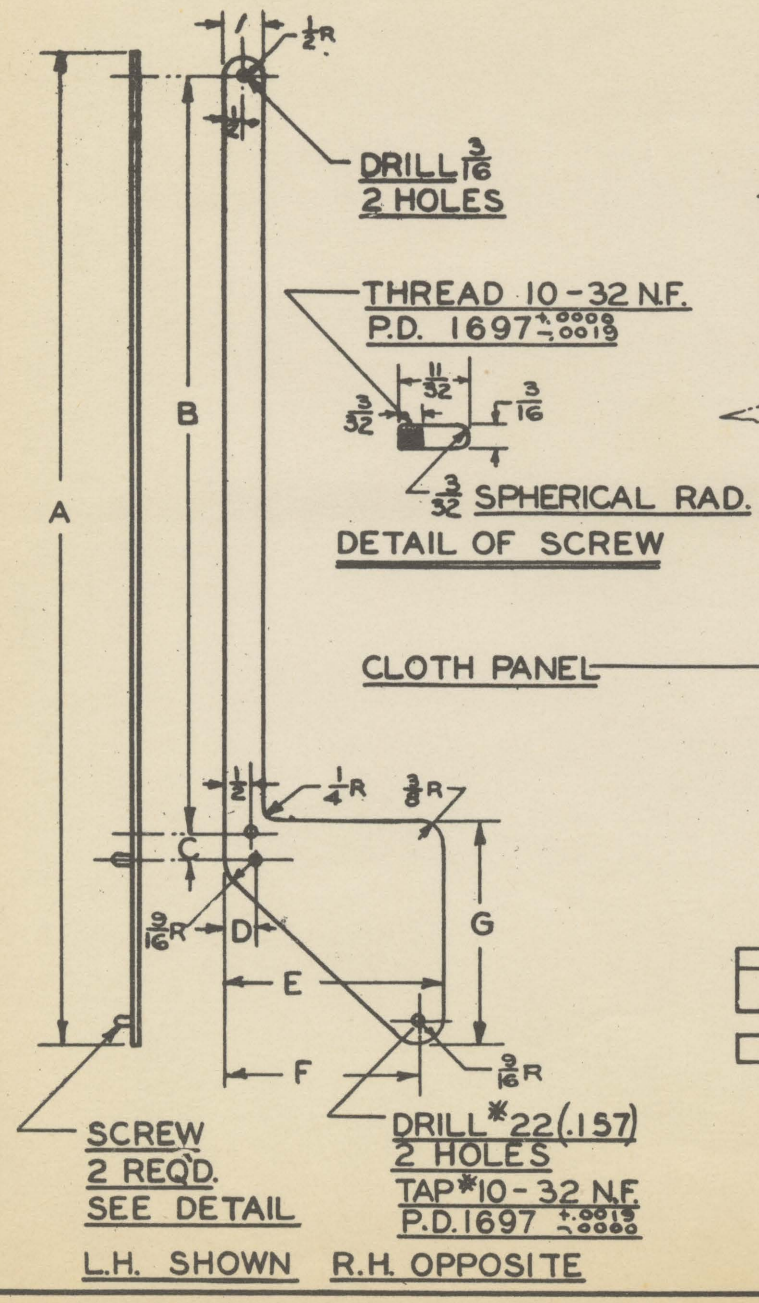
2. The cargo compartment floor consists of panels, which are removable for inspection of control cables, and permanently attached corrugated Alclad sheet.

E. Lavatory

1. The lavatory floor is of Plymetal Haskelite and is permanently attached to the surrounding structure. It is covered with a removable rubber mat. A drain is provided so that the floor may be easily cleaned and flushed off.

2. The baffle or funnel may be lifted off the toilet seat for cleaning and the receptacle under the seat is removable for cleaning and disposal by opening the hinged cover under the fuselage and dropping the cross bar. After cleaning, the receptacle should be filled

AIRPLANE FACTORY SERIAL NO.	DIMENSION						
	A	B	C	D	E	F	G
NO. 1237	20 5/8	15 5/8	11/16	9/16	4 1/16	3 1/8	4 1/2
NO. 1238 & UP	20 1/8	15 1/8	9/16	1/2	4 1/2	3 3/4	4 1/4



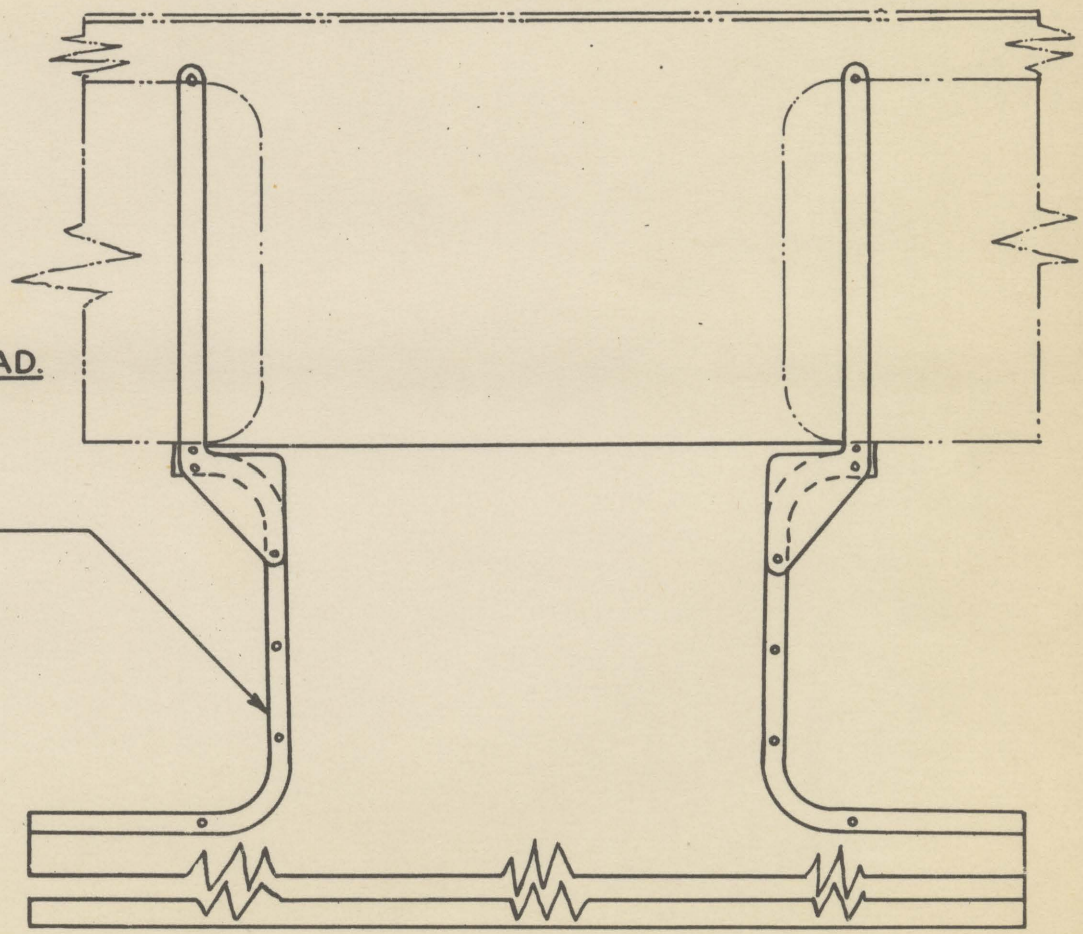


FIG. 3
JIG FOR INSTALLING CLOTH PANELS BETWEEN WINDOWS

with a one quart solution of disinfectant. One tablespoonful of disinfectant to one quart of water will give the correct solution. A quantity of "Sanitor Special Disinfectant" (West Disinfecting Co., New York) is carried in metal clips under the wash basin.

3. The flooring within the toilet frame may be removed by detaching the screws which attach it to the structure. (Refer to handhole diagram, Figure 2, Page 11.)

F. Buffet

1. The water supply for drinking and washing is a 4 1/2 gallon tank in the top compartment of the buffet. This tank may be filled through the filler neck which extends outside of the fuselage. (Refer to water system diagram, Figure 4, Page 16.)

2. The refrigerator, also in the buffet, is kept cool with "Dry Ice" (solidified carbon dioxide), which is to be wrapped in newspaper and inserted in the perforated hanger provided for it. The rate of evaporation of dry ice will naturally vary with the outside temperature, the cabin temperature, the number of times the door is opened, and the number of layers of newspaper around the ice. Therefore, the amount of ice and the number of layers of newspaper necessary must be determined by experiment under the conditions of flight. Aiming at a temperature between 32° and 40° F., it has been found by experiment that, with a cabin and outside temperature varying from 69° to 74°, a piece of dry ice 10 inches square and 1 inch thick with one layer of newspaper lowered the temperature of the box (which was at outside temperature) to 30° F. within the first hour and maintained the limits set for a period of five hours. At this time re-icing seemed necessary.

G. Doors

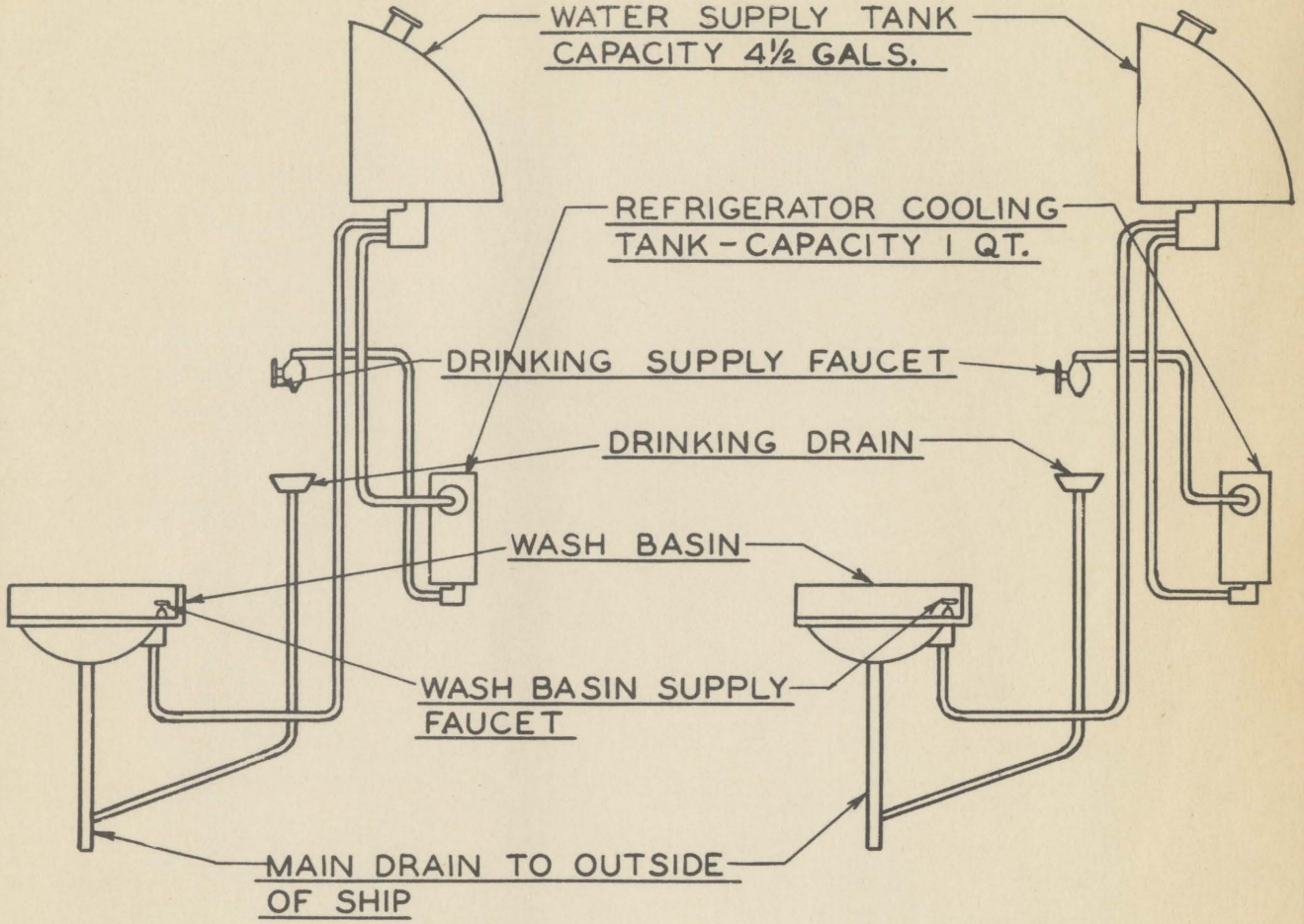
1. The main entrance door, the cargo loading doors and the lavatory door are made watertight and soundproof with a rubber weatherstrip which should be replaced at the first signs of deterioration and at least every three months, as only a small crack will allow a very large percentage of the total of outside noise to enter the cabin.

2. For the same reason the rubber strips around the door at the front of the cabin, the emergency exit door and the lavatory door should be replaced as soon as deterioration is apparent.

H. Passenger Chairs

1. The passenger chairs are equipped with two adjusting devices and a provision for facing fore and aft to give the maximum of comfort to the passenger.

SCHEMATIC DIAGRAM WATER SUPPLY SYSTEM



THIS INSTALLATION USED ON AIRPLANES NOS. 1237 TO 1256 INCL., 1301, 1303, 1305, 1317 & 1320

THIS INSTALLATION USED ON AIRPLANES NOS. 1257 TO 1261 INCL. 1286 TO 1300 INCL., 1302, 1304, 1306 TO 1316 INCL., 1318, 1319 & 1321 TO 1335 INCL.

FIG 4

NOTE:
TOTAL CAPACITY INCLUDING WATER IN COOLING TANK & TUBES - APPROX. 5 GALS.

REFER TO DOUGLAS DRAWINGS NOS. 530575 & 536770

REVISED 7-21-34

2. To tilt the entire seat forward or back:

(a) Release catch on handle of adjusting crank, located on the side of the chair frame, by pulling the handle outward.

(b) Turn the handle in either direction until desired position is attained.

(c) Let go of handle to allow catch to snap into position.

3. To tilt the back only:

(a) Press spring catches on both sides of back bar and tilt chair to desired position.

4. To face chair to the rear:

(a) Lift head cushion from top of chair back.

(b) Release back rest locking pins by pulling release cord located at the base of the back rest.

(c) Swing back rest over seat to position on other side so that locking pins provided at that point will snap into place.

(d) Replace head cushion.

5. To remove a chair pull out clevis pin from the chair and rubber cushion at each of the four seat brackets.

6. When detaching chairs to remove the floors proceed as above on the two side brackets. On the two floor brackets, remove the four bolts holding the rubber cushions to the brackets, then detach the brackets by taking out the four bolts holding them to the floor.

I. Cabin Equipment

1. The various items of cabin equipment, being attached by screws and nut plates, are readily removable. To empty the ash trays, it is necessary to lift the lock spring which can be reached with the finger when the ash tray is open. This allows the ash tray to rotate enough to empty its contents.

2. A jump seat is installed between the rear passenger seat on the right hand side of the cabin, and the buffet. The seat may be folded up against the passenger seat when not in use.

J. Emergency Exits

1. The emergency exit hatch is located overhead and midway between the pilot's and co-pilot's seats.

2. The emergency exit hatch is fitted with two release handles at the forward end. These handles are painted red.

To Open:

(a) Rotate two RED handles toward center.

(b) Push forward end up. (The wind will then carry the entire hatch away, leaving an unobstructed opening in the fuselage roof for quick exit.)

3. An emergency exit door is provided at the rear of the cabin on the left hand side.

To Open:

(a) Turn release handle to right.

(b) Push door clear of opening.

K. Cabin Window Glass Replacement

(Working inside the cabin.)

1. Detach screws from window frame and remove frame from fuselage wall.

2. Remove old glass and rubber from window.

3. Place new glass and rubber on frame.

4. Massage rubber with soapstone or sprinkle with talcum (to facilitate sliding of rubber when replacing) and replace as a unit.

L. Cockpit Windshield Glass Replacement

(Working inside cockpit.)

1. Detach screws from window frame.

2. Slide outboard section of glass inward.

3. Remove glass by bringing it inward.

4. Remove screws from frame holding stationary glass panel and pull panel inward.

5. Insert new glass in a reverse manner to that described above.

6. Seal glass in place by means of Dum-Dum on the outside.

SECTION V

WING

A. Description

1. The wing is of full cantilever, multi-cellular stressed skin construction and consists of three main panels. The center panel is built in two sections, front and rear. The two outer panels each have three sections; the main section, the detachable rear section at the inboard end, and the detachable tip.

2. The center panel contains three spars which are built-up of extruded sections of 24ST with 24SRT Alclad sheet comprising the webs. The ribs are pressed and formed from 24SO Alclad sheet and then heat treated. Aft of the rear spar and along the lower surface, bulb angles of 24ST are employed for longitudinal members. The compression structure of the upper surface forward of the rear spar consists essentially of corrugated 24SRT Alclad sheet, the corrugations running laterally. The covering for both the upper and lower surfaces is of 24ST Alclad sheet.

3. The engine nacelles are of semi-monocoque construction and are attached to the center wing panel by machine screws, thereby allowing removal. The transverse frames are formed from 24SO Alclad sheet. The longitudinal members consist of five main formed "hat" sections, to which the engine supports are attached, and of bulb angles interspersed between the "hat" sections. The shell plating is of 24ST Alclad sheet formed and heat treated before riveting.

4. The outer wing panels are similar in construction to the center panel, with the exception that bulb angles are used in place of the corrugated Alclad sheet.

5. The ailerons are of metal frame construction, fabric covered. The right aileron is equipped with a trimming flap, controllable from the cockpit, to compensate for any unsymmetrical loading. (See Surface Controls, Paragraph 2, Page 41.)

6. The wing has an angle of dihedral of 5 degrees (measured on the upper surface). Data pertinent to the span, chord, type of airfoil, etc., may be found under "Dimensions and Weights", Section II, Page 2.

7. Access to the fuel tanks may be had by removing the tank cover plates located on the underside of the center wing panel just outboard of the fuselage centerline. The fuel valves, wabble pump and control cables are accessible for inspection, etc., by removing the small cover plates located midway between the tank compartments on the lower surface of the center wing

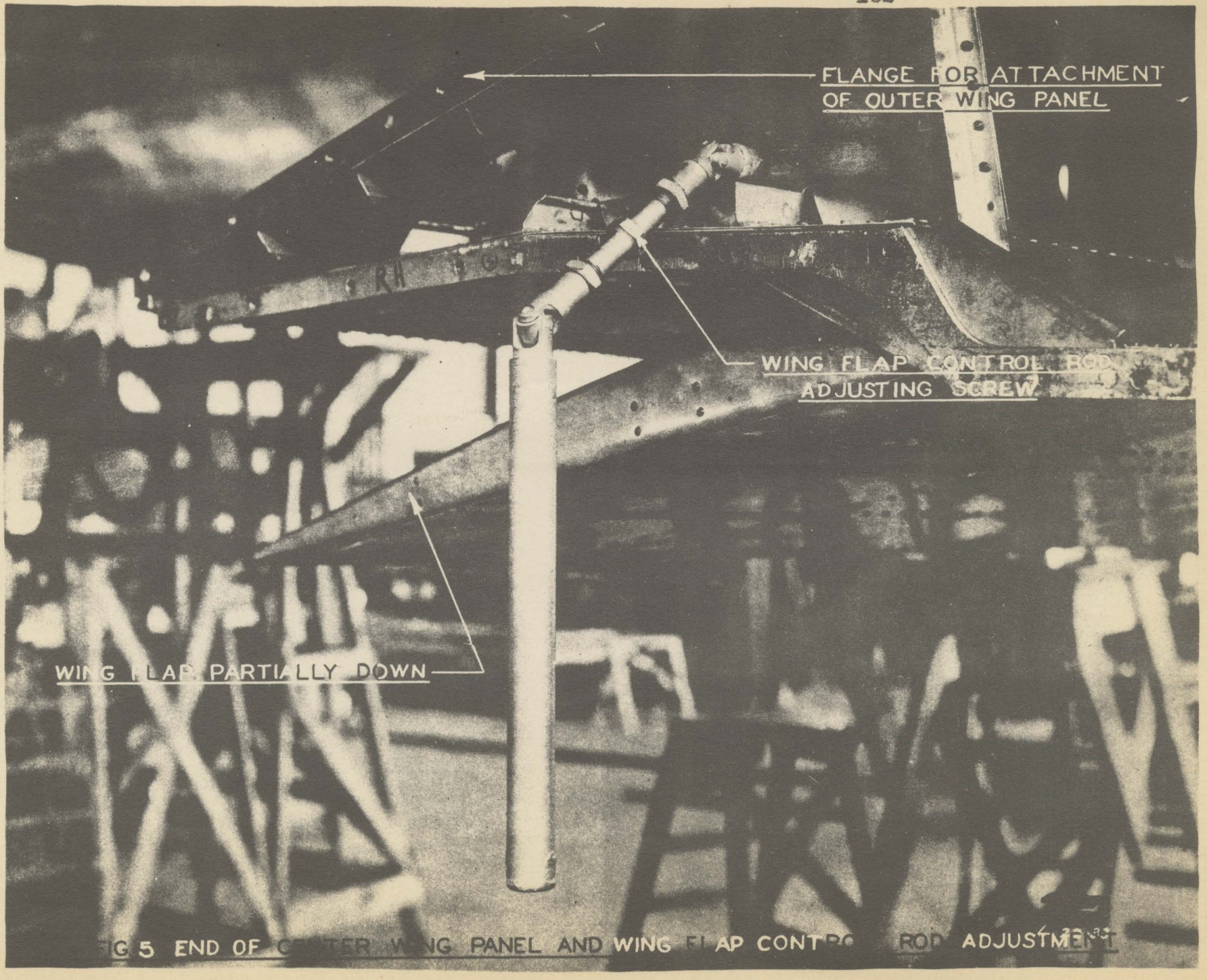


FIG 5 END OF CENTER WING PANEL AND WING FLAP CONTROL ROD ADJUSTMENT

panel. (See Cover Plate and Inspection Door Diagram, Figure 2, Page 11.)

B. To Remove an Aileron:

1. Work through hand hole on the lower surface at each end of aileron and detach control rod by removing bolt.

2. Just aft of each hinge point, remove nut from attaching bolt.

3. At small hand hole on lower surface of right aileron, disconnect aileron flap control rod by removing attaching bolt.

4. Lower the trailing edge slightly and take aileron off by slipping it rearward, guiding free of torque tubes and hinge brackets.

C. To Remove Outer Wing Panel:

1. Remove fairing from wing attachment angle. This may be accomplished by detaching the four hold down clips on the upper surface, the two hold down clips on the lower surface, and by taking out the two screws at the trailing edge fitting.

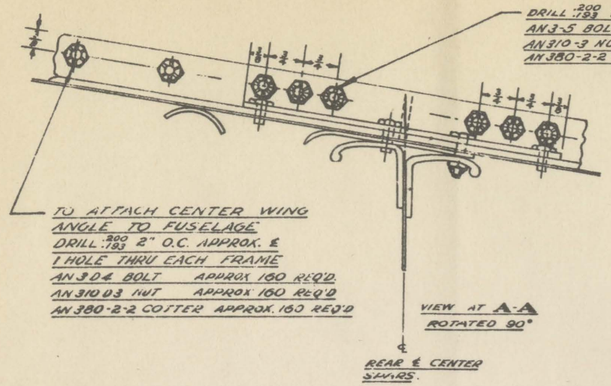
2. Detach attachment angle fairing gap cover by removing machine screws from lower surface at trailing edge.

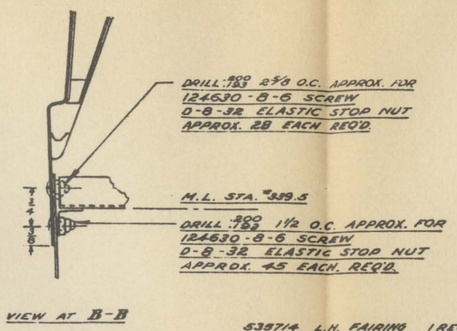
3. Disconnect aileron control cables at turnbuckles located above inspection door in lower surface of outer wing panel at wing attaching point.

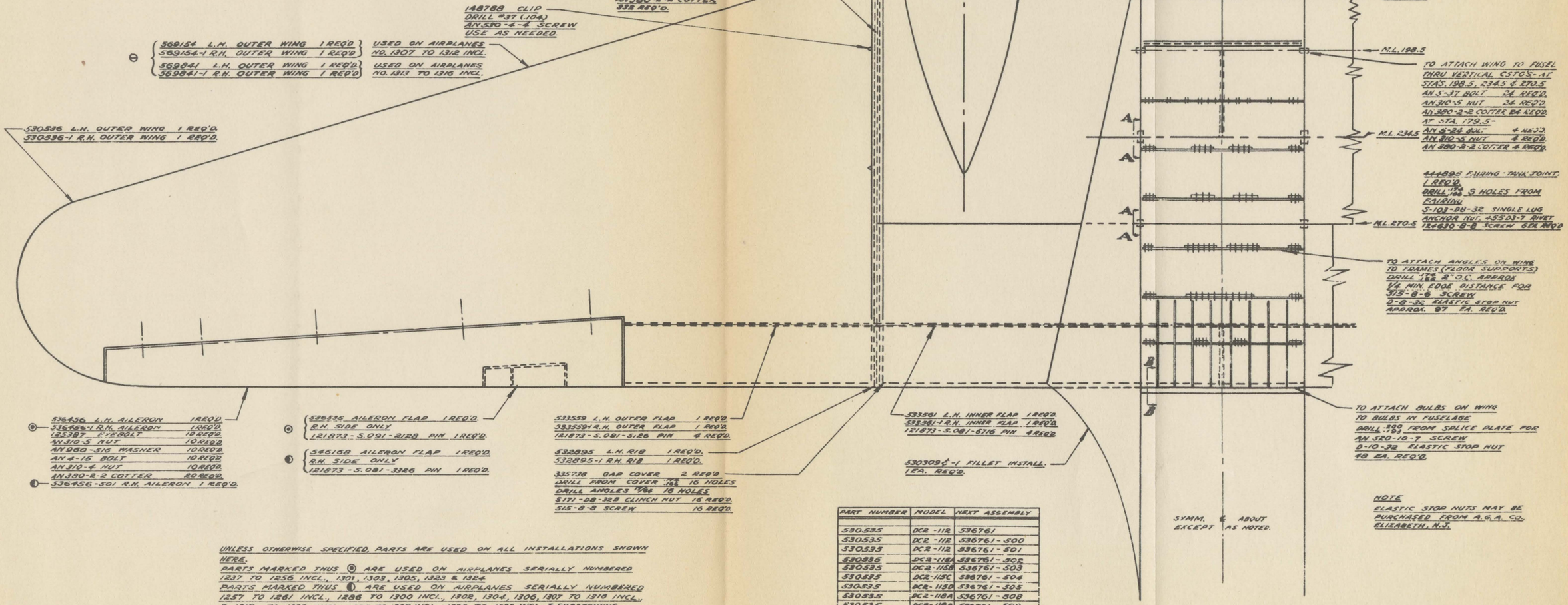
4. Work through inspection door on lower surface of right wing, just forward of aileron flap and wrap the control drum with tape so that cable winding will not be lost. Then disconnect flap control cables at links located above first hand hole outboard of wing attaching point. It is important that the ends of the control cables be fastened to the structure of the center wing panel without allowing an excess of slack in order to prevent the cable unraveling from the drum in the control pedestal.

5. Remove inspection plate from outboard wall of engine nacelle interior and disconnect wing tip light and landing and warning light electrical wires at junction box on the front spar.

6. Lower wing flap and disconnect control rod universal joint at wing attaching points. NOTE: It is advisable to caliper the distance between the adjusting nuts so as to avoid loss of time in adjustment when reassembling.







PART NUMBER	MODEL	NEXT ASSEMBLY
530535	DC2-112	536761
530535	DC2-112	536761-500
530535	DC2-112	536761-501
530535	DC2-112A	536761-502
530535	DC2-112B	536761-503
530535	DC2-112C	536761-504
530535	DC2-112D	536761-505
530535	DC2-118A	536761-508
530536	DC2-118B	536761-509
530535	DC2-123	536761-512
530535	DC2-124	536761-513
530535	DC2-112	536761-514
530536	DC2-127	536701-516
530535-500	RBD-1	536761-515
530535-501	DC2-120	536761-510

UNLESS OTHERWISE SPECIFIED, PARTS ARE USED ON ALL INSTALLATIONS SHOWN HERE.
PARTS MARKED THUS ⊙ ARE USED ON AIRPLANES SERIALLY NUMBERED 1237 TO 1256 INCL., 1301, 1303, 1305, 1323 & 1324.
PARTS MARKED THUS ◐ ARE USED ON AIRPLANES SERIALLY NUMBERED 1257 TO 1261 INCL., 1286 TO 1300 INCL., 1302, 1304, 1306, 1307 TO 1318 INCL., & 1317 TO 1322 INCL., 1325 TO 1327 INCL., 1328 TO 1335 INCL., & SUBSEQUENT.
PARTS MARKED THUS ⊜ ARE USED ON AIRPLANES SERIALLY NUMBERED 1325 TO 1327 INCL.
PARTS MARKED THUS ⊖ ARE USED ON AIRPLANES SERIALLY NUMBERED 1307 TO 1316 INCL.

FIG. 6
WING INSTALLATION

7. Remove machine screws from upper surface of wing and attach the four hoisting sling fittings. See Paragraph 3-a, Page 7, and Figure 1, Page 10, for points and method of hoisting.

8. Remove bolts from wing attachment angle. NOTE: It is possible to remove all the bolts from the lower surface with the exception of a few (4 or 5) at the spar points, and from the upper surface every other one during the time the above items of disconnection are being accomplished.

-28-

9. The outer wing panel may now be lifted clear of the airplane. NOTE: At time of reassembly it is important that the floating rib, between the outer and center panels, is not omitted. This should be attached to the inboard end of the outer panel with countersunk machine screws before commencing the operation of installing the wing.

D. To Detach Rear Section of Outer Wing Panel:

1. The entire outer wing panel must be detached from the airplane.

2. Disconnect aileron control cables from bell cranks, at inspection doors just forward of aileron.

3. Remove ailerons.

4. Remove machine screws from upper and lower surfaces, running from the inboard end at a point approximately 2/3 of the chord, to a point just outboard of the inner end of the aileron, and from that point aft to the trailing edge.

5. Work through inspection holes in the lower surface of the wing and detach bolts securing ribs to rear spars.

6. Remove screws from spliced bulb angle longitudinals which are reached through row of cover plates on lower surface just aft of rear spar.

E. To Detach Tip of Outer Wing Panel:

1. Disconnect wing tip light electrical wire at junction box. Access to this is gained by removing the circular cover plate on the lower surface of the wing tip.

2. Remove screws which attach tip section to outer panel and pull the tip outboard until it is free.

F. To Remove Center Wing Panel

1. Remove outer wing panels. (See Paragraph C, Page 21.)

2. Remove fuel tanks. (See Paragraph B-1, Page 118)

3. Remove engine section. (See Paragraph C, Page 108.)

4. Remove landing gear. (See Section X, Page 80.)

5. Remove wing fillets by taking out machine screws and then remove front lower pan at leading edge and fuselage junction.

6. Remove cabin seats and floor panels which are over wing. (See Paragraph H, Page 15; Paragraph C, Page 13.)

7. Remove cargo compartment floor. (See Paragraph D, Page 13)

8. Disconnect all lines for fuel pressure, fire extinguisher, brake system, landing gear retracting system, wing flap control and instruments at the unions provided at the intersection of the control tunnels and the wing leading edge.

9. Disconnect the dump valve control conduits at the unions under the cargo compartment floor then disconnect the cables at the dump valves and pull them out of the conduit section in the wing. (Omit this paragraph for airplanes 1307 to 1316 inclusive.)

10. Disconnect all surface control cables at the turnbuckles located under the cargo compartment floor. Refer to Page 45 for locations of all turnbuckles.

11. Disconnect all engine controls at the turnbuckles just aft of the firewall in each nacelle and pull them out of the wing section. It is recommended that a threader line be attached to each control cable before removal to facilitate replacement.

12. Detach fuel pump operating shaft at the pump and under the passageway floor, then disconnect the joint in the shaft and remove each half.

13. To disconnect the electrical wires at the junction of the center wing panel and the fuselage, it will be necessary to remove the Cannon plugs located in the leading edge of the center wing section. Removal of the Cannon plugs disconnects all wiring pertinent to removal of center wing panel.

14. Disconnect the heating system steam line at the union located where it enters the fuselage from the wing.

15. Remove screws which attach trailing edge to fuselage skin.

16. Remove bolts which attach fuselage longitudinal bulb angles in trailing edge of wing.

17. Remove all screws which attach fuselage frames to upper surface and leading edge of wing.

18. Remove screws which attach fuselage longitudinals to leading edge of wing.

19. Remove bolts which attach upper surface of wing to side of fuselage.

20. Remove bolts which attach wing-spar fittings to fuselage.

21. Remove cover plate from between leading edge and front spar. Take out bolts from each fitting which attaches front spar to fuselage.

22. The center wing panel should now be free from fuselage.

23. Hoist fuselage clear of wing. (See Paragraph 4, Page 7, for hoisting instructions.)

G. Maintenance

1. The wing being of all metal multi-cellular construction, it requires no maintenance.

2. In cases of repair and replacement, the Department of Commerce has approved the substitution of 24ST alloy material for 24SRT, except for all the wing spar webs and the center panel corrugation.

