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FOR OFFICIAL USE ONLY

AN 01-20EG-2

ERECTION AND MAINTENANCE INSTRUCTIONS

FOR

ARMY MODEL

B-17G

BRITISH MODEL

FORTRESS II

AIRPLANES

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25 AUGUST 1944

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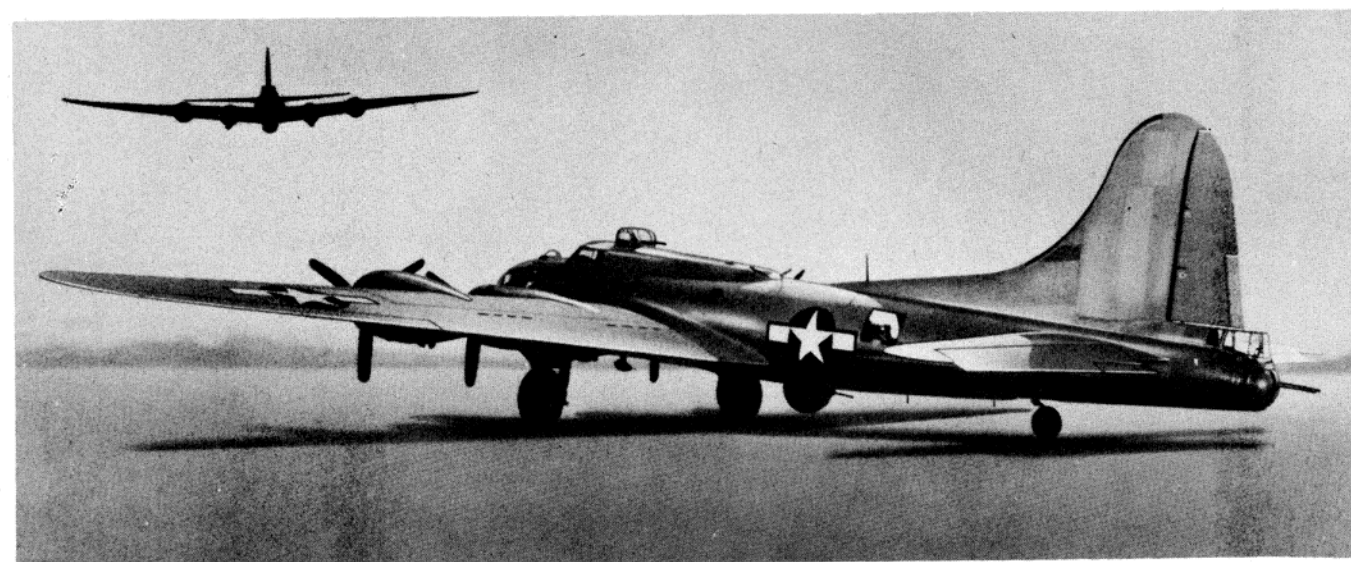
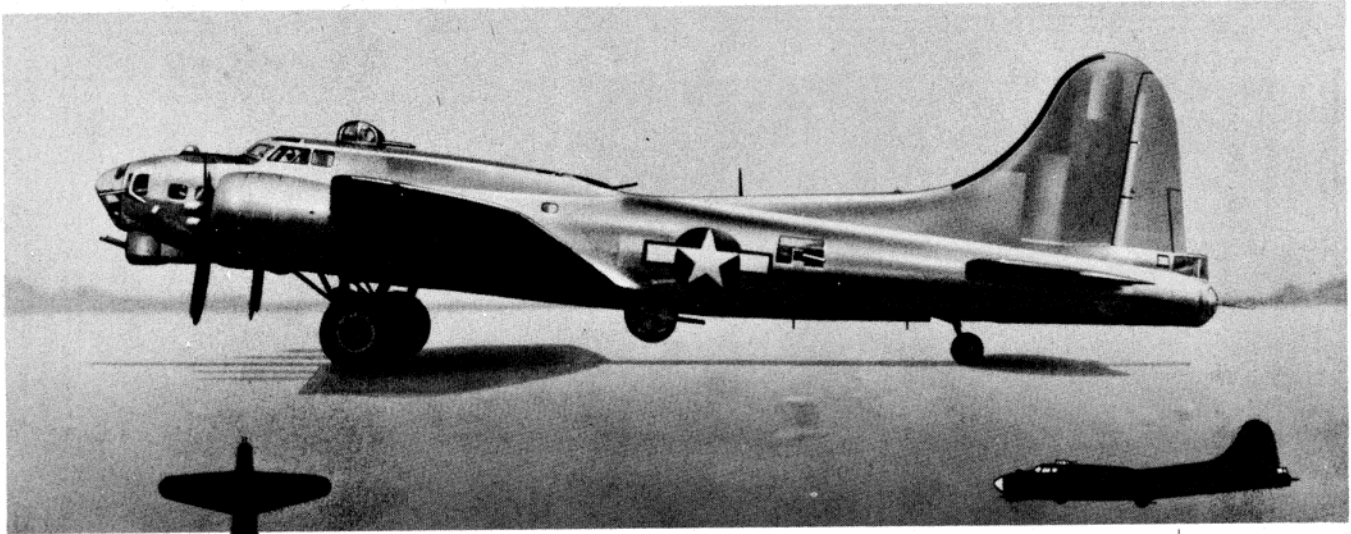
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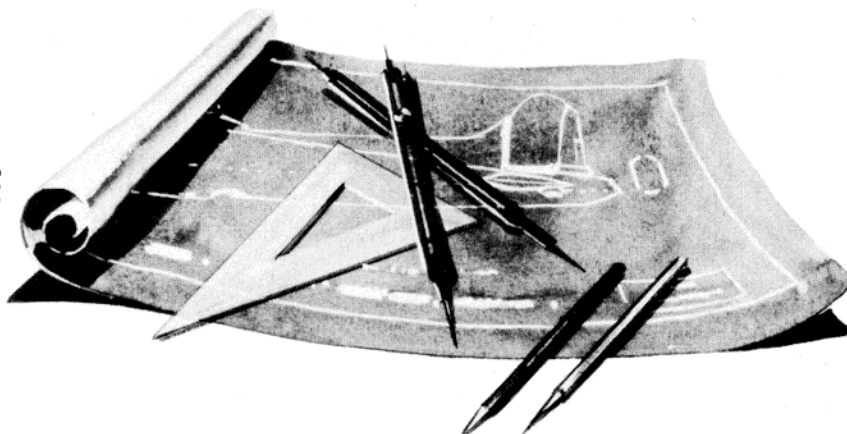


Boeing B-17G Airplane

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SECTION I

DESCRIPTION, DIMENSIONS AND LEADING PARTICULARS



1. DESCRIPTION.

a. GENERAL.—The B-17G Heavy Bomber is a low-wing land monoplane. It is an all-metal airplane of semi-monocoque construction powered by four Wright Cyclone R-1820-97 engines equipped with three-bladed Hamilton Standard Hydromatic propellers. The defensive armament of the airplane includes three power turrets, a twin tail gun installation and three single guns. Later airplanes have five single guns. All guns are .50 caliber.

b. PURPOSE.—The B-17G is a heavy bombardment airplane designed for long distance and high altitude operation.

2. PRINCIPAL DIMENSIONS.

GENERAL.

Over-all span	103 ft., 9.38 in.
*Over-all length	74 ft., 8.90 in.
Over-all height, thrust line level	294.91 in.
Over-all height, at rest	229.00 in.
Height, propeller hub, with thrust line level	86.29 in. (inbd.) 98.78 in. (outbd.)
Height, propeller hub, taxi position (at tip of propeller dome)	101.40 in. (inbd.) 111.00 in. (outbd.)
Clearance, propeller tips, thrust line level	16.79 in. (inbd.) 29.28 in. (outbd.)

*With revised plexiglas nose installation, later B-17G airplanes have an over-all length of 74 ft., 3.90 in.

WING.

Airfoil section	NACA 0018
At root	NACA 0010
At tip	
Chord-root	228.00 in.
Chord-tip	106.70 in.
Incidence	3 1/2 deg. (in plane of wing)
Dihedral	4 1/2 deg.
Sweepback	8 deg., 9 min.

STABILIZER.

Span	43 ft.
Chord-maximum (measured on fuselage center line)	134.4 in.
Incidence	0 deg.
Dihedral	0 deg.

FUSELAGE.

Width (from wing root to wing root)	9 ft., 2 in.
Height	8 ft., 6 in.

3. AREAS.

WING.

Total area (including ailerons and flaps)	1277.5 sq. ft. (net)
---	----------------------

AILERONS.

Total area (each)	69.5 sq. ft.
Area of trim tab (used on left side only)	380 sq. in.

FLAPS.

Total area	139.1 sq. ft.
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STABILIZERS.

Total area	283.5 sq. ft. (net)
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ELEVATORS.

Total area	114.7 sq. ft.
Area of trim tabs	10.0 sq. ft.

FIN.

Total area	170.6 sq. ft.
------------	---------------

RUDDER.

Total area	37.80 sq. ft.
Area of trim tab	3.40 sq. ft.

**4. SETTINGS AND RANGES OF
MOVEMENT OF CONTROL SURFACES.**

AILERONS.

-up	12 deg.	4 in.
-down	12 deg.	4 in.

FLAPS.

45 deg.

ELEVATORS.

-up	23 deg.	14 1/2 in.
-down	14 deg.	8 7/8 in.

RUDDER.

-right	22 deg.	17 5/16 in.
-down	22 deg.	17 5/16 in.

TRIM TABS.

Elevator—up	22 deg.	4 15/16 in.
—down	22 deg.	4 15/16 in.
Rudder—right	22 deg.	3 13/16 in.
—left	22 deg.	3 13/16 in.
Aileron—up	15 deg.	1 13/16 in.
—down	15 deg.	1 13/16 in.

Tolerance on control surface movements ± 2 deg.

5. LANDING GEAR.

MAIN LANDING GEAR.

Type: Electrically retractable gear.	
Tread	253.52 in.

Shock struts:

Type: Air-oil.
Mfgr.: A. O. Smith No. ALG-102-D.
Fluid required: AAF Spec. 3580M.

Wheels (main)

Type: Hayes with dual duplex brakes.
Tires: 56-inch smooth contour.

Brakes: Dual duplex, hydraulically operated.

TAIL WHEEL.