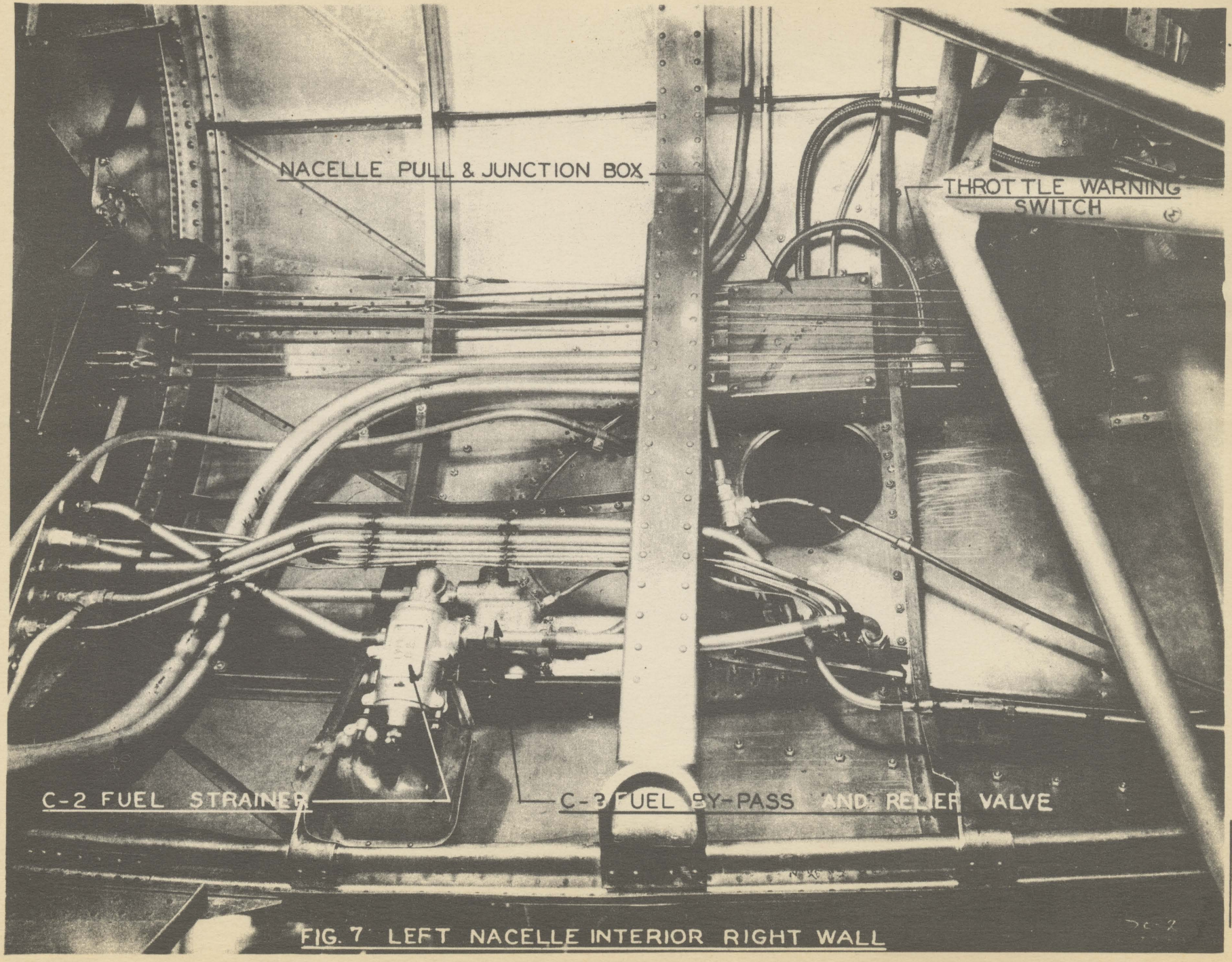


FIG. 7 LEFT NACELLE INTERIOR RIGHT WALL

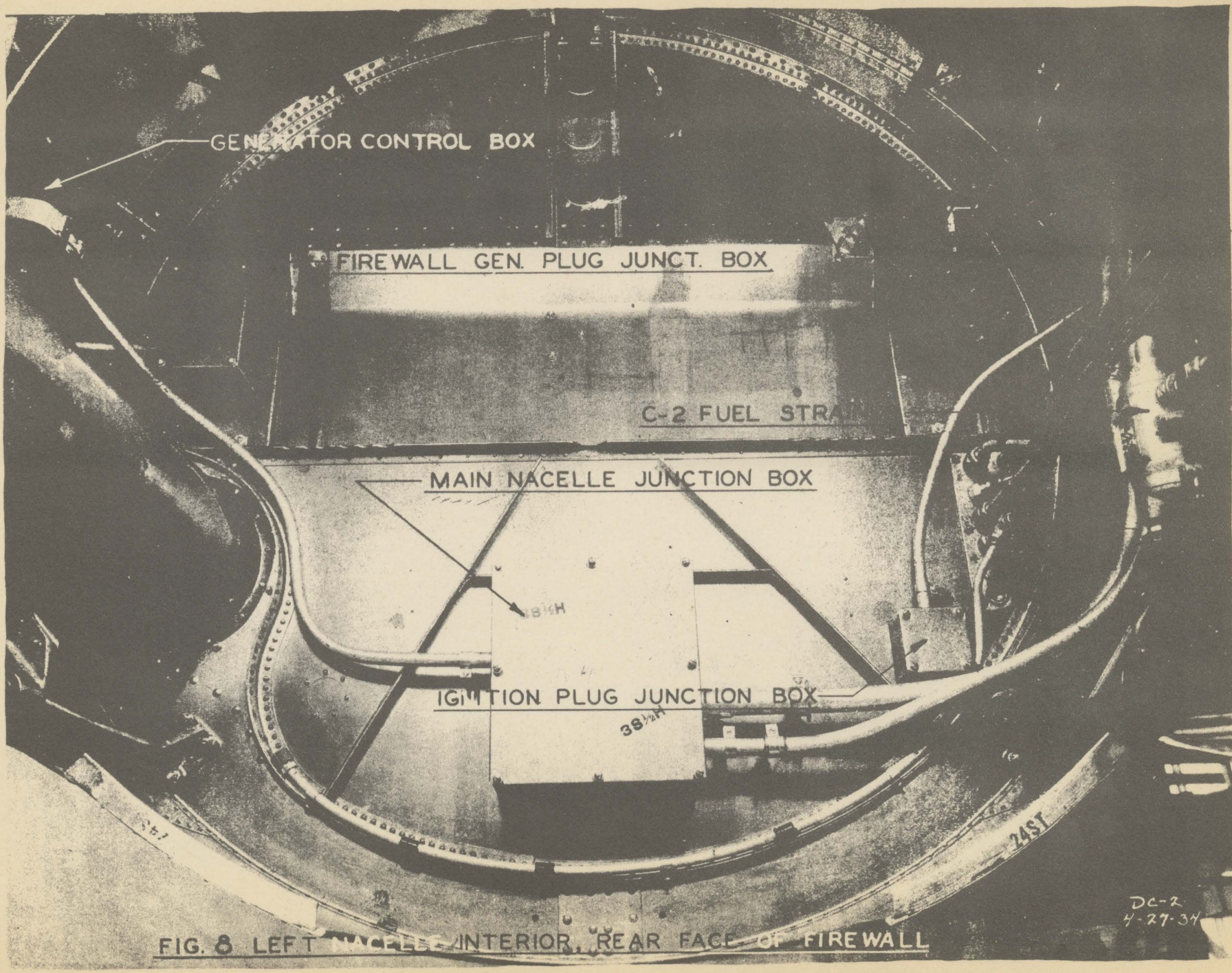


FIG. 8 LEFT [illegible] INTERIOR, REAR FACE OF FIREWALL

DC-2
4-27-34

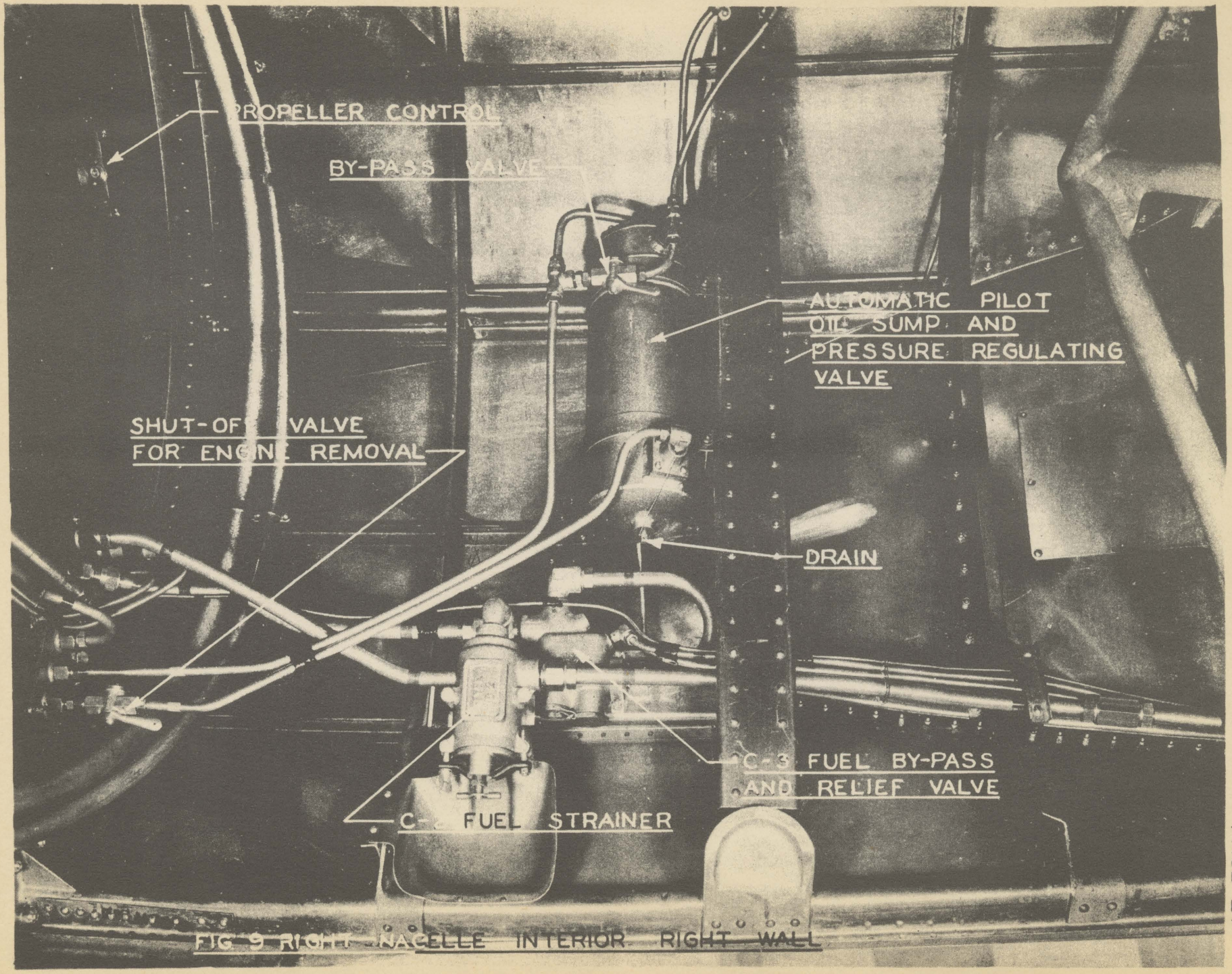


FIG 9 RIGHT NACELLE INTERIOR RIGHT WALL

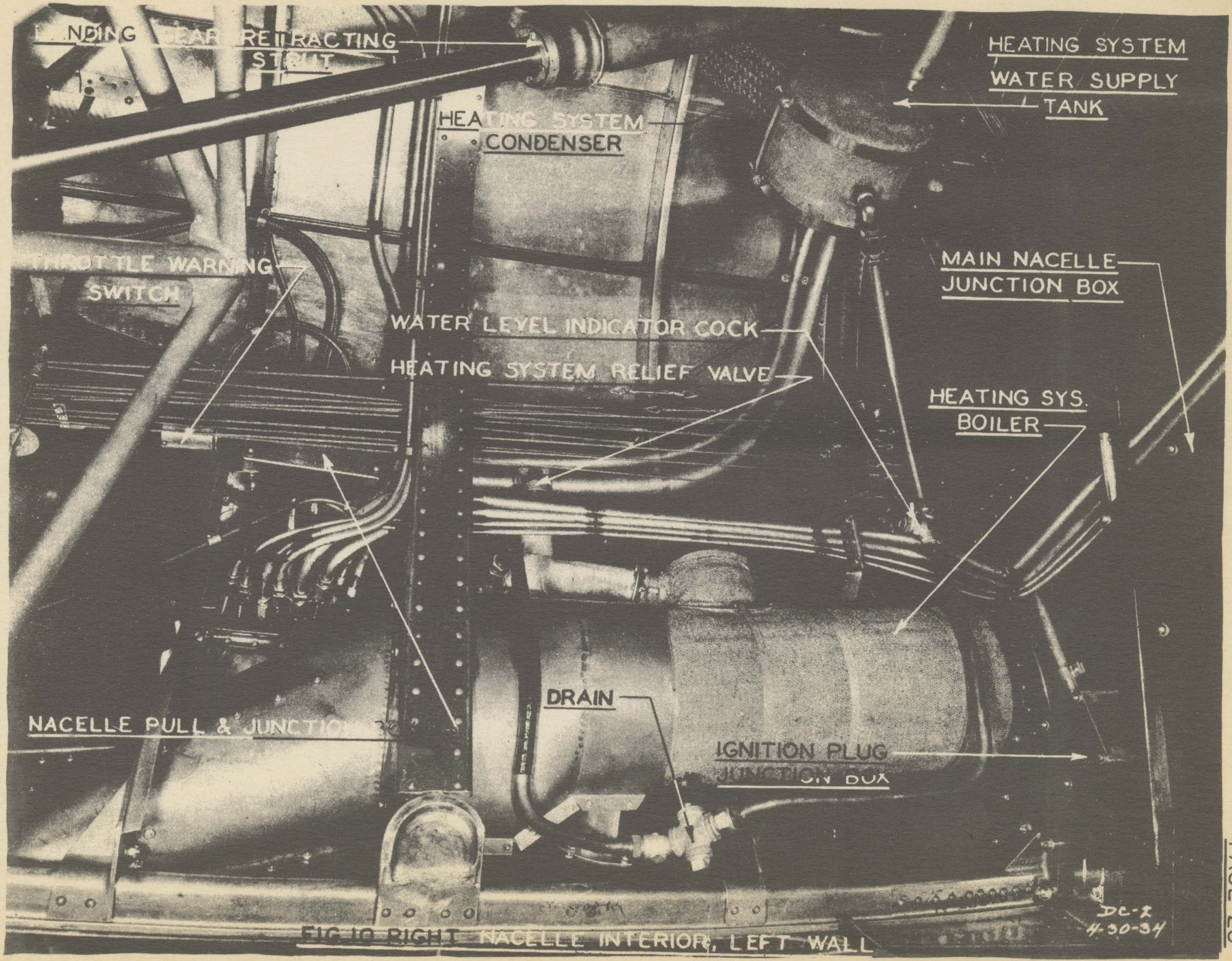


FIG 10 RIGHT NACELLE INTERIOR, LEFT WALL

SECTION VI

EMPENNAGE

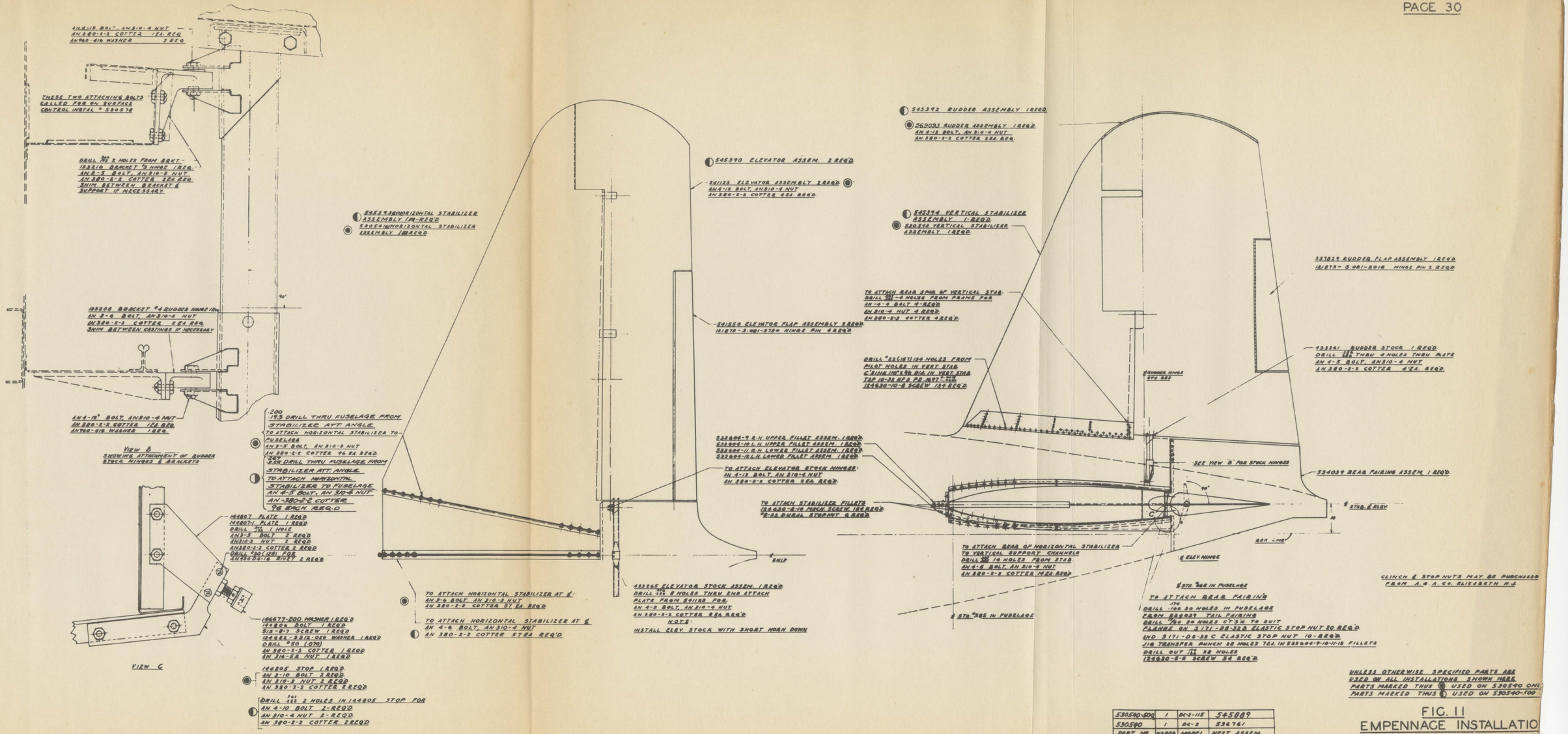
A. Description

1. Horizontal Stabilizer: The horizontal stabilizer is full cantilever and of multi-cellular construction. 24ST "Alclad" sheet is used throughout. There are two halves bolted together at the fuselage centerline and attached in fixed alignment to the fuselage by four (4) flange plates which are riveted to the stabilizer and bolted to the fuselage. Cast aluminum alloy hinge brackets are riveted to the rear spar for attachment of the elevators. The leading edge is fitted with a rubber abrasion strip to prevent any damage from solid objects picked up in the propeller slip stream when taxiing.

2. Vertical Stabilizer: The vertical stabilizer is of multi-cellular construction employing extruded sections of aluminum alloy and sheet 24ST "Alclad". It is attached to the fuselage with bolts and machine screws. Two (2) cast aluminum alloy hinge fittings for attachment of the rudder and a bracket for the attachment of the rudder flap control drum are riveted to the rear spar. A lug for the attachment of the radio beacon receiver antenna is fitted on the leading edge.

3. Elevators: The elevators are of 24ST aluminum alloy frame construction with fabric covering. A twelve (12) pound counter weight is rigidly attached by machine screws in the leading edge of the balance portion of each elevator. Fafnir self-lubricating ball bearings are used. Trimming flaps, which may be adjusted from the pilot's cockpit while in flight, to provide adjustment of longitudinal balance, are fitted in the trailing edge. (The elevator flap control mechanism is described in Paragraph 3, Page 43.) The elevators are interchangeable left and right with or without the flaps installed.

4. Rudder: The rudder is of aluminum alloy frame construction employing 24ST "Alclad" and fabric covering. A fifteen (15) pound counter weight is rigidly attached by machine screws in the leading edge of the balance area. A trimming flap, controllable from the pilot's cockpit while in flight, provides adjustment for variation in engine torque with either or both engines operating. (The rudder flap control mechanism is described in Paragraph 3, Page 43.) The rudder is carried on Fafnir self-lubricating ball bearings.



590540-500	1	DC-2-115	565889
590590	1	DC-2	536761
PART NO.	USE FOR	MODEL	NEXT ASSEM.

FIG. 11
EMPENNAGE INSTALLATIO

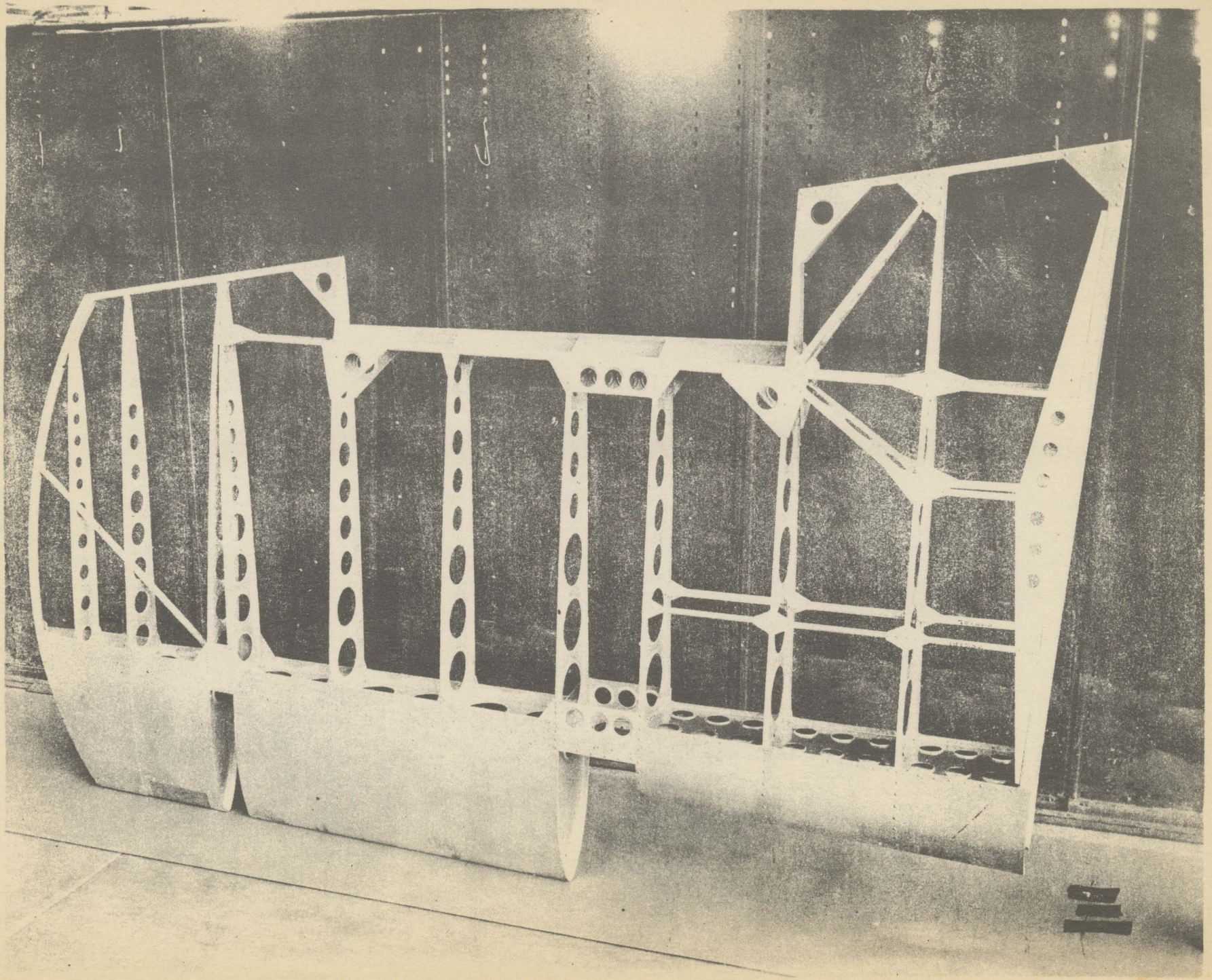


FIG. 12 VIEW OF COMPLETE RUDDER FRAME

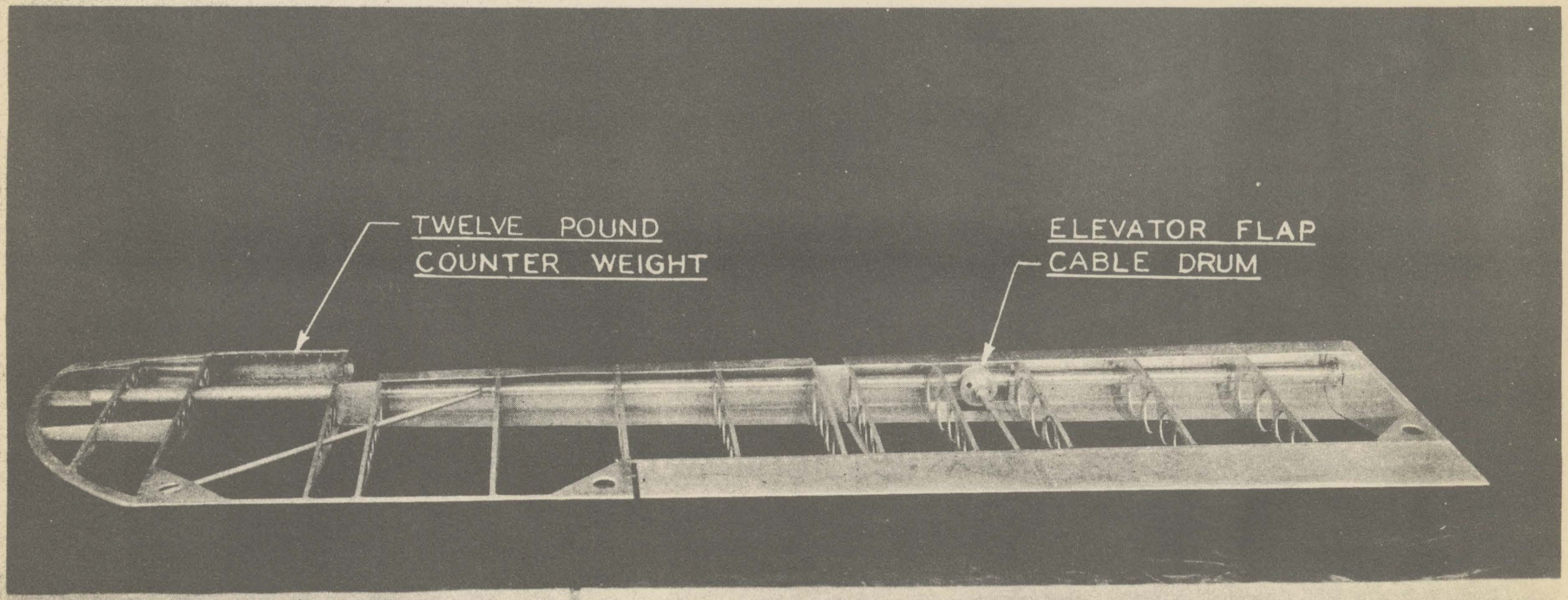


FIG. 13 ELEVATOR FRAME WITH FLAP INSTALLED

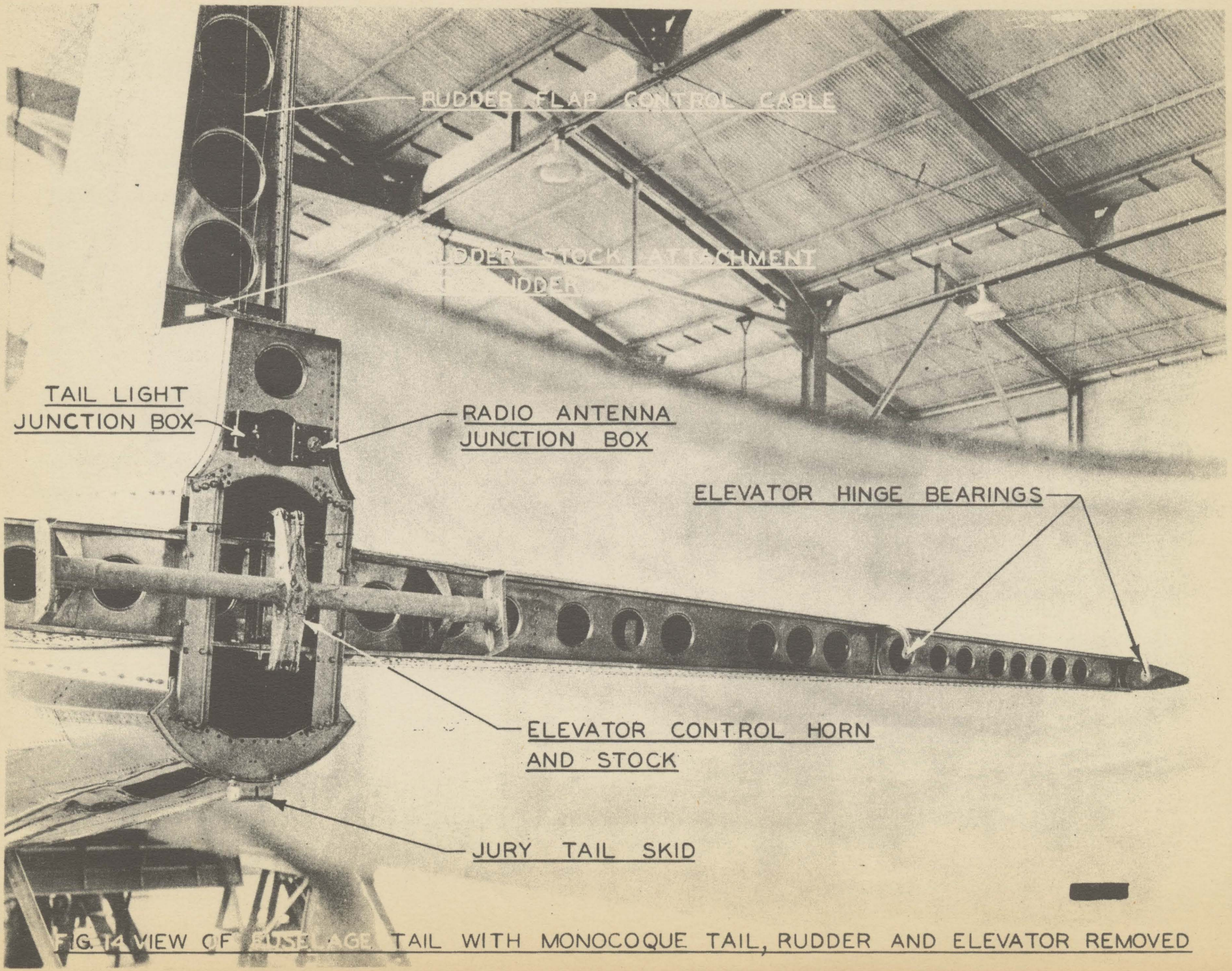


FIG. 14 VIEW OF FUSELAGE TAIL WITH MONOCOQUE TAIL, RUDDER AND ELEVATOR REMOVED

B. To Remove an Elevator:

1. Disconnect the tail light electrical wires at the junction box in the tail cone, which is accessible by removing the inspection plate on the left side of the tail cone, and disconnect the trailing antenna at the pull plug accessible through the same inspection opening.

2. Remove monocoque tail cone by detaching machine screws which secure it to the fuselage.

3. Disconnect the elevator flap control cables at the turnbuckles located in the fuselage tail section just aft of the rear baggage compartment and then pull the cables out of the tail section. It is also recommended that a threader line be attached to each cable before it is pulled out. NOTE: The cable drum in the elevator should be wound with tape to prevent the cable winding from unraveling and the end of the control cables in the fuselage should be fastened securely to prevent any undue slack which would allow the cable winding on the drum in the control pedestal to unravel. To facilitate reassembly, the control cables are marked with yellow at the turnbuckle connection on the line that leads to the upper side of the control drum in the elevator and with red on the cable that leads to the lower side of the drum.

4. Disconnect the elevator control cables at the turnbuckles located in the fuselage tail section just aft of the baggage compartment.

5. Remove the bolt from each of the elevator hinge brackets.

6. Remove the two bolts which attach the elevator control stock to the horizontal stabilizer.

7. Tilt the elevators upward (approximately 10 degrees) and then pull rearward and up to clear hinge brackets.

8. Detach the four bolts which attach each elevator to the control stock.

C. To Remove Rudder:

1. Remove the bolt from the joint in the flap control rod.

2. Detach the bolts which secure the base of the rudder to the control stock.

3. Remove the bolts from each of the hinge brackets.

4. Lift the rudder off with a slight upward movement and then a rearward pull, guiding it free from the flap operating gear.

D. To Remove a Trimming Flap:

(Rudder or Elevator)

1. Disconnect the flap control rod by removing the bolt from the fitting at the leading edge of the flap.

2. Pull out the hinge pins.

E. To Remove Horizontal Stabilizer

1. The right and left halves are removable as a unit.

2. Remove the elevators. (Refer to Paragraph B, Page 34.)

3. Disconnect the elevator control cables at the elevator horn.

4. Remove the bolts which attach the stabilizer and tie channels to the sides and rear frame of the fuselage.

5. Slip the stabilizer rearward until clear of the fuselage.

F. To Remove Vertical Stabilizer:

1. Remove the rudder. (Refer to Paragraph C, Page 34.)

2. Remove the two (2) bolts attaching the lower end of the stabilizer rear spar to the fuselage.

3. Remove all machine screws which attach lower end of the stabilizer to the fuselage.

4. Lift the stabilizer upward until it is clear of the fuselage structure.

NOTE: In replacing vertical stabilizer, all machine screws should be set in litharge.

G. To Replace Horizontal Stabilizer Abrasion Strip:

1. Clean metal surface thoroughly with benzol. CAUTION: It is recommended that about 5% of carbon tetra chloride be added to the benzol to minimize the danger of explosion.

2. Roughen surface with emery cloth and then wipe off with the benzol mixture.

3. Prepare a mixture of approximately 1 part Goodrich Vulcalock cement with 2 parts benzol and apply to surface, brushing well, and allow to dry.

4. After first coat has dried, apply two or three coats of straight Vulcalock, allowing each successive coat to dry thoroughly. Enough Vulcalock should be applied to give a golden brown color. Note: Allow Vulcalock to dry absolutely hard before next step (it is preferable to allow the job to stand over night).

5. Wipe fabric side of abrasion strip with benzol and apply a coat of Goodrich #4 cement (cut with approximately 1 part benzol to 2 parts #4 cement). As soon as this is dry, apply a coat of full strength #4 cement. While this is drying, apply a coat of #4 cement cut with benzol over the Vulcalock that has been applied to stabilizer, then apply another coat of #4 cement to abrasion strip, if necessary, and allow cement on both abrasion strip and stabilizer to dry to a point of strong tackiness.

6. Apply abrasion strip, tacking only the forward edge of the rubber just below the reinforcing nose strip to the metal, then begin working stock down and back from the edge, being careful not to trap air beneath the rubber. If, by accident, the strip sticks down in error, pull it loose with a sharp jerk. After strip has been laid over entire straight portion, work it straight out over the edges, later trim off surplus edges with a sharp knife, being careful not to scratch the metal, then roll down firmly with a rubber roller or equivalent.

7. After strip has been rolled down thoroughly and all trapped air let out by puncturing rubber with a pin and all surplus has been trimmed, the edges should be "oil proofed" to prevent gasoline, oil or other solvent from attacking the cement and weakening the bond to the metal. This may be done by masking off around all edges so as to leave a strip of about 3/8 inch on the rubber and 1/4 inch on the metal exposed. To these strips apply one straight coat of Vulcalock and allow to dry hard, then a second coat of a mixture of 9 parts Vulcalock to 1 part lacquer thinner and allow to dry until not quite hard, then apply a coat of straight lacquer.

H. Maintenance

1. The fabric covering of the rudder and elevators may be repaired with fabric patches if damaged. Refer to Paragraph N, Page 159, for finishing of fabric surfaces.

2. All ball bearings in control hinges and pulleys are self-lubricating for the life of the bearing; therefore, the only points of the empennage requiring lubrication are the three flap operating screws and the ball joints inside the cable drums. Zerk fittings are accessible through the hand holes in the control surfaces. The holes may be lined up with the Zerk fittings, if necessary, by adjusting the flaps.

LUBRICATION EMPENNAGE FLAPS

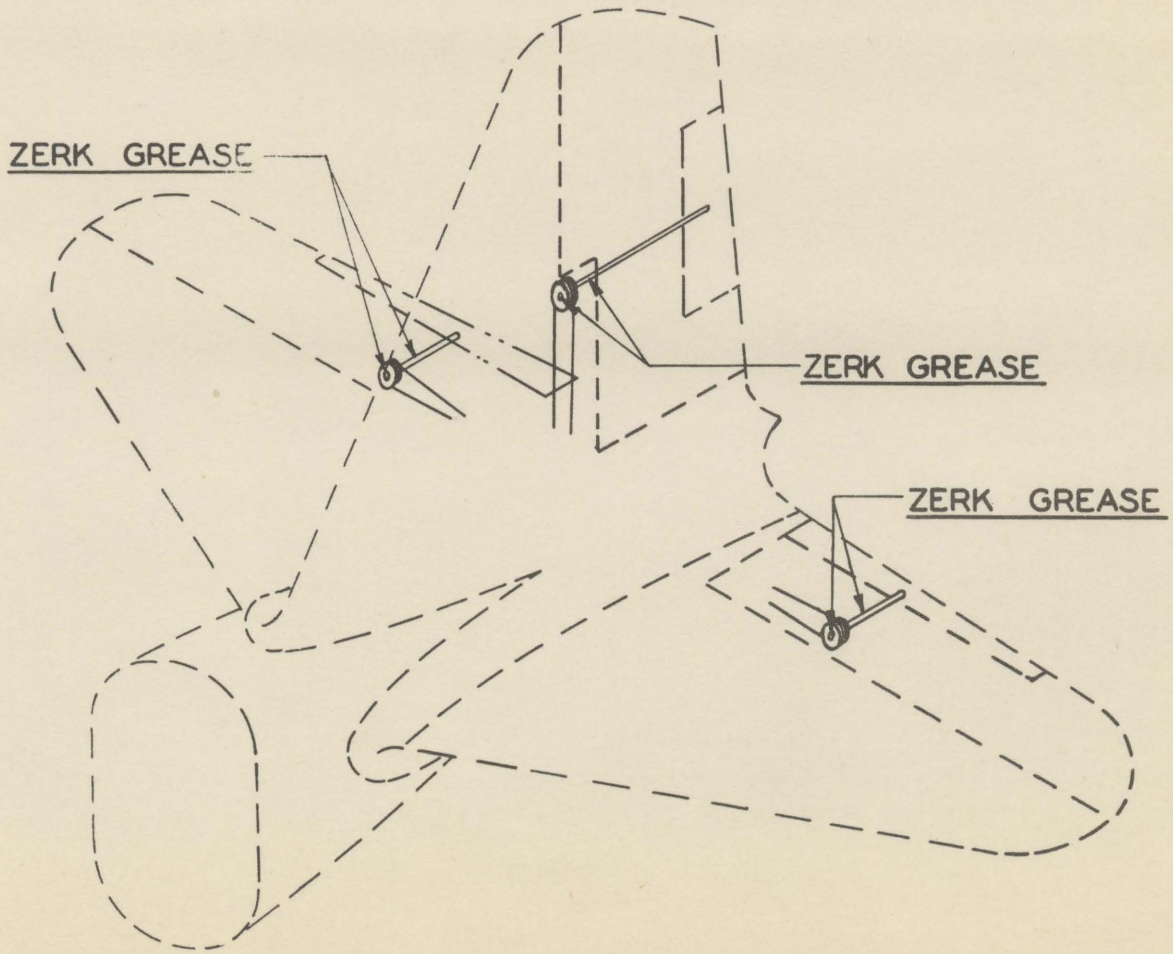


FIG. 15

REFER TO DOUGLAS DRW'GS. #536455 & 541123

SECTION VII

SURFACE CONTROLS

DC2-135 120

A. Description

1. Rudder and Elevator

(Refer to Figures 16 and 17, Pages 39 and 40.)

(a) The rudder and elevators are controlled from the cockpit by cables which run along the centerline of the airplane beneath the flooring and enter the rear fuselage bay where they attach to their respective horns. One cable from each control surface is broken at the Servo Unit, under the forward cargo compartment, and is connected by means of turnbuckles to one of the Servo cylinder pistons. The cable from the cockpit controls is connected to the forward end of the piston and the cable from its respective surface is connected to the aft end. The cables are of 3/16 x 7 x 19 pre-formed extra flexible steel. A strap for locking the rudder and ailerons in the "neutral" position and the elevators in the "down" position is stowed in the cargo compartment. (Refer to Paragraph L Page 9.)

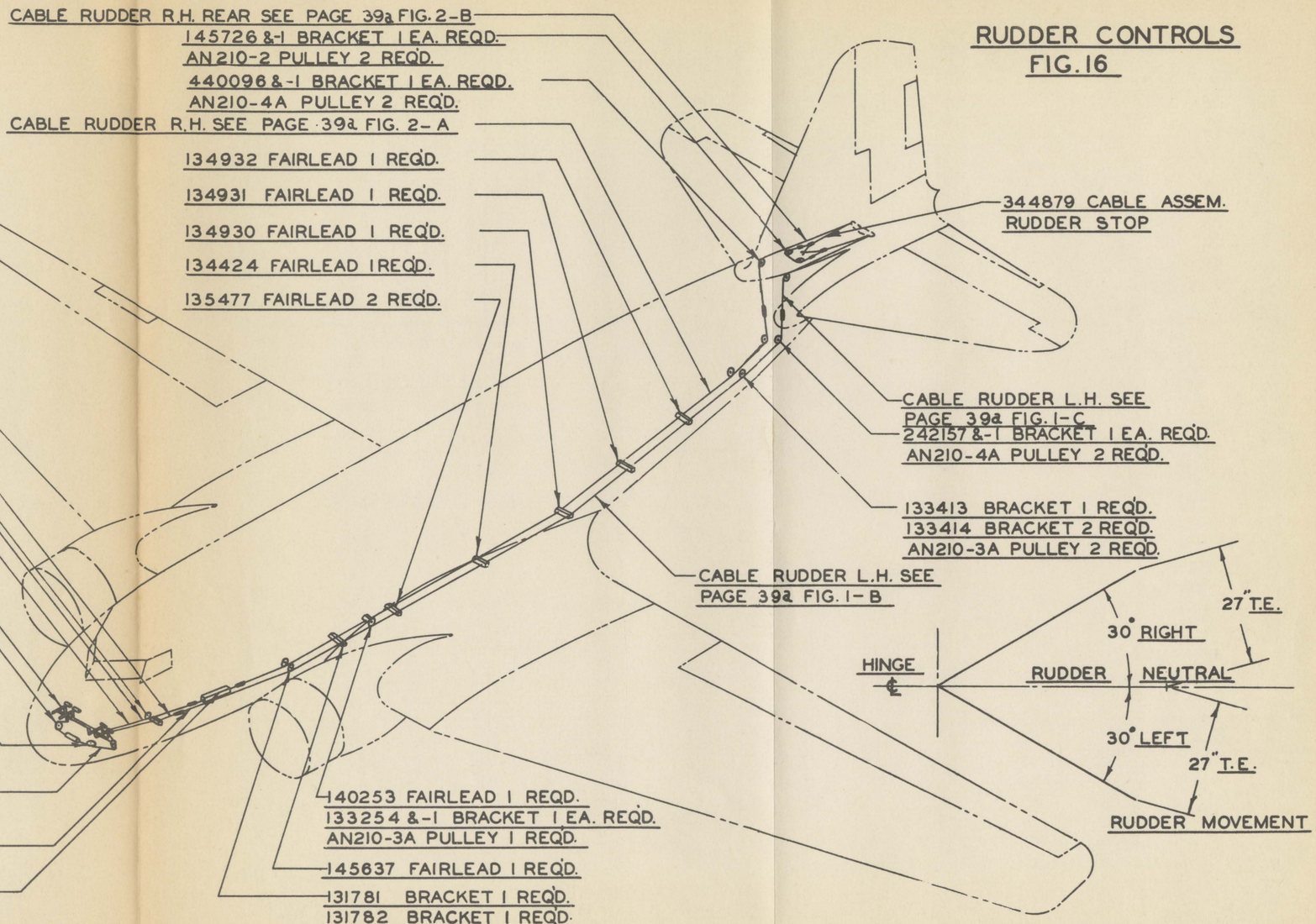
(b) The cargo compartment floor and the center panels of the cabin floor may be easily removed for access to the control cables.

(c) The rear cover plate on the right side of the vertical stabilizer may be removed for access to the rudder horn and the plate on the left side for access to the elevator horn. (See Figure 2, Page 11, for the locations of all access plates and inspection doors.)

(d) A large cover plate is provided in the bottom of the nose for access to the rudder pedals and elevator pulleys. The smaller plates aft of this large one are for access to the control cables.

(e) The rudder pedals are adjustable to suit the pilot and are interconnected by a cable which is also a part of the brake control system.

RUDDER CONTROLS
FIG. 16



REFER TO DOUGLAS DRWG. 530578

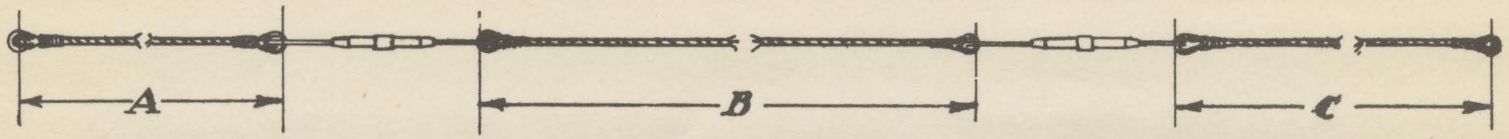


FIG. 1

SEE PAGES 39 & 40

NAME	NO. REQ.	A	B	C	TURNBUCKLES
ELEV. UPPER R.H.	1	30 3/8	492	119 11/18½	AN140 - 32L
ELEV. LOWER R.H.	1	69 3/8	492	107 5/4	AN140 - 32L
ELEV. LOWER L.H.	1	109 3/8	452 1/2	107 5/4	AN140 - 32L
RUDDER L.H.	1	48 1/2	511 1/2	86 7/8	AN140 - 32L

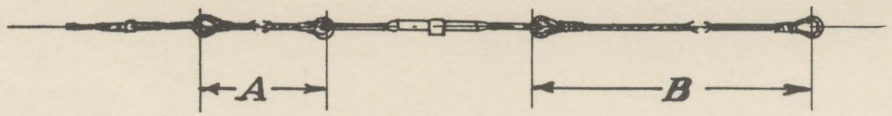


FIG. 2

SEE PAGES 39&40

NAME	NO. REQ.	A	B	TURNBUCKLES
ELEV. UPPER L.H.	1	454	119 11/18½	AN 140 - 32L & AN135-32 S
RUDDER R.H.	1	473	86 7/8	AN 140 - 32L & AN135-32 S

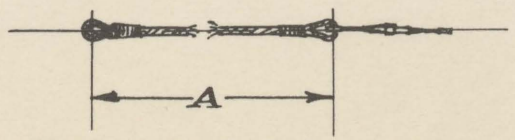


FIG. 3

SEE PAGES 39&40

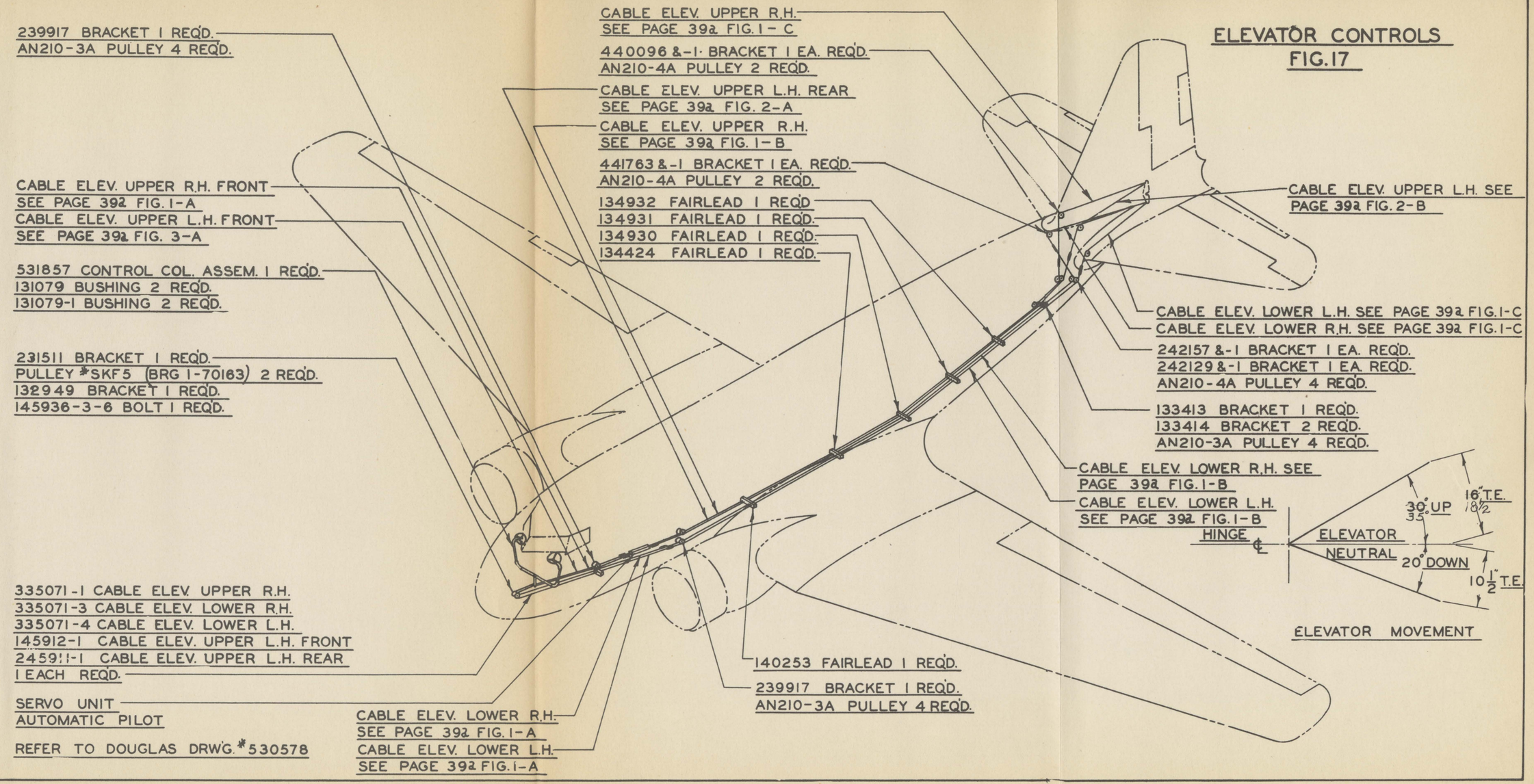
NAME	NO. REQ,	A	TURNBUCKES
ELEV. UPPER L.H.	1	39 3/4	AN 135 - 32 S
RUDDER R.H.	1	61 1/8	AN 135 - 32 S

RUDDER & ELEVATOR CABLE LENGTHS

FIG. 16a

PAGE 39a

ELEVATOR CONTROLS
FIG. 17



REVISED N.C. BLAZED 9-17-34

REVISED 9-21-34

(f) Two short cables, one on each side of the rudder, extend from a point on the vertical stabilizer inside the fuselage, to the rudder control horn. These are held taut at all times by springs attached to the fuselage structure. The cables incorporate turnbuckles, at their control horn connections, for tension adjustment. These cables serve as positive stops for the rudder and limit its movement to 30 degrees either side of the centerline of the airplane.

(g) The movement of the pedals is limited by adjustable bolts (near their lower ends) which strike against fixed stops on the fuselage structure.