Type: Electrically retractable.
Shock strut: Air-oil.
Mfgr.: A. O. Smith No. ATG-100000.
Fluid required: AAF Spec. 3580M.
Wheel: Hayes No. G-3-217A.
Tire: AN-C-55, 26-inch smooth contour.

6. ENGINES.

Four, Wright-Cyclone nine-cylinder engines,
R-1820-97.
Gear ratio: 16:9.
Fuel: AN-F-28.
Oil: AN-VV-0-446.

7. PROPELLER.

Type: Three-bladed, hydromatic, WEE50-473 or 505,
full feathering.
Mfgr.: Hamilton Standard.
Hub: 23E50-473.
Blade: 6477A-6.
Diam.: 11 ft. 7 in.

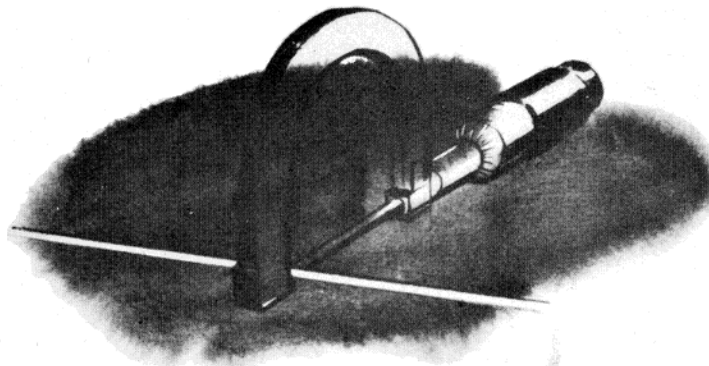
8. TANK CAPACITIES.

FUEL.

Main Tanks	1700 U. S. 1416 B.I.G.
Outer wing tanks (Tokyo tanks)	1080 U. S. 900 B.I.G.
Bomb bay tanks	820 U. S. 682 B.I.G.

OIL.

Oil Tanks (four)	36.9 U. S. 30.7 B.I.G. each.
Expansion space of 10 percent.	



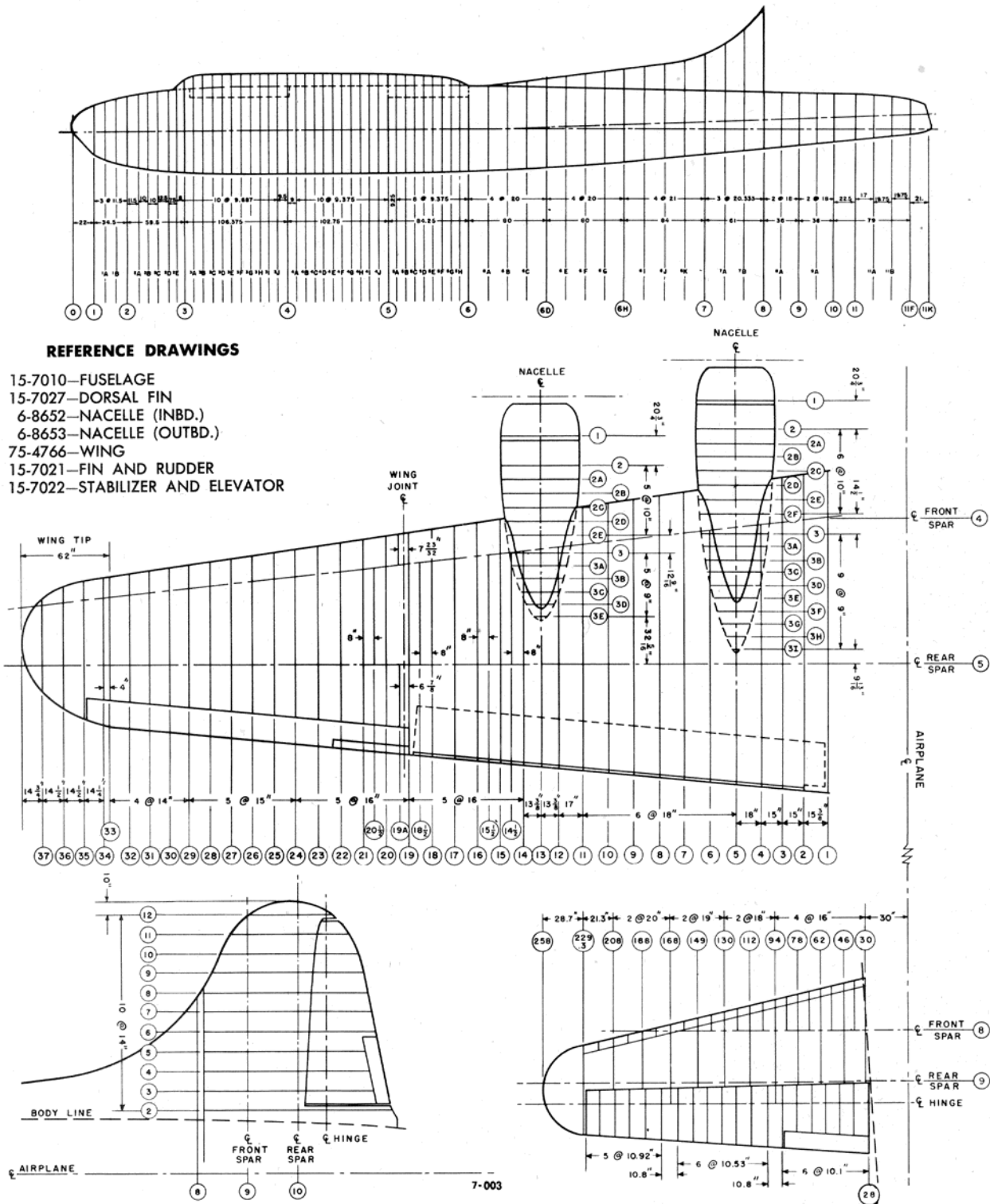


Figure 2—Fuselage, Wing, Nacelles and Empennage Station Diagram

SECTION II

SHIPMENT AND ERECTION PROCEDURE



1. SHIPMENT OF AIRCRAFT.

a. This airplane is not designed for shipment and has sufficient range to be ferried to its destination.

2. ERECTION PROCEDURE.

a. Refer to the appropriate paragraph of Section IV for specific instructions covering the installation of the major components of the airplane.

LEGEND

1. Access Door—Outer Wing Hoisting Ring
2. Access Door—Inner and Entire Wing Hoisting Ring
3. Access Door—Complete Airplane Hoisting Ring
4. Access Door—Landing and Passing Light
5. Access Door—Oil Tank Filler Neck
6. Access Door—Supchgr. Lub. Tank (Outboard Nacelle)
7. Access Door—Fuel Tank Filler Neck
8. Access Door—Outer Wing Fuel Tanks
9. Access Door—Outer Wing Fuel Tanks Filler Neck
10. Access Door—Fuel Tank Gage
11. Access Door—Oil Temperature Regulator
12. Access Door—Gylcol Tank Filler (No. 2 Nacelle)
13. Access Door—Battery
14. Access Door—For Ground Heater Duct
15. Access Door—Wing Tip
16. Access Door—Electrical Connection
17. Access Door—Booster Pump and Drain
18. Access Door—Leading Edge
19. Access Door—Oil Tank Sump
20. Access Door—Outboard Nacelle
21. Access Door—Waste Gate Control
22. Access Door—Drain
23. Access Door—Wing Terminal
24. Access Door—Engine Heating and Propane Starting
25. Access Door—Carburetor Anti-Icer Tank Filler Neck
26. Cover—Deicer Boot Connection
27. Access Opening—Aileron Hinge
28. Access Opening—Aileron Hinge and Control
29. Access Opening—Aileron Hinge and Trim Tab
30. Inspection Door—Aileron Control
31. Inspection Door—Aileron Trim Tab Control
32. Inspection Door—Landing Flap Control
33. Inspection Door—Landing Flap Support
34. Air Intake
35. Air Outlet
36. Access Door—Governor Control
37. Receptacle—External Bomb Rack Electrical Control
38. Landing Wheel Well
39. Turbo Supercharger Well
40. Mooring Well
41. Cutout—Starter Crank
42. Swing Cutout—Landing Flap
43. Gap Cover
44. Fuel Tank Vent
45. Door Installation Remote Compass

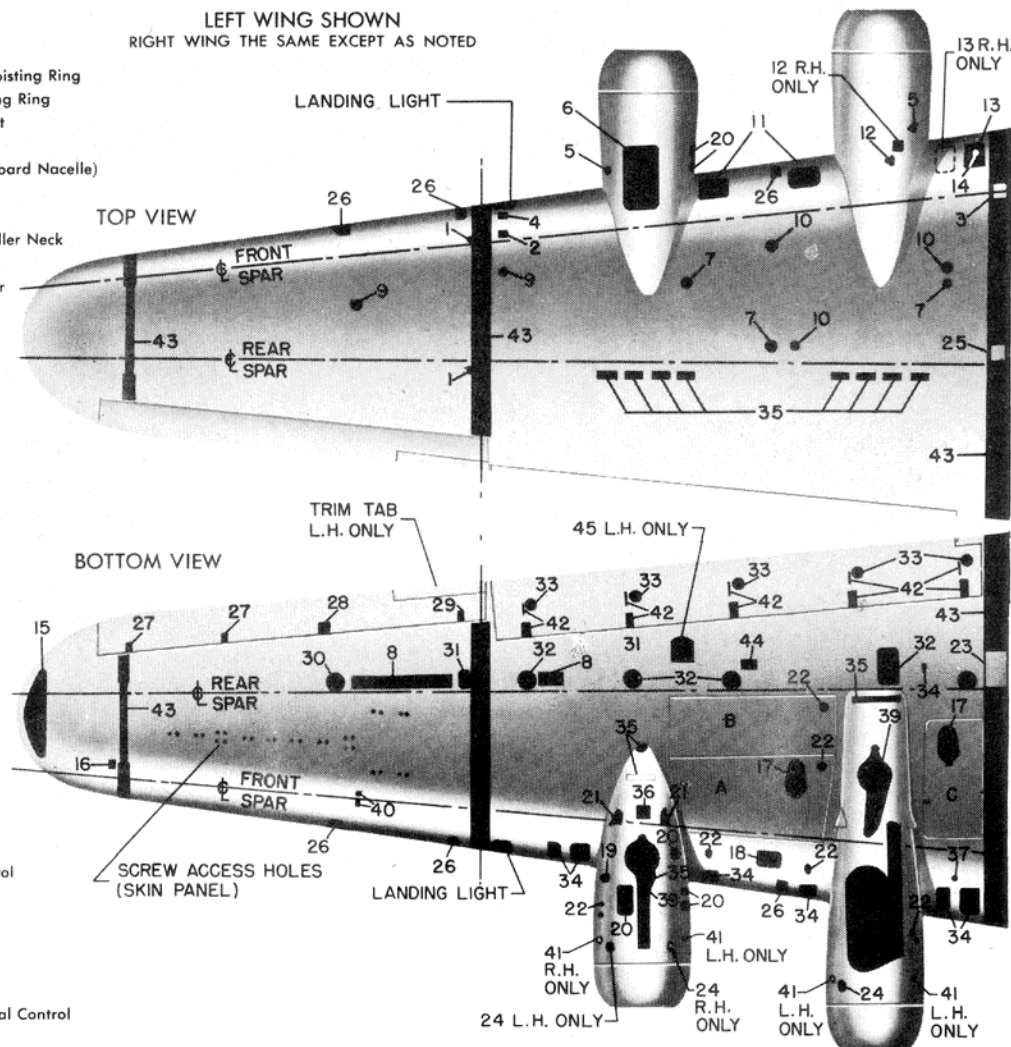
REFERENCE DRAWINGS

- 75-3590 WING TIP ASSEMBLY
 85-4772 WING ASSEMBLY—OUTBOARD
 15-7975 WING ASSEMBLY—INBOARD
 85-4806 NACELLE INSTALLATION—OUTBOARD
 85-4805 NACELLE INSTALLATION—INBOARD
 58-784 AILERON ASSEMBLY
 75-5127 WING FLAP ASSEMBLY

TANK DOOR SCREW SIZES	
D	¼-28 x 1¾ WASHER HD. STL.
E	¼-28 x ¾ WASHER HD. STL.
F	¼-28 x 1½ WASHER HD. STL.

● DOWELS FOR DOOR ALIGNMENT ONLY

LEFT WING SHOWN
 RIGHT WING THE SAME EXCEPT AS NOTED



Caution!
 Do not remove or install fuel tank doors before jacking up outboard nacelle at firewall to take torsion loads from wing. Do not overtighten screws.

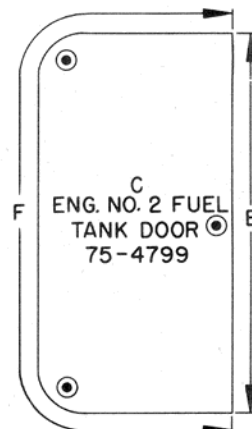
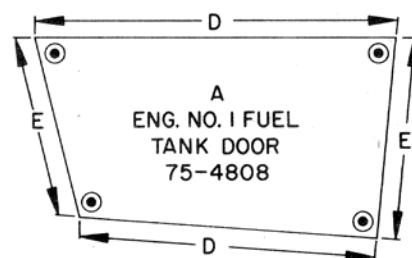
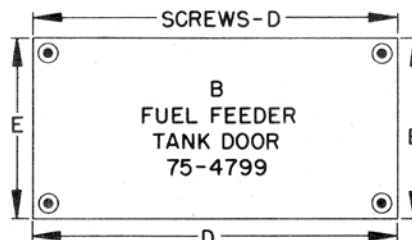
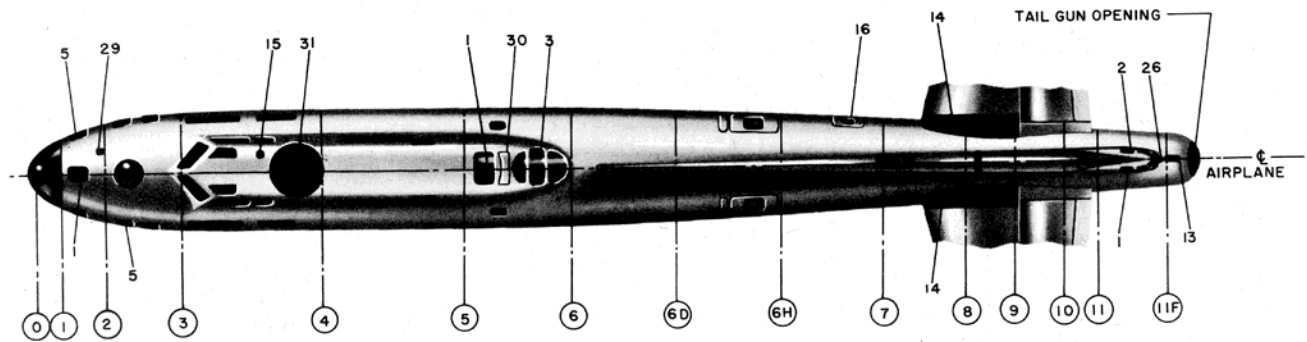
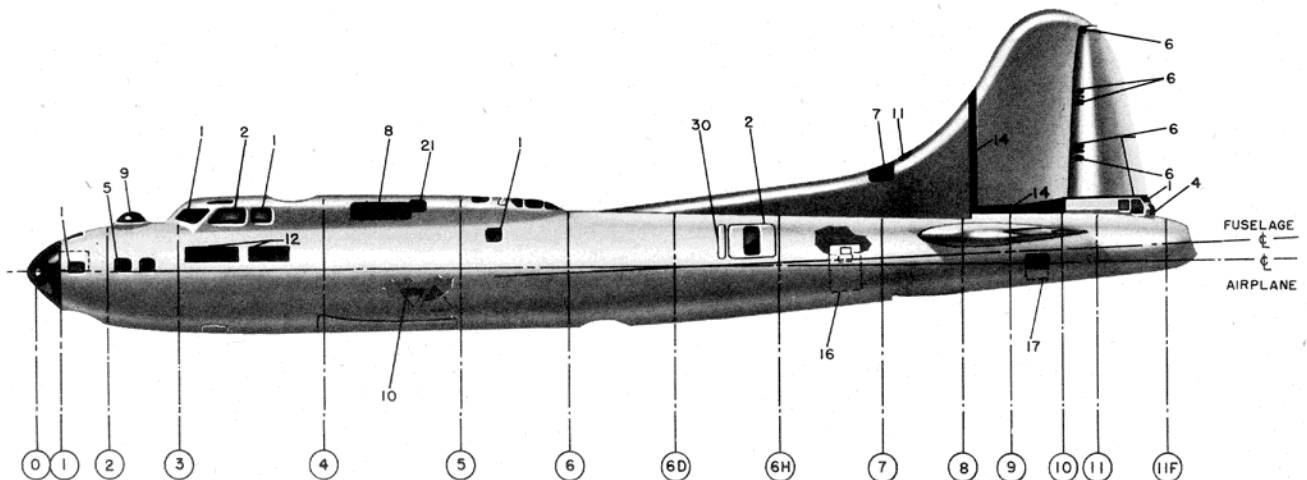


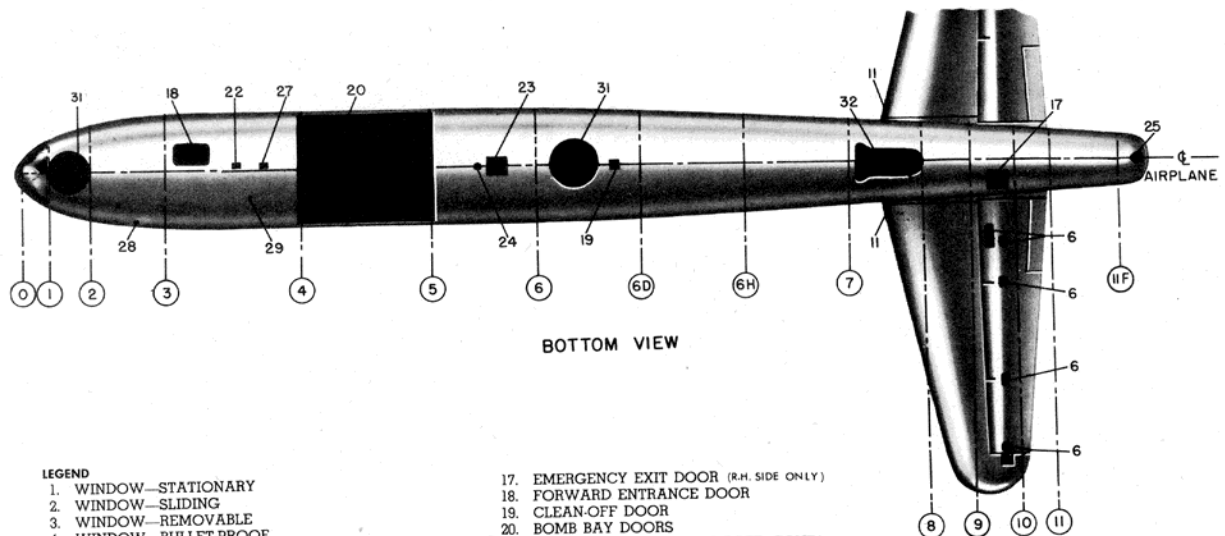
Figure 3—Access Doors and Openings—Wing



PLAN VIEW



L.H. SIDE VIEW



BOTTOM VIEW

LEGEND

1. WINDOW—STATIONARY
2. WINDOW—SLIDING
3. WINDOW—REMOVABLE
4. WINDOW—BULLET-PROOF
5. WINDOW—GUN
6. ACCESS DOOR
7. ACCESS DOOR—LIFT RING
8. ACCESS DOOR—LIFE RAFT
9. ASTRODOME
10. +ACCESS DOOR—DEICER DIST. VALVE
11. ACCESS DOOR—DEICER TUBE
12. ACCESS DOOR—CONTROLS
13. ACCESS DOOR—SIGHT CONTROLS
14. GAP COVER
15. VERY PISTOL DOOR
16. ENTRANCE DOOR—MAIN

17. EMERGENCY EXIT DOOR (R.H. SIDE ONLY)
18. FORWARD ENTRANCE DOOR
19. CLEAN-OFF DOOR
20. BOMB BAY DOORS
21. INSPECTION DOOR (LIFE RAFT. CONT.)
22. DRIFT SIGNAL DOOR
23. CAMERA DOOR
24. CAMERA VIEW FINDER DOOR
25. CARTRIDGE EJECTION CHUTE
26. SIGHT INSTALLATION HOLE
27. EXTERNAL POWER RECEPTACLE
28. FAIRLEAD—DRIFTMETER
29. VENT
30. SPOILER
31. TURRET OPENING
32. TAIL WHEEL WELL