(h) The rearward movement of the control columns is limited by adjustable bolts (near their upper ends) which strike against fixed stops on the structure. Their forward movement is limited by adjustable stops, attached to the structure, which check the columns at their lower ends.

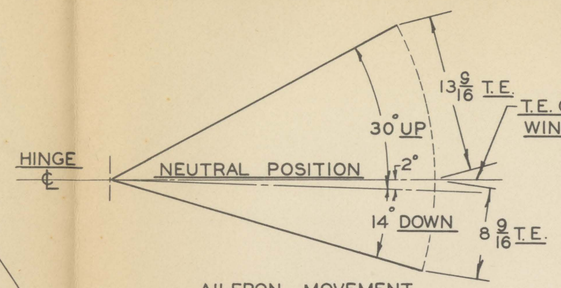
(i) Contacting the elevator horn are two fixed stops located in the tail section to prevent the elevators from riding the hinges. One is contacted when the elevators are in the "up" position and the other is contacted when the elevators are in the "down" position.

2. Ailerons

(Refer to Figure 18, Page 42.)

(a) The ailerons are controlled from the cockpit by pre-formed extra flexible steel cables, 3/16 x 7 x 19, which run beneath the flooring along the center line of the airplane to a large bell crank aft of the rear spar. Similar cables run from this bell crank to the outer wing panel. Within the wing, the cables attach to tri-arm bell cranks which have the aileron control rods attached to their third arm. There are two of these bell cranks in each wing, namely, inboard and outboard, which are interconnected by cables.

AILERON CONTROLS
FIG. 18



AILERON MOVEMENT
NOTE:
AILERONS HAVE 2° DROOP FROM TRAILING EDGE OF WING

CABLE AIL. INNER WING
SEE PAGE 42b FIG. 2-A-B

CABLE AIL. OUTER WING
SEE PAGE 42b FIG. 1-A

139916 BRACKET 1 REQ'D.
139916-1 BRACKET 2 REQ'D.
131782 BRACKET 1 REQ'D.
AN210-3A PULLEY 4 REQ'D.

335072-1&-2 AILERON CABLES
1 EACH REQ'D.

531857 CONTROL COLUMN ASSEM 1 REQ'D.
131079 BUSHING 2 REQ'D.
131079-1 BUSHING 2 REQ'D.
431518 BASE PLATE 1 REQ'D.
231624 ATTACHING BRACKET 4 REQ'D.
231516&-1 BRACKET 1 EA. REQ'D.
AN210-4A PULLEY 4 REQ'D.

231517&-1 BRACKET 1 EA. REQ'D.
231624 ATTACHING BRACKET 2 REQ'D.
AN210-4A PULLEY 4 REQ'D.

CABLE AILERON R.H. & L.H. FRONT
SEE PAGE 42a FIG. 1-A-B

SERVO UNIT
AUTOMATIC PILOT

CABLE AILERON L.H. REAR
SEE PAGE 42a FIG. 2-A-B-C

REFER TO DOUGLAS DRW'G. 530578

145495 FAIRLEAD 2 REQ'D.
144513 FAIRLEAD 1 REQ'D.
145523-1 FAIRLEAD 2 REQ'D.
145523-2 FAIRLEAD 2 REQ'D.

431704 AILERON MAST 1 REQ'D.
133256&-1 BRACKET 2 EA. REQ'D.
AN210-3A PULLEY 2 REQ'D.
117425-3D-016 SPACER 2 REQ'D.

235725 AILERON CABLE 4 REQ'D.
135039 LINK 2 REQ'D.

140254 FAIRLEAD 2 REQD

238114 BRACKET 2 REQ'D.
238115&-1 BRACKET 1 EA. REQ'D.
AN210-3A PULLEY 4 REQ'D.
117425-2D-016 SPACER 4 REQ'D.

◉ 432413&-1 AILERON CRANK 1 EA. REQ'D.
◑ 432413-2&-3 AILERON CRANK 1 EA. REQ'D.
◉ 233237-2 ROD 2 REQ'D.
◑ 233237-7 ROD 2 REQ'D.
111904-4-030 BOLT 2 REQ'D.
133236 ROD END 2 REQ'D.

135070 AILERON CABLE 4 REQ'D.

◉ 432414 AILERON CRANK 2 REQ'D.
◑ 432414-3 AILERON CRANK 2 REQ'D.
◉ 233237-1 ROD 2 REQ'D.
◑ 233237-6 ROD 2 REQ'D.
111904-4-030 BOLT 2 REQ'D.
133236 ROD END 2 REQ'D.

NOTE:-
PARTS MARKED THUS ◉ USED ON AIRPLANES 1237 TO 1256 INC., 1301, 1303, 1305, 1317 & 1324
PARTS MARKED THUS ◑ USED ON AIRPLANES 1257 TO 1261 INC., 1286 TO 1300 INC., 1302, 1304, 1306 TO 1316 INC., 1318 TO 1323 INC. & 1325 TO 1335 INC. PARTS NOT MARKED ARE USED ON ALL AIRPLANES.

-3/3-

DRAWING 9-22-44 BLUE

AMERICAN AIRLINES, INC.

MAINTENANCE BULLETIN NO. 863

Subject: Rigging of Ailerons - Douglas DC-2

Code: DC2-A-3

Date: June 6, 1936

To: Maintenance Supervisor - Chicago
" " - Ft. Worth
" " - Glendale
" " - Newark
All Station Managers
Att: Chief Mechanic

From: Superintendent of Maintenance

1. Please refer to pages 42 and 46 in your Handbook of Instructions for Model DC-2 airplanes.

2. The Douglas Aircraft Company has advised that the instructions issued in regard to rigging the ailerons shall be revised to read as follows:

"Up-throw 26° or 12 11/16 inches. This up-throw is not to exceed 27° or 13 1/8 inches."

Douglas explains this change with the following statements:

"A greater up-throw of the ailerons may result in aileron burble when controls are used in extreme positions. The down-throw may vary in order to compensate for the limits in the up-throw. A perfectly rigged airplane as it leaves the factory would have both right and left ailerons not exceeding 13 1/8 inches up-throw and approximately 9 3/8 inches down-throw.

3. Please have the Douglas Chart No. 1, Aileron Adjustment and Rigging Diagram, at your station revised as follows:

(a) Change the up-throw of 30° to 26°.

(b) Change the up-throw of 13 5/8 inches to 12 11/16 inches, not to exceed 13 1/8 inches or 27°.

(c) Change the down-throw of 14° to 18°.

(d) Change the down-throw of 7 7/8 inches to 9 3/8 inches.

MAINTENANCE BULLETIN NO. 863

4. We are sending you an additional copy of this bulletin in order that it may be inserted in your Handbook of Instructions.

5. We are also preparing 400 additional copies to be distributed to all personnel who have purchased Douglas DC-2 Manuals.

H. D. Ingalls

cc: Vice President - Operations
Operations Manager
Supt. of Stations
Flight Supts: Foremen & Inspectors
Sup. Radio Installation & Repair
Stock Supervisor: Chief Engineer: Sales Dept.
Messrs. Griffin, Larie, Atkinson, Hutchinson, Lawrence, Brower, Muth, Bewley, Calliott
Mr. C. Reed - Dept. of Commerce

ONLY PERSONS ADDRESSED NEED RECEIPT & RETURN ONE COPY

DOUGLAS AIRCRAFT COMPANY, INC.

Douglas Transport DC-2

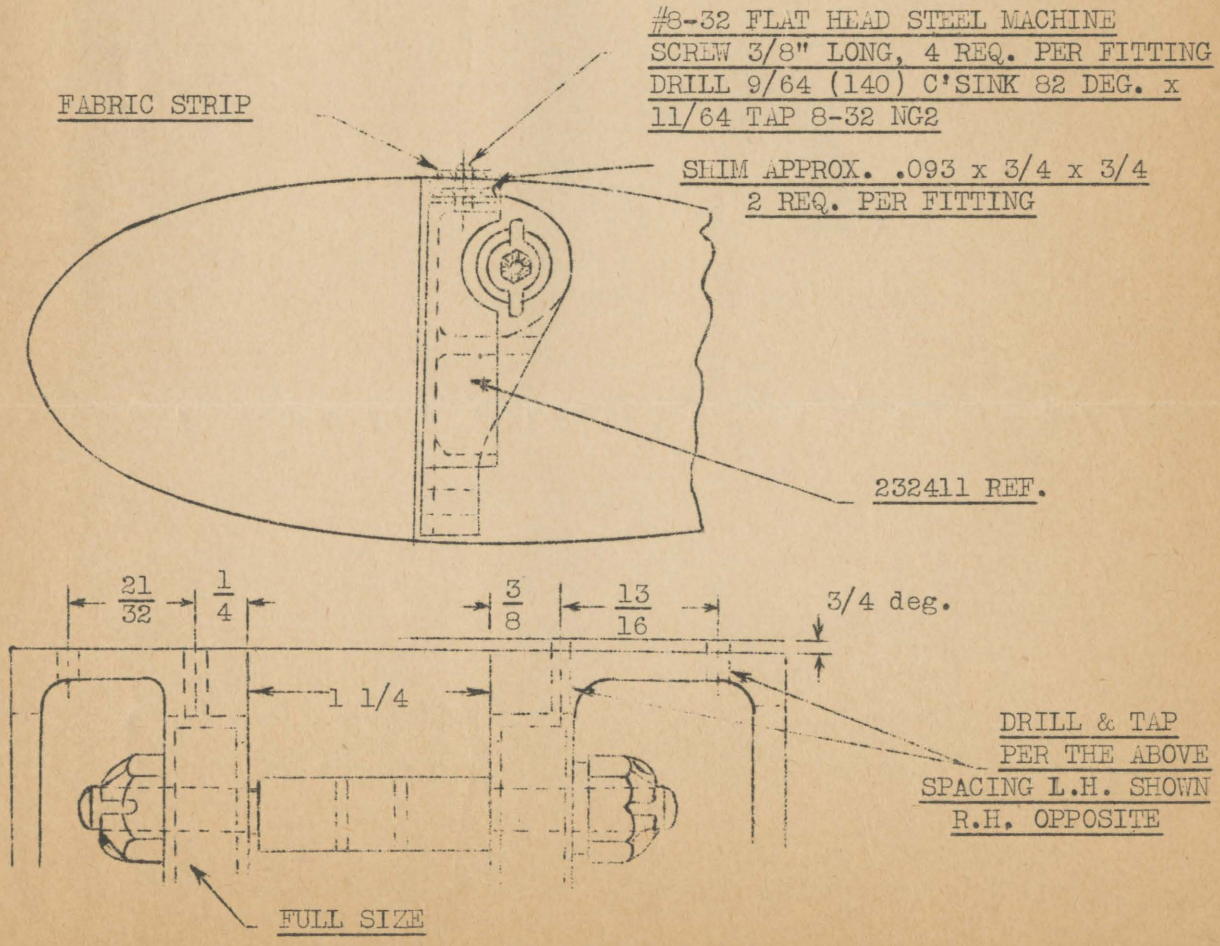
Service Bulletin 116. Section I. May 15, 1936.

Subject: Addition of Machine Screws at Outboard Control Aileron Hinge Casting Attachment.

This Service Bulletin replaces #116 dated May 6, 1936.

In order to increase rigidity in the connection between the aileron beam and the outboard control hinge casting, we have added four (4) 8/32" flat head machine screws in the manner shown on the sketch below.

We recommend that these screws be added to this hinge casting on all ailerons now in service.



CBS:EM

DOUGLAS AIRCRAFT COMPANY, INC.

REVISED 9-24-34 RIOS.

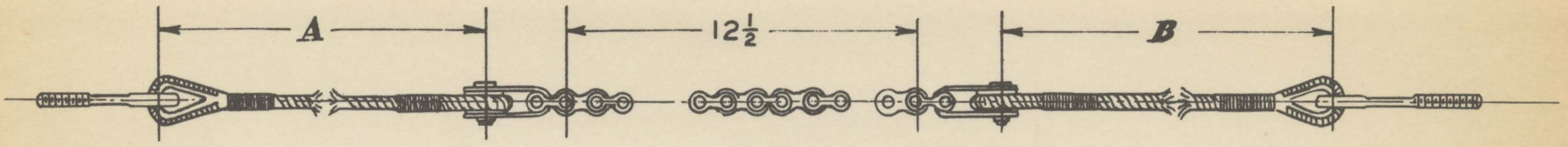


FIG. 1

SEE PAGE 42

NAME	PART NO.	NO.REQ.	A	B	CABLE EYE	NO.REQ.	TURNBUCKLES	NO.REQ.
AIL. R.H. FRONT	330725-1	1	122½	123	AN 170-32RS	2		
AIL. L.H. FRONT	330725	1	102¼	129¼	AN 170-32RS	1	AN135-32RS	1

FIG. 18a

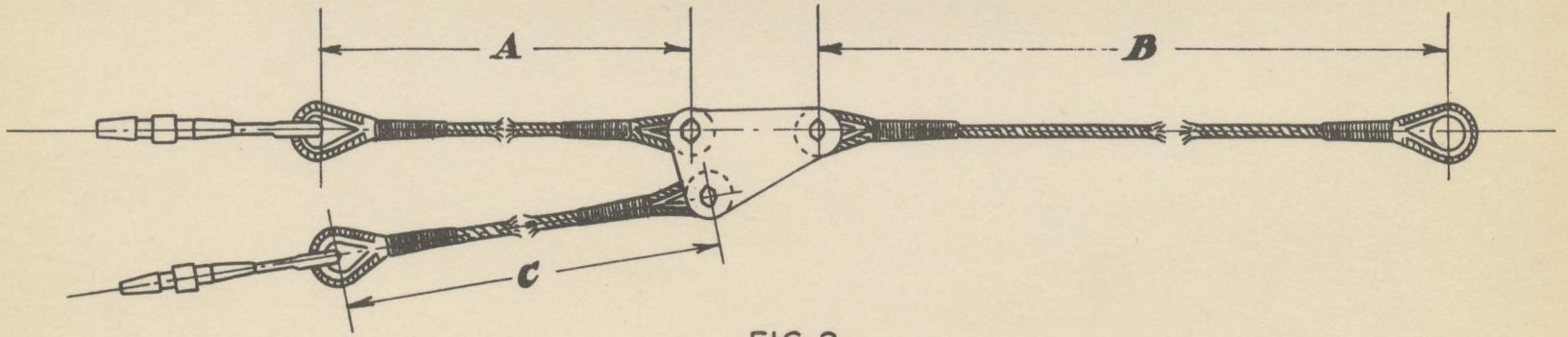


FIG 2

SEE PAGE 42

NAME	PART NO.	NO.REQ.	A	B	C	TURNBUCLES	NO.REQ.
AIL. R.H. REAR	335072-1	1	82	86⅞	77⅞	AN 140-32S & AN 135-32S	1 EA.
AIL. L.H. REAR	335072-2	1	78⅛	86⅞	85⅛	AN 140-32S	2

PAGE 42a

AILERON CABLE LENGTHS

Revised 9-24-34 Rios

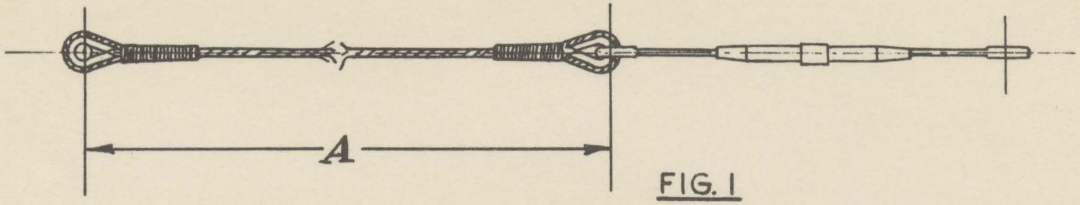


FIG. 1

PART NO.	NAME	NO. REQ.	A	TURNBUCKLES
135070	AIL. OUTER WING	4	156	AN 135 - 32L

SEE PAGE 42

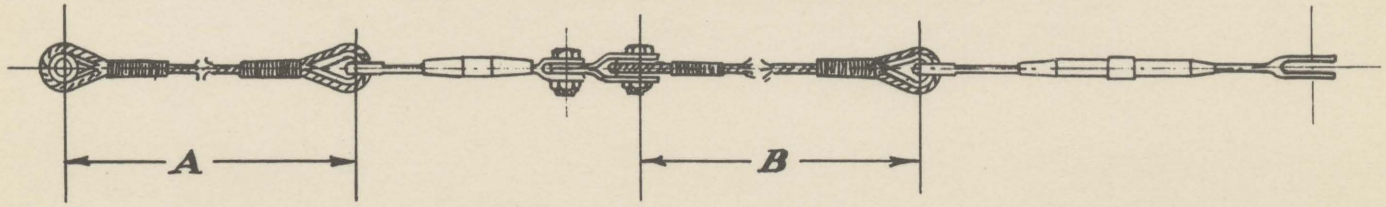


FIG. 2

PART NO.	NAME	NO. REQ.	A	B	TURNBUCKLES
235725	AIL. INNER WING	4	90 1/4	154 1/4	AN 130 - 32 S & L

SEE PAGE 42

FIG. 18b

AILERON CABLE LENGTHS

(b) A situation, similar to that discussed in Paragraph (a), Page 38, prevails in the aileron control system in that one of the cables connects to the Servo Unit.

(c) In the lower surface of the wing on each side of the fuselage are six cover plates for access to the aileron control cables along their route parallel to the rear spar. (See Figure 2, Page 11.)

(d) Hinged doors in the lower surface of the wing and cover plates in the lower surface of the ailerons are provided for access to the attachment points of the aileron control shafts.

3. Rudder, Elevator and Aileron Flaps

(Refer to Figures 19 and 21, Pages 44 and 49.)

(a) The rudder, elevator and aileron flaps are operated by the cranks on the control pedestal. The indicators show the positions of the flaps in degrees either side of neutral.

(b) The control cables for these flaps are 1/16 x 7 x 7 extra flexible steel and follow the same route through the airplane as the rudder and elevator cables with the exception of those of the aileron which follow this route until aft of the rear spar and then enter the right wing. NOTE: To aid in distinguishing the various flap control cables, they have been banded with paint at all turnbuckles and connections as follows: Rudder (both cables), Blue; Elevator (to upper side of drum in elevators), Yellow, (to lower side of drum in elevators), Red; Aileron (to upper side of drum in aileron), White, (to lower side of drum in aileron), None.

(c) The forward one of the two small cover plates on the right side of the vertical stabilizer is removable for access to a rudder flap control cable pulley. (See Figure 1, Page 10.)

(d) A hinged door for access to the aileron flap control gear is provided in the lower surface of the right wing, and a cover plate for access to the control shaft attachment is located in the lower surface of the aileron. (See Figure 2, Page 11.)

EMPENNAGE FLAP CONTROLS
FIG. 19

137940 BRACKET 1 REQ'D.
133253 &-1 BRACKET 1 EA. REQ'D.
AN210-1A PULLEY 6 REQ'D.
117425-3D-006 SPACER 2 REQ'D.
117425-3D-014 SPACER 5 REQ'D.
117425-3D-022 SPACER 1 REQ'D.
117425-3D-600 SPACER 1 REQ'D.

140195 FAIRLEAD 1 REQ'D.

140244 FAIRLEAD 1 REQ'D.
135451 FAIRLEAD 1 REQ'D.

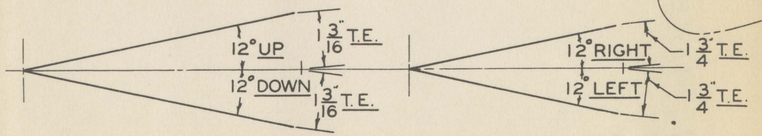
132497 BRACKET 2 REQ'D.
AN210-1A PULLEY 4 REQ'D.

CABLE ELEV. & RUDDER CONTROL DRUMS
SEE PAGE 44a FIG. 2
232294-4 RUDDER CABLE 1 REQ'D.
232294-7 ELEVATOR CABLE 1 REQ'D.

REFER TO DOUGLAS DRWG.
532075 FOR FLAP PARTS
CONNECTED WITH CONTROL PEDESTAL

231916 BRACKET 1 REQ'D.
AN210-2A PULLEY 2 REQ'D.

231914 BRACKET 1 REQ'D.
AN210-2A PULLEY 2 REQ'D.



ELEVATOR FLAP MOVEMENT

RUDDER FLAP MOVEMENT

REFER TO DOUGLAS DRWGS. 530578 & 541123

CABLE ELEV. FLAP
SEE PAGE 44a FIG. 1
133253 &-1 BRACKET 3 EA. REQ'D.
AN210-1A PULLEY 6 REQ'D.
117425-3D-019 SPACER 3 REQ'D.

134932 FAIRLEAD 1 REQ'D.

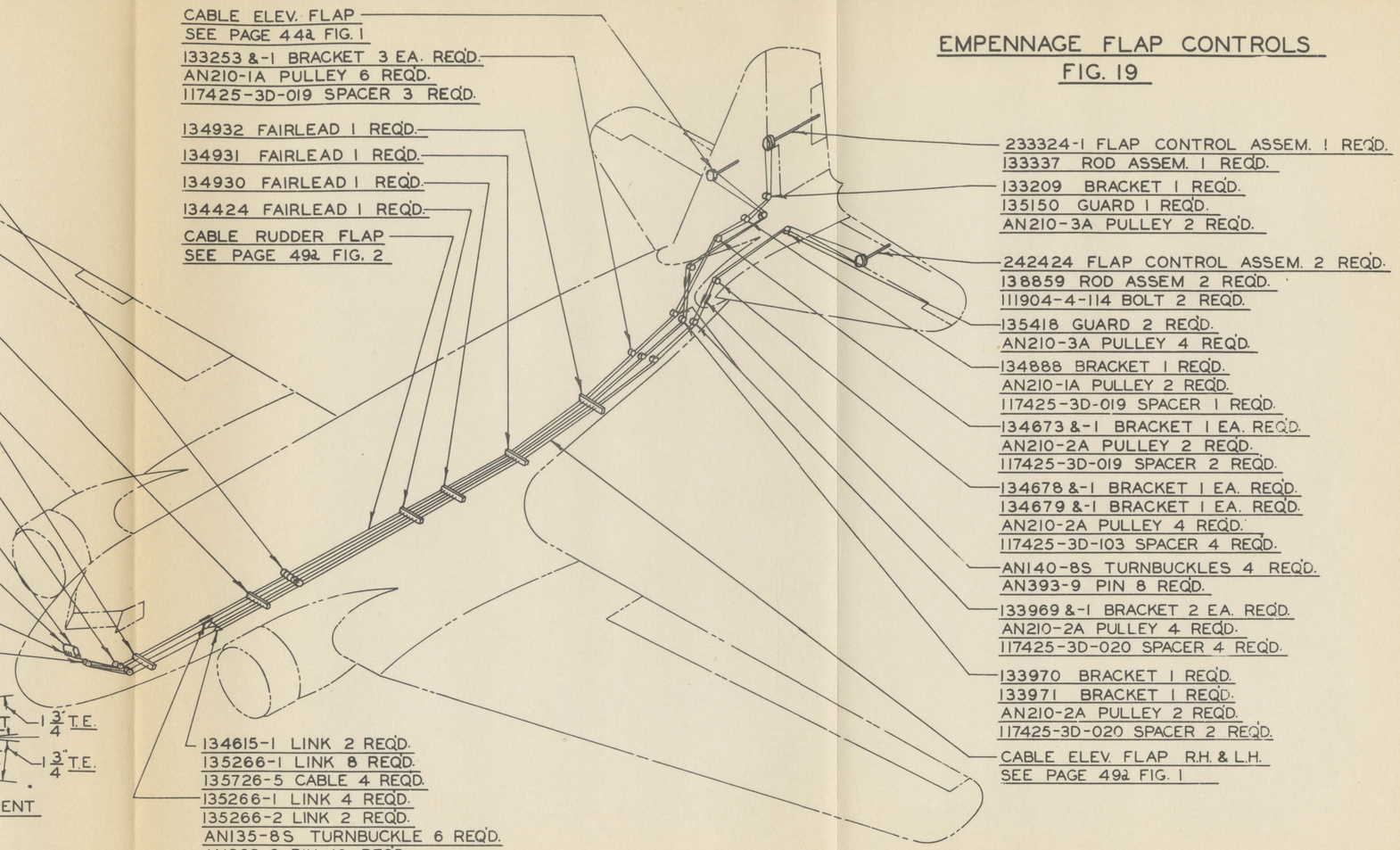
134931 FAIRLEAD 1 REQ'D.

134930 FAIRLEAD 1 REQ'D.

134424 FAIRLEAD 1 REQ'D.

CABLE RUDDER FLAP
SEE PAGE 49a FIG. 2

134615-1 LINK 2 REQ'D.
135266-1 LINK 8 REQ'D.
135726-5 CABLE 4 REQ'D.
135266-1 LINK 4 REQ'D.
135266-2 LINK 2 REQ'D.
AN135-8S TURNBUCKLE 6 REQ'D.
AN393-9 PIN 16 REQ'D.



233324-1 FLAP CONTROL ASSEM. 1 REQ'D.
133337 ROD ASSEM. 1 REQ'D.

133209 BRACKET 1 REQ'D.
135150 GUARD 1 REQ'D.
AN210-3A PULLEY 2 REQ'D.

242424 FLAP CONTROL ASSEM. 2 REQ'D.
138859 ROD ASSEM 2 REQ'D.
111904-4-114 BOLT 2 REQ'D.

135418 GUARD 2 REQ'D.
AN210-3A PULLEY 4 REQ'D.

134888 BRACKET 1 REQ'D.
AN210-1A PULLEY 2 REQ'D.
117425-3D-019 SPACER 1 REQ'D.

134673 &-1 BRACKET 1 EA. REQ'D.
AN210-2A PULLEY 2 REQ'D.
117425-3D-019 SPACER 2 REQ'D.

134678 &-1 BRACKET 1 EA. REQ'D.
134679 &-1 BRACKET 1 EA. REQ'D.
AN210-2A PULLEY 4 REQ'D.
117425-3D-103 SPACER 4 REQ'D.

AN140-8S TURNBUCKLES 4 REQ'D.
AN393-9 PIN 8 REQ'D.

133969 &-1 BRACKET 2 EA. REQ'D.
AN210-2A PULLEY 4 REQ'D.
117425-3D-020 SPACER 4 REQ'D.

133970 BRACKET 1 REQ'D.
133971 BRACKET 1 REQ'D.
AN210-2A PULLEY 2 REQ'D.
117425-3D-020 SPACER 2 REQ'D.

CABLE ELEV. FLAP R.H. & L.H.
SEE PAGE 49a FIG. 1

J.A. GRAVES 5-24-34

AILERON-ELEVATOR & RUDDER FLAP CABLES

FIG. 19a

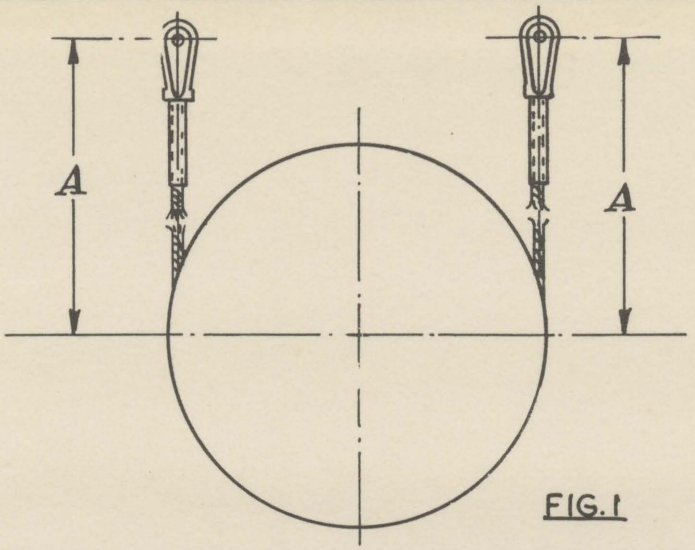


FIG. 1

NOTE:
LENGTH OF CABLE INCLUDING PART WRAPPED AROUND DRUM = 435

NAME	NO. REQ.	A	CLEVISES
ELEVATOR FLAP	2	$162\frac{1}{4}$	133318

SEE PAGE 44

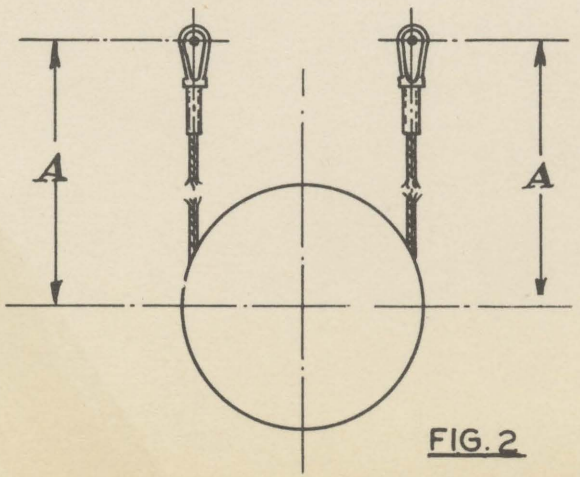


FIG. 2

NOTE:
LENGTH OF CABLE INCLUDING PART WRAPPED AROUND DRUM = 272

NAME	NO. REQ.	A	CLEVISES
AIL.-ELEV.-RUD. CONTROL DRUM	3	$84\frac{3}{8}$	133318

SEE PAGES 44 & 49

(e) The elevator flaps are interchangeable. A small cover plate for access to the elevator flap control rod is provided near the leading edge on the upper surface of each elevator. A larger plate for access to the flap control drum is located near the leading edge on the lower side of the elevator.

(f) The rudder, elevator and aileron flap control cables are provided with fixed stops which check the travel of the cables when coming in contact with fairleads on the structure below the cargo compartment floor.

(g) A large cover plate for access to the master bell crank and the wing flap mechanism is provided in the lower surface of the center wing panel on the centerline of the airplane. Forward of this plate is a small cover plate provided for access to control cable pulleys. (See Figure 2, Page 11.)

B. Location of Turnbuckles

1. Turnbuckles are provided in the control cables at the following locations:

(a) Rudder and Elevator

(1) In the lower fuselage bay below the cargo compartment accessible through the floor panels. (At the Servo Unit.)

(2) In the rear fuselage bay aft of the baggage compartment.

(3) At the attachment of the rudder bus cables to the pedals.

(b) Aileron

(1) In the lower fuselage bay below the cargo compartment accessible through the floor panels. (At the Servo Unit.)

(2) At the master bell crank accessible through the cover plate in the lower surface of the wing on the centerline of the airplane.

(3) Within the wings at the attachment of the center and outer panels accessible through cover plates on the lower surface of the wing.

(c) Aileron, Rudder and Elevator Flaps

In the lower fuselage bay below the cargo compartment accessible through the floor panels; also at this location are provided adjustable links which allow for taking up cable slack when it is greater than that which may be taken up by the turnbuckles. The elevator flap control cables have turnbuckles located in the rear tail section for convenience in disconnecting the cables. The aileron flap control cables are equipped with links at the point of connection of the center and outer wing panels.

C. Adjustment (Cable Controls)

1. Rudder (See Figure 16, Page 39.)

With the rudder and pedals in their neutral positions, adjust the turnbuckles for equal tension in the cables. Set the stops described in Paragraphs (f) and (g), Page 41, for the proper movement of the rudder, which is 30 degrees either side of neutral.

2. Elevators (See Figure 17, Page 40.)

With the control column in its neutral position (13 1/2 degrees forward of the vertical) and the elevator set at 5 degrees upward, adjust the turnbuckles for equal tension in the cables. Set the stops described in Paragraphs (h) and (i), Page 41, for the proper movement of the elevators, which is 35 degrees upward and 20 degrees downward.

3. Ailerons (See Figure 18, Page 42.)

With the ailerons and control columns in their neutral positions, adjust the turnbuckles for equal tension in the cables. The proper movement is 30 degrees upward and 14 degrees downward.

4. Aileron, Rudder and Elevator Flaps

(See Figures 19 and 21, Pages 44 and 49.)

(a) The neutral position of the flaps is determined by the alignment of their trailing edges with those of the respective control surfaces in which they are installed. The neutral position of the pilots' control is shown on their respective indicators. With the flaps and controls in their neutral positions, adjust the turnbuckles for equal tension in the respective cables. The stops mentioned in Paragraph (f), Page 45, limit the flaps to their proper movements, which are as follows:

(1) Rudder - 12° either side of the neutral position.

(2) Elevator - 12° either side of the neutral position.

(3) Aileron - 12° either side of the neutral position.

D. Wing Flaps

1. The airplane is provided with hydraulically controlled wing flaps of the split trailing edge type, extending from aileron to aileron. These wing flaps are in four sections, but are integral and function as a single continuous unit. In operation, these flaps have a downward movement of 45°, giving an increase in lift of approximately 35% with an increase in drag of approximately 300%.

2. The wing flaps are attached to the underside of the wing by piano type hinges. A hydraulic strut located in the center wing panel has a piston and a longitudinally acting cylinder mounted on rollers. Toggle rods are connected to both the cylinder and piston, forming a variable parallelogram giving equalized motion. Push-pull rods are connected to the exterior points of the toggle rods, and these toggle rods are connected to turnbuckles on the wing flaps. Lengthening of the hydraulic strut causes the push-pull rods to move inward, thus lowering the wing flaps. The reverse action raises the wing flaps.

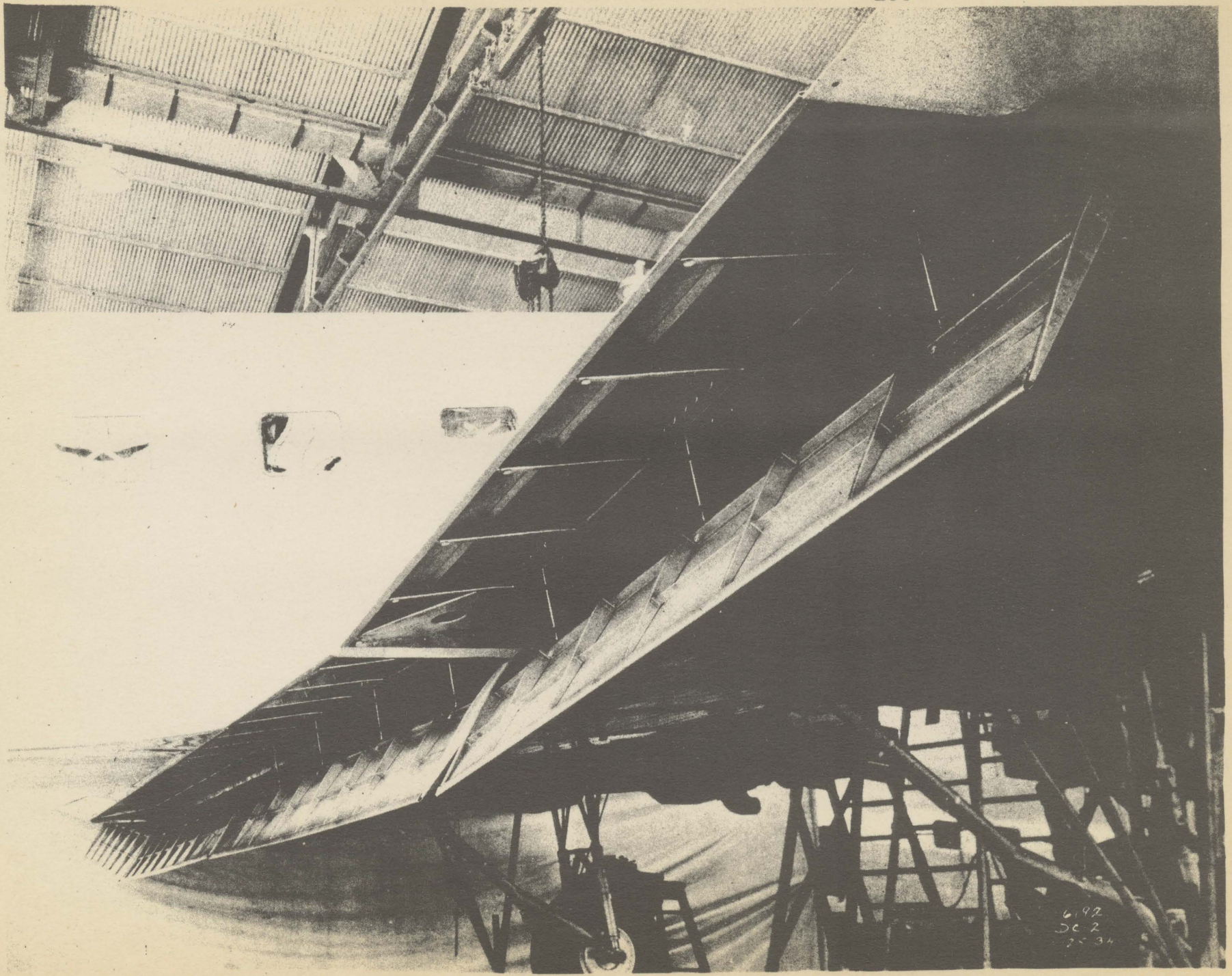


FIG. 20 VIEW OF WING FLAPS IN FULL "DOWN" POSITION

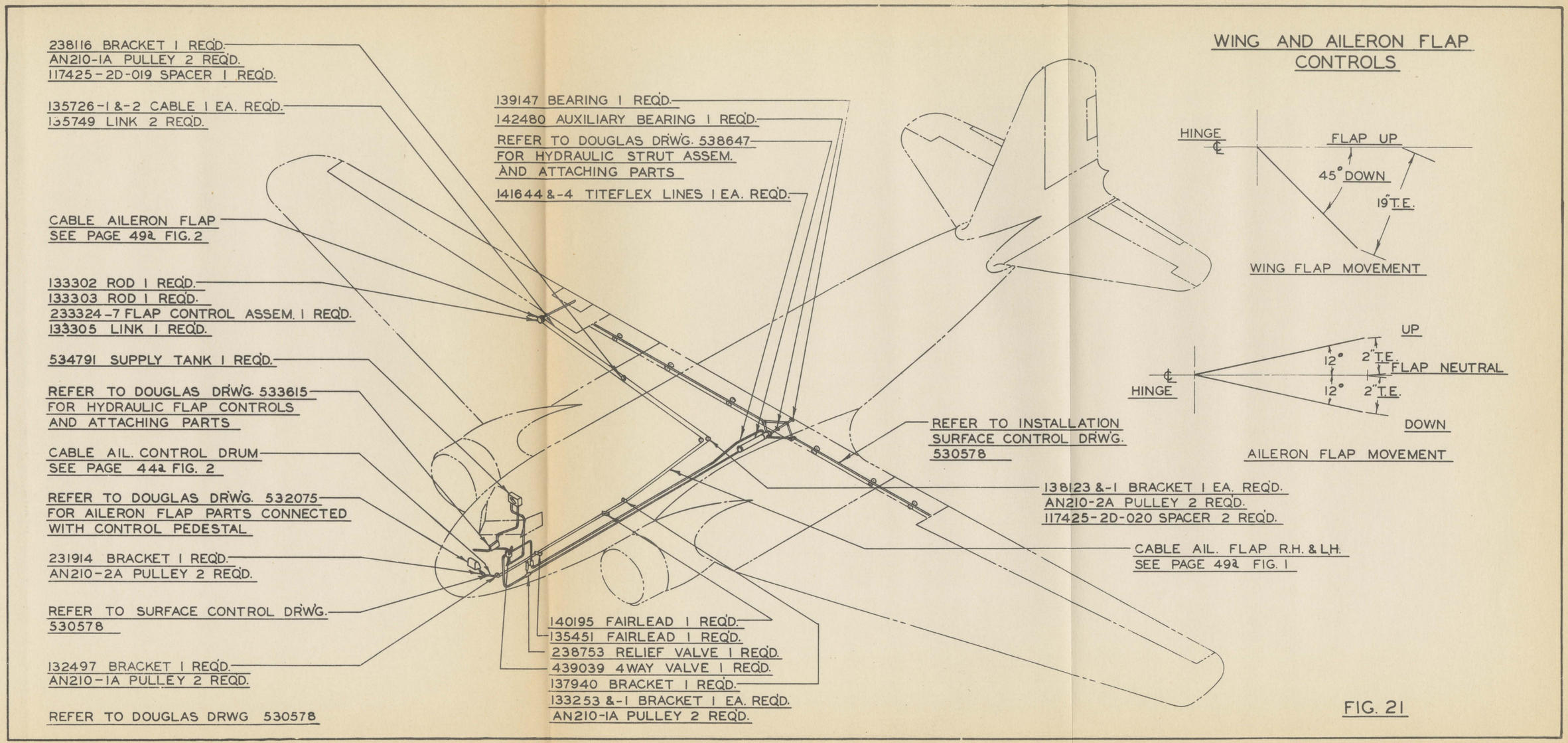


FIG. 21

REVISED 9-26-34 BLATEE

J A GRAVES 5-24-34

AILERON & RUDDER FLAP CABLE LENGTHS

FIG. 21a.

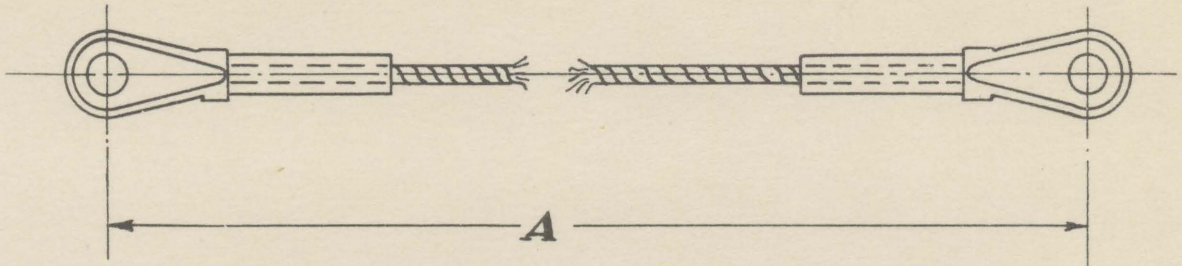


FIG. 1

NAME	NO. REQ.	A	CLEVISES
AIL. FLAP R.H. & L.H.	2	336	133318
ELEV. FLAP R.H. & L.H.	4	458 1/8	133318

SEE PAGES 49 & 44

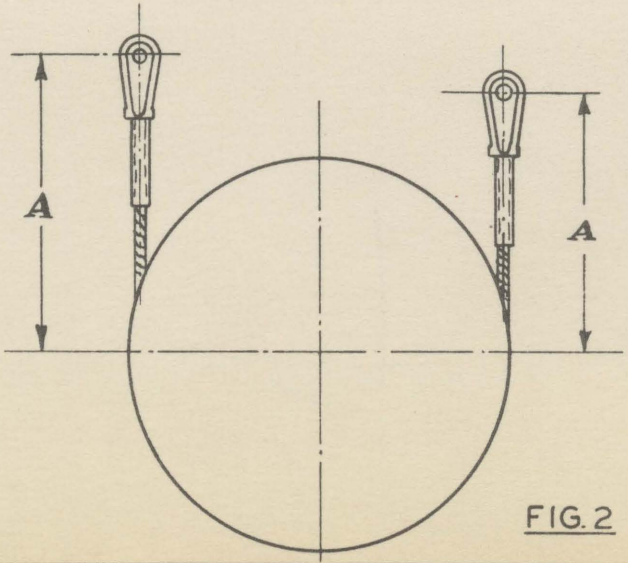


FIG. 2

NAME	NO. REQ.	A	CLEVISES
RUDDER FLAP	1	616 1/2	133318
AILERON FLAP	1	120	133318

SEE PAGES 44 & 49

NOTE:
LENGTH OF CABLES INCLUDING PART WRAPPED AROUND DRUMS.
RUDDER FLAP = 1345
AILERON FLAP = 350

3. A fluid supply tank is located just behind and above the co-pilot's seat. (See Figure 40, Page 91.) The fluid used is Lockheed hydraulic brake fluid #5. On the left side of the co-pilot's seat is a double-acting hydraulic pump. A four-way control valve is located on the floor at the right side of the pilot's seat. A relief valve is inserted in the wing flap hydraulic system to prevent lowering of the wing flaps when the airspeed of the airplane is in excess of 100 miles per hour. The high pressure line from the control valve has a tee connection to the lower end of the valve and the low pressure line a tee connection to the side of the valve. When lowering the wing flaps, the high pressure side is forward of the piston on the hydraulic strut and the low pressure side is behind the piston. These pressure conditions are reversed when the wing flaps are raised. When the airspeed is greater than 100 miles per hour, the back pressure in the line built up by the air acting on the wing flaps is great enough to cause the valve, held in place by a spring, to be pushed off its seat. This connects the high pressure line directly to the low pressure line allowing the fluid to by-pass through the valve without operating the hydraulic strut. If, when operating the hydraulic pump to lower the wing flaps, the pressure does not build up in the system, the fluid must be by-passing through the relief valve and would indicate that the airspeed is too great to lower the wing flaps. NOTE: A pipe tee is located under the floor of the pilot's compartment to permit installation of a pressure gauge in the wing flap hydraulic system, if so desired.