REFERENCE DRAWINGS

- 15-7991—NOSE INSTALLATION
- 55-7330—FUSELAGE (FWD. SECT.)
- 65-7331—FUSELAGE (REAR SECT.)
- 15-7360—TAIL GUN ENCLOSURE
- 15-7023—FIN ASSEMBLY
- 15-7024—RUDDER ASSEMBLY
- 15-7027—DORSAL FIN INST.
- 15-7025—STABILIZER ASSEMBLY
- 15-7026—ELEVATOR ASSEMBLY

+ACCESSIBLE INSIDE BOMB BAY

Figure 4—Access Doors and Openings—Fuselage and Empennage

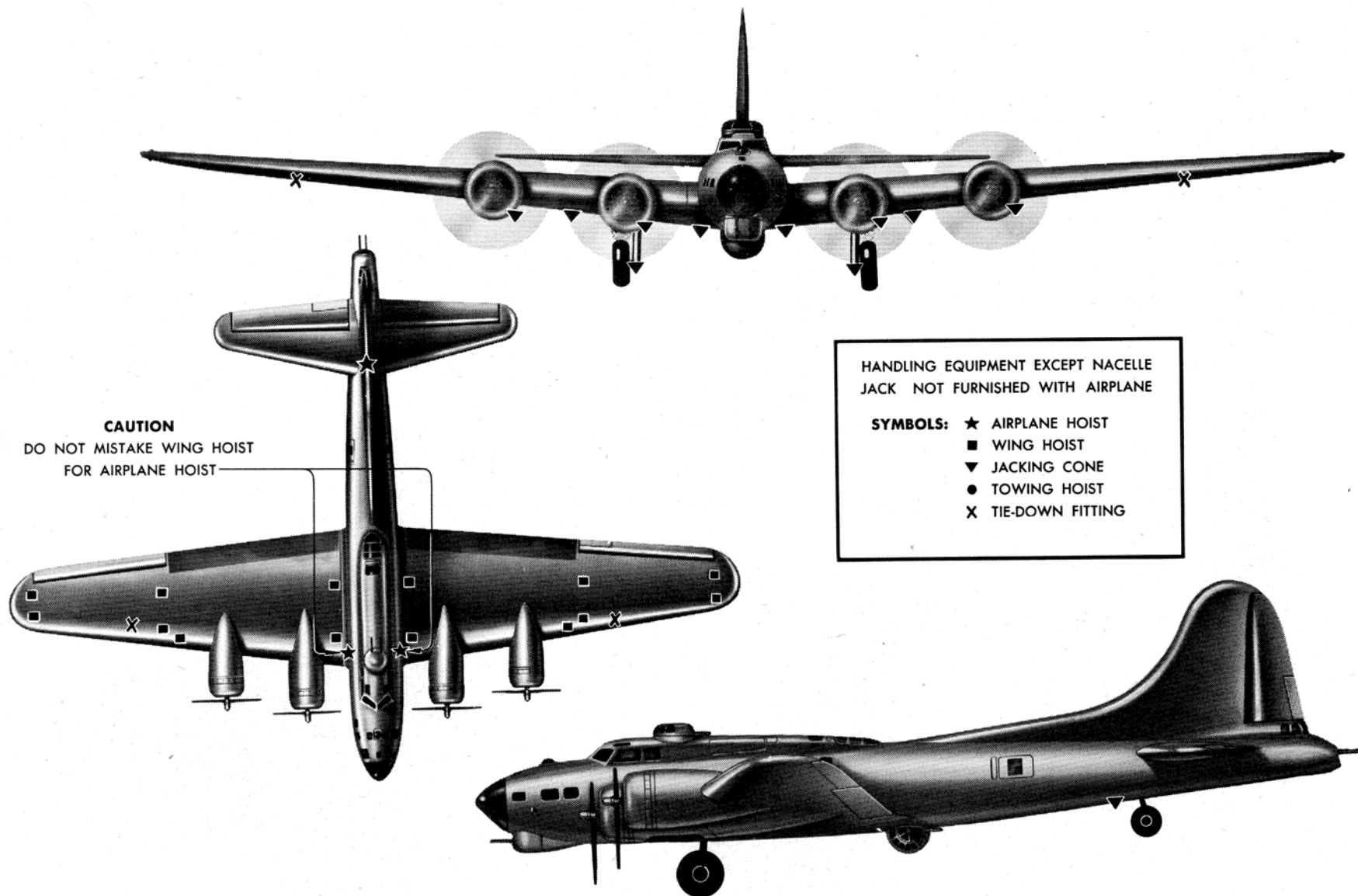
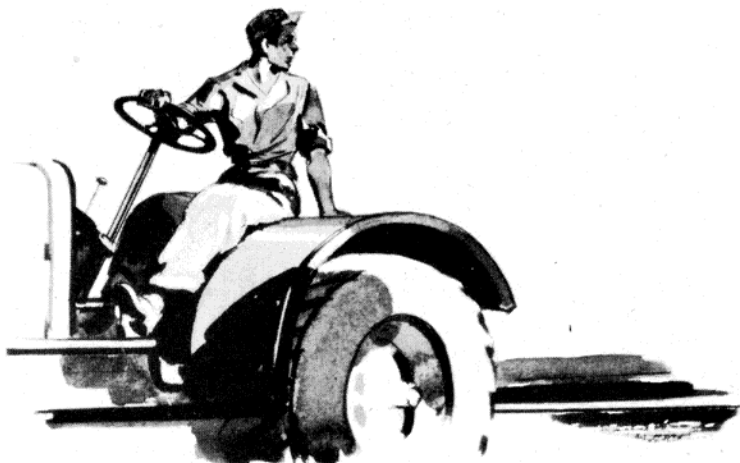


Figure 5—Handling Diagram

SECTION III

HANDLING AND GENERAL MAINTENANCE INSTRUCTIONS



1. ACCESS AND INSPECTION PROVISIONS.

See figures 3 and 4.

2. GROUND HANDLING.

a. HOISTING.

(1) GENERAL.

(a) Overhead hoisting equipment will be carefully checked as to capacity and suspension before use. Specific authority must be secured from the station engineering officer for its use on each particular type of airplane.

(b) In hoisting the complete airplane or any of the various assemblies, the loads must be applied in a vertical direction only. The hoist-sling diagrams contained in this section illustrate the manufacturer's handling slings, which in some cases, due to the extremely light loads involved in handling structure only, indicate loads not applied vertically. However, this does not in any way affect the limitations against non-vertical loads in normal hoisting operations.

(c) The complete airplane or portions thereof may be hoisted as indicated in the accompanying diagrams. Combinations of hoisting points other than those indicated may be used, provided the allowable loads given in the hoisting diagram (figure 6) are strictly observed. The hoisting loads diagram (figure 7) provides a tabulation of cable loads for various conditions of the assemblies involved.

(2) **OUTER WING.**—The outboard wing panel (either with or without the wing tip) may be hoisted at the rings provided on the upper front and rear spar chords between stations 19 and 20 and at the upper wing tip terminals. When hoisting with wing tip attached, remove the terminal bolt in each top terminal at the tip

connection, and replace with a bearing bolt of the same diameter but of sufficiently greater length to permit looping the hoist cable around the extended portion of each end of the special bolt. Screw the original nut onto the special bolt to retain the cable at the threaded end. The slight lift required at the tip hoist points will permit the loads to be applied as illustrated in the diagram. (See figure 8.)

(3) **INNER WING.**—The inboard wing (less engines) is hoisted by two rings provided on the wing compression strut at station 1 and one fitting on the upper front spar chord at station 19. The inboard wing plus engines is hoisted by the front ring on the wing compression strut at station 1, a sling on the inboard propeller shaft aft of the spline, and the hoisting ring provided on the upper front spar chord at station 19. The hoist location on the propeller shaft is not available with the propeller installed and damage to the propeller assembly may occur if the sling is attached at the propeller dome. However, in the event that other considerations might warrant risking damage to the propeller assembly in an emergency, that condition will be found on the hoisting loads chart. If used in this manner, the hoisting cables should attach to two propeller blade shafts as near the hub dome as possible. Should conditions make this method of attachment impractical, the sling should bear on the housing, close to the blades, instead of on the dome.

(4) **COMPLETE WING.**—The complete wing, including engines, may be hoisted by the same arrangement as used for the inboard panel. Hoisting the entire wing without engines is not recommended as the balance in this condition falls forward of the remaining hoist points.

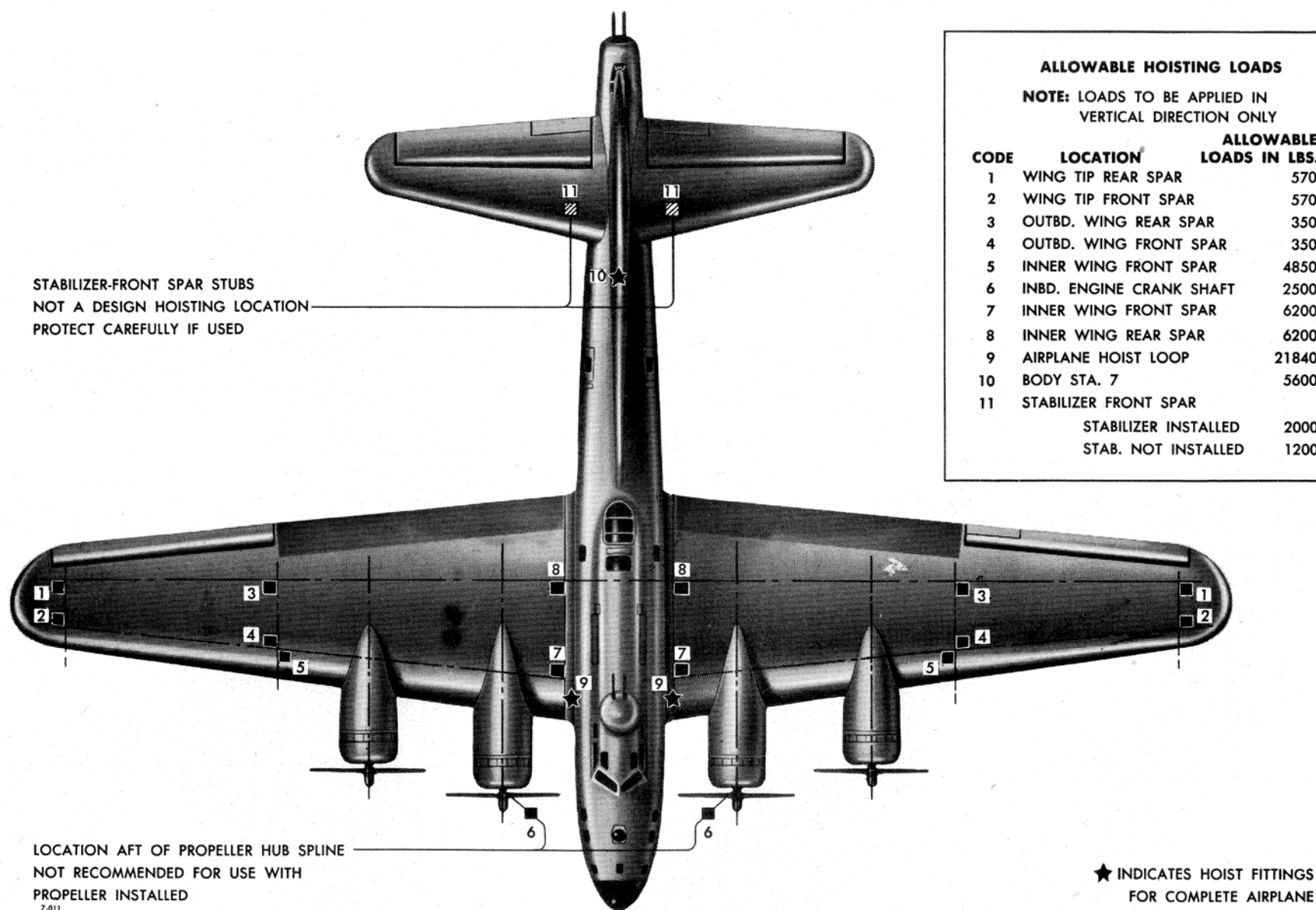


Figure 6—Hoisting Diagram

UNIT HOISTED	CONDITION OF UNIT	APPROXIMATE VERTICAL HOISTING LOADS IN LBS. GROSS WEIGHT, LBS.					
OUTBOARD WING	Less Tip.	S ₁ = 121	S ₂ = 122	R ₁ = 135	R ₂ = 147	525	
	Including Tip.	S ₁ = 145	S ₂ = 146	R ₁ = 134	R ₂ = 144	570	
INBOARD WING	Structure Only.	T = 1980	U ₁ = 3571	U ₂ = 924			6475
	Plus Engines and Landing Gear.	N = 3190	Q = 1162	O = 5679			10031
	Plus Engines, Ldg. Gear and Propellers.	N = 3858	Q = 1883	O = 5146			10887
COMPLETE WING	Plus Engines and Landing Gear.	N = 4117	O = 5630	Q = 800			10547
	Plus Engines, Propellers and Landing Gear.	N = 4598	O = 5308	Q = 1497			11403
FUSELAGE	Sta. 1 to Sta. 6 Structure Only.	B = 830	B = 830	C = 381	C = 381	2422	
	Sta. 1 to Sta. 6 Full Equipment.	B = 3446	B = 3446	C = 103	C = 103	7098	
	Sta. 6 to Sta. 11F Structure Only.		I = 364	E = 969			1333
	Sta. 6 to Sta. 11F Plus Equipment and All Empennage.		I = 154	E = 3235			3389
	Complete Fuselage Structure Only.	A = 1246	A = 1246	E = 1263			3755
	*Complete Fuselage Plus All Equipment and Tail Gear	A = 3657	A = 3657	E = 2290			9604
	*Complete Fuselage Plus Equipment, Tail Gear and						
	Empennage.	A = 3561	A = 3561	E = 3365			10487
COMPLETE AIRPLANE	Weight Empty.	X = 14891	X = 14891	E = 2469			32251
	Normal Design Gross.	X = 18588	X = 18588	E = 3083			40260

*Use Sling Similar to IME-15-7377 (Fig. 26) But Design for Loads Shown Here.

SEE HOISTING DIAGRAMS FOR LOCATION OF HOIST POINTS INDICATED BY LETTERS IN THIS CHART

Figure 7—Hoisting Loads (Approximate)

(5) FUSELAGE.

(a) The fuselage section, stations 1 to 6, is hoisted by attaching cables to taper pins in the wing terminals. If the taper pin holes have been reamed, care must be taken to use either pins of the proper taper or tapered bushings to avoid damage to the wing terminal. Should the taper pin installed in the airplane be used for hoisting purposes, the taper pin itself should be protected by a suitably tapered hoisting fitting. The slight loads involved in hoisting the structure only, permit the cables to be attached as illustrated in figure 14.

(b) The fuselage section, stations 6 to 11-F, is hoisted by a special fitting on station 6 and the hoisting lug at station 7. If necessary, a sling looped around the horizontal stabilizer upper front terminals may be substituted for the fitting at station 7, but cables must not bear on any other part of the airplane. Care should be taken when the fitting at station 7 is used, to avoid damage to deicer tubing and electrical wiring near the hoisting lug.

(c) The tail gunner's enclosure is not provided with hoist fittings and is most easily handled by the

use of a dolly or carriage equipped with padded cradles for support of the assembly at the bulkheads.

(d) The entire fuselage may be hoisted by means of cables attached to pins in the upper wing terminals and the terminal at station 7. Reamed holes must be protected as described in instructions for hoisting the front section and stabilizer terminals may be substituted, if necessary, for the fitting at station 7, as described in the procedure for hoisting the rear section.

(6) EMPENNAGE.—The vertical stabilizer, rudder, horizontal stabilizer, and elevator may be handled manually. Hoisting rings and lugs are not provided for these items.

(7) COMPLETE AIRPLANE.—For hoisting the entire airplane use the two rings provided in the wing spar terminals and the fitting at station 7. Stabilizer front spar fittings may be substituted for the hoisting lug at station 7, if necessary.

CAUTION

Do not mistake the front wing hoist ring for the complete airplane hoist ring. The airplane hoist ring is part of the upper front wing ter-

minal assembly, whereas the wing hoisting ring is merely attached to the wing compression rib.

b. JACKING.

(1) Jacking cones are provided on the lower side of the front spar chords on bulkhead 4 just inboard of the wing terminals, on the lower side of the front spars at wing station 8, on the landing gear axle, and at the bottom of bulkhead 7.

(2) The airplane as a whole may be jacked by using either the cones on the body near the front spar terminals, and the cone on the bottom of the body at station 7, or the cones on the front spar at wing station 8, and the cone on the bottom of the body at station 7. Adequate strength is provided to permit jacking of the airplane at any weight up to the maximum alternate gross weight (48,726 pounds). The use of the inboard jacking cone on one side of the airplane and the outboard point on the opposite side is not only allowable but in some cases desirable.

(3) When changing tires or servicing the brakes, the cone on the landing gear axle may be used, provided the gross weight does not exceed 42,000 pounds. It is recommended, however, that the airplane be securely jacked at three points and the gear partially retracted instead.

CAUTION

Do not use the torsion link for jacking under any condition.

(4) A jacking cone is provided on the lower left engine mount connection in each nacelle. Jacking at these points is required in order to relieve torsional stresses in the wing while removing or replacing the wing fuel tank doors. For any use of the nacelle jacks, the body should be securely jacked to avoid the possibility of body weight settling on the jacked nacelles. If wing tank doors are to be removed from one wing only, a minimum of four jacks should be used; one to support the outboard engine nacelle on the wing concerned, one on either side of the body at station 4 and one at body station 7. **DO NOT USE JACKING CONES ON THE WHEEL AXLES FOR THIS PURPOSE.**

(5) It is recommended that the nacelle jacks be left in place while the panels are off. However, if it is necessary to move the airplane with panels removed, no damage will result if it is towed slowly on a smooth surface.

(6) Any combination of jacking conditions may be used provided the load on any individual jacking point does not exceed the value given in the jacking diagram, figure 23. These loads must be observed or structural damage may result.

(7) When lifted at a single joint, the path of that point is an arc and thus the cone will not remain centered above the jack. This displacement will tend to cause failure of the jack, or shifting of the airplane, or both. Therefore, *jacking of the airplane at one point*

only must be held to a minimum. Jack failure may also result from too great an extension of the jack piston or screw, therefore, the maximum jacking lift, in any case, should be limited to approximately seven inches.

(8) If damage has caused the airplane to rest considerably off the laterally level position, extend the shock strut fully on the low side by means of a high-pressure air bottle, and, if necessary, deflate the strut on the high side. This will permit leveling of the airplane in most cases, and will expedite the jacking operations. Extension of the shock strut on one side will result in approximately 8 1/2 inches lift.

CAUTION

Release the parking brakes before jacking at the body or wing cones. Extension of the shock strut tends to force the airplane rearward if the brakes are set and may cause jack failure, airplane damage, or both.

(9) The following additional precautions will be taken, as circumstances warrant, when jacking up the airplane:

(a) When jacking points are close together, yawing moments due to wind may cause the jacks to flex and clamp, and the airplane must be shored with adjustable height steel stands brought to bear against such units of the primary structure as are capable of sustaining the weight of the airplane. These stands must support the airplane forward of its center of gravity or the airplane tail must be weighted with sufficient sand bags to bring the center of gravity back of the point of support.

(b) Operate all jacks as nearly simultaneously as possible, when raising the airplane, in order to keep the wings in a horizontal position at all times. Allow for movement of the tail wheel if it is to stay on the ground. When the tail also will be raised, operate the jacks to keep the airplane in its normal position, as when at rest on the ground. Raising the tail of an airplane excessively, without also raising the forward portion, will produce a forward load on the tail jack which will tend to unseat or overturn the jack.

(c) Be sure the jacks, shoring stands, etc., are of sufficient capacity to support the airplane safely.

(d) If the airplane is to be unattended for any length of time while being supported, be sure no ladders or equipment are left in such a position as to cause damage to the airplane should a jack fail because of leakage of the hydraulic fluid. Always support the airplane either by hoists from above or shoring from below.