4. The hydraulic lines are of 1/2 O.D. x .035 normalized chrome molybdenum steel tubing. In order to insure fluid tight connections, the ends of the tubes are flared and reamed for Parker fittings. All pipe plug fittings are tinned. Figure 40, Page 91, shows the hydraulic system diagrammatically.

E. Wing Flap Indicating System

1. Attached to the forward end of the hydraulic strut cylinder is a steel wire carried in a Bowdenite conduit, which is connected to an indicator located on the instrument panel. Any movement of the hydraulic strut cylinder is shown by an equivalent horizontal movement of the indicating needle, recording directly the position of the wing flaps from neutral.

F. Operation of Wing Flaps

1. To lower wing flaps:

(a) Release button in handle of control valve.

(b) Place handle in extreme forward position.

(c) Operate hydraulic pump until indicator shows wing flaps full down.

(d) Return handle of control valve to neutral.

2. To raise wing flaps:

(a) Release button in handle of control valve.

(b) Place handle in extreme rear position.

(c) When in flight, the air pressure on the wing flaps is sufficient to raise them without necessitating the use of the hand pump; this applies only when the control valve is placed in the extreme rear position. It is advisable after doing this to build up pressure in the hydraulic system, after the flaps have come into position, by means of two or three strokes on the pump.

(d) When on the ground, it is necessary to raise the wing flaps by means of the hydraulic pump.

(e) Return valve handle to neutral.

3. Electric Pump:

(a) Besides the hand operating hydraulic pump, the airplane is furnished with an ~~Eclipse~~ Pneumatic Pressure Motor Driven Oil Pump shown in Fig 22 Page 52 ~~electric pump~~, Type Y-150, mounted on the right hand side of the hand pump, back of the co-pilot's seat. The pump is equipped with a push button, located in the end of the hand pump handle, which when pressed makes a contact closing the circuit between the solenoid switch, located in the cargo compartment, and the battery. The solenoid switch completes the electrical circuit between the battery and the motor which operates the hydraulic pump. The box housing the two 66A fuses hooked in parallel and the electrical connections between the battery and the motor, is mounted on the forward wall of the cargo compartment. This box also contains two spare fuses. The solenoid switch is equipped with contact points of non-burning material and the fuses for this switch are located in the pilot's electrical fuse panel.

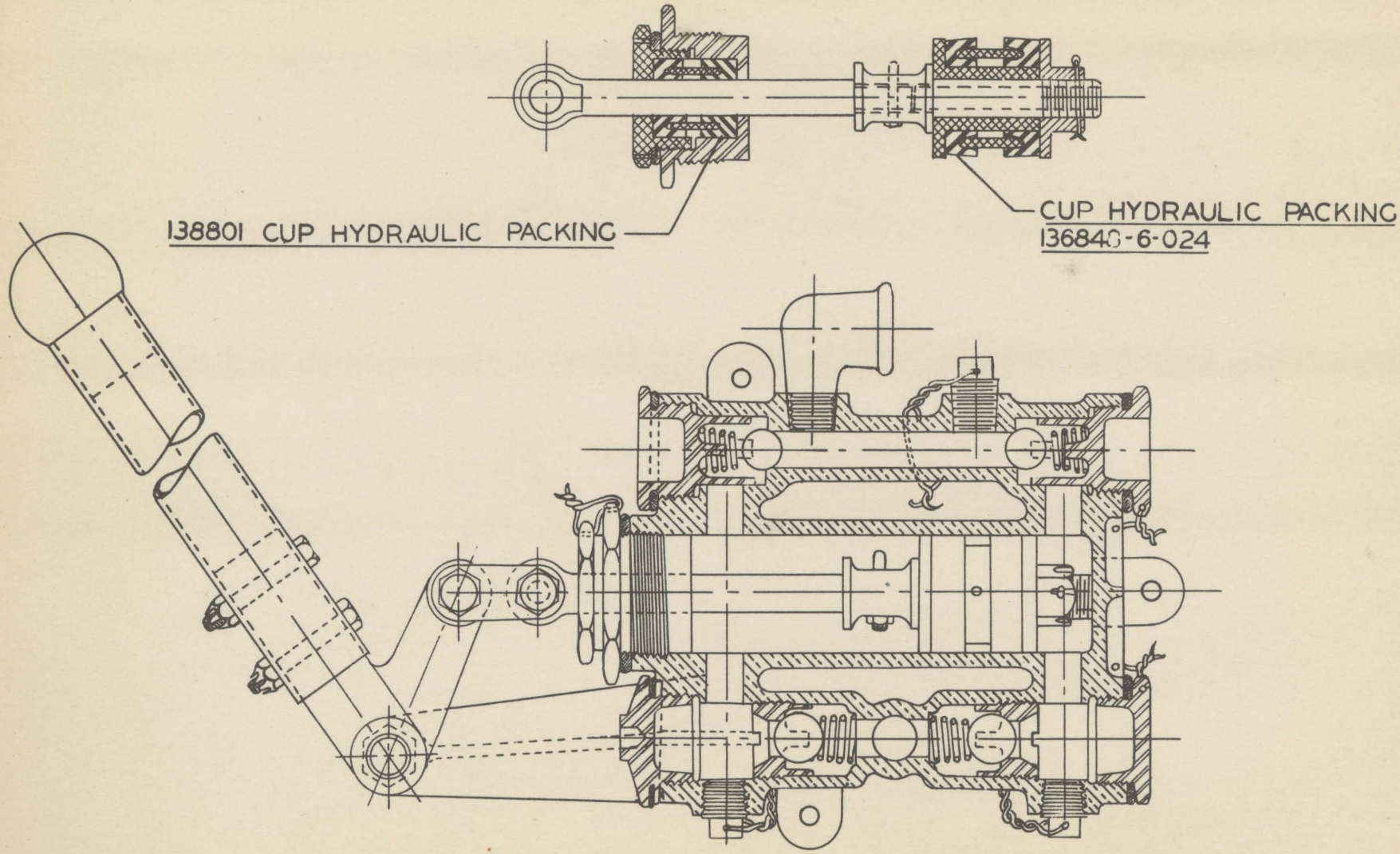


FIG. 22
HYDRAULIC PUMP

REFER TO DOUGLAS DRAWING 438810

(b) A pressure switch located on the wall behind the co-pilot's seat opens the electrical circuit when the pressure in the hydraulic system builds up in excess of 300 pounds. The switch should be reset immediately after each time that it is used.

(c) A "Striker" button is located on the wall behind the co-pilot's seat for use should the solenoid contacts fail to break automatically. By pressing the "Striker" button toward the wall the contact points of the solenoid switch are forced open.

G. To Remove Wing Flaps:

1. With the flaps lowered, disconnect their respective turnbuckles (four on each center section flap and three on each outer panel flap) and pull out the hinge pins. The flaps may then be removed with a downward pull.

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H. To Remove Piston Unit From Hydraulic Pump:

(The hydraulic pump is shown in Fig. 22, Page 52, and the landing gear and wing flap system in Fig. 40 Page 91.)

1. Disconnect and plug line from supply tank to pump.

2. Protect adjacent furnishings from any oil that might be spilled.

3. Disconnect pump handle from piston rod.

4. Unscrew stuffing box (large hex.).

5. To replace packing on piston unit:

(a) Remove cotter pin.

(b) Take off retaining cup assembly.

(1) Replace old packing with Cup - Hydraulic Packing - Douglas Part No. 136848-6-024 (2 required).

(c) Remove pin from piston rod spool and remove spool.

(d) Take off stuffing box nuts.

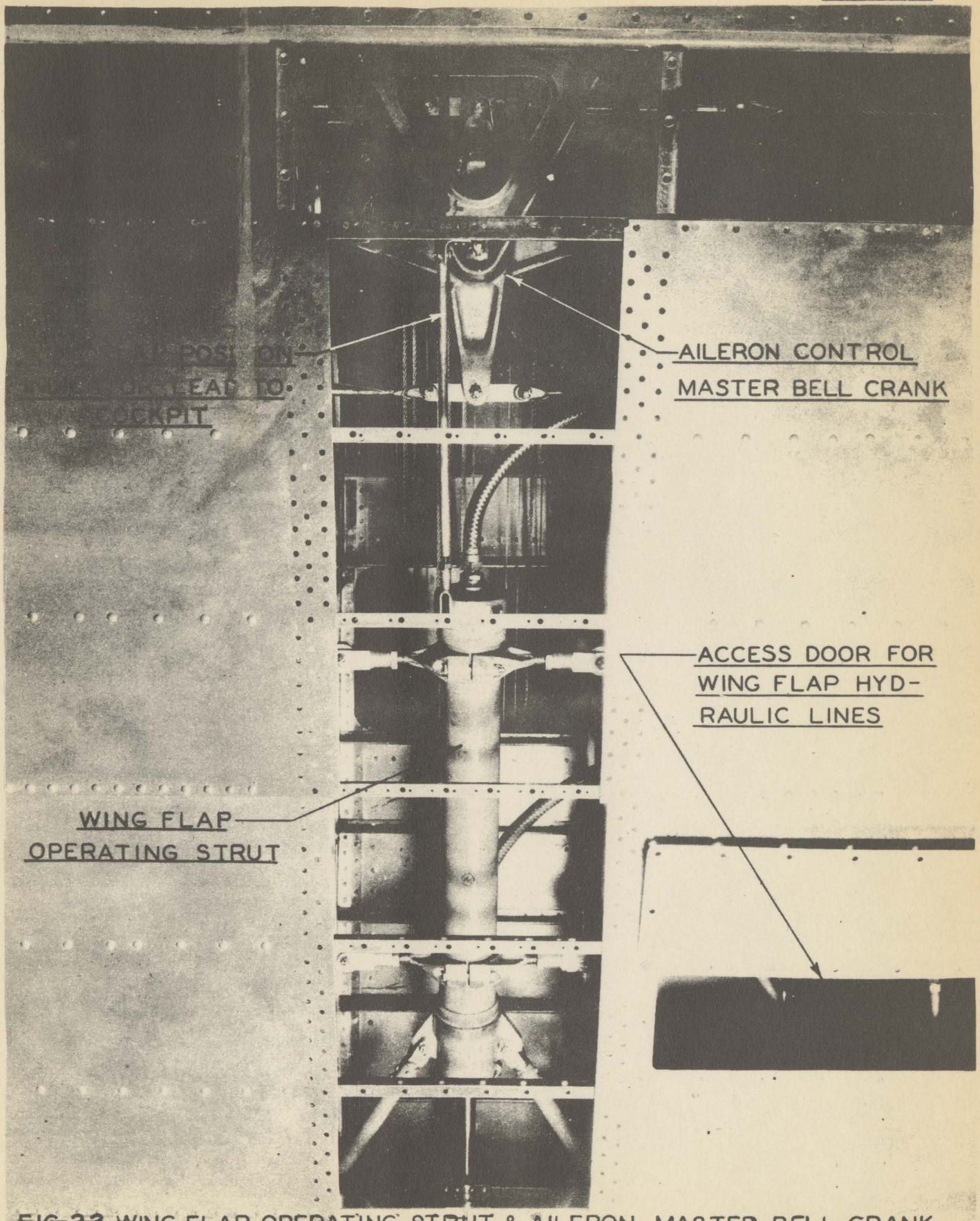
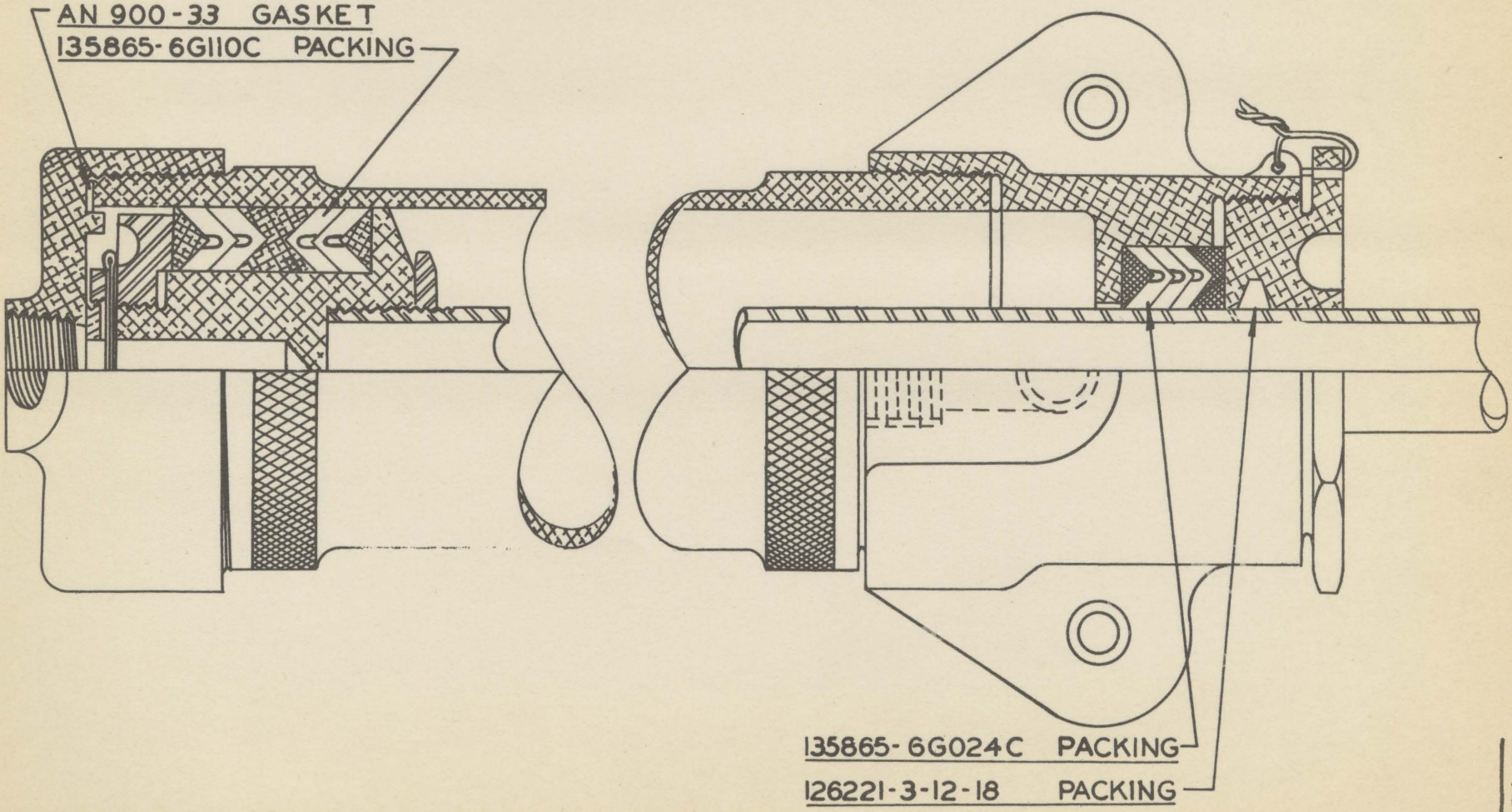


FIG. 23 WING FLAP OPERATING STRUT & AILERON MASTER BELL CRANK



REFER TO DOUGLAS
DRAWING 538647

FIG. 24
WING FLAP OPERATING STRUT

(1) Replace packing of smaller nut with Douglas Part No. 126221-3-7-13.

(2) Replace packing of larger nut with Douglas Part No. 138801.

I. To Replace Piston Unit in Hydraulic Pump:

1. Place smaller stuffing box nut on piston rod, followed by larger nut.

2. Put piston rod spool in position and secure with piston rod spool pin.

3. Place retaining cup assembly on piston rod and secure with cotter pin.

4. Place piston rod unit in cylinder and tighten stuffing box nut.

J. To Remove Wing Flap Operating Strut:

(See Figure 23, Page 54.)

1. Remove access plate, marked "Bell Crank Turnbuckle Zerk" and "Wing Flap Cylinder" from underside of center section.

2. Disconnect and plug fluid lines.

3. Disconnect cylinder and piston linkage and then detach indicator lead from cylinder.

4. Remove roller bolts holding cylinder to slide.

NOTE: Do not remove yoke clamps from strut cylinder since these are jigged in place to insure alignment with piston rod bearings in wing structure.

5. Slide strut forward so that piston rod clears bracket and take it out of wing section.

6. Remove block and shear collar.

7. Take out lock wire and unscrew stuffing box nut.

(a) Replace washer packing with Douglas Part #126221-3-12-18.

(b) Replace packing in base with Douglas Part No. 135865-6G024C packing (3 required).

8. Unscrew base from cylinder.

9. Remove piston unit from cylinder.

(a) Take out cotter pin and unscrew bearing.

(b) Remove spacers and packing (note arrangement carefully).

(c) Replace packing with Douglas Part #135865-6G110C (4 required).

K. To Reassemble Wing Flap Operating Strut:

1. After packing has been replaced, screw bearing in place and secure with cotter pin.

2. Place piston unit in cylinder.

3. Reverse order and procedure from items 1 to 7 inclusive under Paragraph J, Page 56.

L. To Adjust Wing Flap:

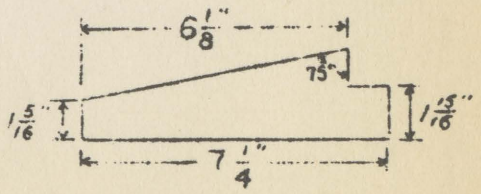
1. When it is found necessary to replace or readjust the wing flaps for any reason, care must be exercised to avoid damage to the flap surfaces and/or the control mechanism. The following system for installing the wing flaps and adjusting them properly has been developed at the factory and it has been found to save considerable time.

2. Fill hydraulic control system with fluid and operate control strut several times to eliminate all air from the system. Connect the push-pull control rods, in the wing, to the strut, and make sure that the adjustments on the rods are all turned up to make the rods as short as possible.

3. Connect all turnbuckles to the flap surfaces and the push-pull rods. Tighten the turnbuckles until the threaded ends show in the locating holes which have been drilled in the turnbuckle barrels.

4. Readjust the turnbuckles until the trailing edge of the flap is 21 inches below the trailing edge of the wing. Under the fuselage, the flap trailing edges may be sighted for alignment.

5. Adjust the push-pull control rods until the turnbuckles are at a 75 degree angle between the control rod and the flap attaching point. This may be easily accomplished by using a metal template (see sketch), resting the template on the flap spar just behind the turnbuckle barrel.



-592-

6. Pump the flaps into the full "up" position, watching the movement of the flaps carefully and noting any difference in travel. Lengthening the push-pull rod increases the travel of the flaps and shortening the rod decreases the travel.

7. When the push-pull rods have been adjusted so that all flap surfaces have equal travel and the trailing edges are in line, tighten each turnbuckle one full turn and pump flaps into "up" position. It will be necessary to make another adjustment of the turnbuckles in order to make the trailing edge of the flaps have a slight pressure on the felt pads when they are raised to their full "up" position.

8. Cautions:

(a) Do not have control rods connected to strut while testing hydraulic strut movement.

(b) Do not move flap surfaces to full "up" position by hand if turnbuckle ends are on control rods. (Upper ends of turnbuckles are long enough to bear on flap covers and will damage covers if pushed up against them.)

(c) Set lock nuts on turnbuckles, safety turnbuckle barrels and set lock nuts on push-pull rods when adjustment is completed.

M. Warnings: Wing Flap:

1. Fasten all turnbuckles with safety wire.

2. Never attempt to operate wing flaps when airspeed is in excess of 100 miles per hour.

3. Use only specified fluid in the hydraulic system; namely, Lockheed fluid #5 (a mixture of three parts castor oil and one part high boiling point alcohol may be used if Lockheed fluid is not available). CAUTION: Never use a mineral oil in the hydraulic system as it will cause the packing in all of the hydraulic units to seize. Check fluid level in reservoir after bleeding of lines.

4. Always check indicator on instrument panel for position of wing flaps.

N. To Bleed Wing Flap Hydraulic System:

1. With the exception of the brake system, all the hydraulic lines are self bleeding.

LUBRICATION WING AND AILERON FLAPS

USE A MIXTURE OF THREE PARTS CASTOR OIL AND ONE PART HIGH BOILING ALCOHOL IN HYDRAULIC STRUT SYSTEM LOCKHEED HYDRAULIC BRAKE FLUID NO.5 MAY BE USED CAUTION: DO NOT USE A MINERAL OIL

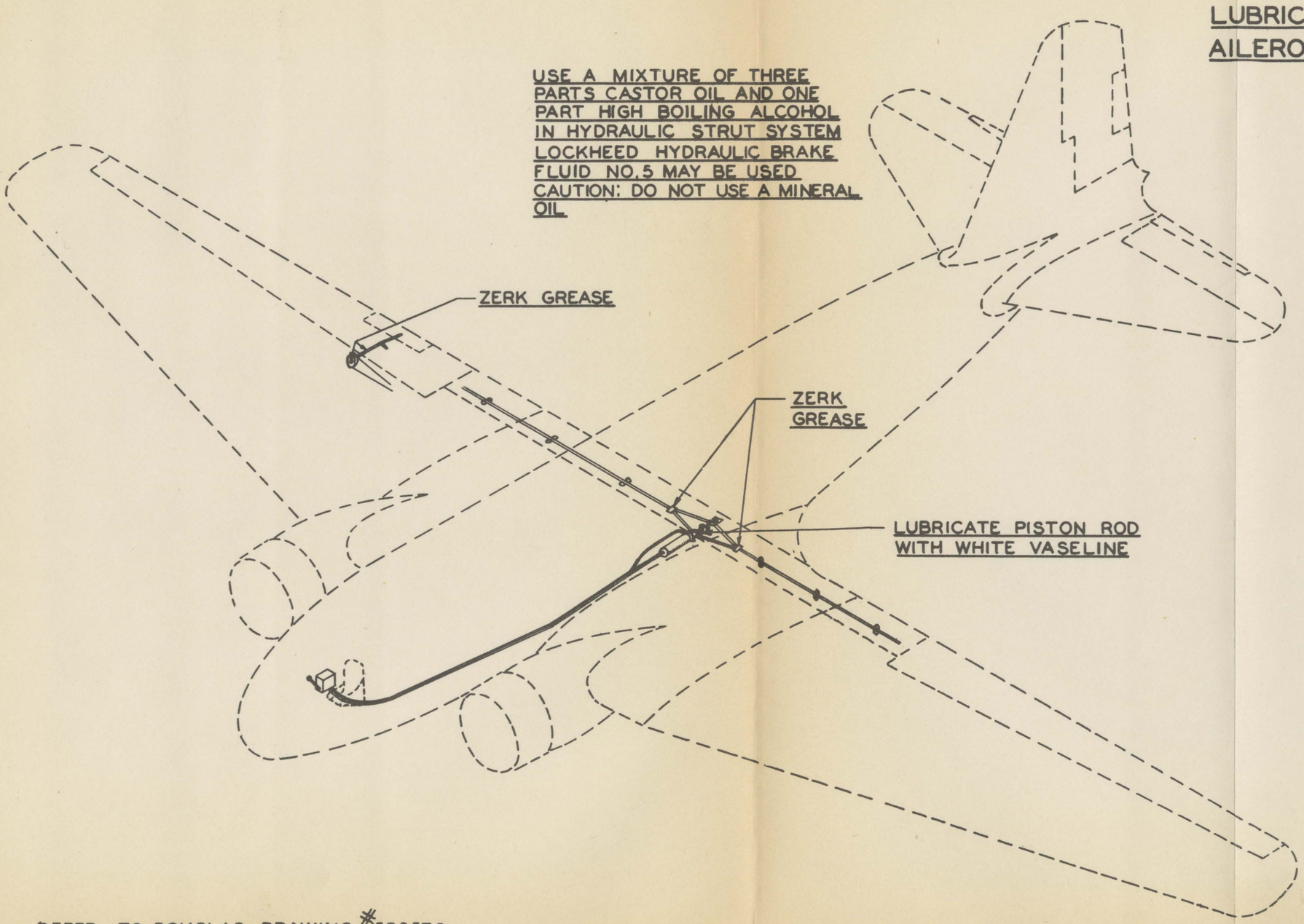


FIG. 25

REFER TO DOUGLAS DRAWING #530578

LUBRICATION PILOT'S CONTROL COLUMN

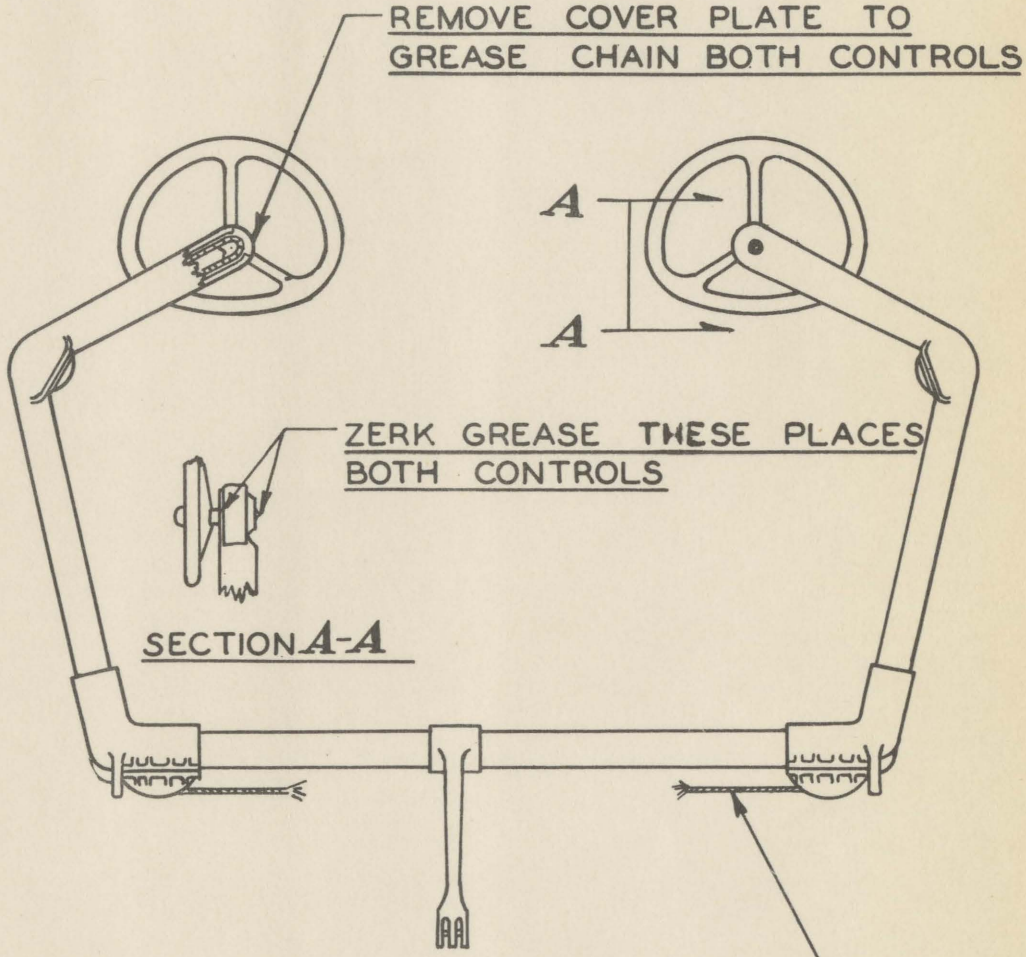


FIG. 26

REFER TO DOUGLAS DRW'G. #531857

GRAVES JA 4-5-39

Section VIII, Automatic Pilot

Information on the
Automatic Pilot Installation to be added.

April 26, 1934

SECTION IX

TAIL WHEEL

A. Description

1. The tail wheel is of the full swiveling type, but is restrained in the trailing position by a centering arm. In addition, a latch which is operated from the control pedestal in the pilot's compartment, may be used if desired, to lock the tail wheel in the trailing position during takeoff and landing.

2. A 17 x 7 - 5 wheel fitted with Timken bearings and an 8:00-5, 6 ply pneumatic tire (inflate to 55 pounds) is mounted in a fork by a straight pin axle. The fork is attached to a spindle shaft supported by two Timken roller bearings at each end of the housing. The housing is part of a built-up tubular frame which is attached to the structure to dampen out landing and taxiing loads. Two cross cables attached to a collar at the top of the spindle and attached to the structure by a flat link, which is connected to the turnbuckles by 3/8 inch dural bolts, anchor the unit against rotative movement. NOTE: It is important in the event of replacing these bolts that dural bolts of the same dimensions be used.

B. Shock Strut

(Figure 35, Page 74, shows the shock absorber strut.)

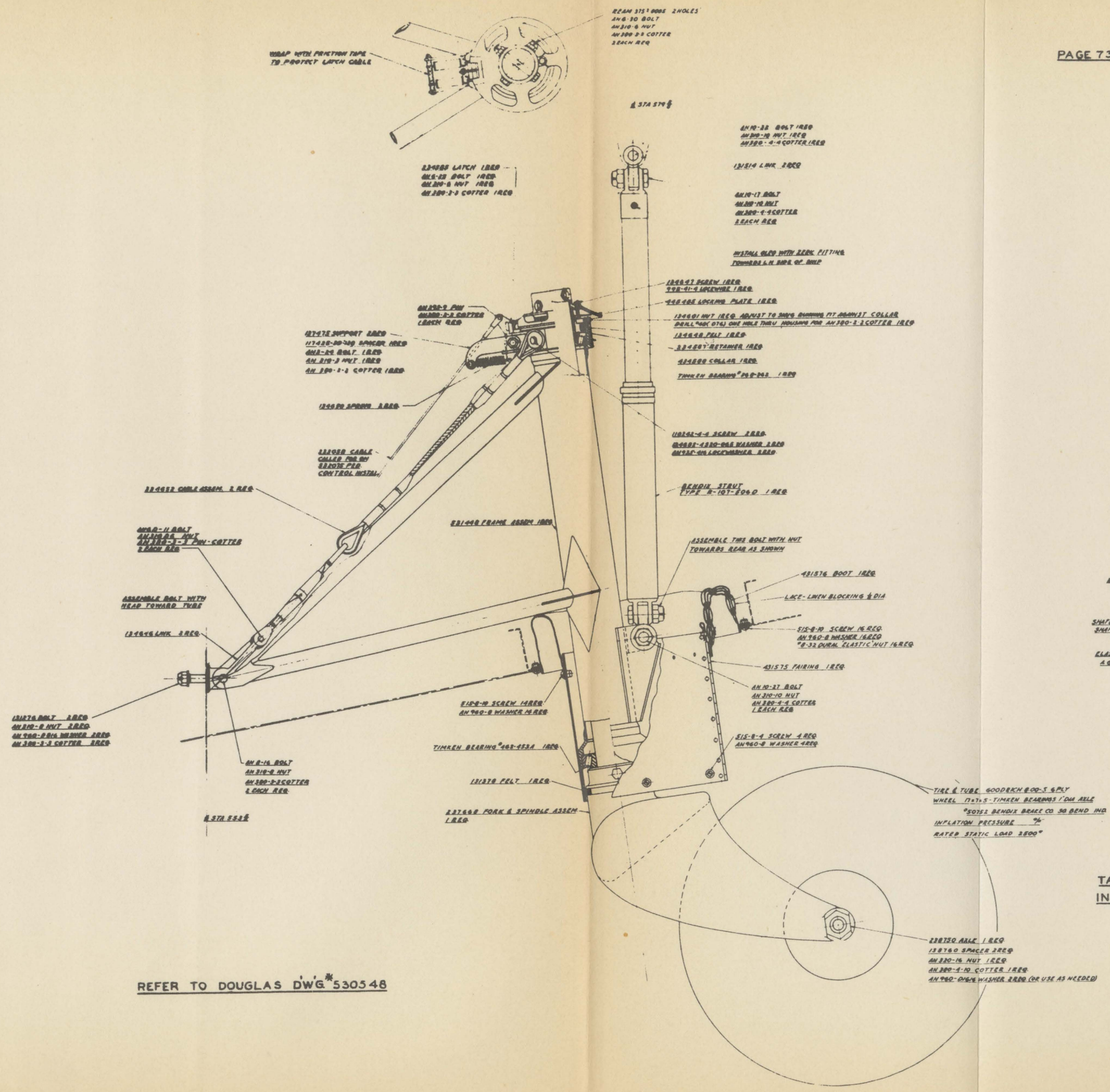
1. The shock strut is a combined hydraulic and pneumatic type of Bendix design. Impact loads are dissipated in the hydraulic unit by forcing fluid through an orifice. Taxiing loads are absorbed mainly by the compression of the air.

2. The strut is comprised essentially of two cylinders, one working within the other. The inner cylinder or piston contains an orifice at the lower end. The outer cylinder has a metering pin fastened to it at the lower end which controls the flow of fluid through the orifice as the piston moves within the cylinder.

3. The action of the strut is as follows: When the airplane is in the air, the strut is in the extended position and fluid is in the lower cylinder. As the wheel hits the ground, the lower cylinder is pushed upward, forcing the fluid past the metering pin, through the orifice in the piston, into the upper chamber, where the rising fluid level compresses the air above it. When the strut has made a sufficient stroke to absorb the energy of impact, the air in the top expands and forces the fluid back.

4. Filling of cylinder:

(a) The fluid used in this strut is Lockheed hydraulic fluid #5. CAUTION: Do not use



BENDIX STRUT PURCHASED FROM BENDIX AVIATION CORP 105 W ADAMS ST CHICAGO, ILL

SHAFER BEARINGS PURCHASED FROM SHAFER BEARINGS CO. CHICAGO ILL (BULLETIN #501)

ELASTIC STOP NUTS PURCHASED FROM A & A CO ELIZABETH N.J.

FIG. 34

TAIL WHEEL INSTALLATION

REFER TO DOUGLAS DWG.# 530548

FLUID
MIXTURE OF 3 PARTS CASTOR OIL AND 1 PART HIGH BOILING ALCOHOL. LOCKHEED HYDRAULIC BRAKE FLUID #5 MAY BE USED

BENDIX PART # 53113
2¼ O.D. X 1⅝ I.D.
JOHNS-MANSVILLE ENDLESS SEA RING PACKING (REVERSE STYLE-LIP ON OUTSIDE)

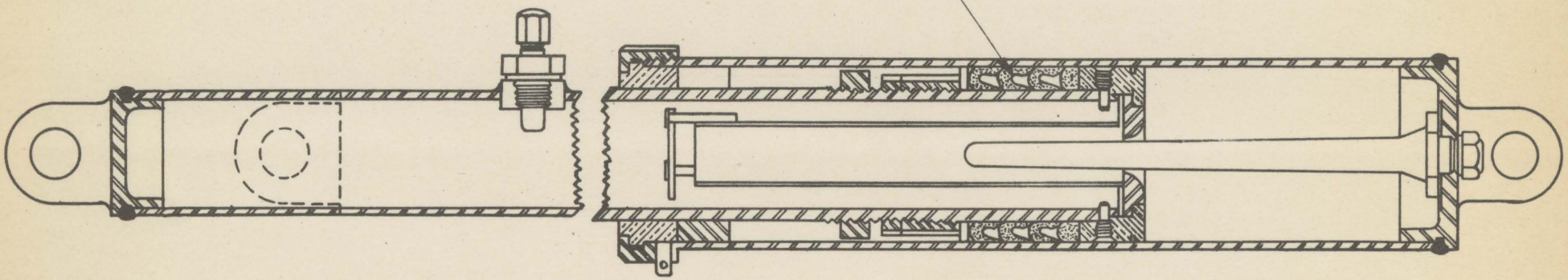


FIG. 35

REFERENCE: BENDIX DWG. 53103

SHOCK ABSORBER-TAIL WHEEL

a mineral oil in this strut as it will cause the packing to seize.

(b) The strut is filled through the filler plug in the piston when the piston is fully compressed and with the airplane in three point landing position. The strut has the correct amount of fluid when the fluid comes to the level of the filler plug, however, leakage of the fluid to a level not more than 1/2 inch below this point will not materially affect the characteristics of the strut.

5. Inflation of Strut:

(a) Air pressure of approximately 800 lbs./sq.in. is required to inflate the strut under full load. This may be obtained with the Bendix Booster Air Pump (see Page 76) attached to a pressure line of 80 pounds to 120 pounds. One man with ordinary effort can boost the pressure to 1,000 pounds. If he cannot do this, there is a leak somewhere in the line, the pump valves or the connections.

(b) Air should be added until the distance from the center of the filler plug to the top of the cylinder is 6 3/4 inches when the airplane is fullyloaded, and 8 3/4 inches when the airplane is not loaded. For the first inflation, the distance should be approximately 1/4 inch greater as moving the airplane will cause some absorption of the air by the fluid. A variation of 1/4 inch either way for final reading should not be considered of importance. Adjustment should be made with the airplane out of the wind, without the slipstream of the propeller and with the tail on the ground. After the strut is once correctly adjusted, readjustments should not be made for minor changes as this may be due to change in position of the airplane, change of load, wind action, packing friction, etc. Always check only after the airplane has been correctly loaded with tail down. Do not over-inflate as hard taxiing and bounce will result.

6. Air Valve:

(a) The air valve is a special Shrader rubber type developed for this purpose. This valve functions similarly to that of an automobile tire. The hex cap provided with this type of valve has a soft metal seat to furnish a secondary seal. It should be screwed down tightly. The cores are replaceable.

(b) The valve core and the seat around the filler plug should be tested for leaks by putting a little oil on these points to show the presence of air bubbles. Mineral oil should not be used as gumming may result if it is allowed to reach the packing rings.

7. Packing:

(a) The Johns-Manville Sea Ring Packing used in the strut is an automatic adjusting type and should be tightened down only enough to keep the packing from moving in the packing box, which is the space between the piston and the packing nut.

8. Booster Air Pump:

(a) The Bendix Booster Air Pump is a hand operated pump of small bore and long stroke, which is designed to boost moderately high air pressure to approximately ten to twelve times the intake pressure. The intake pressure is obtained by attaching the air chuck of the ordinary high pressure air line, or if this service is not available, any reasonably good tire pump can be used as an emergency source of supply by attaching the hose to the intake side of the booster pump.

(b) Operation of Pump:

(1) While attaching air line, hold pump handle up to avoid the piston being forced upward.

(2) Do not tighten thumb screw on air chuck of intake line more than is necessary to admit the air without leakage.

(3) Be sure that all other connections are tight, as any leakage will result in a loss of pressure.

(4) Care should be taken to drain any water in the air line before attaching to the pump.

(5) Operate pump through full stroke.

C. Tail Wheel Centering Arm

(Refer to Figure 35a, Page 76a.)

1. Description

(a) The tail wheel centering arm assembly is mounted at the top of the tail wheel column, with the

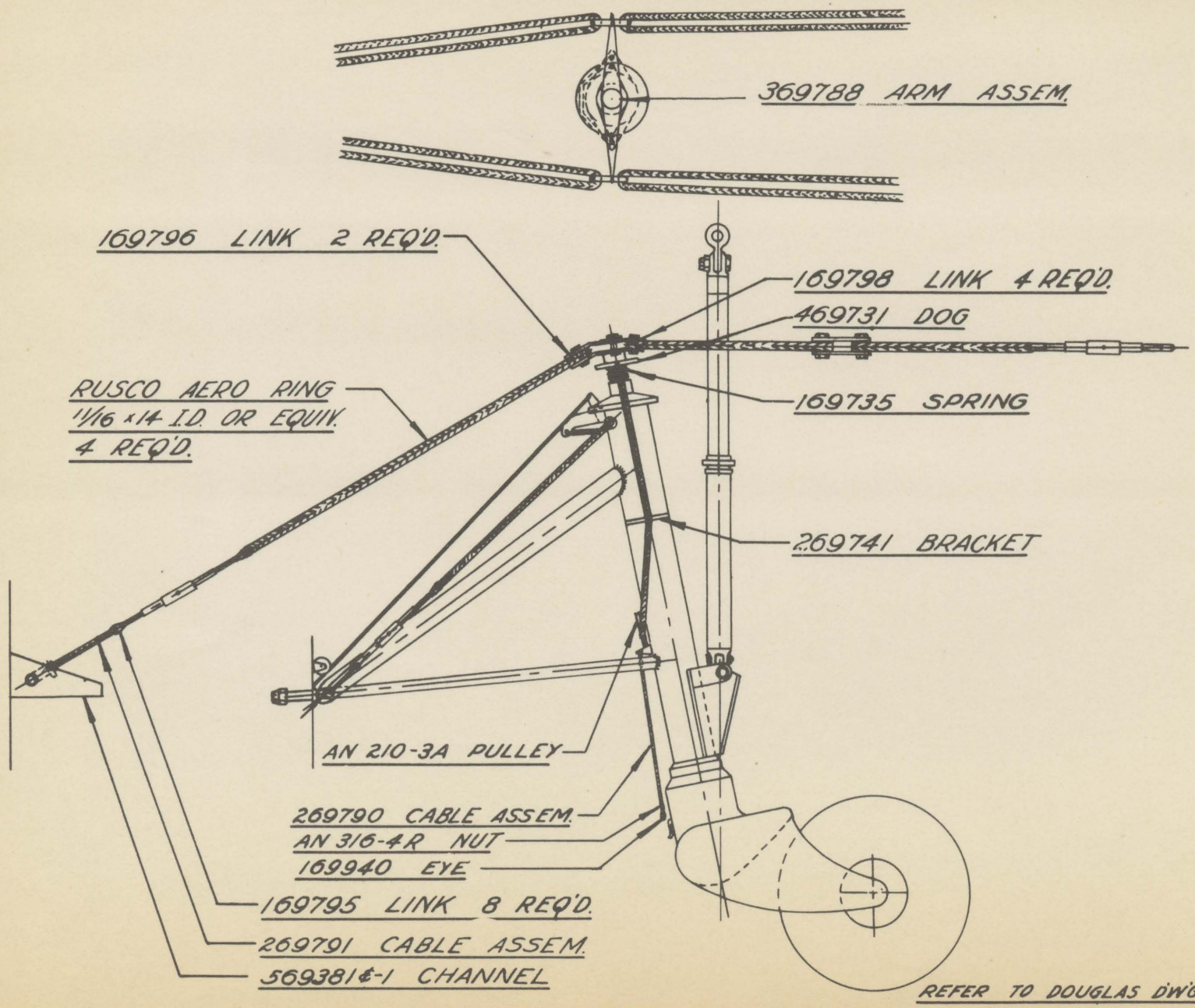


FIG. 35a
TAIL WHEEL CENTERING
ARM DIAGRAM

arms at right angles to the centerline of the airplane. To a link at the end of each arm, is attached a "Rusco Aero Ring", 11/16 x 14 I.D., which leads rearward and is attached by means of a lug to the stabilizer doubler on each side of the tail section. Similarly, two rings of the same dimensions are attached, one to each end of the arms and forward to two cable and turnbuckle assemblies which in turn connect to a lug located between two channels in the bottom of the fuselage, just aft of the rear baggage compartment bulkhead.