(e) Airplanes will first be headed downwind and in no case raised when exposed to winds of more than 15 MPH velocity.

(f) In addition to the use of shoring stands and hoists for support of airplanes on jacks, yawing may be eliminated by means of ropes passed through wing

and tail mooring rings and properly secured to anchor points on the ground.

(g) During periodic inspection, including operation of the landing gear, wheel inspection, etc., or replacement of these items, shoring or overhead support of the airplane may be dispensed with unless the airplane remains on jacks overnight, or the airplane remains unattended.

(b) Other suitable means of shoring are:

1. Heavy timber cribbing with top members felt padded and snugly fitted under the wing spars along three or four feet of span.

2. Large felt-padded timbers fitted to the chord-wise contour of the wing extending several inches to the front and rear of the spars, and supported by wooden horses or by a stand of suitable strength.

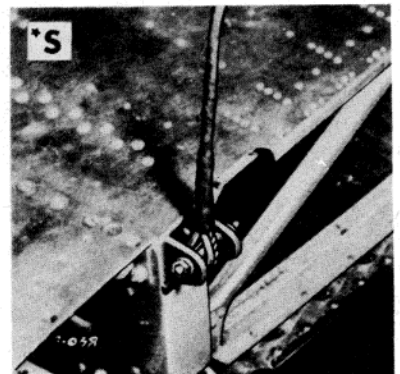
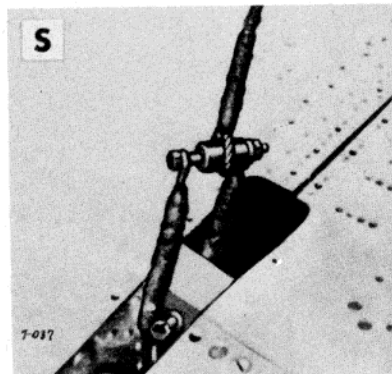
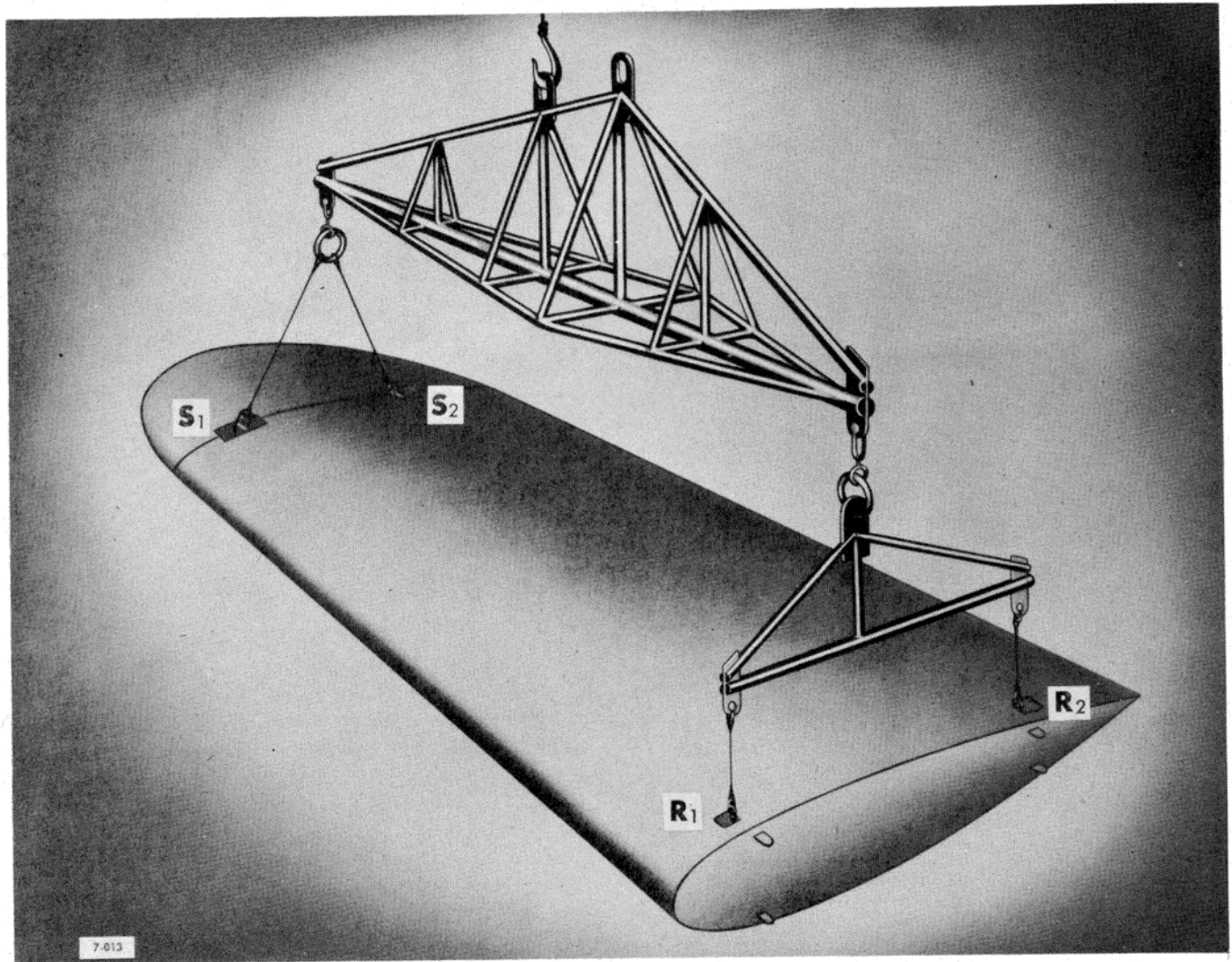


Figure 8—Outboard Wing Panel Hoisting Sling

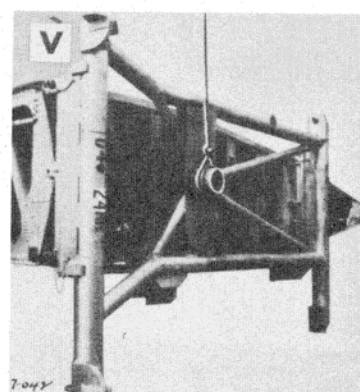
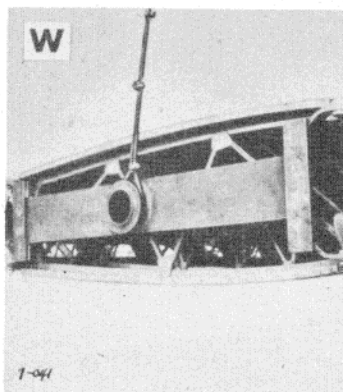
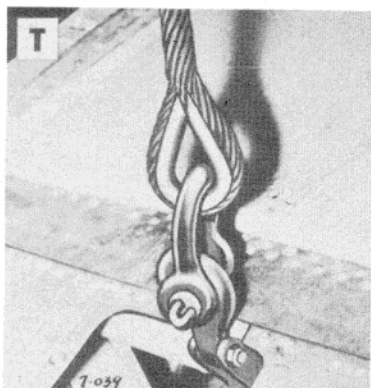
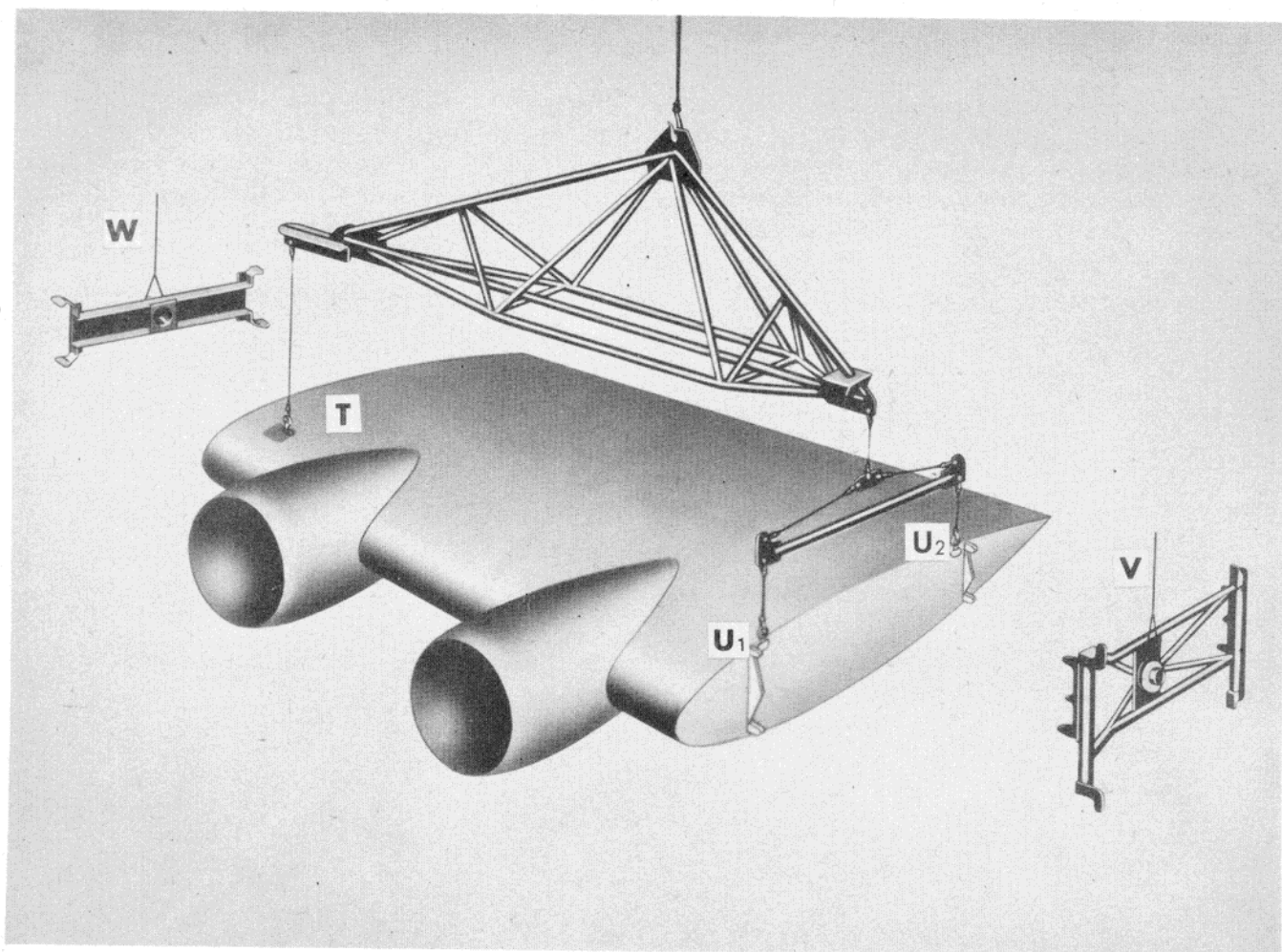