-513-

(b) The stabilizing effect of the centering arm assembly is realized when the tail wheel reaches the neutral position where the lugs on the centering dog match with the recesses in the tail wheel centering shaft, and the dog is forced into place by the spring below, thereby coupling the tail wheel assembly to the centering arm assembly. Due to the arrangement of the lugs on the dog, the two assemblies are allowed to couple only when the tail wheel reaches the neutral position. When coupled, the tail wheel must swivel approximately 35 degrees against the drag of the "Aero rings" before the dog is automatically forced to disengage, and the tail wheel permitted to swivel freely.

(c) Automatic declutching is caused by the action of a cable, the ends of which are attached to each side of the dog. The sides of the loop thus formed pass through fairleads on the tail wheel shaft housing below the dog, and through a return pulley at the lower end of the housing. As the swiveling motion begins, the cable ends are forced to follow the path of the dog, to approximately 35 degrees swivel, where the cable has been shortened sufficiently to pull the dog out against the action of the spring and clear of the recesses in the centering shaft. The centering arm is thus free of the tail wheel, and snaps back into neutral by action of the "Aero Rings", ready to be engaged when the tail wheel again comes into the neutral position.

(d) The tail wheel centering arm may be declutched manually by pulling down on the cable provided on the pulley of the declutching device, and attaching the link to the clip lever at the lower end of the housing. Such declutching is advantageous when moving the airplane by hand.

2. Maintenance

(a) Adjustment

(1) The arc through which the tail wheel must swivel before being automatically declutched may be adjusted to any desired angle. As the airplane leaves the factory, this angle is approximately 35 degrees. By loosening or taking up the check nuts on the clevis bolt of the declutching cable, the arc may be respectively increased or decreased.

(2) The tension of the "Aero Rings" should be kept equalized by adjustment on the turnbuckles on each "Ring" assembly. When the tension is equalized, the centering arms will be at right angles to the centerline of the airplane, provided the tail wheel is free to swivel.

(b) Lubrication

(1) A Zerk fitting is provided in the centering arm bearing.

(2) The declutching cable should be kept well greased with "No-oxide" grease.

D. Removal of Tail Wheel Spindle

(See Figure 34, Page 73)

1. Remove two bolts attaching cam plate and centering arm assembly to spindle.

2. Lower spindle out of housing.

E. Adjustment of Spindle Bearing

1. Remove retainer locking screw from cam plate.

2. Tighten retainer until there is no end movement of spindle. Be sure, however, that the spindle is still free to rotate easily.

3. Replace retainer locking screw. Should the screw not match with a notch, the retainer may be backed up to the nearest notch.

F. Removal of Wheel from Fork

1. Detach nut from end of axle.

2. Pull axle clear of wheel and fork.

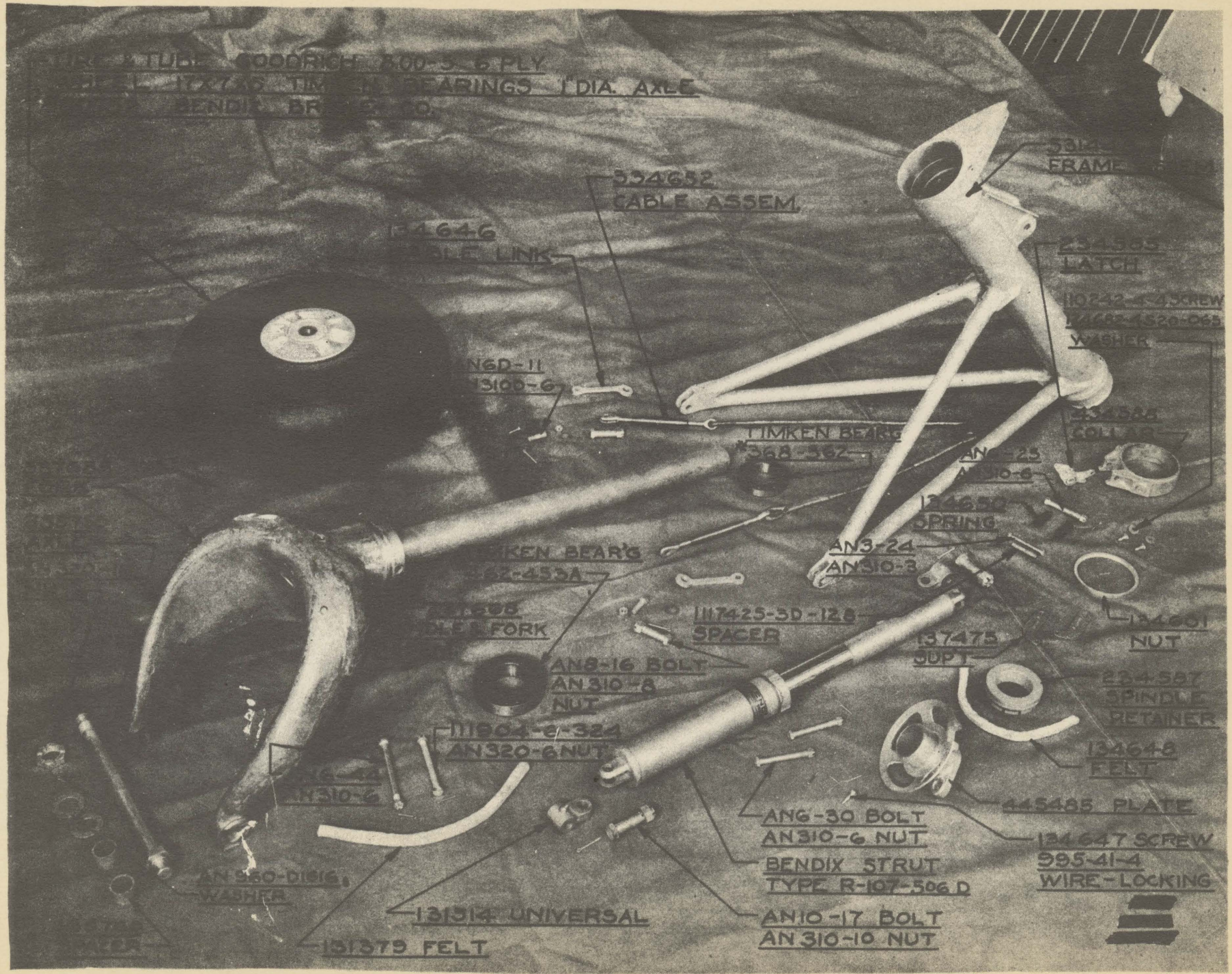
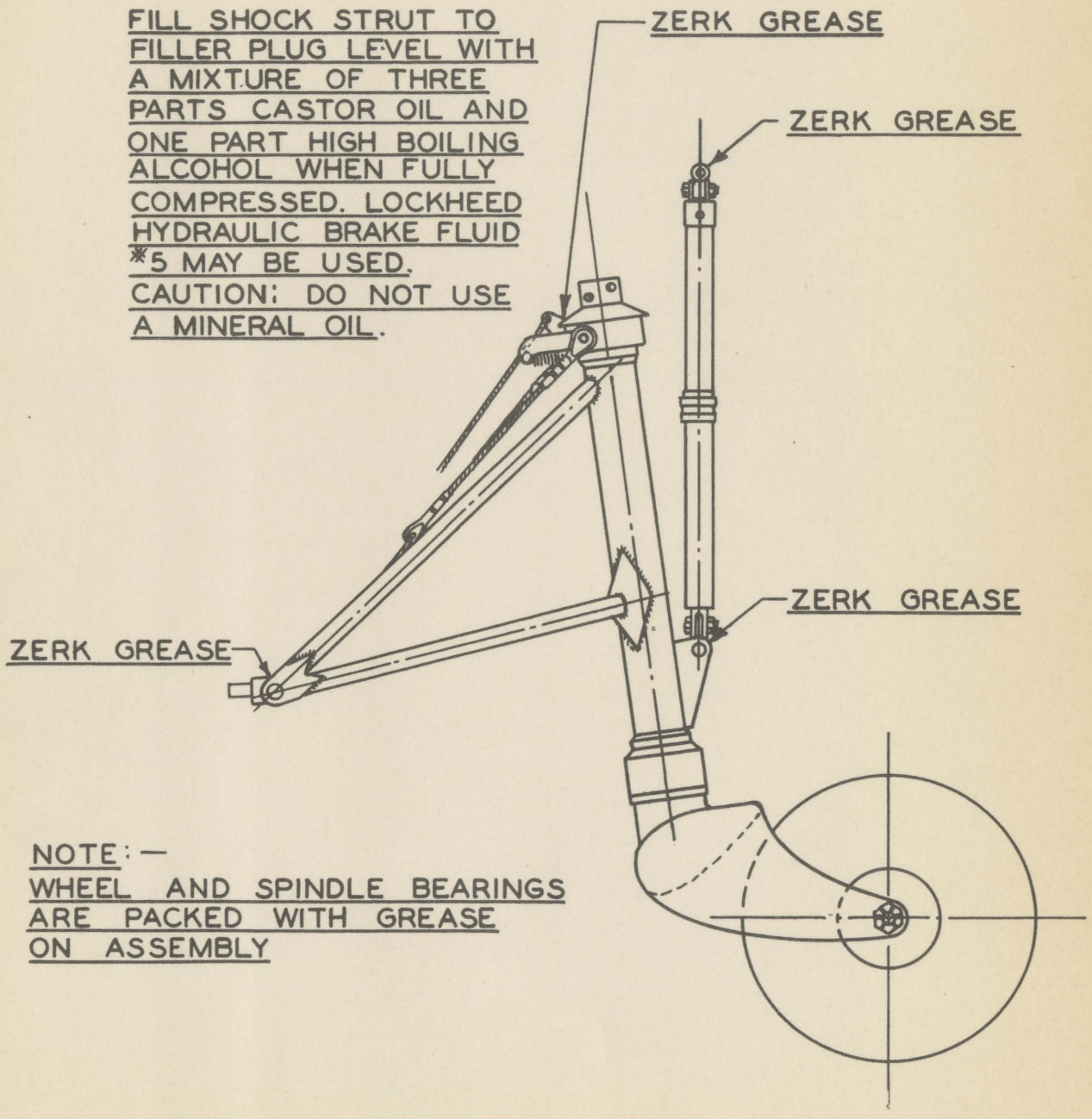


FIG. 36 VIEW OF TAIL WHEEL UNIT READY FOR ASSEMBLY

FILL SHOCK STRUT TO FILLER PLUG LEVEL WITH A MIXTURE OF THREE PARTS CASTOR OIL AND ONE PART HIGH BOILING ALCOHOL WHEN FULLY COMPRESSED. LOCKHEED HYDRAULIC BRAKE FLUID #5 MAY BE USED. CAUTION: DO NOT USE A MINERAL OIL.



NOTE:—
WHEEL AND SPINDLE BEARINGS ARE PACKED WITH GREASE ON ASSEMBLY

LUBRICATION TAIL WHEEL

REFER TO DOUGLAS DRWG. #530548

FIG. 37

SECTION X

LANDING GEAR

A. Description

1. General: The landing gear consists of two independent units; one mounted under each nacelle and so arranged that they may be folded into the nacelles, leaving only the bottoms of the wheels projecting. The description of each of these units is as follows: The wheel is mounted between two oleo-pneumatic shock absorber struts which are solidly clamped to the axle and connected together at their upper ends by rigid trusses. Attached to the axle at each side of the wheel is a yoke type brace strut which runs up and to the rear, hinging just aft of the center spar to a double wing rib designed for this purpose. The upper end of the shock absorber and wheel assembly is hinged to a movable truss, rotative about its upper fittings which are attached to the front wing spar. A hydraulic retracting strut is attached near the center of this rotative strut in such a manner that when the strut is retracted it rotates the upper truss forward and up into the nacelle. Since the shock absorber and wheel assembly is hinged to the lower end of the upper truss, it is also pulled into the nacelle. The wheel moves in an arc having the rear fitting of the brace strut as its center. When the gear is fully retracted, the projecting ends of the axles fit in sockets built into the sides of the nacelle and designed to take the weight of the airplane if it should be applied on the gear when in the retracted position. Because of this latter arrangement, the airplane may be set down with the wheels retracted to lessen the danger of nosing over if a forced landing on rough ground is imminent.

2. Axles: The axles are of heat treated chrome molybdenum steel tubing and each is made in one piece. The axles are interchangeable left and right.

3. Wheels: Bendix wheels mounting 42 x 15.00-16 tires are used. (The Department of Commerce requires that these tires be 10 ply.) Both wheels are made left hand style in order to facilitate interchangeability on right and left sides of the airplane. The proper air pressure for the tires is 40 pounds per square inch.

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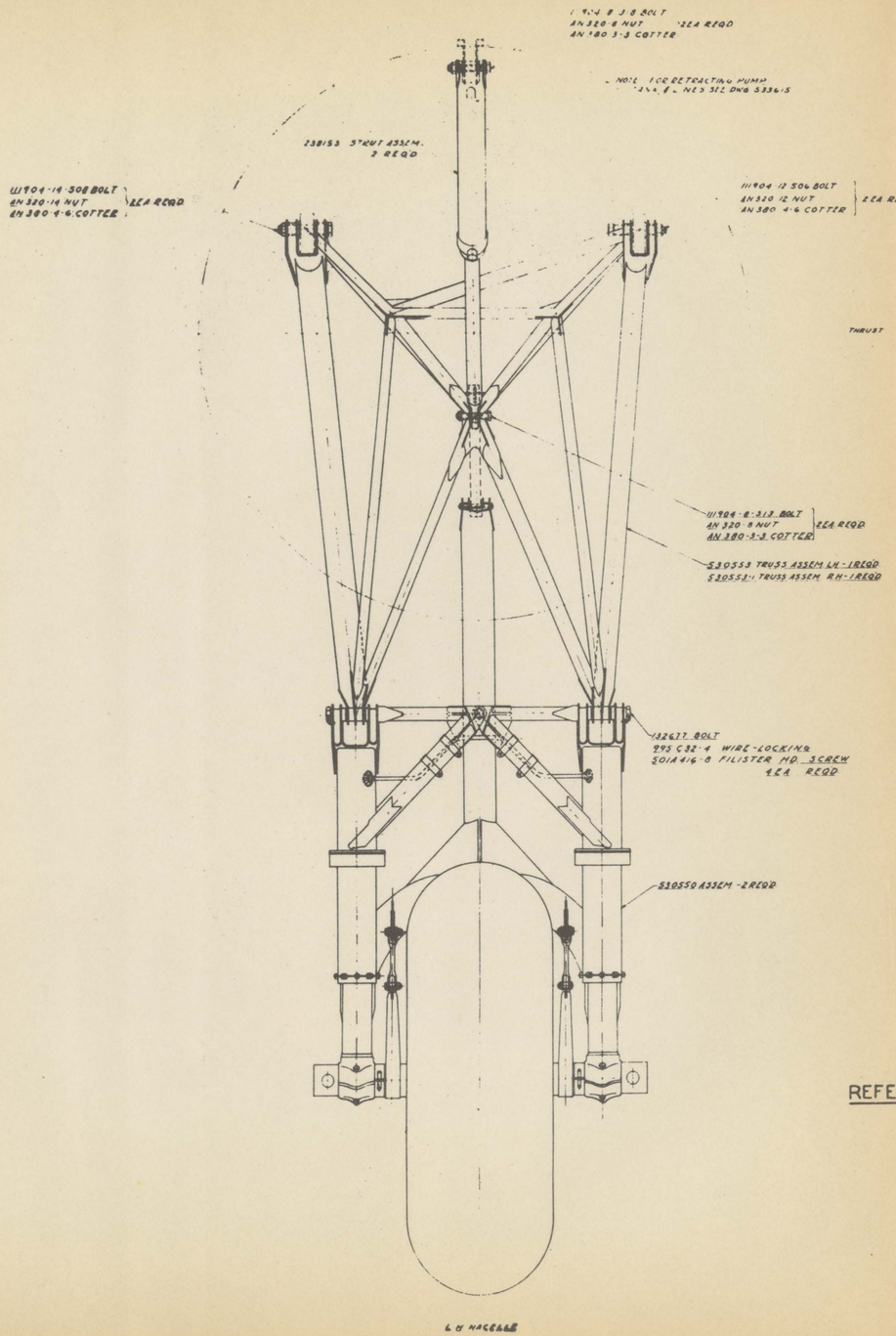
" 5-22-34



REFER TO DOUGLAS D'W'G. NO. 530549

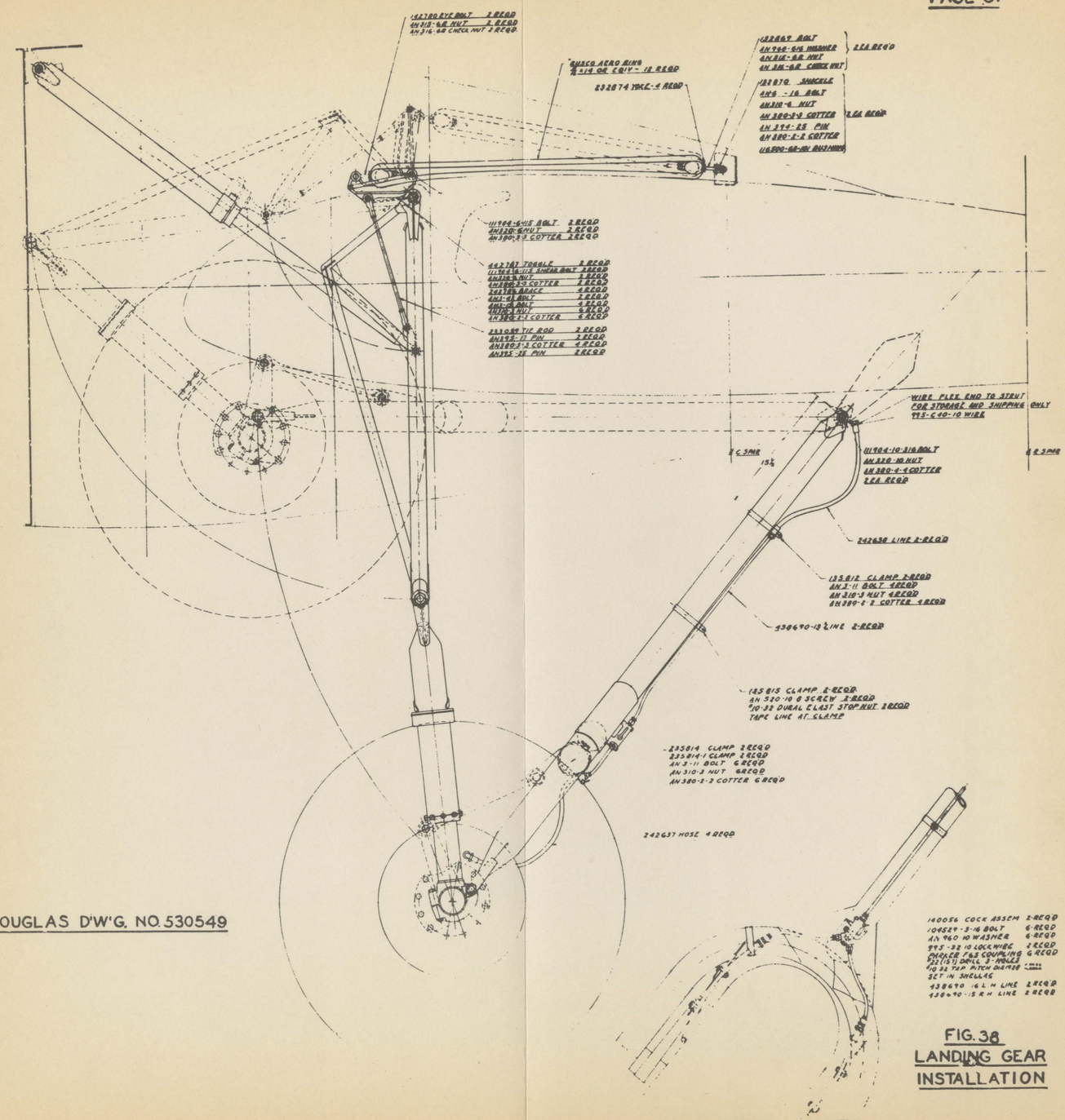


FIG. 38
LANDING GEAR INSTALLATION

4. Shock Absorbers: (See Figure 39, Page 83.) The shock absorbing units are Bendix Pneudraulic shock struts. There are two struts for each wheel. This strut is of the telescoping type employing a combined pneumatic and hydraulic strut including a rebound snubbing device. The pneumatic chamber is above and the hydraulic chamber is below. Impact loads are absorbed by the flow of oil through an orifice, which varies at different points in the stroke, and by the compression of the air above the oil as the oil level rises. Taxiing loads are absorbed largely by the compression of the air as the velocity of the oil through the orifice is not sufficiently great to absorb much energy. Rebounds are reduced by a snubbing device so set that the natural period of rebound of the tire may be almost instantly damped out by another period of the strut controlled by the snubber.

(a) Operation of Pneudraulic Shock Strut:

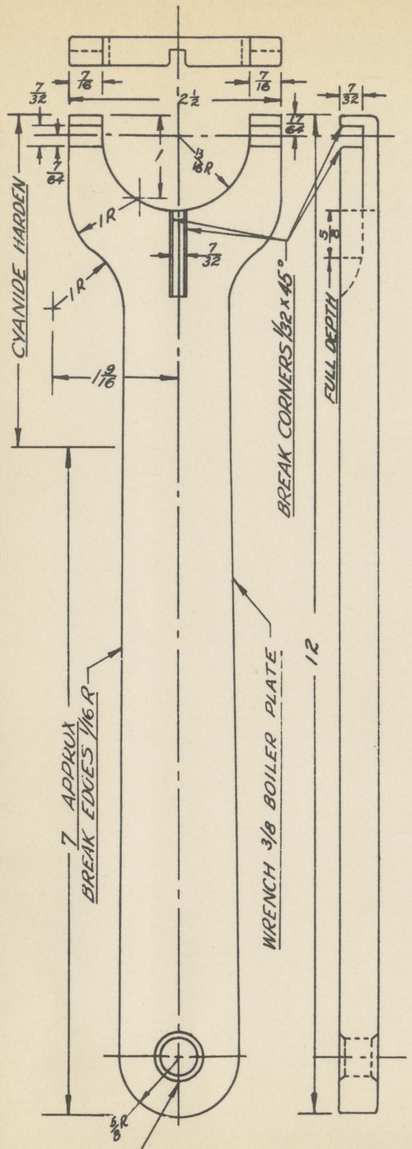
After takeoff, the strut is completely extended by the air pressure in the strut which is sufficient to seal the packing against leakage. Upon landing, the oil is forced through the orifice by the downward movement of the piston into the upper chamber, compressing the air above the oil but passing freely through the flap valve on the top of the snubber tube mounted above the orifice. As soon as the stroke is completed, the compressed air tends to force the oil back, which closes the flap valve and allows the oil to be metered slowly out through the small holes at the bottom of the tube, thereby controlling rebound. The size of these holes may be varied to suit the rebound characteristics desired.

(b) Filling of Cylinder:

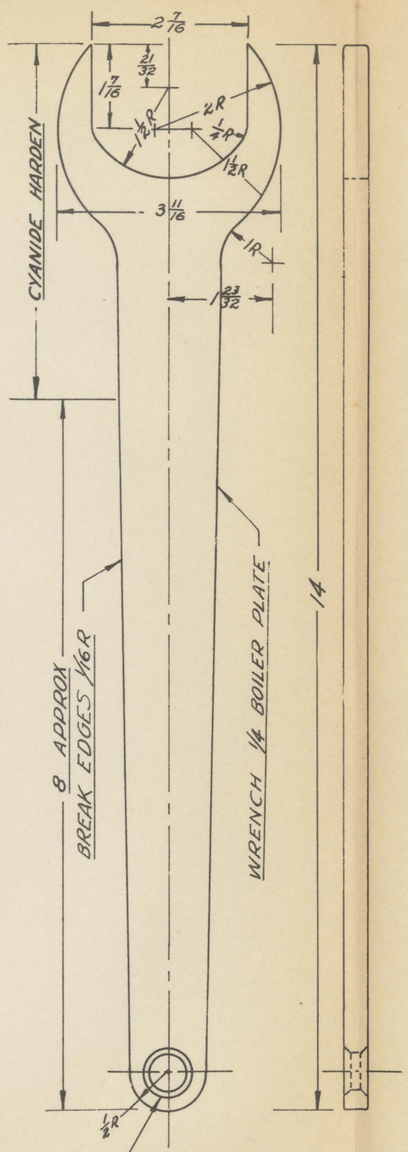
(1) The fluid used in this strut is Lockheed hydraulic fluid #5. (CAUTION: Do not use a mineral oil in this strut as it will cause the packing to seize.)

(2) The strut is filled through the filler plug when the strut is fully compressed and the airplane is in three point landing position. Fill the strut until the fluid comes to the level of the filler plug. A variation of the fluid level to not more than 1/2 inch

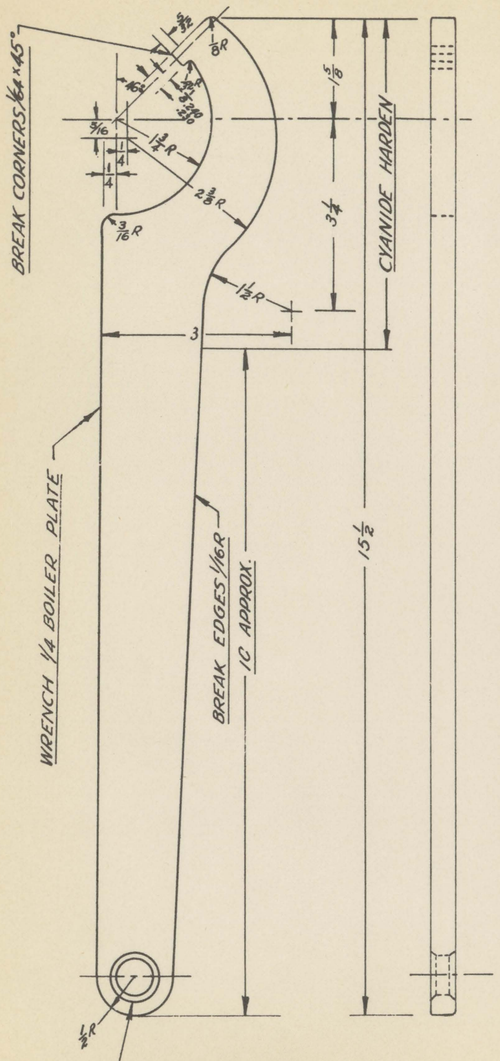
FIG. 38a SPECIAL TOOLS



DRILL 3/8 C'S'K 90° x 1/2 DIA
RETRACTING STRUT CYLINDER
PACKING NUT WRENCH
REFER TO DOUGLAS DRAWING #269844

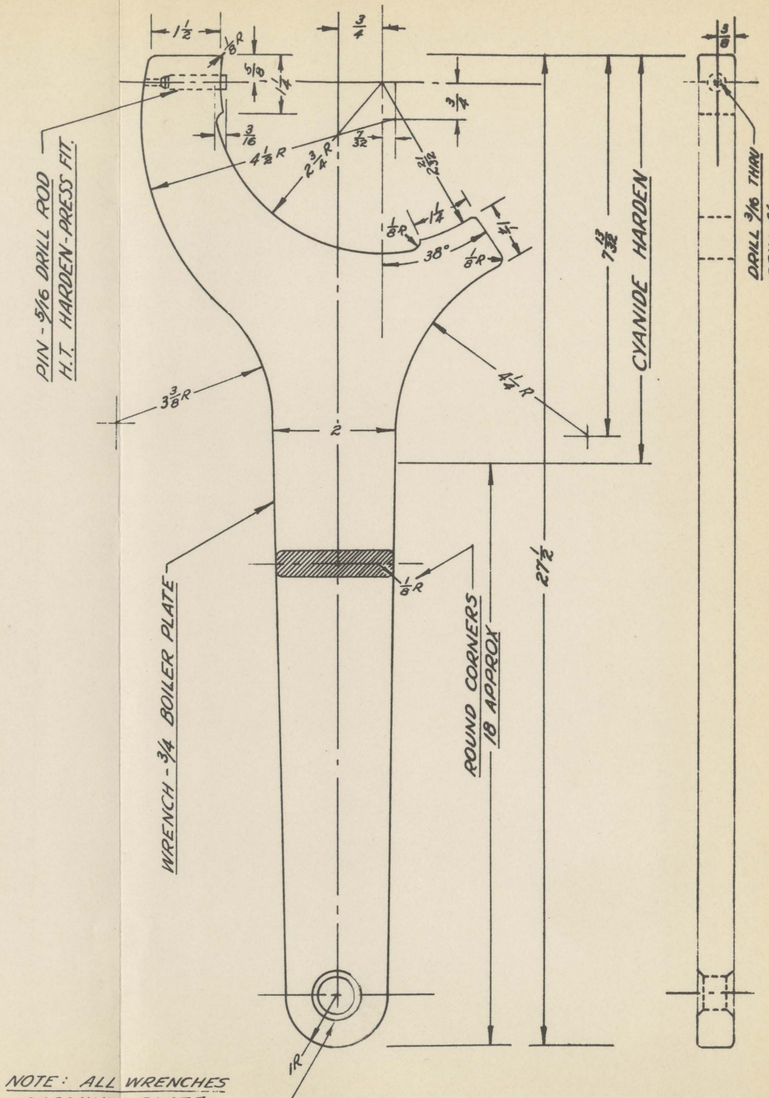


DRILL 3/8 C'S'K 90° x 1/2 DIA.
WING FLAP OPERATING PISTON
NUT WRENCH
REFER TO DOUGLAS DRAWING #269845



DRILL 3/8 C'S'K 90° x 1/2 DIA.
RETRACTING STRUT CYLINDER
PACKING HOUSING LOCK NUT WRENCH
REFER TO DOUGLAS DRAWING #269842

NOTE: ALL WRENCHES
CADMIUM PLATE
DOUGLAS F-21



DRILL 3/8 C'S'K 90° x 1/2 DIA.
SHOCK ABSORBER UNION WRENCH
REFER TO DOUGLAS DRAWING #269843

A.S. ROMERO

BENDIX PART NO. R-107-522D
REFER TO DOUGLAS DWGS. NO.
530549 & 530550

THE FLUID USED IN THIS STRUT IS A MIXTURE OF 3 PARTS CASTOR OIL AND 1 PART HIGH BOILING POINT ALCOHOL (LOCKHEED HYDRAULIC BRAKE FLUID NO. 5 MAY BE USED)

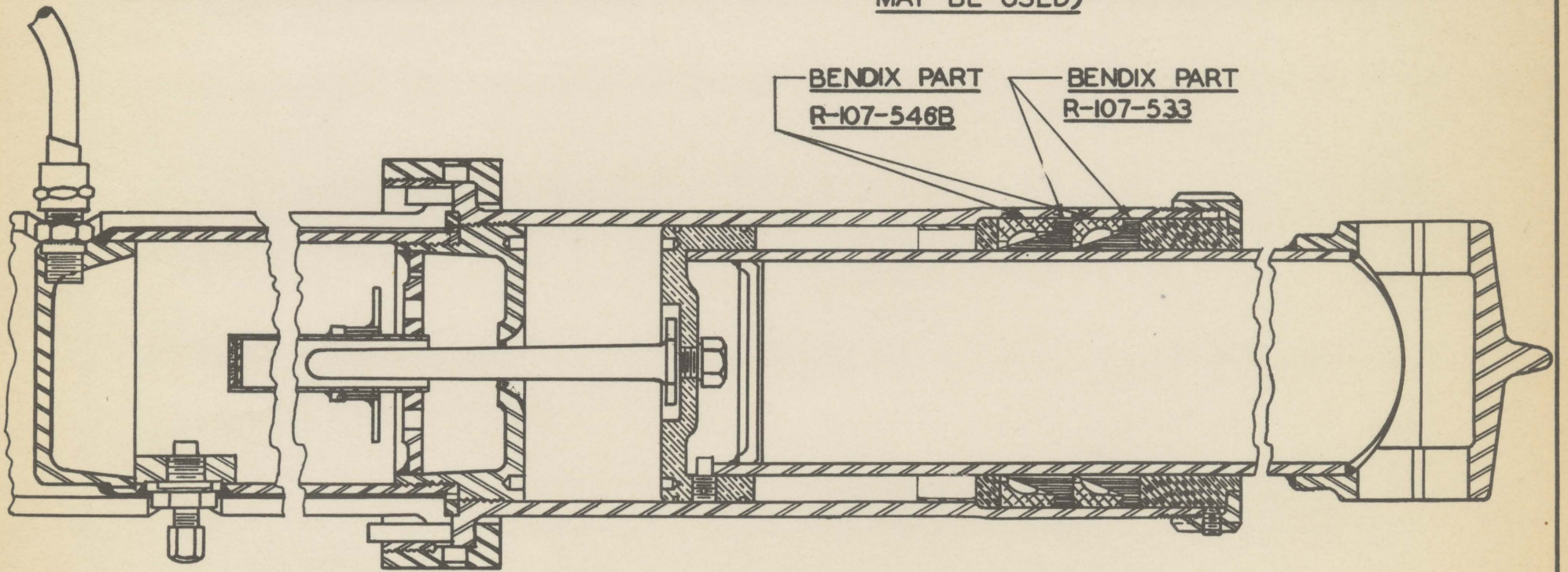


FIG. 39

LANDING GEAR PNEUDRAULIC SHOCK STRUT

below the filler plug level will not materially affect the operating characteristics of the strut. Be positive that the filler plug is tightened sufficiently to insure an airtight connection under high pressure.

(c) Inflation of Strut

(1) Air pressure of approximately 675 pounds per square inch is required to inflate the strut under full load. This pressure may be obtained with the aid of the Bendix Booster Pump (Instructions on the operation of the Booster pump will be found on Page 85) attached to a pressure line of 80 to 120 pounds per square inch. In case the pressure cannot be boosted to approximately 1000 pounds per square inch, inspect all pump valves and connections in the lines for leaks.

(2) Air should be added until the distance from the center of the axle to the underside of the clamping nut is 16 5/8 inches when the airplane is under full load. For the first inflation, the distances should be approximately 1/4 inch greater as some take-up will be caused by absorption of the air by the fluid. A variation of 1/4 inch either way for final reading may be tolerated. All adjustments should be made with the airplane in quiet air and with the tail wheel and landing gear wheels resting on the same level horizontal plane. Re-adjustments should not be made for minor variations, such as change of load, wind conditions, packing friction, etc. Checking of adjustments should be done only after placing airplane in proper loaded position. Do not over-inflate as hard taxiing and bouncing will result.

(d) Air Valve:

(1) The air valve is a special Schrader rubber type developed for this purpose. It is similar to that of an automobile tire. The hex cap provided with this valve has a soft metal seat to furnish a secondary seal. It should be screwed down tightly. Valve cores are replaceable.

(2) The valve core and seat around the filler plug should be tested for leaks by putting a little oil in these places. Leaks will show their presence by formation of air bubbles. CAUTION: Do not use a mineral oil as gumming may result if the oil reaches the packing rings.

(e) Booster Air Pump:

(1) The Bendix Booster Air Pump is a hand operated pump of small bore and long stroke, which is designed to boost moderately high air pressure to approximately ten to twelve times the intake pressure. The intake pressure is obtained by attaching the air chuck of an ordinary high pressure line; or, if this service is not available, any reasonably good tire pump can be used as an emergency source of supply by attaching a hose to the intake side of the booster air pump.

(2) Operation of Booster Pump:

a. While attaching air line, hold pump handle up to avoid having piston forced upward.

b. Do not tighten thumb screw on air chuck of intake line more than is necessary to admit the air without leakage.

c. Be sure that all other connections are tight, as any leakage will result in a loss of pressure

d. Care should be taken to drain any water in the air line before attaching to the pump.

e. Operate pump through full stroke.

5. Brace Strut and Upper Truss: The rear brace strut is a welded fork of heat treated chrome molybdenum steel tubing. The upper truss is made of normalized chrome molybdenum steel tubing, with the exception of the two main tubes which are heat treated chrome molybdenum steel tubing. With the wheels extended, they serve as compression members and with the wheels retracted, are subject to bending.

6. Bungee: The weight of and the air drag load on the landing gear are balanced by a bungee consisting of eight loops of 11/16 inch x 14 inch elastic shock cord, "Rusco" Aero Ring (or equivalent), which has been tested to 1100 lbs. per square inch with an allowance of plus or minus 100 pounds at 100 per cent elongation. This bungee is attached to a fitting connected to the upper truss by a 5/16 inch diameter heat treated nickel steel rod, and to a fitting in the rear section of the nacelle. This practice serves to reduce to a minimum the oil pressure necessary to operate the retracting mechanism. To facilitate removal of the bungee shock cords for replacement or for disassembly of the landing gear, a special spreader bar, as shown in Figure 39a, Page 87a, is necessary. The tool holds the loop of shock cord extended and relieves the attaching fittings of the tension load.

7. To Remove Bungee Shock Cords:

(a) Enter nacelle and place spreader bar between yokes of bungee.

(b) Place landing gear control valve in "up" position and raise landing gear until tension of shock cords is relieved from landing gear and nacelle attachment points and transferred to spreader bar. Lock landing gear in "up" position, or preferably, provide a support, such as a jack, under landing gear axle.

(c) Detach fittings from landing gear and nacelle, and take fittings, shock cord and spreader bar out as a unit.

(d) By means of a chain fall, or other available equipment, stretch shock cords far enough to free spreader bar. Approximately 7,000 pounds pull is necessary.

(e) Remove spreader bar.

(f) Relieve shock cords of tension so that they may be easily removed from fittings.

8. Retracting Strut: The retracting strut consists of two tubes of normalized chrome molybdenum steel which telescope together. The upper end is attached to the nacelle structure and the lower end to the landing gear upper truss. Oil pressure from the retracting pump causes this strut to extend or retract according to the setting of the control valve. At the lower end of the retracting strut there is a screw fitting provided to adjust the extended length. This fitting should be screwed in or out until the strut, when installed, holds the rear tubes of the upper truss parallel with the front face of the wing spar.

9. Safety Latch: A spring loaded safety latch is installed on the rear wall of the nacelle. The latch operates with the retracting strut in that it moves into place when the wheels are extended, thereby locking them in the safe landing position. The spring in the latch cylinder handles this action. When the gear is retracted, the hydraulic fluid goes into the bottom of the latch, exerting pressure on the spring and forcing the latch upward, thereby releasing the gear.

10. Retracting Pump: The retracting pump (shown in Fig. 22 Page 52) is located in the pilots' compartment at the left side of the co-pilot's seat. A four-way valve, located to the left of the co-pilot's seat, controls the operation of the mechanism. Refer to Fig. 40 Page 91

11. Retracting Lines: The retracting lines are 1/2 O.D. x .035 normalized chrome molybdenum steel tubing. In order to insure oil tight connections, the ends of the tubes are flared and reamed for Parker fittings. Pipe fittings are tinned to further insure oil tight connections. The hydraulic line from the retracting strut to the tee connection for the latch is made of 5/16 inch copper tubing.

12. Fluid Reservoir: The reservoir for the fluid used in both the retracting and the brake systems is located on the front bulkhead of the cargo compartment and is fitted with a filler neck which extends to the passageway for servicing. With the gear down,

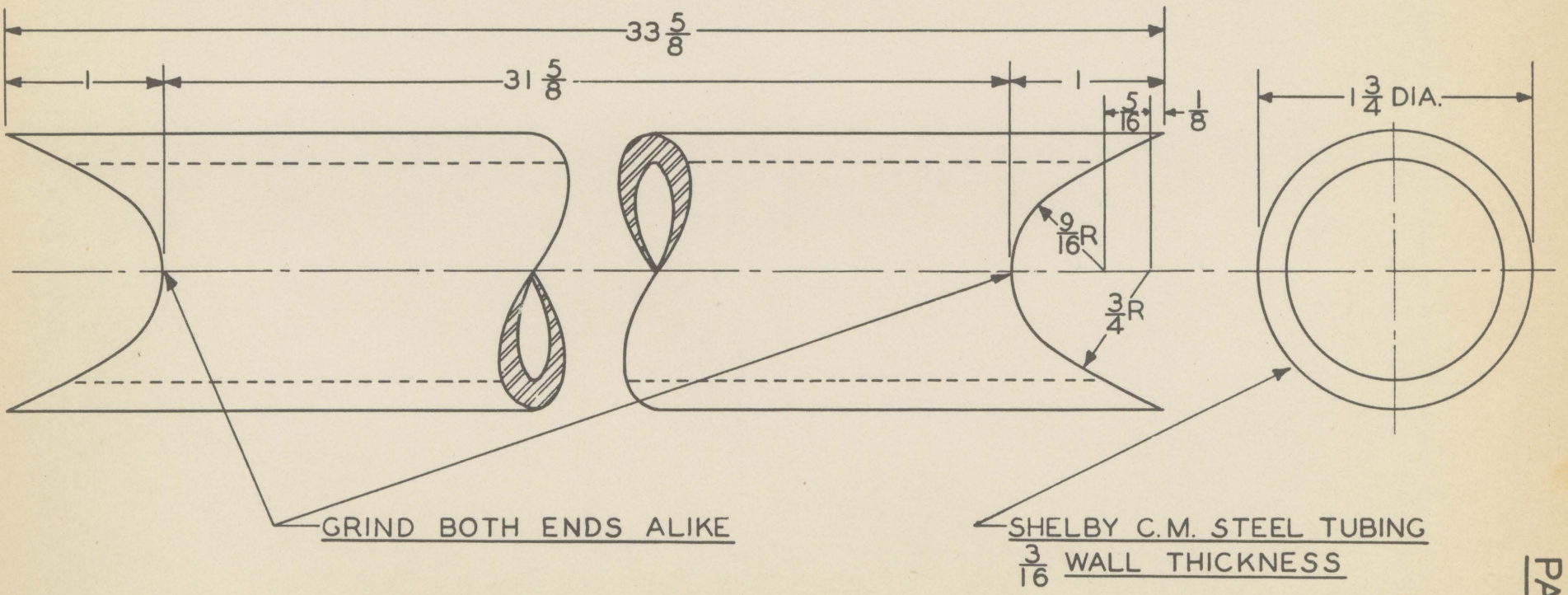


FIG. 39a SPREADER BAR—LANDING GEAR BUNGEE

fill to the petcock level with Lockheed fluid #5. CAUTION: Under no consideration use a mineral oil in this reservoir as it will render the retracting strut inoperative at once by causing the piston packing to swell and seize within the cylinder. A sight gauge is provided to aid in determining the contents of the reservoir at all times.

13. Shut-off Valves: A hand operated globe valve is provided at the upper end of each retracting strut. If these valves are closed when the gear is fully extended the gear will be held in that position and pressure may be relieved in the rest of the system. This provision is made in order that the lines or the pump may be disconnected for repairs. The globe valves must be safetied in the open position when the gear is to be operated. Whenever these globe valves are used a tag should be attached to the throttles so that the pilot will know before taking off that he cannot retract the landing gear.

B. Indicating System

(Refer to page 131a for adjustment of landing gear warning switches.)

1. WARNING HORN:

A horn located on the bulkhead at the rear of the co-pilot sounds whenever the throttle is closed if one or both sides of the landing gear are retracted, unlatched, or the control valve handle is not in the neutral position. The horn is operated by three two-circuit switches in parallel; one on each landing gear truss and one on the control valve.

2. WARNING LIGHTS:

The retracting pump valve handle in the pilots' cockpit has a two-circuit switch which, when the valve is in the neutral position, operates a green light. The switches on the upper truss of the landing gear are in series with the valve switch and must be closed, by the wheels being in the safe landing position, before the green light will go "on". When the valve is not in the neutral position, a red light will be "on" in the panel to the right of the electrical panels.

3. PRESSURE GAUGE:

The pressure gauge located in the cockpit indicates the presence or absence of fluid pressure acting on the retracting strut when in the extended position. (It records the actual pressure but this is unimportant. See Paragraph 3, Page 90.)

4. Summary of Signal Meanings:

(a) Green light and no horn at closed throttle indicates both wheels in safe landing position and control valve in neutral position.

(b) Red light and horn at closed throttle indicates either one or both of the following are not in correct position: control valve not in neutral position and/or landing gear not in safe landing position.

(c) Red light and no horn (throttle not closed) indicates wheels in retracted position. (Note: Control valve must be in neutral or wheels will extend without indication.) The control valve should always be returned to the neutral position upon completing any landing gear operation.

C. Operation of Retracting Gear:

(Refer to Figure 40, Page 91.)

1. To Retract:

(a) Pull control valve handle up. Red warning light will go "on" as soon as valve leaves neutral position.

(b) Operate pump until gear is retracted. The accumulation of pressure in the line will be felt on the pump handle. After the wheels have come up into place, a hard push or pull on the pump handle will insure that they are fully up against the pillow blocks in the nacelle structure. If this is not done, the wheels may hang slightly out of the nacelle.

(c) Return control valve to neutral position immediately. This will keep wheels fully retracted.

2. To Extend:

(a) Push control valve handle to "down" position. If throttle is closed, horn will sound until wheels are in safe landing position.

(b) Operate pump until gear is fully down. This will be indicated by the building

up of pressure in the system which may be felt on the pump handle and shown on gauge.

(c) Return control valve to neutral position. If wheels are latched in safe landing position, horn will stop sounding, red light will go "off" and green light will go "on".

NOTE: Approximately 15 seconds are required to extend the gear and approximately 25 seconds to retract.

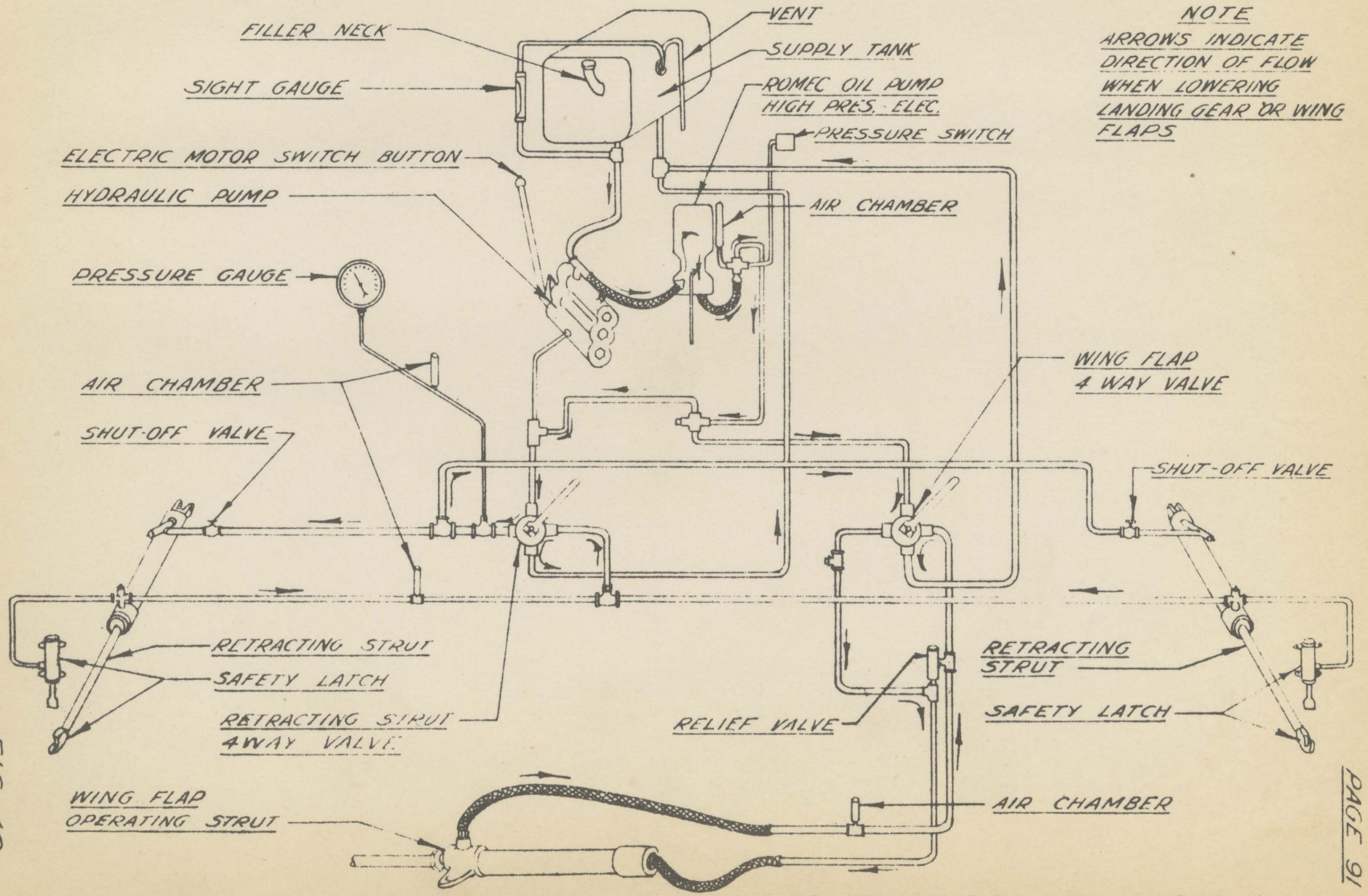
3. To Land Without Latch Engaged:

(a) The airplane may be landed whether the wheel latches are engaged or not provided the gear is fully down with the fluid in the system under pressure. The horn will keep on sounding and the red light will stay "on" as the latch is connected with the horn switch.

(b) The actual amount of pressure on the gauge is immaterial as the only requisites are that the system contain a full column of fluid and that the control valve handle be moved to the neutral position. Solid resistance felt on the pump handle when the gear is fully down indicates that there is sufficient pressure.

4. To Land Without Fluid Pressure:

(a) The airplane may be landed with no pressure maintained in the system provided the latches are engaged. This will be indicated by the green light.



NOTE
ARROWS INDICATE DIRECTION OF FLOW WHEN LOWERING LANDING GEAR OR WING FLAPS

FIG. 40

PAGE 91

LANDING GEAR & WING FLAP HYDRAULIC SYSTEMS

REFER TO DOUGLAS DWGS. # 540059 & 538615

D. Replacement of Pneudraulic Strut Packing:

(Refer to Figure 39, Page 83.)

1. To remove shock strut:

(a) Jack up airplane and support it on wing jacks.

(b) Remove bolts from upper and lower connecting points of strut.

(c) Lift entire Pneudraulic strut out.

2. To disassemble Pneudraulic strut for repacking:

(a) Loosen filler plug and drain out fluid by compressing strut manually.

(b) Loosen set screw in lower outside cylinder locking nut.

(c) Unscrew locking nut.

(d) Pull lower chamber out, pulling packing, spacers and bushings. (Carefully note arrangement to facilitate reassembly.)

(e) Replace old packing with Bendix Part No. R-107-546B. This packing is an automatic adjusting type and should be tightened down only enough to keep it from moving in the packing box.

E. Replacement of Packing in Retracting Strut:

(See Figure 41, Page 92a.)

1. Support airplane on tripods.

2. Disconnect and plug both fluid lines.

3. CAUTION: Because of the tension in the bungee, it is important that a cable support be lashed between the rear brace strut and upper truss before removing the retracting strut.

4. Remove attaching bolts from top and bottom of strut and take strut out.

Revised 5-3-34

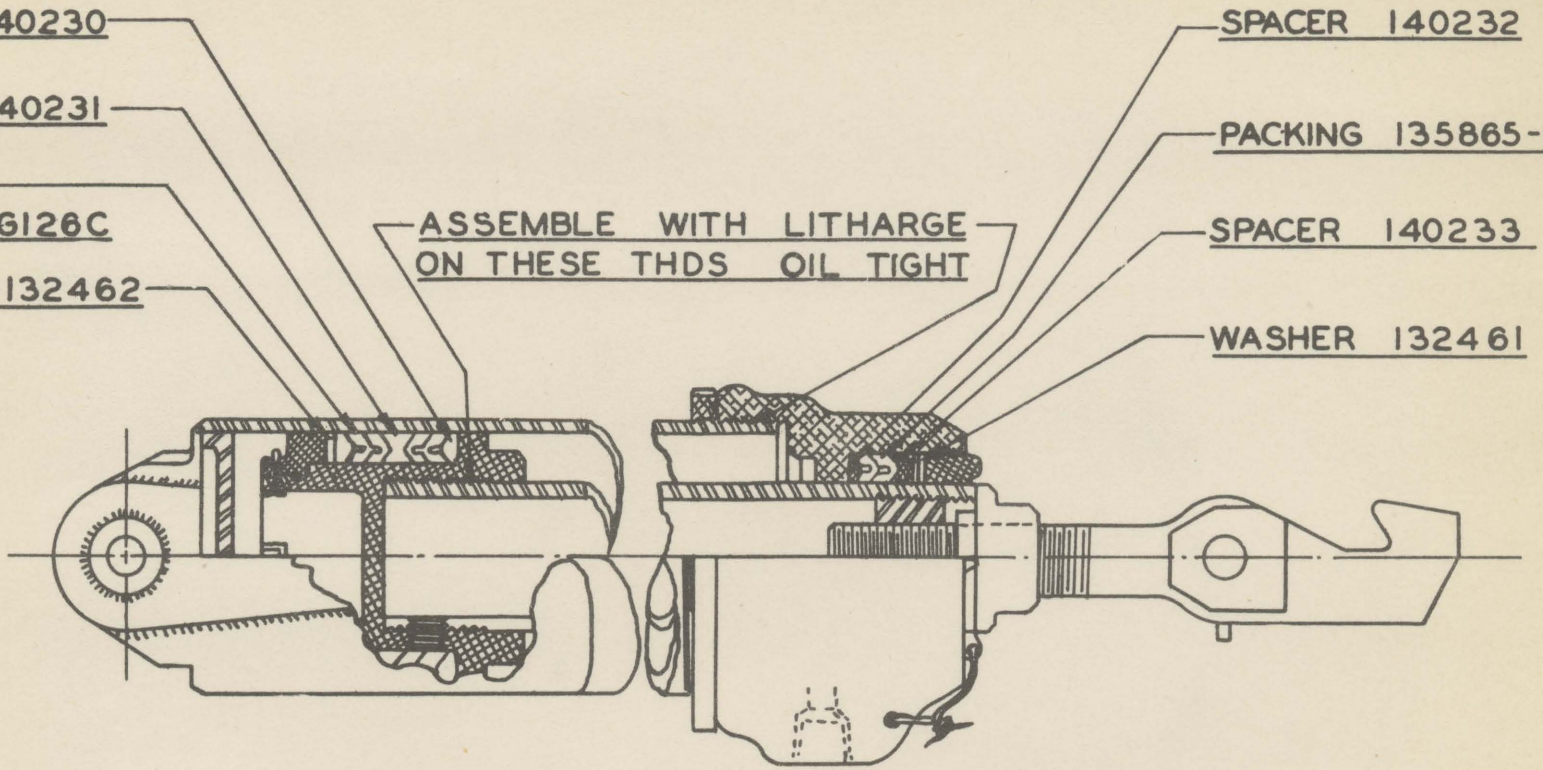


FIG. 41

REFER TO DOUGLAS DRWG. 238153

RETRACTING STRUT

5. Piston:

(a) Unscrew packing flange. (The threads on this are set in litharge.)

(b) Pull out piston.

(c) Remove cotter pin and unscrew nut.

(d) Remove old packing and replace with packing ring, Douglas Part #135865-6G126C (4 required per strut).

6. Cylinder:

(a) Remove nut.

(b) Remove old packing and replace with Douglas Part #135865-6G116C (2 required per strut).

7. Packing should be tightened so as to hold fluid but be free enough to slide.

F. Replacement of Packing in Pump

1. Refer to Paragraph H, Page 53.

G. Bleeding of Hydraulic System

1. With the exception of the brake system, all the hydraulic lines are self bleeding.

H. Removal of Wheel

(Refer to Figures 42 and 43, Pages 95 and 96.)

1. Jack up wheel until it clears ground, using jack pads provided on rear brace strut. If possible, use wing jacks while wheel is off.

2. Close valve in hydarulic brake lines at chassis fork. NOTE: When closing this valve, first loosen jam nut on side of valve as this nut, when screwed up, tends to lock valve control handle to prevent leakage. Then turn valve handle slowly.

3. Disconnect and plug brake fluid lines at their first union connection above the brake. (This union is held to the wheel fork by a clip.)

4. Disconnect both brake torque rods from their respective torque arms and swing them upward and out of way.

5. Loosen bolt in axle clamp at lower end of both right and left hand Pneudraulic struts.

6. Remove keys from slots. Check arrangement to facilitate reassembly.

7. Pull entire wheel assembly forward and out.

NOTE: Do not reconnect brake lines until after wheel has been completely reinstalled, then open bleeder plug on "Y" valve and at same time open valve SLOWLY as this will allow air bubbles in lines below valve to rise and escape. Continue bleeding until fluid runs clear and free from air. When bleeding process is complete, tighten jam nut (mentioned in Paragraph H-2, Page 93) to prevent valve from leaking.

I. Adjustment of Bearings

1. Slip axle into wheel until integral bearing comes into place.

2. Slip other bearing and ring onto axle with male tit of ring in keyway.

3. Screw on nut until bearings hold wheel firm and snug but not tight. (NOTE: Insert three or four machine screws into holes provided in nut. This will aid in screwing nut up.)

4. Check to see if brake drums and linings are lined up properly. If they are not, it will be necessary to add spacers outside the integral bearing until brake drums and linings are in their proper position.

5. After wheel is properly set up, tighten the screws around the nut until they are snug, as these screws prevent the nut from turning.

6. Safety screws with wire.

J. Lubrication

(The Landing Gear Lubrication Chart is shown in Figure 44, Page 97.)

1. Zerk fittings are provided at the following points:

(a) At both ends of the retracting strut.

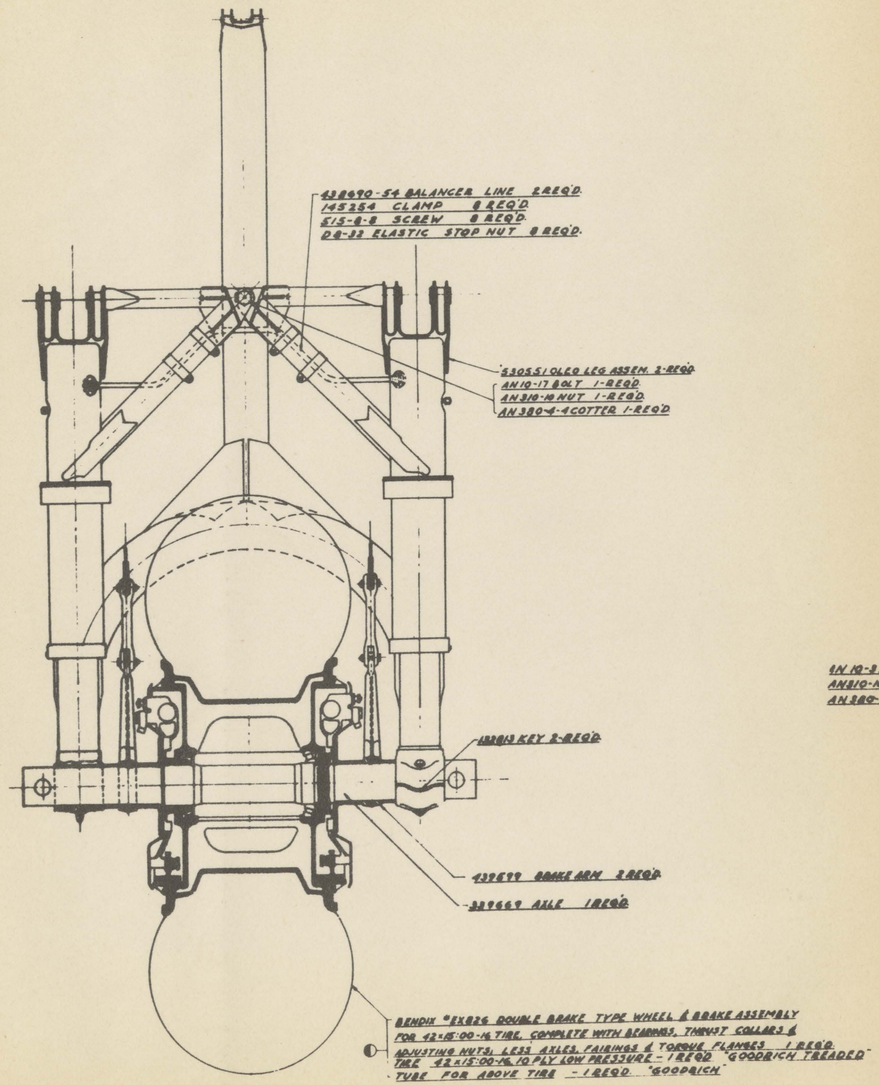
(b) Upper and lower ends of upper truss.

(c) Both forks and upper end of rear brace strut.

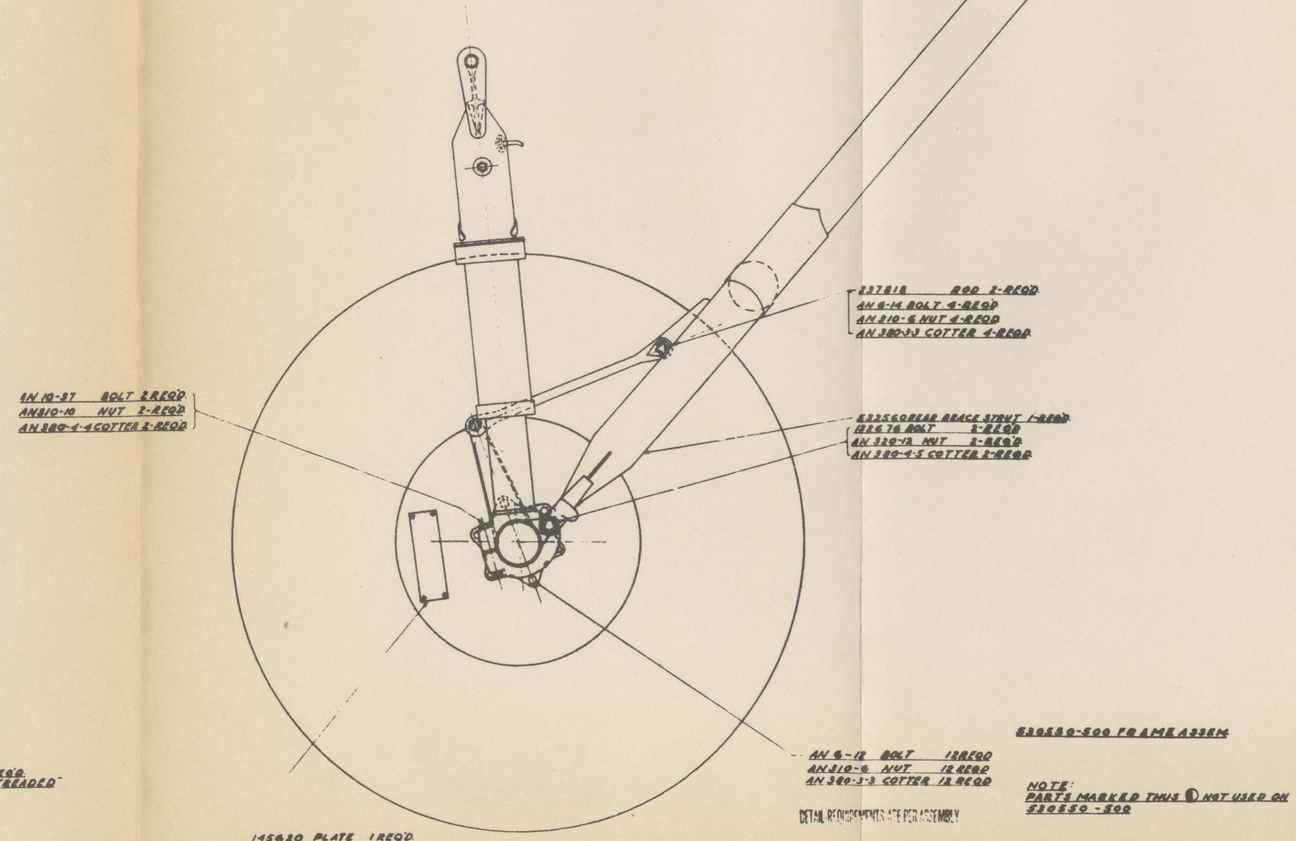
(d) At each end of the forward bungee fitting.

2. Wheel bearings are packed with Standard "BRB" grease.

Revised 5-31-34



REFER TO DOUGLAS D'W'G. NO. 530550



530550-500 FRAME ASSEM.

DETAIL REQUIREMENTS AS PER ASSEMBLY

NOTE:
PARTS MARKED THUS ◐ NOT USED ON 530550-500

FIG. 42 LANDING GEAR ASSEMBLY

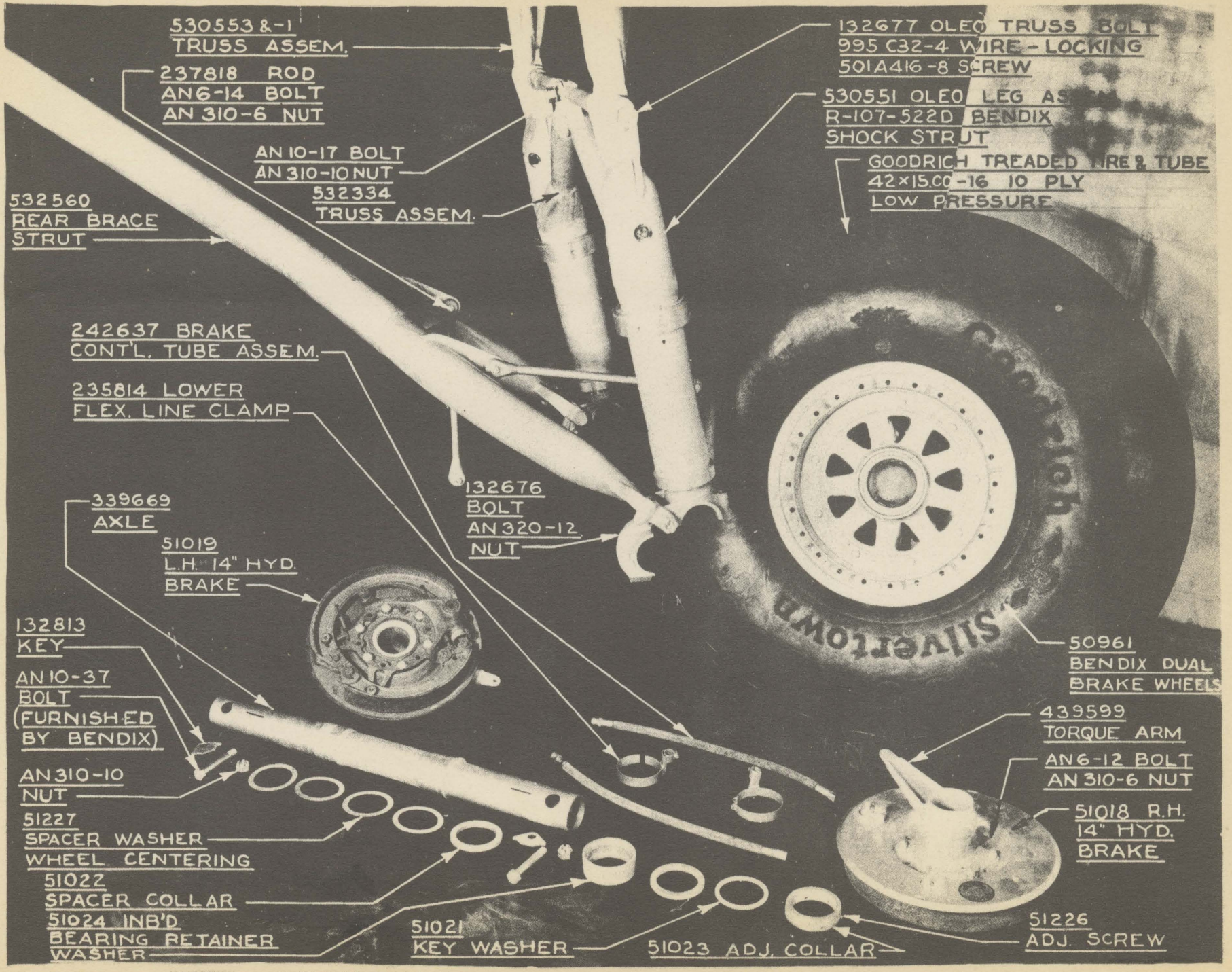
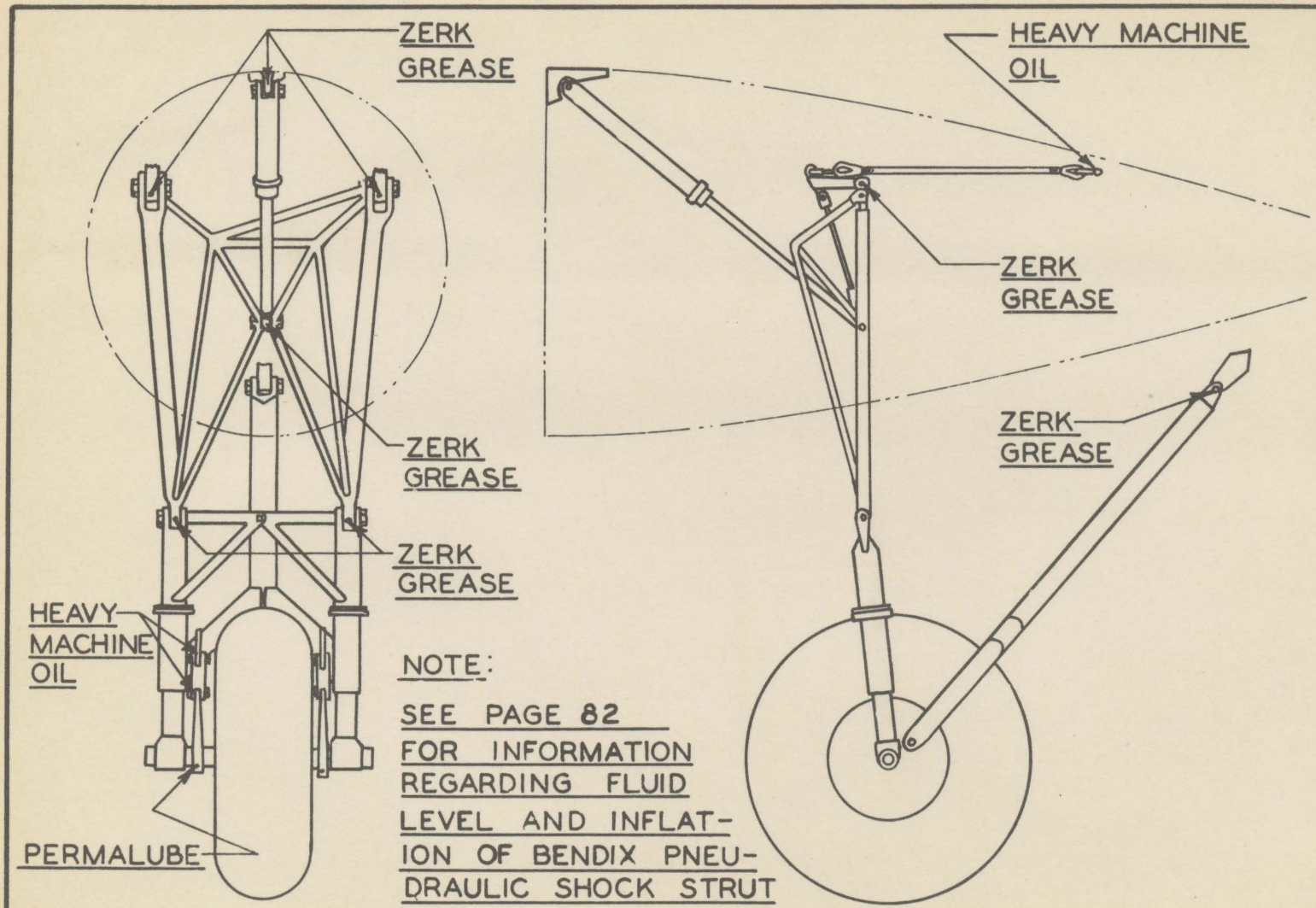


FIG. 43 WHEEL AND AXLE READY FOR ASSEMBLY AND INSTALLATION



REFER TO DOUGLAS DRAWING #530549

FIG. 44 LUBRICATION LANDING GEAR

SECTION XI

BRAKE SYSTEM

A. General Description

(The brake system is shown diagrammatically in Figure 45, Page 99.)

1. The brakes are Bendix Hydraulic size 12 x 2 1/2 inch. There are two brakes to each wheel, one being mounted on each side of the wheel. The fluid used in the brake system is the same as that used in the shock absorbers and retracting mechanism; namely, Lockheed fluid #5. The brakes are operated by two brake handles and the rudder pedals. The two brake handles extend rearward through the instrument panel, one in front of each pilot. Pulling either handle applies pressure to the system. This pressure may then be differentiated between the wheels as desired by pushing on the appropriate rudder pedal. The left or pilot's brake handle may be set in any position by turning the handle to the left or right, thus providing a parking brake. A fluid supply tank located on the bulkhead at the rear of the co-pilot's seat, furnishes the fluid for the hydraulic system. The fluid passes from the supply tank to the master cylinder and then to the differentiating cylinder. From this cylinder, the fluid passes to a tee connection fitted with a cock valve and located at the fork of each landing gear chassis. At this point the hydraulic lines divide, with one line going to each side of the wheel. The fluid of the hydraulic system is carried in 3/8 inch 4S0 aluminum tubing. The hydraulic lines, adjacent to the brakes, are 21/32 inch O.D. Wagner Electric Company flexible rubber hose.

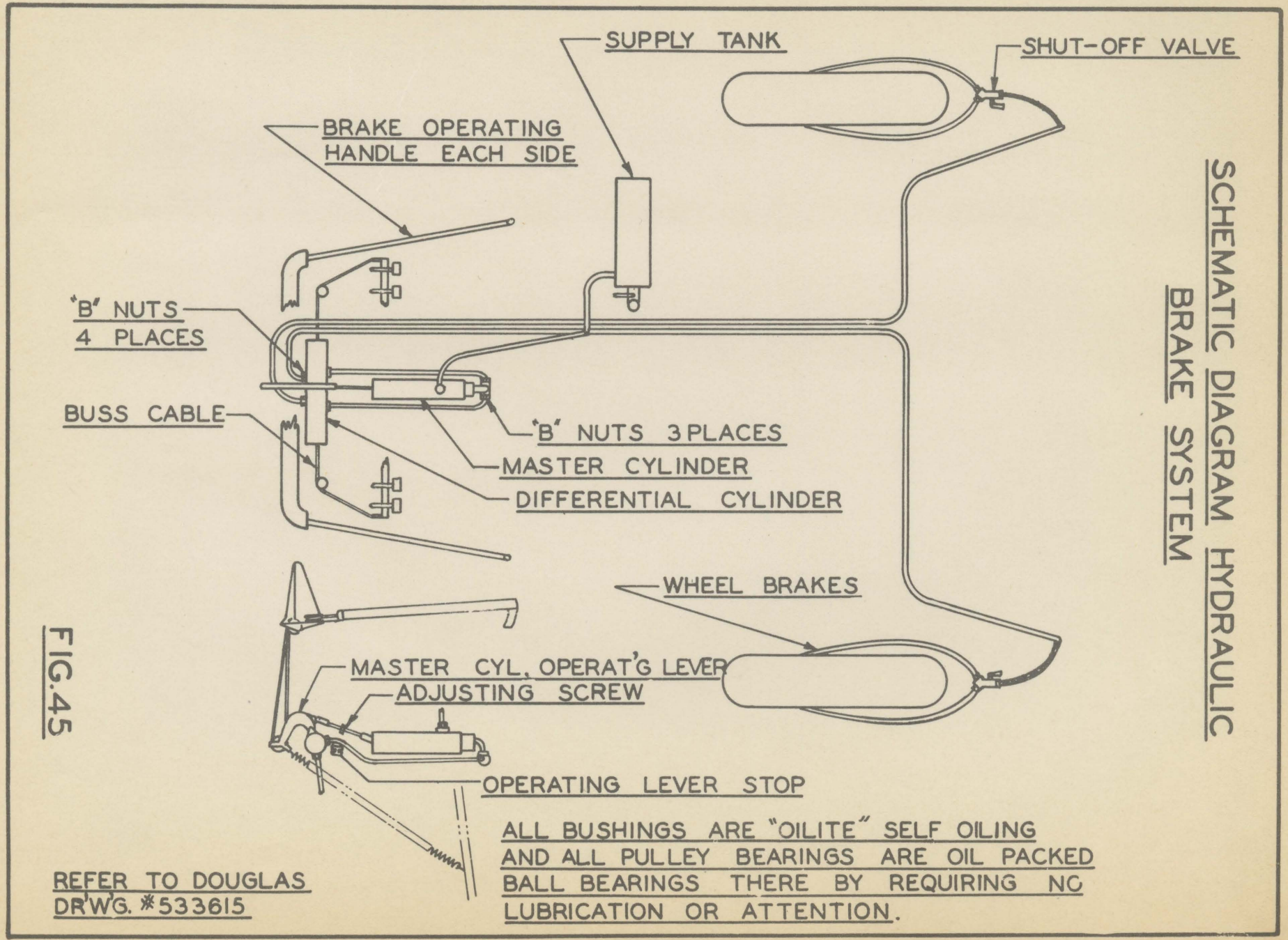
B. Master Cylinder

(The master cylinder is shown in Figure 46, Page 100.)

1. Description

(a) The master cylinder is so designed that it automatically maintains a constant volume of fluid in the system, thus compensating for any expansion or contraction of the fluid due to temperature changes, or replenishing any loss resulting from slight leaks. Fluid is furnished to the master cylinder by the supply tank mounted on the wall of the cargo compartment.

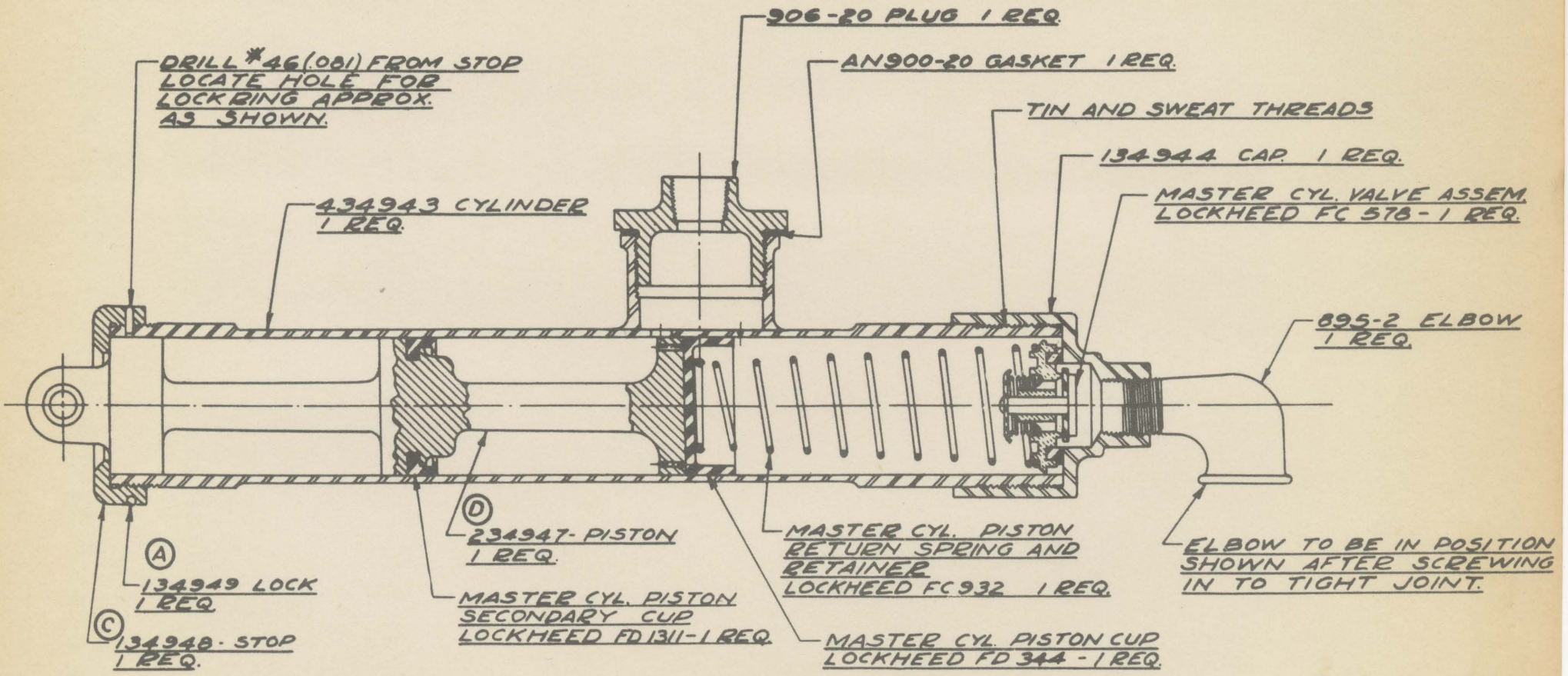
(b) A small port hole through the wall of the cylinder into the inlet chamber on the top of the cylinder is located so as to be directly forward of the master piston cup when



SCHEMATIC DIAGRAM HYDRAULIC BRAKE SYSTEM

FIG. 45

PAGE 99



REFER TO DOUGLAS D'WG. 234942

DETAIL-REQUIREMENTS ARE PER ASSEMBLY

FIG. 46 BRAKE SYSTEM MASTER CYLINDER

the piston is in the "off" or released position. The first 1/16 inch of forward travel closes the port.

(c) When a rise of temperature causes the fluid in the brake system to expand, the excess finds its way through the port hole into the supply tank. When a drop in temperature causes the fluid to contract, the loss is replenished from the supply tank through this port. Thus a constant volume of fluid is maintained in the system.

(d) From the foregoing discussion, it is apparent that the compensating feature will be lost unless the piston always moves back against the stop, so that the master cup is at all times back or clear of the port with the piston in "brake off" position.

(e) A combination inlet and outlet check valve in the head of the master cylinder is held in place by a piston return spring. When the operating handle is pulled, the master cylinder piston is pushed aft and the outlet check valve (small center valve) is opened by the fluid as it is being forced into the system. When the operating handle is released, the master piston return spring forces the piston back to the "off" position against the stop.

(f) Simultaneously, the wheel cylinder pistons are returned by the brake shoe return springs, forcing the fluid back through the inlet (large outer) check valve until the fluid pressure balances the weight of the master piston return spring, at which point the inlet valve is allowed to close.

(g) Should the volume of fluid thus returned be insufficient to equal the displacement caused by the return of the master piston, a partial vacuum is created in the master cylinder forward of the master cylinder cup. This vacuum causes the master piston cup to turn in at the lip, and because the area, at the rear of the master cup and forward of the secondary cup, is filled with fluid under slight pressure from the supply tank, sufficient fluid is allowed to by-pass into the master cylinder by way of a series of small holes through the piston. Any excess fluid introduced into the

system by this means will pass freely back into the supply tank through the port hole when the complete system has returned to its "brake off" position.

2. To Remove Master Cylinder:

(See Figure 45, Page 99)

(a) Disconnect operating lever adjustment screw clevis from piston; break inlet and outlet lines at "B" nuts (3 places); and remove cylinder attaching screws (4 places).

3. To Remove Piston:

(See Figure 46, Page 100)

(a) Remove cylinder from airplane (See 2 (a) above).

(b) Remove lock ring, "A", and stop, "C".

(c) Piston, "D", may now be removed.

(d) Piston cup, spring and valve assembly may be removed with light charge of air through end fitting.

(e) Replacements for following parts are:

Secondary Cup on Piston	Lockheed F.D. 1311
Piston Cup	Lockheed F.D. 344
Piston Return and Valve Retaining Spring	Lockheed F.C. 932
Valve Assembly	Lockheed F.C. 578

4. To Adjust Master Cylinder Operating Lever:

(See Figure 45, Page 99)

(a) The function of the master cylinder adjustment screw is to compensate for varying fluid requirements caused by brake lining wear and other variables.