Figure 9—Inboard Wing Panel Hoisting Sling, Without Engines

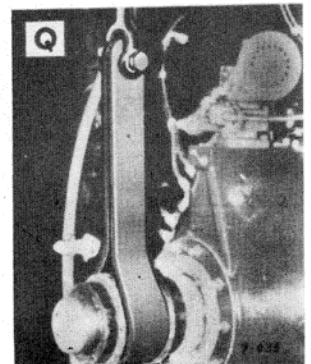
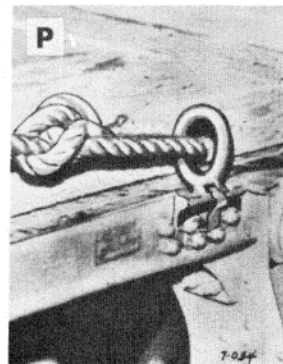
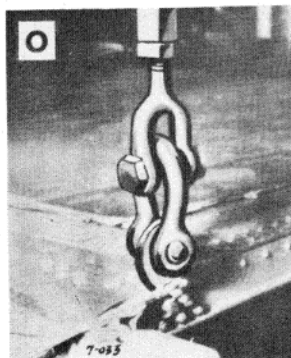
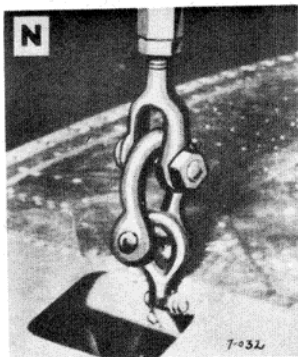
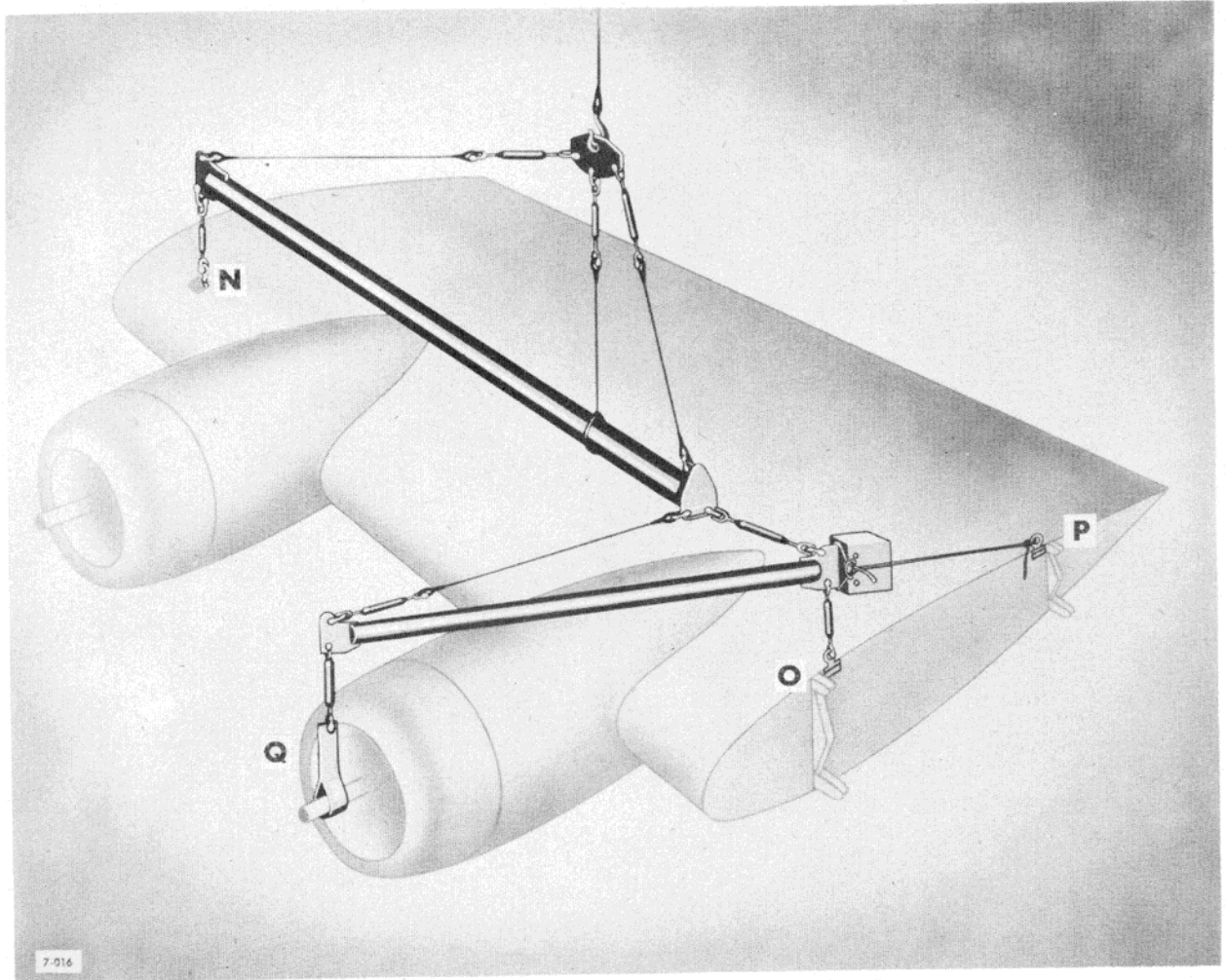


Figure 10—Inboard Wing Panel Hoisting Sling, With Engines

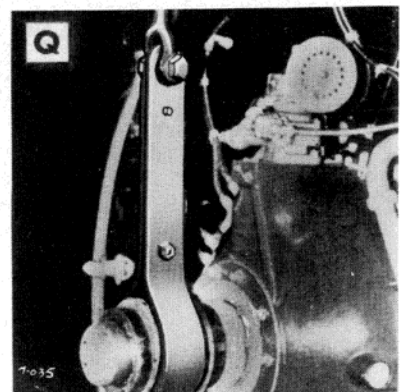
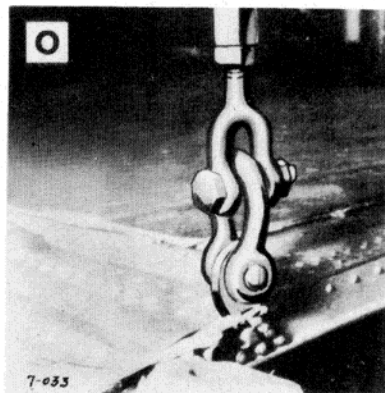
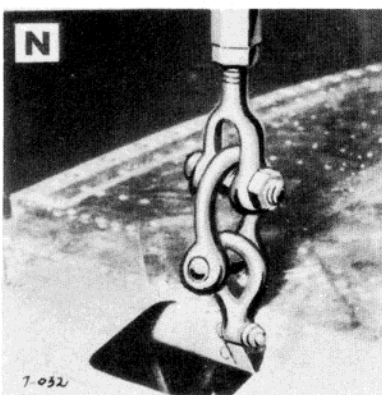
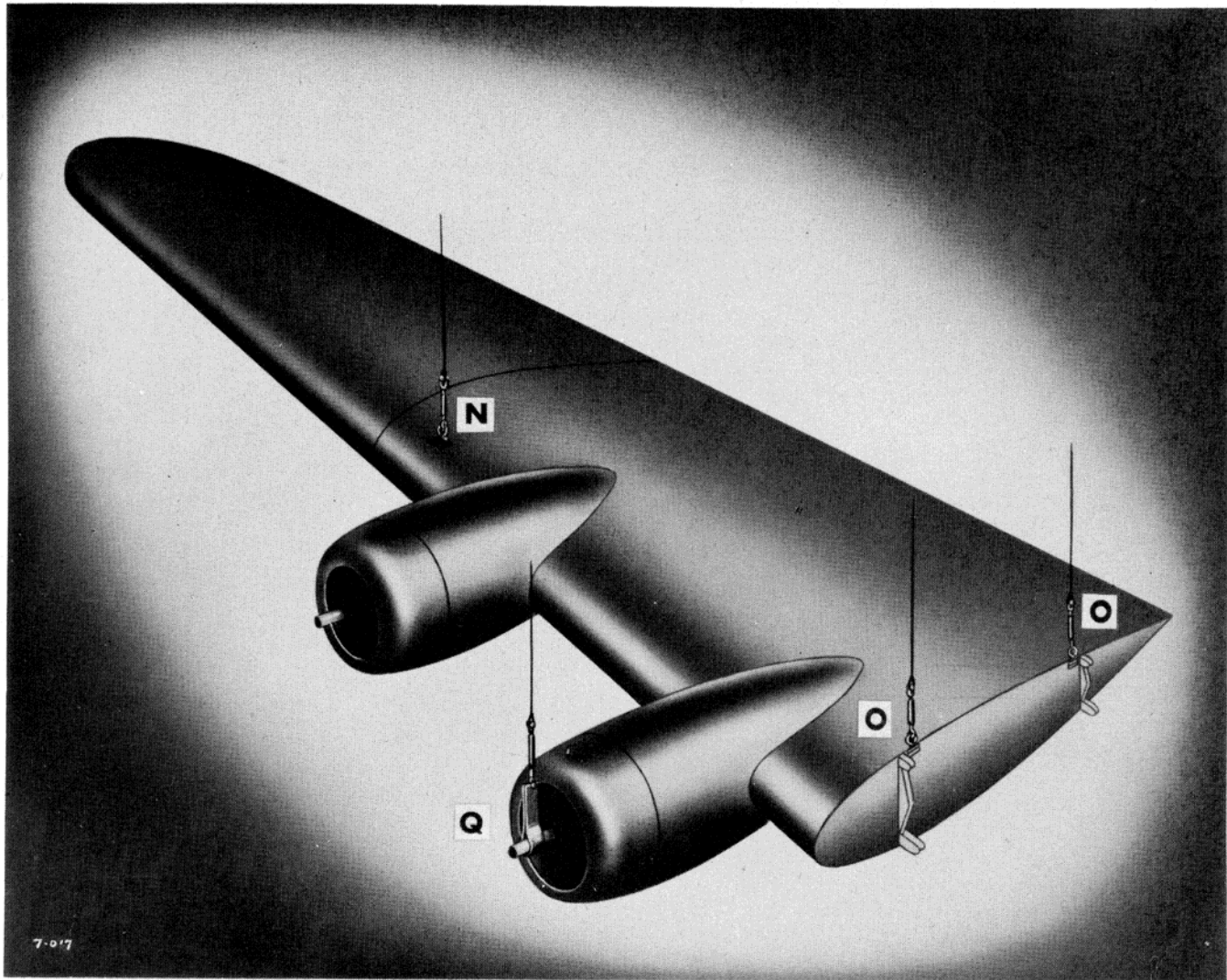