(b) Adjustment should always be made so that with the brakes "full on", the master cylinder operating lever will have 1/4 inch to 5/16 inch clearance from the lever stop. This will allow for slight lining wear before further adjustment is necessary. The lever should always stop against the fluid rather than against the lever stop to allow for excessive braking requirements in an emergency. The most effective braking is with the operating lever working

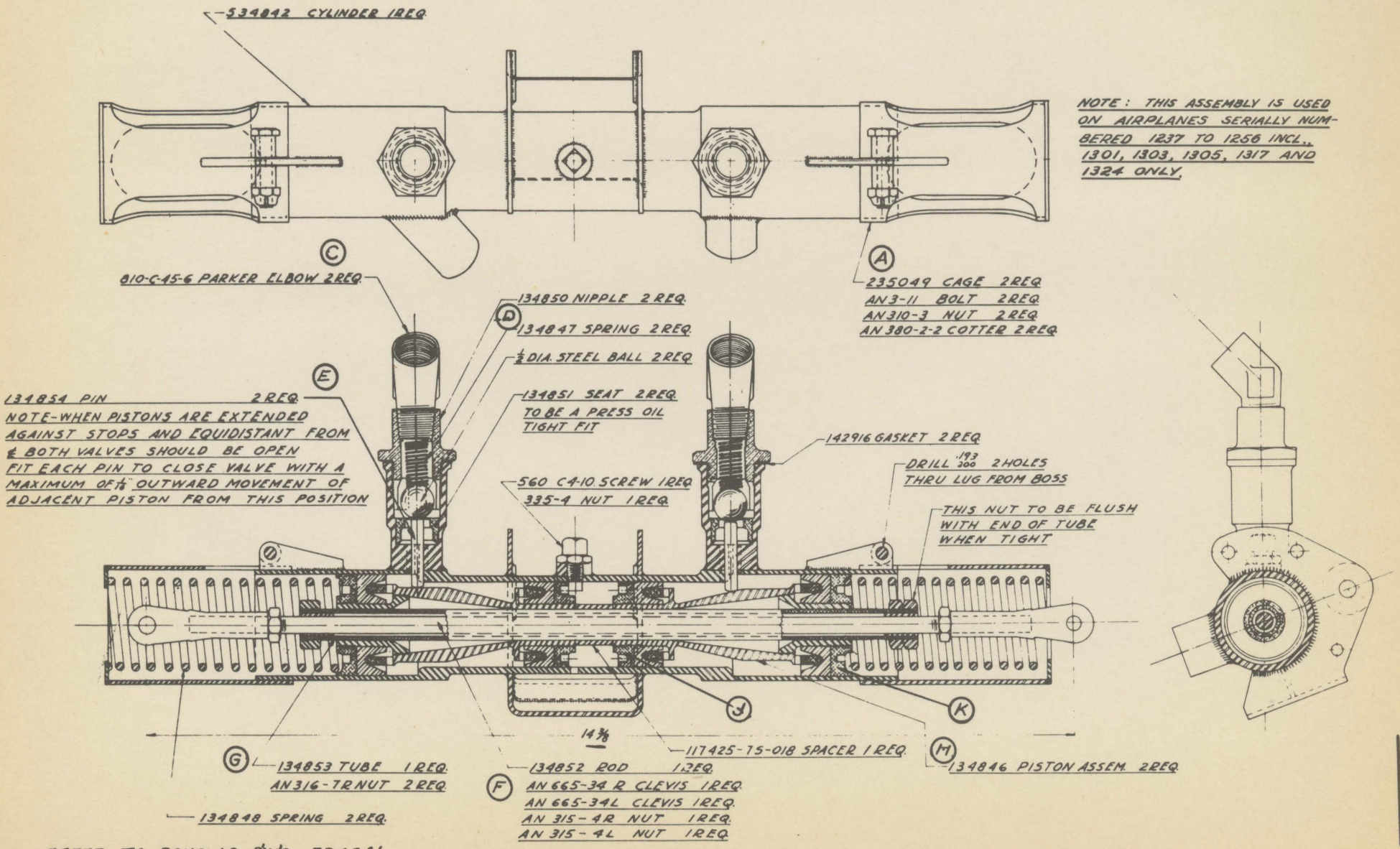


FIG. 47 BRAKE SYSTEM DIFFERENTIATING CYLINDER

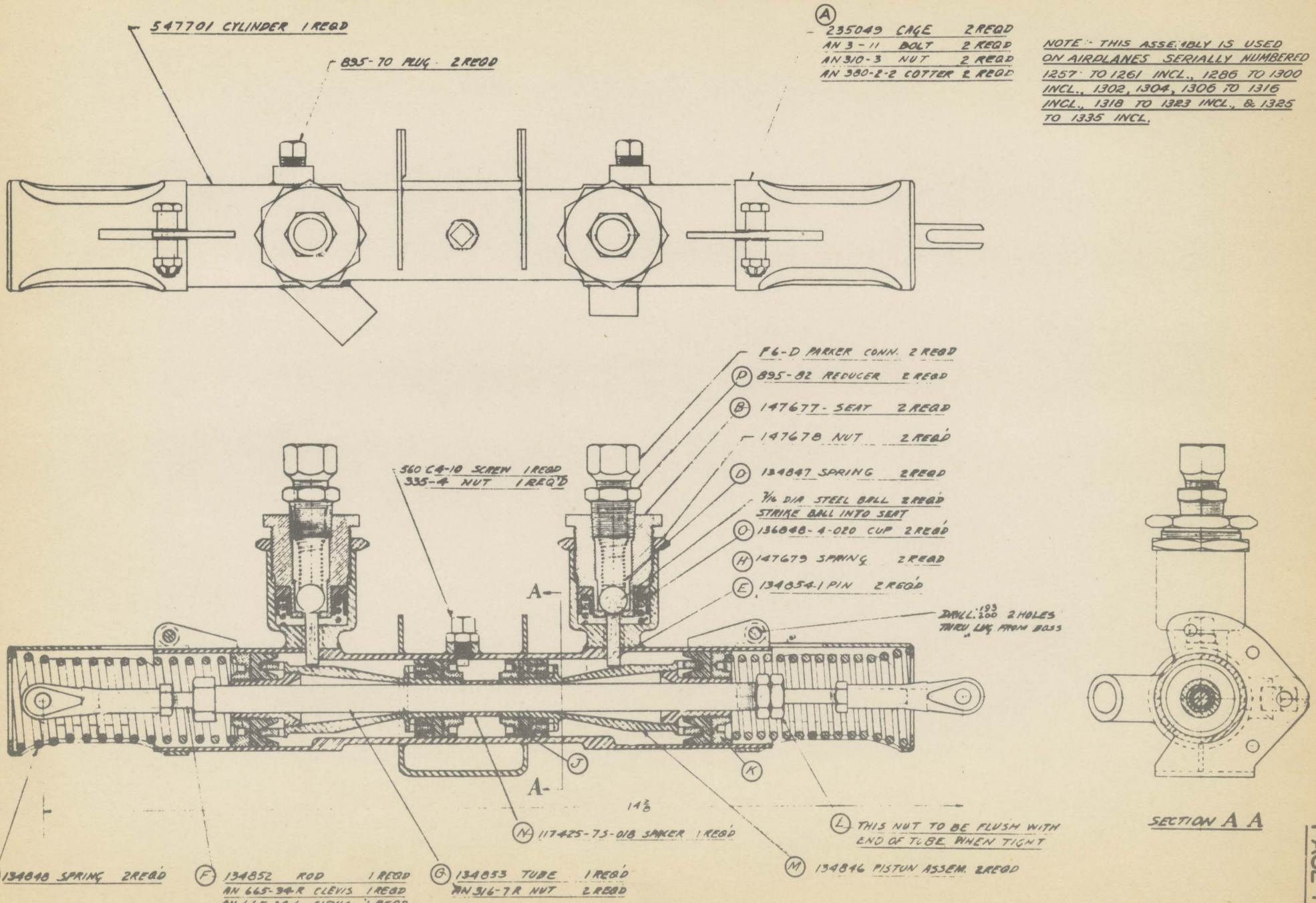


FIG. 47a BRAKE SYSTEM DIFFERENTIATING CYLINDER

near the stop at "full on".

(c) It is evident that with the piston in the "brake off" position (which is against the stop on the end of the cylinder) that the position of the operating lever will vary with each change of adjustment. It is with this adjustment made for new lining that the cable length and take-up requirements are determined for the lever operating cables.

C. Differentiating Cylinder

(See Figure 47, Page 103, and Figure 47a, Page 103a)

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1. Description

(a) The design of the differentiating cylinder is such that both pistons are held against a center spacer in a neutral position by end retaining springs until actuated by the master cylinder. Due to the permissible floating of tube and rod within the pistons, the rudder bus cable is permitted to travel freely approximately 7/8 inch each way from the neutral position without requiring the pistons to move, thereby causing no fluid to be displaced by the differential pistons into the brake lines.

(b) Howeyer, when the master cylinder is operated, fluid is forced equally into the inlets of both cylinders thus forcing both pistons outward against the springs to the limits of the stop nuts on the tube which extends through the pistons. The fluid and pressure necessary to deflect the end springs to this position is built up in the brake lines while taking up slack in the system in preparation for braking.

(c) While in this position, the piston, through the medium of the valve metering pin, allows the valves to assume the partly closed position.

(d) As the left rudder pedal is moved forward, the bus cable is moved to the left, causing the pistons also to move to the left, thus closing the left valve and leaving the right valve open. Due to the two different size piston cups on each piston, and the two different areas occupied by the pistons, the

outer portion of the bore being larger than the inner portion, the movement of the pistons to the left causes fluid to be forced from the right piston. The fluid tends to flow back through the inlet valve to the master cylinder and around to the left cylinder, but since the left valve is closed, the only open passage is through the right outlet to the brake line which leads to the left brake cylinder.

(e) The amount of fluid displacement and consequently the pressure built up in the brake cylinder depends on the amount of forward movement of the respective rudder pedal and master cylinder piston.

2. To Remove Differentiating Cylinder:

(See Figure 45, Page 99)

(a) Disconnect bus cables from clevis ends, break inlet and outlet oil lines at "B" nuts, (4 places) and remove cylinder attaching bolts. Drop cylinder down to clear mounting channel and remove endwise.

NOTE: The procedure for the removel of the pistons and the adjustment of the differentiating cylinder which is given in Paragraphs 3 and 4 below, applies to airplanes serially numbered 1237 to 1256 inclusive, 1301, 1303, 1305, 1317 and 1324.

3. To Remove Pistons:

(See Figure 47, Page 103)

(a) Remove differentiating cylinder from airplane (See Section 2 (a) above).

(b) Remove spring cages, "A" (each end).

(c) Remove Parker Elbow, "C", from inlet (2 places), which permits removing spring, "D", thus removing pressure on check ball and metering pin, "E".

(d) Remove clevis and nut from right end of rod, "F", (making note of exact pin centers between clevis eyes, which should be 14 3/8 inches (See Paragraph 4, Page 106) as this setting determines amount of brake differentiating for a given pedal travel).

(e) Remove two lock nuts from right end of tube, "G", making note as to nut location from end of tube, (as this setting determines limits of piston travel which effect available pressure for braking).

(f) With piston of cylinder held so that ball check valve cage is on lower side (thus permitting metering pins, "E", to drop clear of cylinder bore) each piston, "H", may be removed from its respective cylinder end. If it is required to replace ball check valve or valve seat, it will be necessary to apply heat to nipple in order to unscrew it as this thread is sweat in place to make an oil tight thread. Re-sweat in replacing.

4. To Adjust Differentiating Cylinder:

(See Figure 47, Page 103)

(a) With cylinder held in position as previously explained in 7 (e) and being sure that metering pins are in place and clear of the cylinder bore, assemble left piston into cylinder. Next assemble tube into piston.

(b) From the opposite end slip spacer over end of tube, followed by the assembling of right piston over tube and into cylinder.

(c) With both pistons shouldering against spacer and end nut on tube bearing against left piston, screw lock nuts on to right end of tube so as to allow 21/32 inch free endwise movement of tube through pistons. Lock nuts in this position.

(d) Next insert rod through tube assembly, onto which has been assembled lock nut and clevis.

(e) Onto opposite end of rod, assemble lock nut and clevis so as to allow 1 1/8 inch free endwise movement of rod assembly within tube, locking in this position.

(f) Be sure that thread engagement of rod is the same in each clevis.

NOTE: The procedure for the removal of pistons and adjustment of the differentiating cylinder, which is given in Paragraphs 5 and 6 below, applies to airplanes serially numbered 1257 to 1261 inclusive, 1286 to 1300 inclusive, 1302, 1304, 1306 to 1316 inclusive, 1318 to 1323 inclusive, and 1325 to 1335 and subsequent.

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5. To Remove Pistons:

(See Figure 47a, Page 103a)

(a) Remove differentiating cylinder from airplane (See Paragraph 2 (a), Page 105).

(b) Remove spring cage, "A", and spring, "R", from each end of cylinder.

(c) Remove right clevis from end of rod, "F", and pull rod out left end of tube assembly.

(d) Remove valve seat assemblies and pull out metering pins, "E".

(e) Remove nuts, "L", from right end of tube, "G", and pull tube out from left end.

(f) Pull pistons out of each end of cylinder.

6. To Adjust Differentiating Cylinder:

(See Figure 47a, Page 103a)

(a) Whenever the differentiating cylinder is disassembled, it is advisable to remove and clean ALL parts.

CAUTION: Use alcohol only for cleaning, as other solvents deteriorate the rubber washers. It is advisable also to "time" the valve mechanism when reassembling to insure proper functioning of the differentiating cylinder; i.e., correct amount of brake differentiating for a given pedal travel, and correct amount of pressure available for braking. The following procedure includes the operations necessary for assembling and "timing" the differentiating cylinder.

(b) Clean piston assemblies, "M", of any dust particles, lubricate with brake fluid, and while differentiating cylinder is held in vise with valve assembly cages at top, insert left piston into left end of cylinder. Assemble tube, "G", into position through left piston.

(c) Use a special timing spacer similar to regular spacer, "N", but 1 3/16 inch in length. Slip spacer over right end of tube, and assemble right piston assembly, "M", over tube and into cylinder.

(d) Thread on nut at right end of tube to a loose working fit against piston, lock in place with second nut, "L", provided, and mark position of lock nut on tube.

(e) Insert valve metering pins, "E", and rubber cup springs, "H", into place. Lubricate rubber cups, "O", with brake fluid and work down over springs by means of a blunt tool. Make sure that cups work freely when in place.

(f) Assemble valve mechanism as follows: Put ball down on seat, "B", tap lightly, insert spring, "D", and reducer, "P", and screw on lock nut. Install valve mechanisms into valve cages.

(g) Push right piston assembly to extreme left, and measure with a depth gauge the distance of piston from right end of cylinder. If dimension is 1 1/4 inch, set gauge at 5/8 plus 3/32 inch lag allowance. If dimension is plus or minus 1 1/4 inch, set gauge at 5/8 plus 3/32 plus or minus this difference.

(h) Push right piston to right to meet the gauge, and while blowing into left valve, raise or lower left valve seat, "B", until valve is just off the seat. Test by working piston and blowing into valve to determine when valve is barely open. When adjustment is correct, as shown by gauge, lock valve seat in place with lock nut provided.

(i) Push piston to extreme right and proceed to adjust right valve similar to procedure given in paragraphs (g) and (h) above.

(j) When adjustment is complete, lock right valve seat in place and scribe a line across the top of the valve seat and seat cage. Punch mark valve seat and valve cage at arbitrary points on this line. Set caliper to this dimension and save for use in reassembly.

(k) Loosen right valve lock nut, remove valve seat assembly, remove metering pin, remove nuts on right end of tube, and remove right piston.

(l) Replace 1 3/16 inch timing spacer with 9/16 inch spacer, "N", assemble right piston in cylinder and tighten nuts on end of tube to original position by use of markings.

(m) Install pin and seat assembly and lock in original position by means of calipers on centers described in (j), Page 106b.

(n) Apply "Titeseal" compound to Parker "F" fittings and screw into inlet and outlet openings.

(o) Assemble lock nut and clevis on one end of rod, "F", insert through tube assembly and assemble lock nut and clevis on other end so as to allow 1 3/16 inch free endwise movement of rod and clevis assembly within tube. With thread engagement of rod same in each clevis, and with clevis ends aligned, lock clevises on rod.

(p) Install spring, "R", and cage, "A", at each end of cylinder and insert bolt through lug. Draw up nut and safety. CAUTION: Do not tighten this bolt to point of causing piston to seize.

D. To Adjust Brakes:

1. Jack up wheels.

2. Check wheel bearings for proper adjustment.

3. Loosen eccentric lock nut and turn eccentric in direction of wheel rotation until wheel is locked in position. Back off eccentric until wheel just rotates freely. With a close fitting wrench, hold eccentric in this position and tighten lock nut.

4. Uncover adjusting screw hole by rotating cover plate and with screw driver turn notched wheel of adjusting screw away from axle until brake drag is noticed when turning wheel by hand. Back off notched wheel until there is no brake drag. Replace cover plate.

5. Check all connections for signs of oil leakage.

6. Inasmuch as brakes are hydraulic, any inequalities in braking will be due to out-of-round drums, oil soaked or scored lining.

7. Since there is a brake on either side of the wheel, each should be adjusted individually and then as a unit in order to insure proper distribution of braking.

E. To Bleed Brake System:

1. Disconnect supply line from fluid reservoir at master cylinder.

2. Attach line from a pressure tank to master cylinder and fill system slowly under a pressure of from 20 to 100 lbs.

3. Open bleeder valves on brakes and allow fluid to escape until it runs free and clear from air. (Approximately 3/4 gallon of fluid should be allowed to run from each brake.)

4. Remove plugs in differentiating cylinder and bleed air out.

5. Close bleeder valves and disconnect pressure tank.

6. Reconnect supply line from fluid reservoir.

NOTE: Any air in the system above the master cylinder will be released through the fluid supply tank vents.

SECTION XII

POWER PLANT

A. Description

1. The airplane is powered with two Wright Cyclone Model SGR-1820-F-3 engines (geared 16:11, compression ratio 6.4:1, impeller ratio 8.3:1). The accessories for each engine include four choke carburetor, complete A.A. radio shielding, Eclipse electric and direct cranking starters, Type E-160; with shielded booster coil, Eclipse engine-driven vaquum pump model M-2932-1A and F-4 Romec fuel pump. In addition, one fifty ampere radio generator is mounted on the left engine.

2. The engine nacelle is so designed that the whole section forward of the firewall may be handled as a quick-detachable unit, including engine mount, engine, cowling, propeller, complete oil system and all engine accessories. These quick-detachable complete engine installations are interchangeable, right and left. However, in interchanging them the radio generator with its conduits and attaching plug must be put with the unit on the left hand side of the airplane.

3. The complete engine section is comprised of the following major details; namely, engine, engine mount, oil system, outer ring cowl, inner cowl, collector ring with preheater and valve, starter, and magneto retarding solenoid. The fuel system, engine controls, all electrical wiring and the propeller controls in the engine section are continuations of their respective systems but remain integral with the engine section and are quickly detachable at the firewall. NOTE: The booster coil is connected to the right magneto on each engine.

B. Operating Limits

1. Aviation gasoline of 87 octane anti-knock rating is specified by the engine manufacturer. In cases of emergency where only fuels of inferior knock rating (not less than 80) are available, the engine is rated at 635 h.p. at 1950 r.p.m. at 9,500 feet. Under this rating the engine is not to be operated beyond the following limits:

	Manifold Pressure in Inches of Mercury
Takeoff	34.5 (not to exceed one minute)
Initial Climb	31.5
Normal Climb or Level Flight	30.

C. To Remove Engine Section:

1. Each engine section can be removed completely as follows:

(a) Remove all hose connections from front side of firewall group fitting.

(b) Disconnect all electrical wiring by unscrewing lock nuts and pulling Cannon plugs. CAUTION: As the ignition is grounded through the plug on the firewall, removal of the plug leaves the ignition "on". Service personnel should exercise suitable precautions against pulling the propeller through if the engine is warm and the ignition plug is out.

(c) Disconnect throttle, mixture, preheater and propeller controls by removing pins from the respective levers at the jackshaft on the front face of firewall.

(d) Attach hoist sling as outlined in Paragraph 5, Page 7.

(e) Unscrew the four bolts which hold the main structural frame work, but do not take them out. (Approximately 4 1/2 turns are required to free them.)

(f) Remove the lower bolts and make a final check to be sure everything is clear and the chain hoist tight.

(g) Remove the two upper bolts and swing the engine section forward about four inches to clear the exhaust stack and then hoist.

(h) When installing the engine section, care must be exercised in setting up the exhaust pipe universal joint in order to insure ample room for expansion of the exhaust pipe and movement of the engine. This requires clearance for approximately 1/2 inch movement either way in the slip joint of the universal.

D. Anti-Drag Ring

1. The anti-drag ring is interchangeable for right and left engines. The ring is made in three segments, which are connected by toggle locks and guide pins and bound together by two cables. The cable on the inside of the ring passes through a series of clips and runs around in front of the cylinder heads. The other cable rests in a groove around the outside of the ring at the rear of the cylinder heads.

2. To install the ring:

(a) Place the top segment in position.

(b) Place other two segments in position.

(c) Close all toggle locks and place safety pins into place.

(d) Install the cables and lock with turnbuckles.

Fig. 48 - Front Face of Firewall Ready for Engine Installation and Complete Engine Section Ready to be Attached

(Photo to be added)

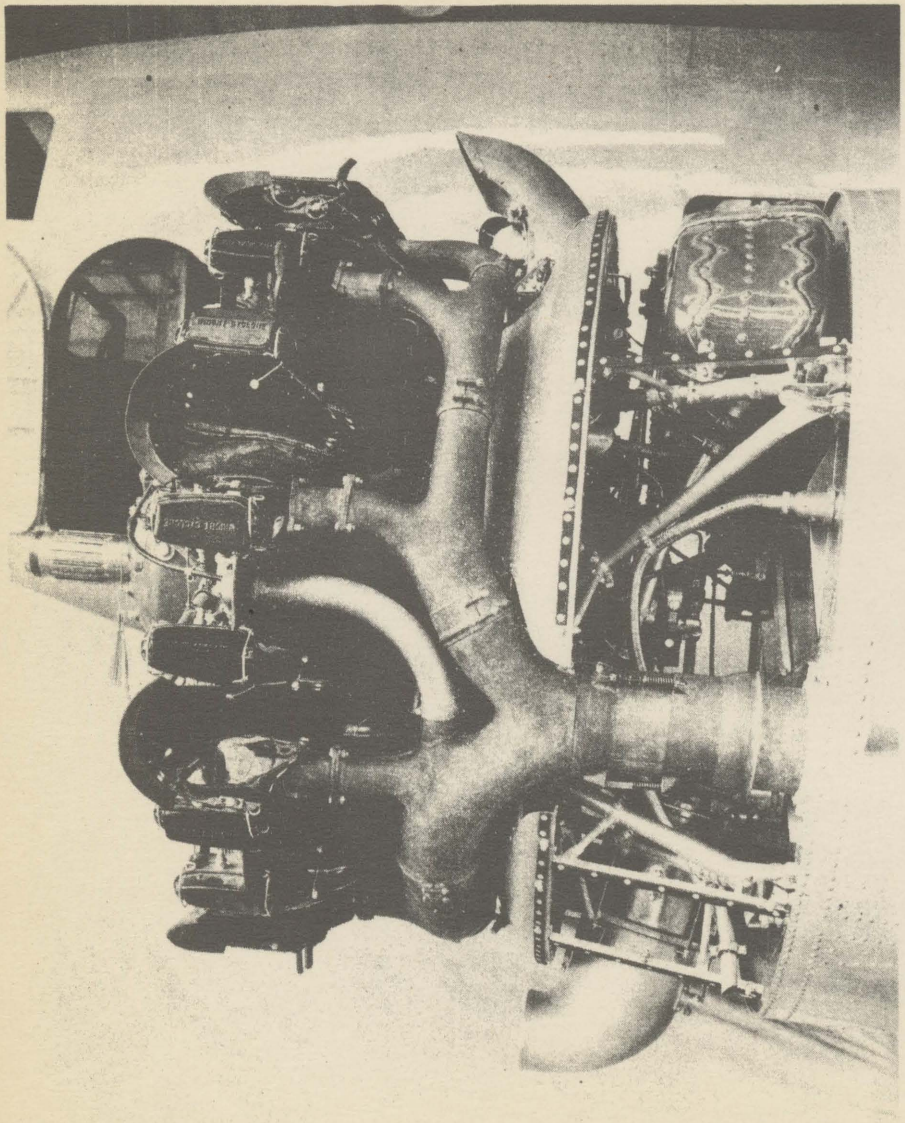


FIG.49 LEFT HAND ENGINE SECTION, LEFT SIDE

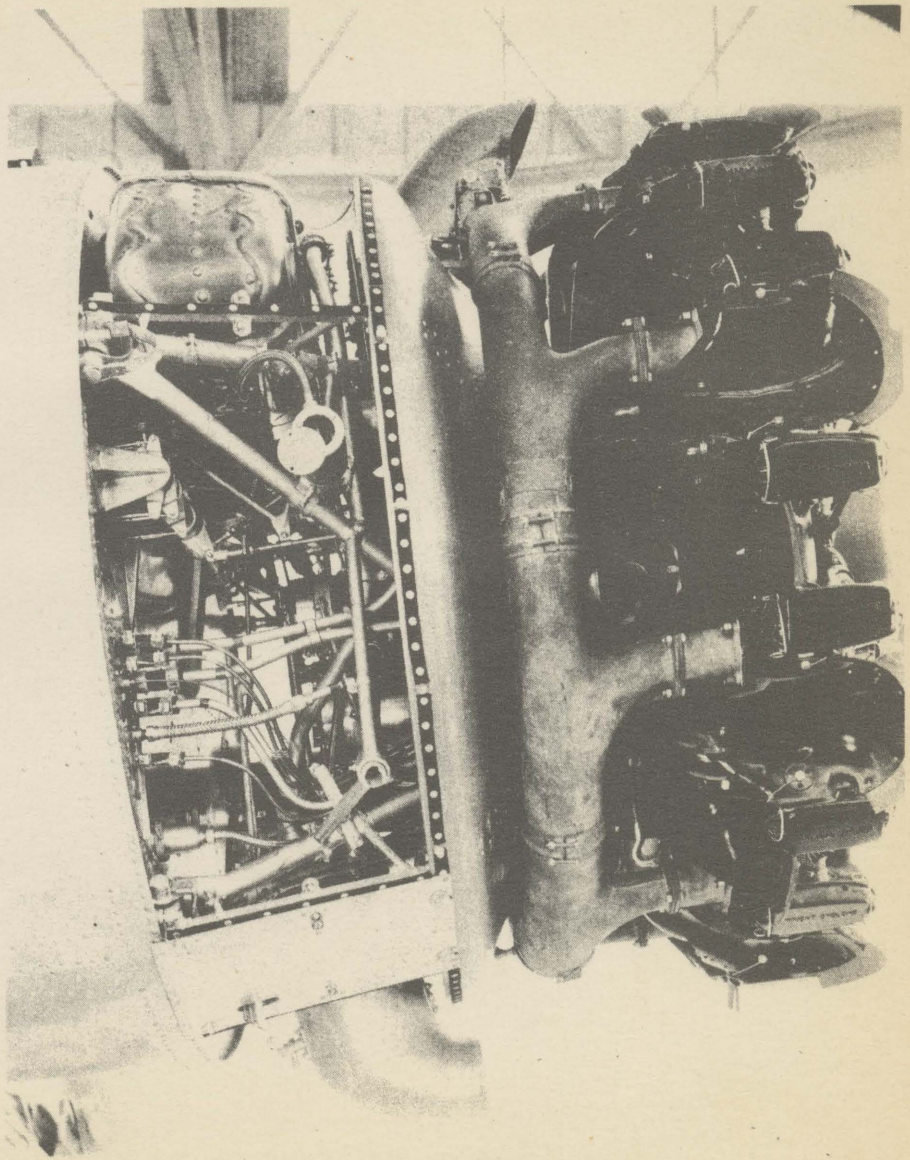


FIG.49a LEFT HAND ENGINE SECTION, RIGHT SIDE

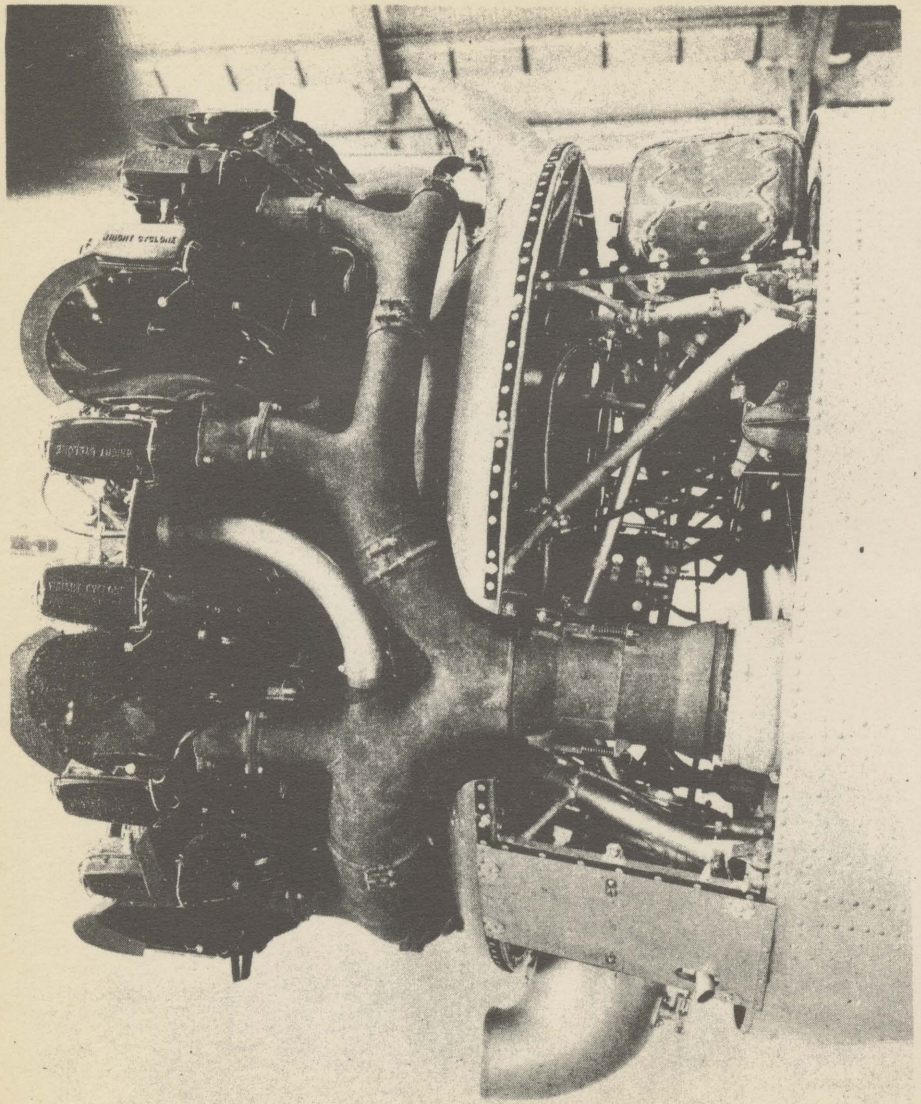


FIG.49b RIGHT HAND ENGINE SECTION, LEFT SIDE

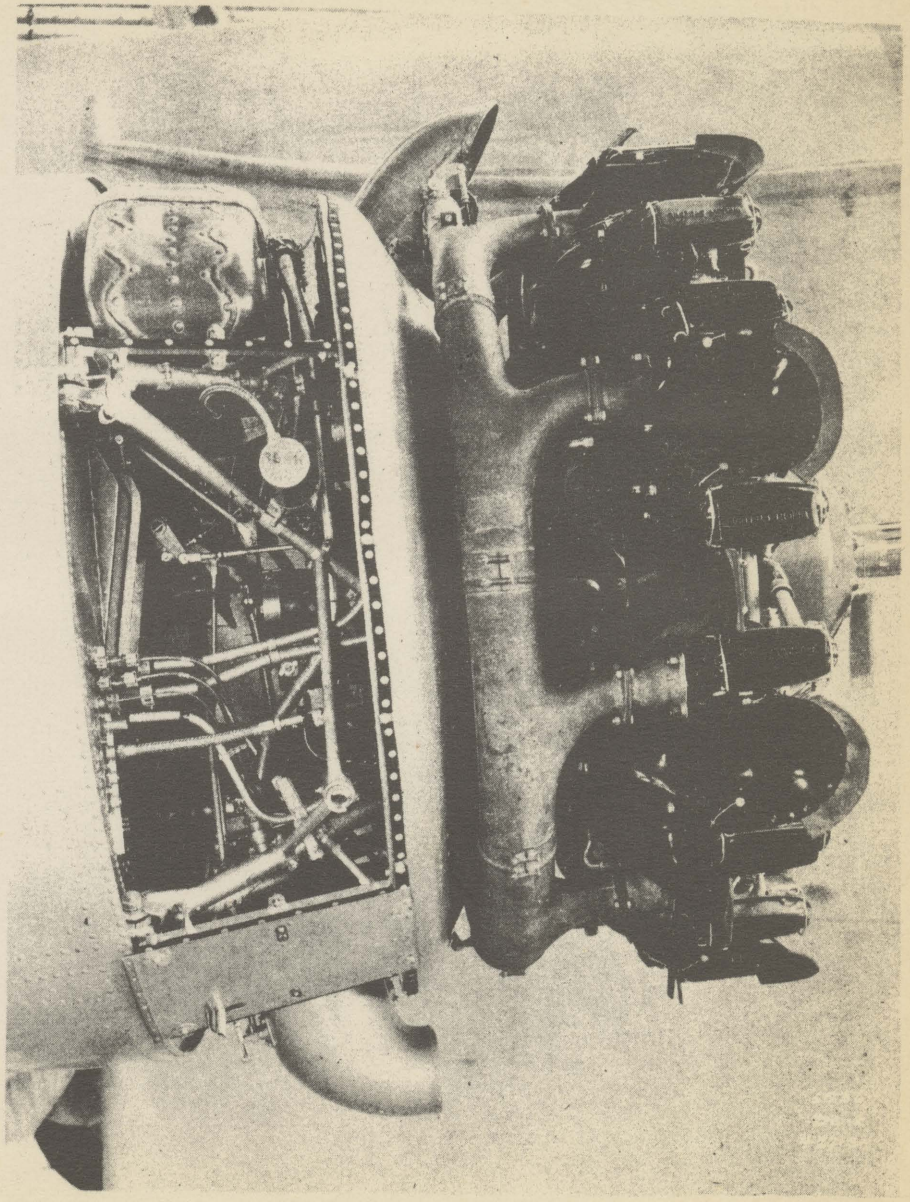


FIG.49c RIGHT HAND ENGINE SECTION, RIGHT SIDE

SECTION XIII

PROPELLERS

A. Description

1. Hamilton Standard, three bladed, hydro-controllable propellers (Diameter 11 feet 6 inches cut down to 11 feet, Blade Dwg. No. 6105-18, Hub. No. 8452) are employed. They are set to give their best efficiency in low pitch during takeoff and climb, and in high pitch during level flight full throttle cruising at high altitudes where the airspeed for any given percent power is a maximum.

2. The propeller pitch control lever is mounted on the front face of the control pedestal near the base. When it is in the "up" position the propellers are in the high pitch position (32.5 degrees), and when in the "down" position the propellers are in the low pitch position (25 degrees). The base setting is 34 degrees.

3. The control lever operates a drum, in the control pedestal, to which cables are attached. The cables to each nacelle follow the same route along the front spar as the engine control cables (Figure 53, Page 124, shows the engine controls diagrammatically). At the rear face of the firewall within the nacelle the cables attach to a small jackshaft which extends through the right side of the firewall where a section of Arens flexible control attaches to the jackshaft lever. The Arens control runs to the left side of the nacelle and forward through an intercylinder baffle to the engine gear case where it attaches to the propeller control valve.

4. The engine oil pressure is used only to move the blades into the low pitch position. When the oil pressure is released the blades are rotated to the high pitch position by centrifugal action of the counterweights attached to the blades at the hub.

5. The propellers can be used in two positions only, full low pitch and full high pitch. They cannot be controlled individually. The control lever handle should be in either the extreme "down" position or the extreme "up" position. No intermediate positions will correspond to any intermediate pitch but will merely allow the oil to leak into or out of the controlling cylinder.

6. Whenever the propeller is off, the end of the shaft should be kept closed by means of the cap provided.

SECTION XIV

FUEL SYSTEM

A. Description

1. General

a. The fuel system consists essentially of two main tanks, two auxiliary tanks, G-2 tank selector valve, wabble pump with an integral relief valve, E-2 engine selector valve, two C-2 strainers, two C-3 by-pass and relief valves, two F-4 Romec engine-driven pumps and the necessary lines and fittings.

b. The diagram shown on Page 114 shows the fuel circulating system, including lines, valves, cocks, gauges, pumps, strainers, etc., and gives information as to the sizes of the lines and the relative location of all parts.

2. Lines

a. All fuel lines, except those in the engine section of less than 3/8 inch diameter, which are of copper, are made of 4S0 aluminum alloy tubing.

b. For information regarding the size of the various lines, refer to Figure 50, Page 114.

3. Flow

a. The fuel lines from the two main and the left auxiliary tanks all concentrate at a G-2 tank selector valve. (NOTE: The auxiliary tanks are interconnected by a line having a check valve that allows the fuel to flow from the right to left tank only; hence, a supply line from the left auxiliary tank only is necessary.) The main fuel line then runs forward to the bottom of the wabble pump. The flow is then through the wabble pump with its integral by-pass valve and up to an E-2 engine selector valve, which is attached directly to the wabble pump by a close nipple. From this valve the lines run to their respective engine nacelles. The line to the right engine crosses over to the right side of the nacelle and then forward to the C-2 strainer.

The outlet from the strainer is connected to the supply line by a tee at the C-3 by-pass and relief valve outlet marked "engine pump". This supply line attaches to the firewall fitting and then runs forward to the suction side of the F-4 Romec engine-driven pump. A tee located in the pressure outlet of the engine-driven pump connects a supply line, which runs vertically to the carburetor and a relief line for the excess fuel, which runs back to a separate fitting on the firewall and aft to the C-2 unit outlet marked "relief". The line to the left engine runs forward along the right side of the left nacelle to the strainer, and from there forward the installations are identical in each nacelle.

4. Locations of Valves, Wabble Pump and Strainers:

   a. G-2 Tank Selector Valve - aft of center spar on centerline of airplane and accessible through a movable structure plate on lower surface of wing.

   b. Wabble Pump - forward of front spar at left of centerline of airplane and accessible through hinged doors in lower surface of center wing panel.

   c. E-2 Engine Selector Valve - attached directly to wabble pump.

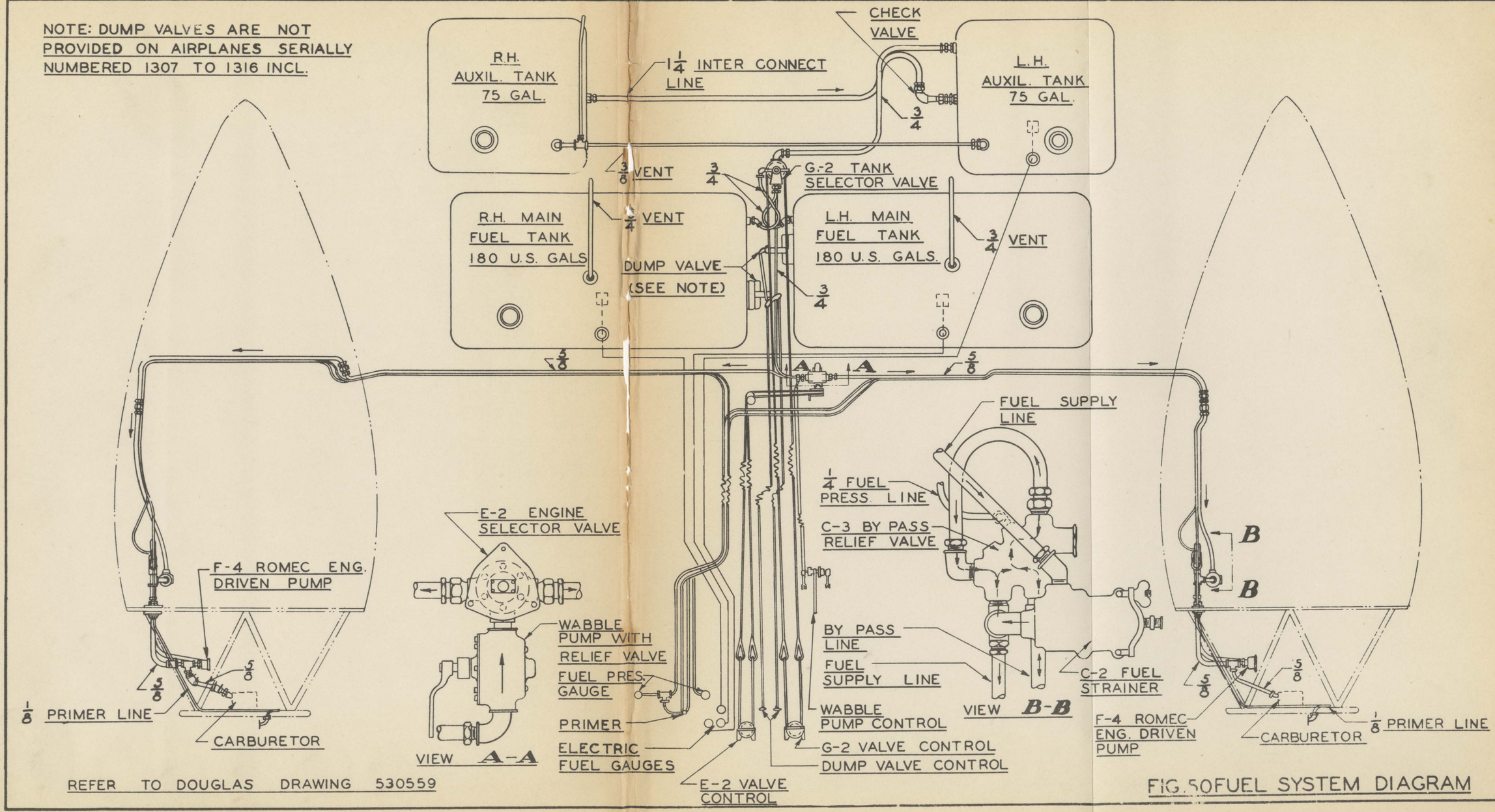
   d. C-2 Strainer - mounted aft of firewall in engine nacelle (both left and right) and accessible through bottom of nacelle.

   e. C-3 By-Pass and Relief Valve - mounted with C-2 Strainer.

5. Fuel Valve and Wabble Pump Controls:

   a. The controls for the fuel valves are mounted on the control pedestal. The left control is for the selection of tanks and the right control for the engine selection. These handles control the valves through a system of drums and cables, a flexible connection being placed between the final driving drum and each valve. The wabble pump handle is located to the right and behind the pilot's seat and is pivoted to swing outward 45 degrees so that it may also be used by the co-pilot.

NOTE: DUMP VALVES ARE NOT PROVIDED ON AIRPLANES SERIALLY NUMBERED 1307 TO 1316 INCL.



REFER TO DOUGLAS DRAWING 530559

FIG. 50 FUEL SYSTEM DIAGRAM

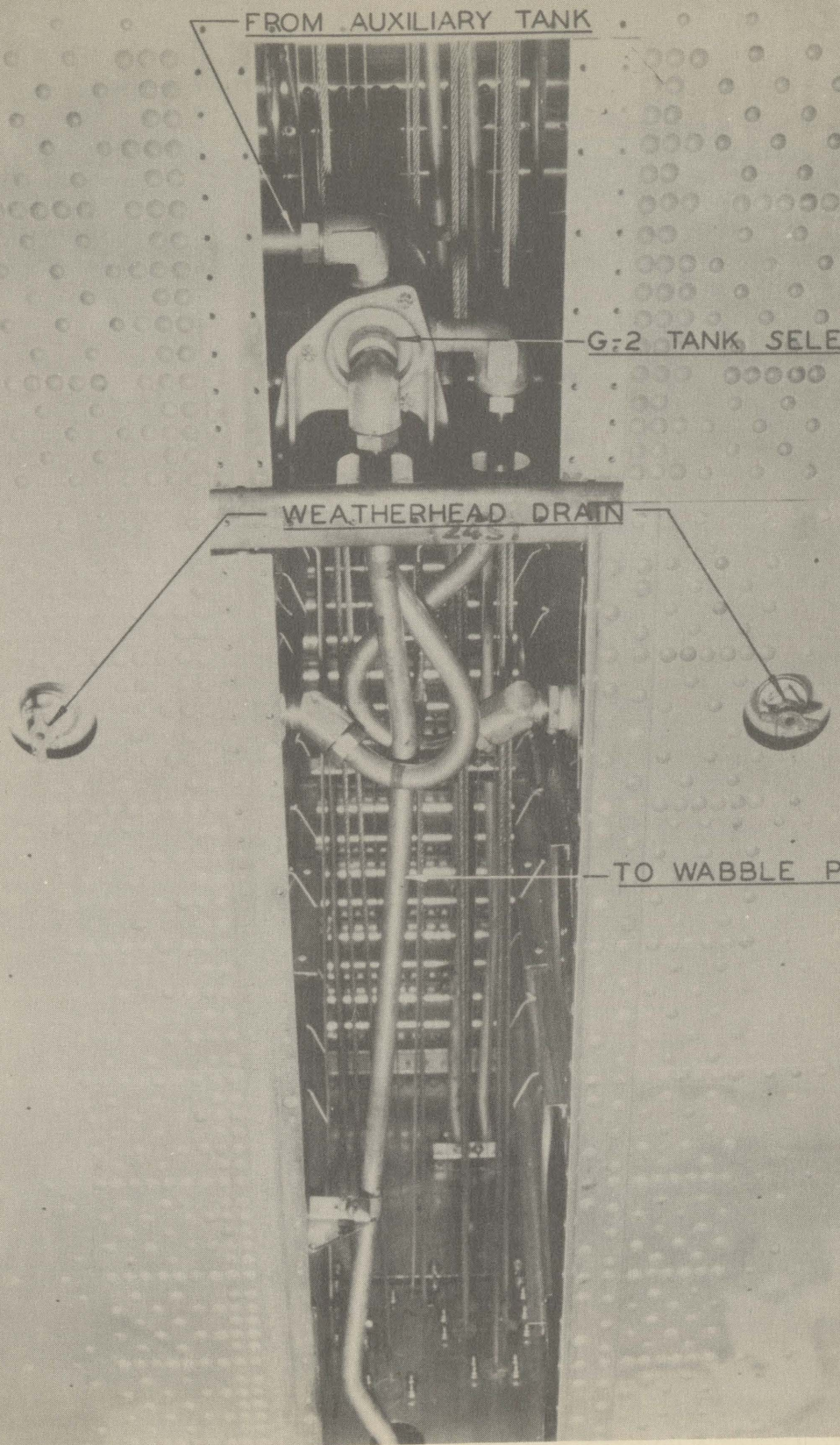
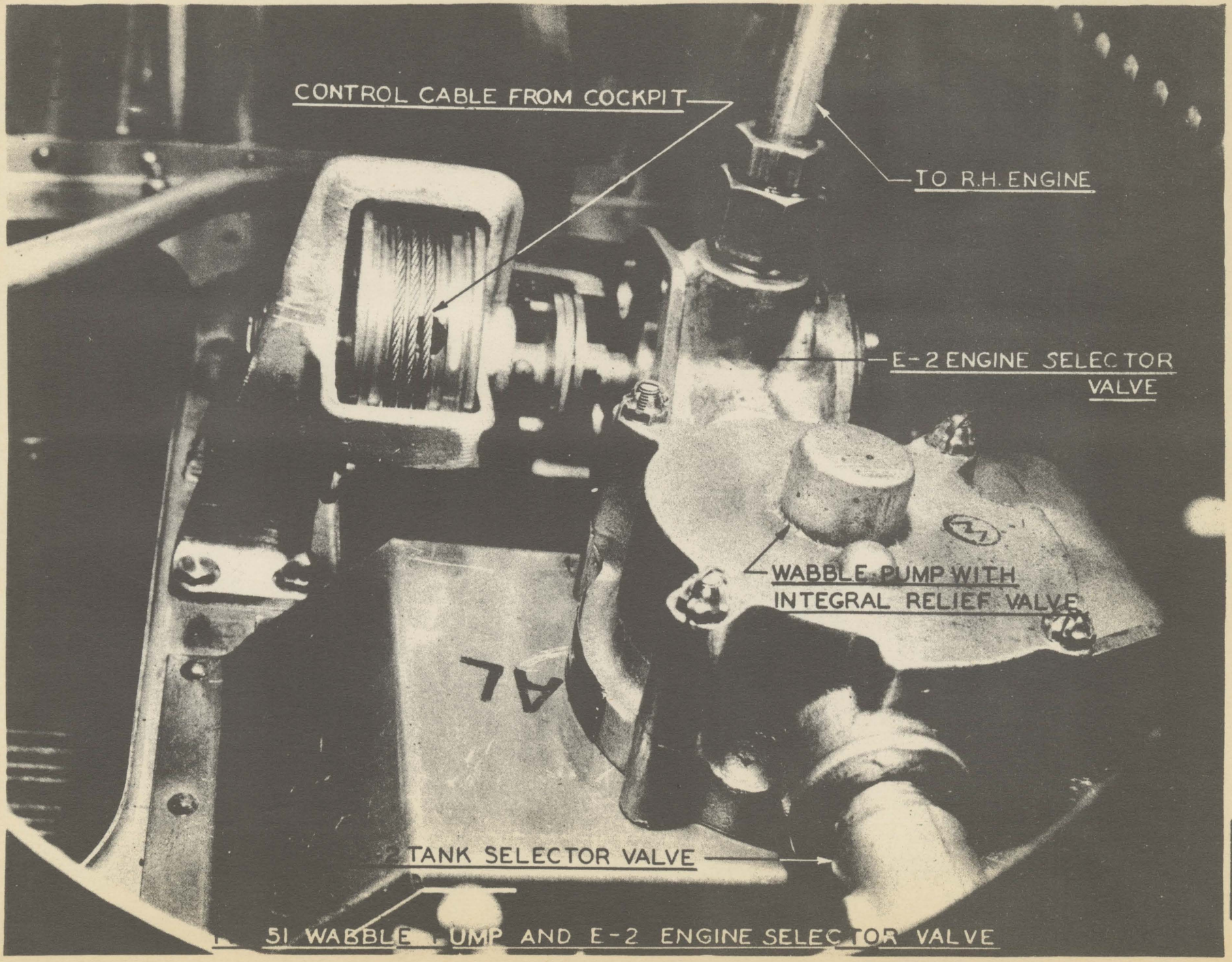


FIG. 50a WEATHERHEAD DRAIN & G-2 TANK SELECTOR VALVE



51 WABBLE PUMP AND E-2 ENGINE SELECTOR VALVE

6. Engine Primer

a. The engine primer is located on the right wall of the pilots' compartment just aft of the instrument panel. The primer takes its gasoline from the right fuel pressure line and delivers it to the right or left engine. The primer must be in the "off" position when the engines are in operation.

7. Fuel Pressure

a. The fuel pressure for each engine is taken from the by-pass and relief valve through a #55 drill size restriction in the fitting. A branch line from the fuel pressure line is connected to the fuel pressure warning switches, which are located on the right wall of the cockpit just below the instrument panel. The switches are connected by wires to red warning lights on the instrument panel. WARNING: The fuel pressure, as read on the instrument panel, does not directly correspond to the fuel pressure at the carburetor, due to the difference in height. The fuel pressure indicator on the instrument panel reads 1 3/4 pounds less than that at the carburetor when in flight. For normal operation, the fuel pressure at the carburetor should be between three and four pounds.

8. Tanks

a. The tanks are constructed of 3S aluminum manganese shell with internal baffles of aluminum alloy riveted to the shell. Each main tank and the left auxiliary tank have electric fuel gauges, which may be removed through the attaching flange at the top of the tanks. Each tank is provided with a water collecting sump and a Weatherhead cock for frequent draining.

b. Each filler neck is arranged so that a rubber grommet or gasket fits tightly around the neck, forming a watertight seal to prevent freezing around the cap itself and also, by its attachment to the upper wing skin, prevents the overflow gas from running down into the fuel tank compartment.

c. The fuel tank compartments are so vented that the air flow through them is diagonal from bottom to top and from centerline outboard.

Air enters through holes around the Weatherhead drain cocks in the bottom surface of the center wing panel and goes out through "clamshells" on top of the center wing near the filler necks.

d. The total fuel capacity is 510 U.S. gallons, divided as follows:

Left Main Tank	180 gal.
Right Main Tank	180 gal.
Left Auxiliary Tank	75 gal.
Right Auxiliary Tank	75 gal.

B. Maintenance

1. To Remove Main Fuel Tank (either left or right):

a. Remove top plate from around filler neck allowing rubber gasket to remain with tank.

b. Disconnect vent at top of tank, working through inspection door in wing-to-fuselage fillet.

c. Remove bottom plating from wing center section under tank.

d. Disconnect electrical bonding at rear of tank.

e. Disconnect dump valve operating mechanism.

f. Remove plate from under G-2 valve.

g. Remove line which connects G-2 valve with tank.

h. Reach through hand hole just forward of tank and disconnect electric fuel gauge wires at terminal block.

i. Reach inside front part of tank compartment and unscrew collar on flexible conduit for fuel gauge wires and pull conduit and wires out.

j. Unscrew turnbuckles in tank support straps and drop tank downward.

2. To Remove Left Auxiliary Tank:

a. Remove top plate around filler neck, allowing rubber gasket to remain with tank.

b. Release vent at top through inspection door in wing-to-fuselage fillet.

c. Remove wing plating from under tank.

d. Reach through hand hole at rear of tank compartment and disconnect fuel gauge wiring and conduit.

e. Disconnect balance line which leads from right auxiliary tank.

f. Disconnect fuel line to G-2 valve.

g. Unscrew turnbuckles in tank support straps and drop tank downward.

3. To Remove Right Auxiliary Tank:

a. Proceed same as on left auxiliary tank, except that there is no fuel gauge to disconnect and no feed line to G-2 valve to disconnect.

4. To Repair Tanks:

a. The tanks may be repaired by welding.

5. To Fill Tanks:

a. The left fuel tanks may be filled at the filler necks located on top of the center wing between the nacelle and fuselage, and the right tanks at a corresponding position on the right side of the fuselage. Because of the check valve in the interconnecting line between the auxiliary tanks, it is necessary that the left auxiliary tank be filled first.

6. To Remove Electric Fuel Gauges:

a. Remove hand hole cover in wing fillet.

b. Reach through fillet and hole provided in top surface of center section and unscrew gauge rheostat.

7. Inspection and Miscellaneous Maintenance Items:

a. Make a daily examination of the entire system for leaks.

b. Clean strainers before each flight.

c. Drain lines and tanks through Weatherhead cocks located in sumps of each tank.

d. Drain sumps daily to pass off accumulated water and sediment.

e. Air blow the entire system at time of each engine overhaul.

f. Remove and anneal all fuel lines after each 1000 hours of flight to counteract the hardening due to vibration.

g. Inspect system daily for worn or damaged parts, corrosion and abrasions to paint.

h. CAUTION: Aluminum alloy threaded parts will seize and gall when threaded together with pressure. This is particularly true when fuel line fittings are assembled with pressure for permanent tight makeup. All aluminum alloy parts, contacting under pressure seize and gall particularly when in contact with or moistened by gasoline without other lubricant. Do not assemble aluminum alloy threaded parts without applying a reliable anti-seize compound to the contacting surfaces. Parker Threadlube, Grade #6PB, is an approved anti-seize compound prepared especially for aircraft installations and is of greasy, non-fluid, smooth spreading consistency.

SECTION XV

OIL SYSTEM

A. Description

1. General

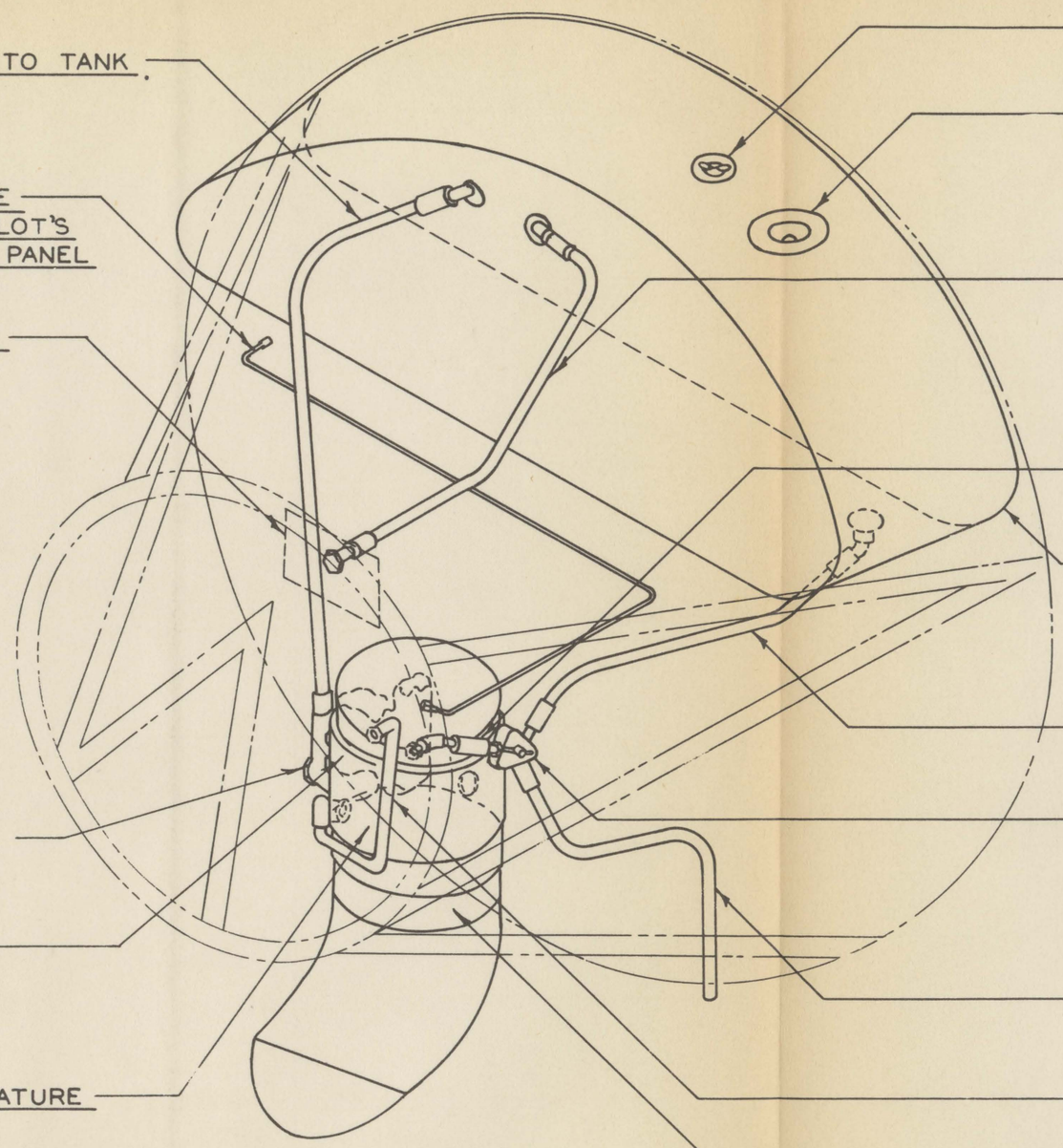
a. The schematic diagram, Figure 52, Page 120, shows the oil circulating system, including information as to the sizes of the lines and relative positions of the various parts.

b. All units of the oil system are interchangeable between the right and left engine sections. The complete oil system for each engine, with the exception of the oil pressure line, is contained in the engine section.

c. All lines of the oil system in the engine section, except the portion of the pressure line forward of the firewall, which is copper, are 4S0 aluminum alloy and are annealed after forming.

2. Tanks

a. The oil tanks are constructed of 3S half hard aluminum alloy sheet with internal baffles riveted to the shells. They are mounted in cradles on the upper horizontal members of the engine mount and are held in place by metal straps equipped with turnbuckles for tension adjustment.



REGULATOR TO TANK 1" DIA.

OIL PRESSURE PUMP TO PILOT'S INSTRUMENT PANEL 1/4" DIA.

CRANK CASE

PRESSURE BY PASS VALVE

OIL PUMP

OIL TEMPERATURE REGULATOR

GAUGE ROD

FILLER CAP

VENT 3/4" DIA. CRANK CASE TO FOAMING SPACE

DRAIN VALVE TO PUMP 1" DIA.

OIL TANK CAPACITY 19 U.S.GAL'S. FOAMING SPACE 2 U.S. GAL'S.

TANK TO DRAIN VALVE 1" DIA.

LUNKENHEIMER TYPE "Y" 1" DRAIN VALVE

DRAIN 1" DIA.

PUMP TO REGULATOR 1" DIA.

SHUTTER

FIG. 52 OIL SYSTEM DIAGRAM

REFER TO DOUGLAS DRWG. #542367

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W. C. BLAZER 9-11-34

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b. Each tank is vented to its respective crankcase through the fitting at the left of the inlet connection.

c. The oil tanks, which may be filled from the top of the nacelles, have a capacity of 19 U.S. gallons each to the filler neck, allowing two gallons for foaming space. (Note: As the Department of Commerce requires only one gallon of oil for each 15 gallons of gasoline, the tanks may, if desired, be filled accordingly to gain pay load advantage.)

d. A sounding rod (T.W.A. type) is carried within a sleeve in each tank to eliminate foam and give a correct reading. The rod is located near the tank filler neck.

3. Flow

a. From the tanks, the oil flows down to the oil pump through a drain valve which may be used to drain the entire system except for the engine sumps and oil coolers. The oil outlet from the engine runs down to the right side of the oil cooler which is mounted in a vertical position inside the engine section. The flow is then through the cooler and out the upper fitting, on the same side, which is connected by tubing to the inlet fittin on the right front of the oil tank. In case the oil becomes congealed or due to some obstruction in the cooler, the by-pass and relief valve will by-pass the oil through the muff as soon as the pressure builds up to 25 pounds per square inch. The valve has a fixed setting and requires no adjustment.

4. Oil Cooler

a. Two United Aircraft Products 8 inch coolers are used (one in each nacelle, installed in a vertical position.)

b. Oil temperature control is accomplished by shutters on the bottoms of the coolers. These shutters are controlled manually by levers located on the control pedestal.

c. Two drain plugs are provided in each cooler for draining the entire system. One plug is in the lower right fitting and the other in the rear of the cooler near the bottom.

5. Oil Pressure Line

a. The oil pressure is taken directly from the engine through a 1/4 inch line which attaches to both the engine mount and the firewall fitting by hose connections. From the firewall, the line leads to the instrument panel where it is attached to the pressure indicator by oil proof rubber tubing. The pressure line is of 4S0 aluminum manganese magnesium with the exception of the portion forward of the firewall, which is copper. If it becomes necessary at any time to disconnect the oil pressure, it is necessary that the pressure line be filled at the indicator connection with a light engine oil (S.A.E. #10) before reconnecting. All oil and vent lines in the engine section are connected by hose couplings. The oil pressure line fitting in the engine is restricted to a number 50 drill size hole to prevent immediate loss of oil pressure in the event of a pressure gauge line failure.

B. Maintenance

1. To Remove Tanks:

a. Remove engine section cowling.

b. Disconnect and plug all attaching lines.

c. Detach bonding strip.

d. Disconnect tank retaining straps at turnbuckles.

e. Lift tank straight up through top of engine section.

2. To Repair Tanks:

The tanks may be repaired by welding.

3. Inspection and Miscellaneous Maintenance Items

a. Inspect entire system weekly for leaks and correct operation of pumps and relief valves.

b. Clean oil strainers after every 25 hours' service.

c. To drain oil system:

(1) Drain oil tank and lines through cock attached to engine at left side of nacelle.

(2) Drain cooler by removing plug from the side of cooler and line.

(3) Drain crank case through plug connection provided on engine sump, removing screen for this operation.

d. Inspect system daily for worn or damaged parts, corrosion and abrasions to paint.

SECTION XVI

ENGINE CONTROLS

A. Description

(The engine controls are shown diagrammatically in Figure 53, Page 124.)

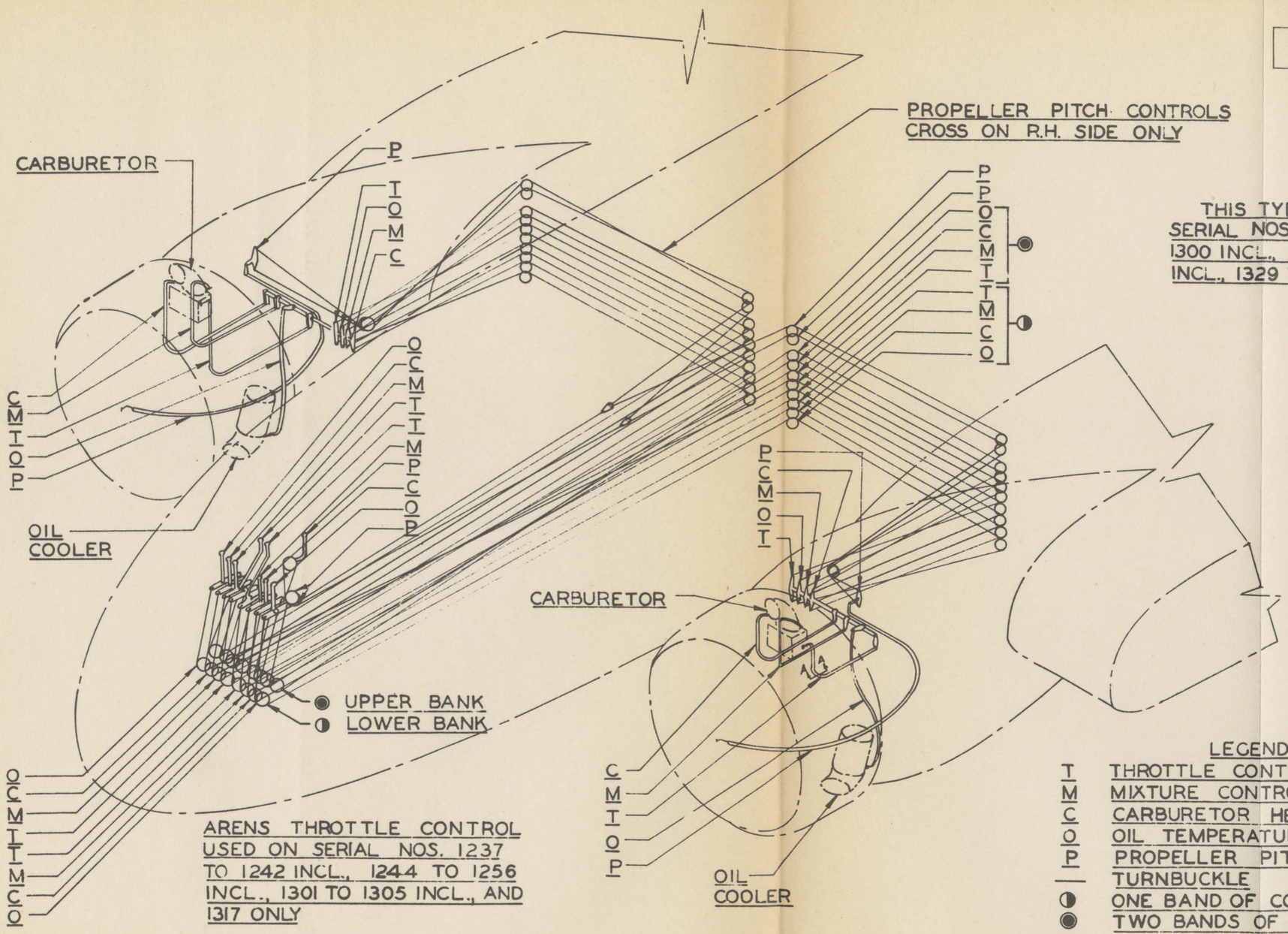
1. All of the engine control levers are located on the control pedestal in the pilots' compartment. The arrangement of the levers is shown in Figure 53, Page 124. From the handles, cables of 3/32 x 7 x 7 flexible steel run down through the pedestal to pulleys beneath the floor. From here, they pass over pulleys rearward to the front spar, out along the spar to the inboard side of their respective nacelles, and forward through the firewall to a jackshaft to which they are attached by means of turnbuckles. Forward of the firewall, all engine controls are of the Arens type on airplanes serially numbered 1237 to 1256 inclusive, 1301, 1303, 1305, 1317 and 1324. On airplanes serially numbered 1257 to 1261 inclusive, 1286 to 1300 inclusive, 1302, 1304, 1306 to 1316 inclusive, 1318 to 1323 inclusive, 1325 to 1335 inclusive, and subsequent, all engine controls forward of the firewall are of the Arens type, with the exception of the throttle control. In these airplanes, the throttle control consists of two push-pull rods and a bell crank. A ballbearing push-pull rod connects the bell crank to the throttle.

2. When changing any control cable, it is advisable for purposes of reinstallation, to solder a thread line to the end of the cable being removed. Adjustments of the cables may be made at the turnbuckles rearward of the firewall. Further adjustments of the system may be made on the Arens control ends and push-pull rod ends.

B. Maintenance

1. The jackshaft bearings and push-pull rod ends should be kept well lubricated. Use a thin lubricant frequently on the Arens controls.

2. Worn or damaged cables or bearings should be replaced.



REFER TO DOUGLAS DRAWING 530556 & 542365

FIG. 53 SCHEMATIC DIAGRAM ENGINE CONTROLS

SECTION XVII

ELECTRICAL INSTALLATION

The electrical system is shown diagrammatically in Figure 54, Page 126.

A. Electrical Panel and Fuses

1. The electrical panel is located above the windshield in the pilots' compartment and is in two units which are separated by the ignition switch panel.

2. Located on the left panel are the following:

(a) Three rheostats; one for the airspeed indicator light, one for the compass light and one for the instrument light.

(b) Thermostat switch.

(c) Pitot head heater switch.

(d) Cabin-seat-belt sign switch.

(e) Cabin lights master switch.

(f) Warning lights switch.

(g) Running lights switch.

(h) Electrical panel lights switch.

(i) Airspeed indicator light switch.

(j) Compass light switch.

(k) Instrument lights switch.

(l) Instrument control light switch.

3. Located on the right panel are the following:

(a) Generator field control switch.

(b) Main line switch.

(c) Starter button.

(d) Starter selective switch.

(e) Volt-ammeter.

(f) The fuse panel contains the following fuses:

(1) Landing gear oil pump solenoid - 10 amperes.

(2) Landing gear signal light - 5 amperes.

(3) Heat control motor - 5 amperes.

(4) Fuel pressure warning - 5 amperes.

(5) Instrument lights - 5 amperes.

(6) Electrical panel lights - 5 amperes.

(7) Instrument control - 5 amperes.

(8) Landing light solenoid, R.H. - 10 amperes.

(9) Landing gear signal horn - 10 amperes.

(10) Red warning light in wing - 10 amperes.

(11) Running lights - 10 amperes.

(12) Cabin reading lights - 10 amperes.

(13) Dome lights - 10 amperes.

(14) Pitot head heater - 10 amperes.

(15) Landing light solenoid, L.H. - 10 amperes.

B. Ignition System

1. The ignition system consists of a switch unit which incorporates a master switch and two ignition switches, one for each engine. A conductor runs from each magneto on each engine to this ignition switch unit. The structure is used as the return.

2. A warning sign located on the front of each fireshield is marked "DANGER-WITH IGNITION PLUG OUT, IGNITION IS ON". As the ignition is grounded through the plug on the firewall, removal of the plug leaves the ignition "on". Service personnel should exercise suitable precautions against pulling the propeller through if the engine is warm and the ignition plug is out.

C. Starting System

1. The starting system consists of a push button and single pole double-throw selective safety switch, located on the right hand electrical panel, with a solenoid starting switch, a spark retarding solenoid and a booster coil in each nacelle.

D. Generator System

1. The generator system contains an engine-driven generator mounted on the left engine and a generator control box mounted in the left side of the left nacelle behind the firewall. A flexible conduit carries the leads to a Cannon plug mounted on the firewall. From this point the leads go to the generator control box. The negative lead is grounded in the plug junction box. The positive lead is carried in a conduit to the main line switch and volt-ammeter on the electrical panel; thence through the master switch to the battery.

E. Landing Lights

1. Conductors run from the fuses, located on the right electrical panel, to the switches on the left electrical panel, thence to the junction boxes inside of the outboard sides of each nacelle. Connections are made at these points and wires lead through the wing to the lights.

2. When the airplane leaves the factory the left wing light is adjusted to project a beam of light on the ground 500 feet in front of the nose of the airplane on the center line of the pilot's seat, when the airplane is in the normal flying position. The right wing light is adjusted to project a beam of light on the ground 300 feet in front of the nose of the airplane on the centerline of the left wheel when the airplane is in the normal landing position.

3. After the lights are once installed no further adjustment is provided.

4. Each landing light can be illuminated independently by means of individual switches in the pilots' compartment.

5. To replace a bulb, open the small door in the top of each wing panel above the lights, and insert bulb in light.

F. Running and Warning Lights

1. The running light switch on the left electrical panel controls the four wing tip running lights and the left on the tail cone. The red warning light in the leading edge of the left wing is controlled by a switch on the left electrical panel.

G. Interior Lights

1. The interior lights are placed in such a manner that adequate illumination for compartments, instruments, etc., is provided.

2. The fuselage tail compartment light and switch are located on the ceiling.

3. The rear baggage compartment has a dome light controlled by three-way switches placed at the dome light and side door.

4. The lavatory compartment dome light is controlled by a switch near the lavatory door. A push button beside the switch operates the co-pilot signal light on the electrical instrument panel.

5. The buffet light and switch are located in the upper right side of the buffet.

6. The rear cabin dome light is operated by an automatic switch which functions whenever the entrance door is opened.

The three forward cabin dome lights are controlled by a switch placed near the entrance door.

7. The fourteen individual reading lights are located in ducts along the sides of the cabin. The control switches and co-pilot's and steward's signal switches are located along side of each light.

(a) To change a reading light bulb it is necessary to remove the mask plate from the air duct. This may be done by removing two screws.

8. The cabin-seat-belt sign is located on the forward bulkhead and is controlled from the pilot's electrical panel.

9. The passageway and cargo compartment light and switch are located on the ceiling of the passageway.

10. The instrument lights are controlled by a switch and rheostat on the electrical panel. A push button on the control pedestal is wired in parallel to facilitate momentary illumination.

11. The compass and airspeed indicator lights are controlled by individual switches and rheostats located on the electrical panel.

12. A call button and buzzer for the steward are located on the aft end of the left hand air duct. Both the button and the buzzer are connected in series with the co-pilot's signal light and call button and all passenger call buttons. It is suggested that a code be arranged to allow the steward and co-pilot to call each other without confusion. (Note: The cabin light master switch must be kept in the "ON" position so the signal system will remain operative.)

H. Radio Supply

1. Positive and negative leads are carried from the master switch junction box, under the forward end of the cabin floor, to the radio distribution panel box located in the cargo compartment.

I. Landing Gear Warnings

1. There are three landing gear warning signals provided; namely, a Klaxon horn, located above the co-pilot's seat, a red light located in the warning light box located on the main instrument panel, and a green light, located just below the red light.

2. The retracting pump valve handle in the pilot's cockpit has a two-circuit switch which, when the valve is in the neutral position, operates a green light. There are similar two-circuit switches on the upper truss of the landing gear which are in series with the valve switch and must be closed, by the wheels being in the safe landing position, before the green light will go "on". When the valve is not in the neutral position, a red light will be "on" in the panel to the right of the electrical panels.

3. The horn is operated by the other circuits of the three switches (mentioned in Paragraph 2) in parallel; one on each landing gear truss and one on the control valve. The horn sounds whenever the throttle is closed if one or both sides of the landing gear are retracted, unlatched, or the valve is not in the neutral position. Refer to Page 131a for adjustment of landing gear warning switches.

4. A careful study of Figure 54a, Page 130a, is recommended.

J. Pitot Static Tube Heater Warning Light

1. The pitot static tube heater warning light is amber colored and is located in the upper right hand corner of the warning light box located on the main instrument panel.

K. Exterior Doors Closing Warning Light

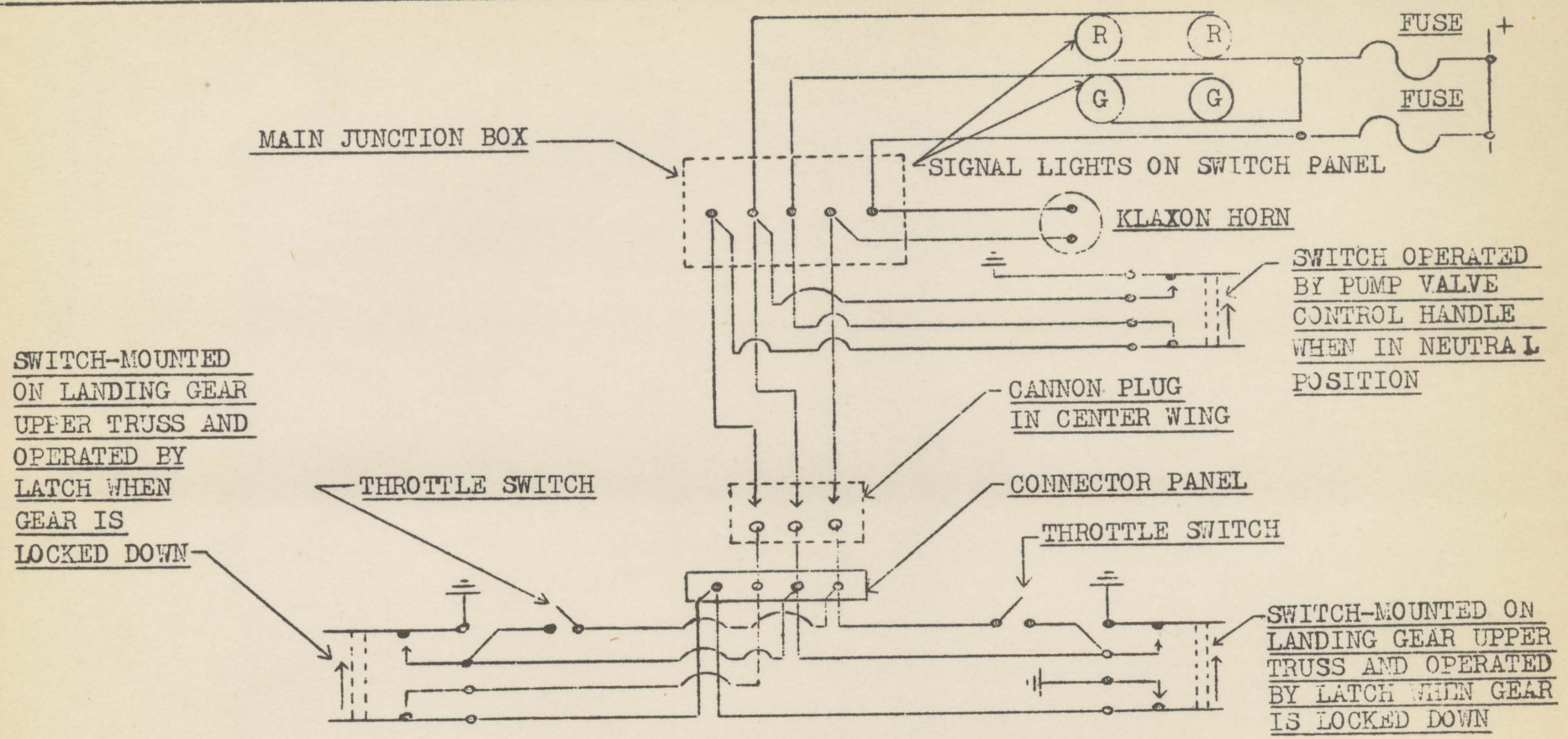
1. In the lower right hand corner of the warning light box, located on the main instrument panel, is the door warning light. This light remains illuminated until all exterior doors are properly closed.

L. Electrical Instruments

1. The oil temperature indicators, ice warning indicator, and fuel pressure gauges are electrically operated, controlled by respective switches on the electrical panel. The engine temperature indicators are operated by a thermocouple unit. Two pressure operated switches in the fuel pressure line are located on the right wall of the pilots' compartment just below the instrument panel. When the pressure in the lines decreases, these switches operate warning lights located above the fuel pressure gauges on the instrument panel.

M. Battery

1. The storage battery is located in the bottom of the fuselage forward of the wing. Access to it is gained through a trap door in the bottom surface of the fuselage. The battery is mounted on a platform which can be lowered until the battery is clear of the fuselage. A catch on the rear support tube of the platform locks it down so the battery may be removed. Special battery terminals plug into receptacles in the fuselage so that lowering the battery disconnects it.



LANDING GEAR SIGNAL SYSTEM DIAGRAM

BOTH WHEELS UP	CONTROL VALVE IN NEUTRAL	RED LIGHT	HORN WHEN THROTTLE CLOSED
BOTH WHEELS DOWN NOT LATCHED	CONTROL VALVE IN NEUTRAL	RED LIGHT	HORN WHEN THROTTLE CLOSED
BOTH WHEELS DOWN AND LATCHED	CONTROL VALVE NOT IN NEUTRAL	RED LIGHT	HORN WHEN THROTTLE CLOSED
ONE WHEEL DOWN & LATCHED	CONTROL VALVE IN NEUTRAL	RED LIGHT	HORN WHEN THROTTLE CLOSED
ONE WHEEL DOWN & NOT LATCHED	CONTROL VALVE IN NEUTRAL	RED LIGHT	HORN WHEN THROTTLE CLOSED
BOTH WHEELS DOWN & LATCHED	CONTROL VALVE IN NEUTRAL	GREEN LIGHT	NO HORN

Fig. 54a

Page 130a

2. A battery master switch control is located on the wall behind the co-pilot. The upper position is used for connecting the electrical system to a battery cart and consequently is the "off" position for the airplane's battery. The lower position connects the system to the airplane's battery.

3. The cart plug connections are located on the bottom of the fuselage just aft of the storage battery trap door. The front plug is negative and the rear plug is positive. The battery master switch should always be "off" before removing or replacing the battery.

4. A container is installed in the baggage compartment for installation of a spare battery, Exide, Model 6XT-13.

N. Junction Boxes

1. A main junction box is located on the left wall of the passageway just forward of the cabin door. Other junction boxes are installed where disconnections for disassembly are necessary.

O. Cannon Plugs

Cannon plugs are mounted at the following places:

1. On firewall of each nacelle to facilitate removal of engine equipment wiring.

2. In center wing junction box for disconnection of wing and nacelle wiring.

P. Quantities and Types of Light Bulbs

The following are quantities and types of light bulbs used:

Location	Quantity	Mazda No.
Running		
Wing Tip	4	90
Tail	1	93
Instrument Panel		
Compass	1	(Switchboard Type)
Pilot Call	1	67
Fuel Pressure Warning	2	68
Landing Gear Warning	4	68
Door Closing Warning	1	68
Pitot Static Tube Heater Warning	1	68
Switch Panel		
Pilot's Compartment Lights	6	67
Cabin Reading Lights	14	89
Dome Light	7	93
Buffet Lights	1	89

Location	Quantity	Mazda No.
Landing Lights	2	Purchased from Pyle-National Light Co. Under American Airlines Specifications.
Warning Light	1	1143
Cabin-Seat-Belt Signal Light	4	67
Cabin Dome Light (Rear)	1	67

Q. Maintenance

1. Battery: Both male and female terminals of the battery must be kept clean and be tight fitting to insure positive contact, and self-aligning receptacle should be frequently cleaned and greased to insure ease of operation to prevent bending of terminals in the event of sticking.

2. To Change the Battery:

(a) Pull out lock wires which hold battery door closed.

(b) Pull release handle locking pin out.

(c) Pull release handle and battery platform straight down until catch on rear slide tube engages. Note: It is important that safety catch be engaged before removing battery as platform is spring loaded.

(d) Loosen battery clamps and lift battery off platform.

(e) Place new battery on platform and tighten clamps.

(f) Hold battery platform down and release safety catch, then push platform up and insert locking pin.

3. To Adjust Landing Gear Warning Switches

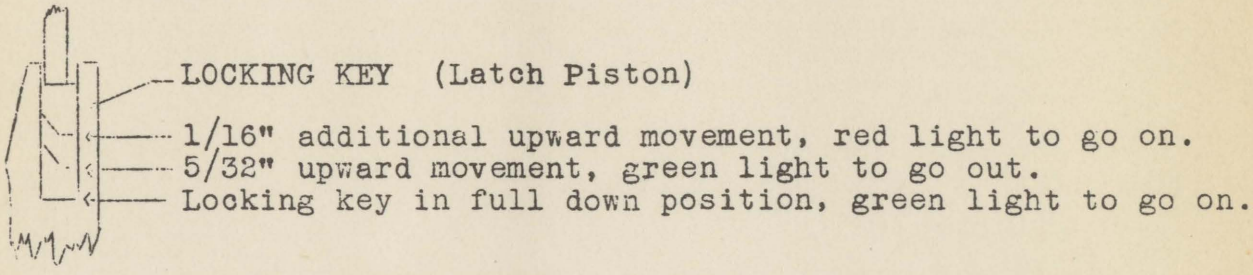
(a) Warning switches must be set individually for each airplane as follows:

(1) With latch in locked position, set switch actuating cam on latch piston so that distance from top of latch packing nut to underside of cam is 3/4 of an inch.

(2) From this setting adjust cam locknuts so as to give signal

simultaneously on each side of landing gear. To do this it will be necessary to hoist airplane and operate retracting gear slowly.

(3) The retracting gear truss signal switch should be set to operate the red and green warning lights at the dimensioned positions of the locking key as indicated in the sketch below.



4. Maintenance of Landing Gear Latch Switch

(a) The landing gear latch switch, which operates the landing gear warning signal, is located on the rear wall of the nacelle. Operation of this latch is explained in Paragraph 9, Page 87. The spring and contact points in this unit should be inspected for tension and cleanliness at least every thirty hours. For access to the switch, remove the cover from the switch box.