Figure 11—Hoisting Points for Complete Wing

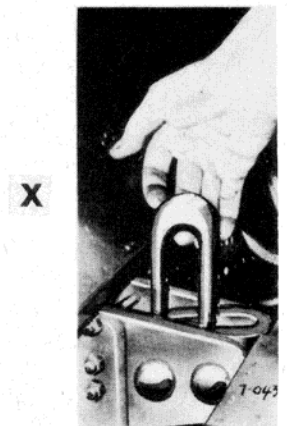
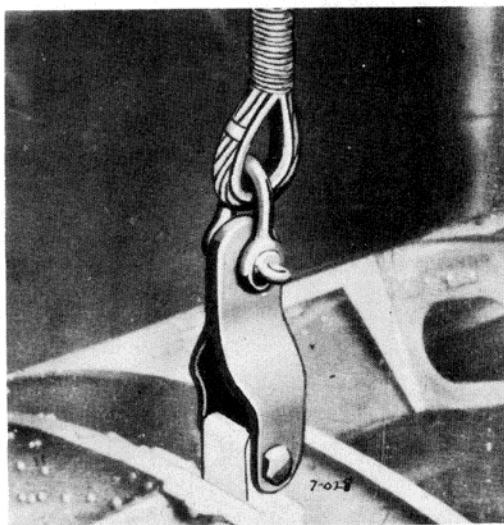
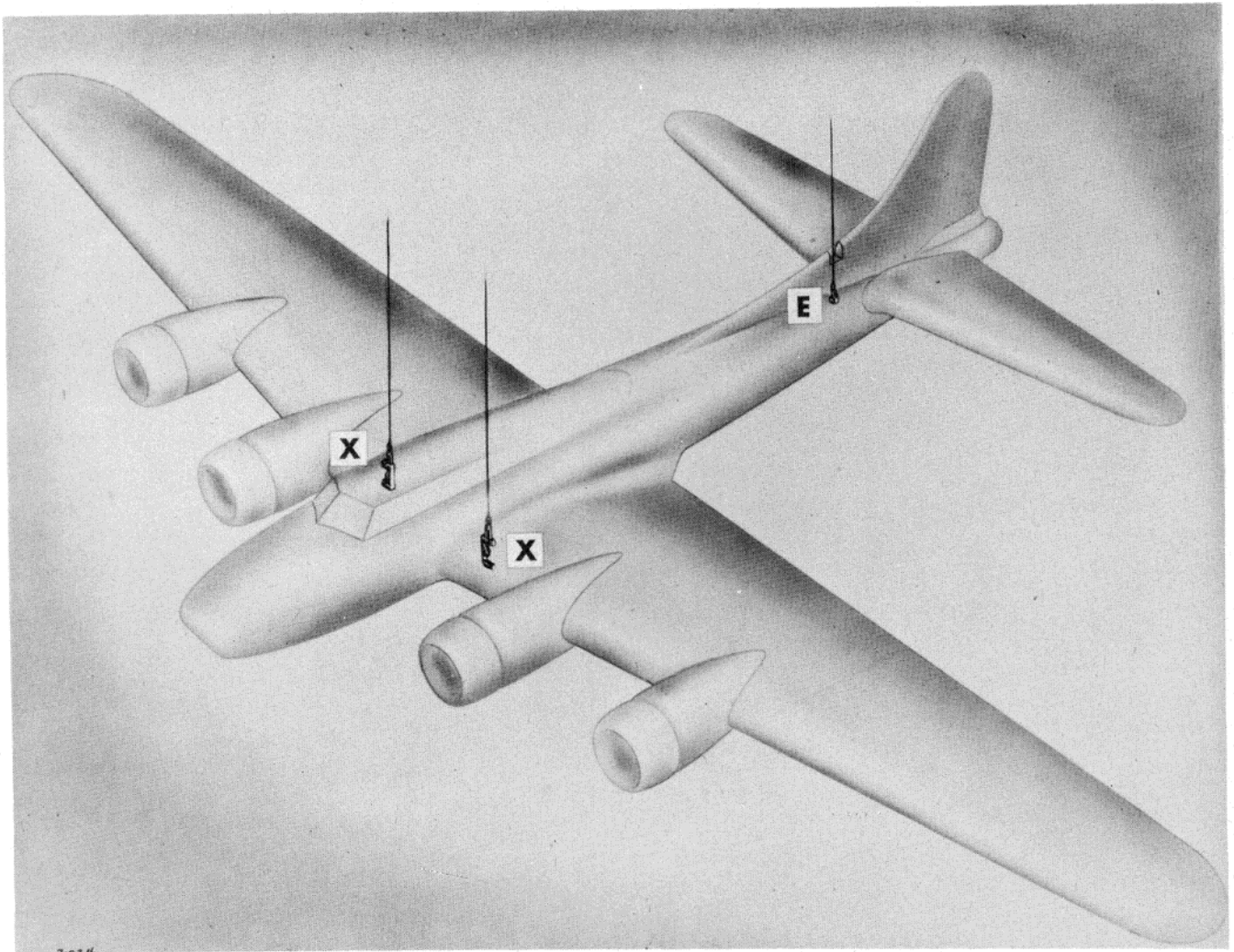
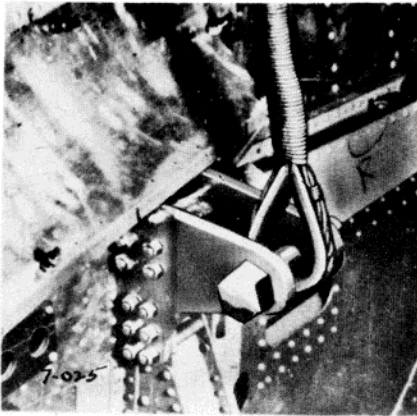
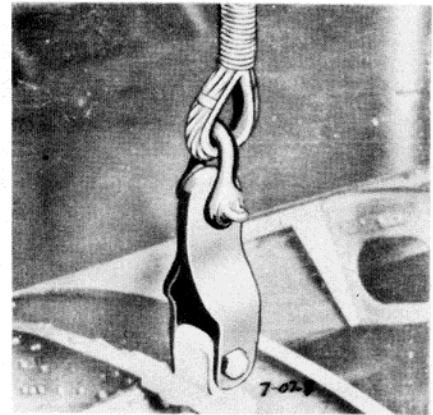


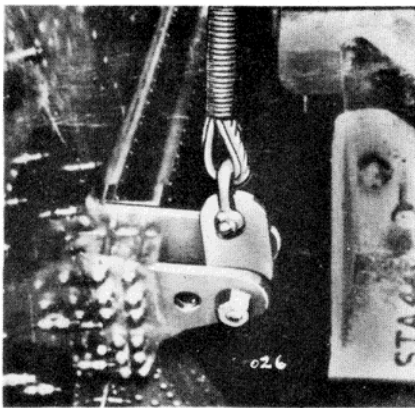
Figure 12—Hoisting Points for Complete Airplane



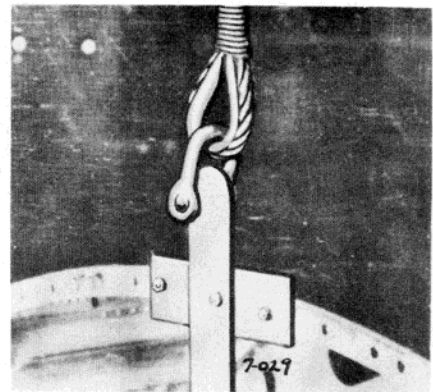
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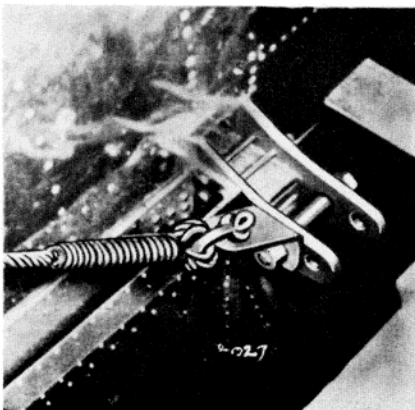
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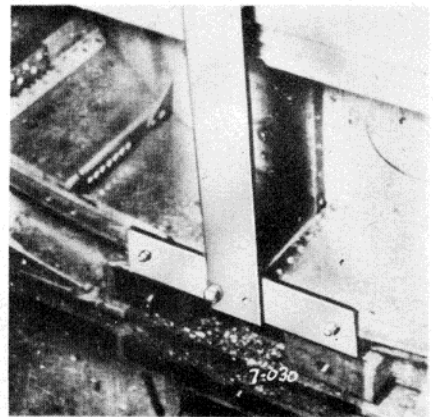
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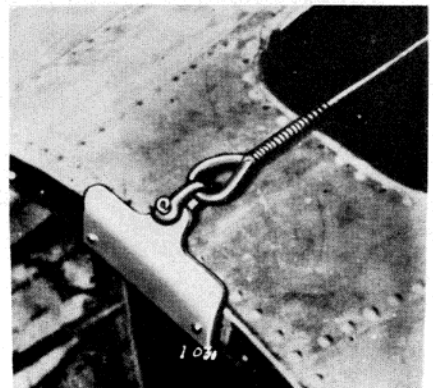
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C



J



M

Figure 13—Hoisting Connection Details

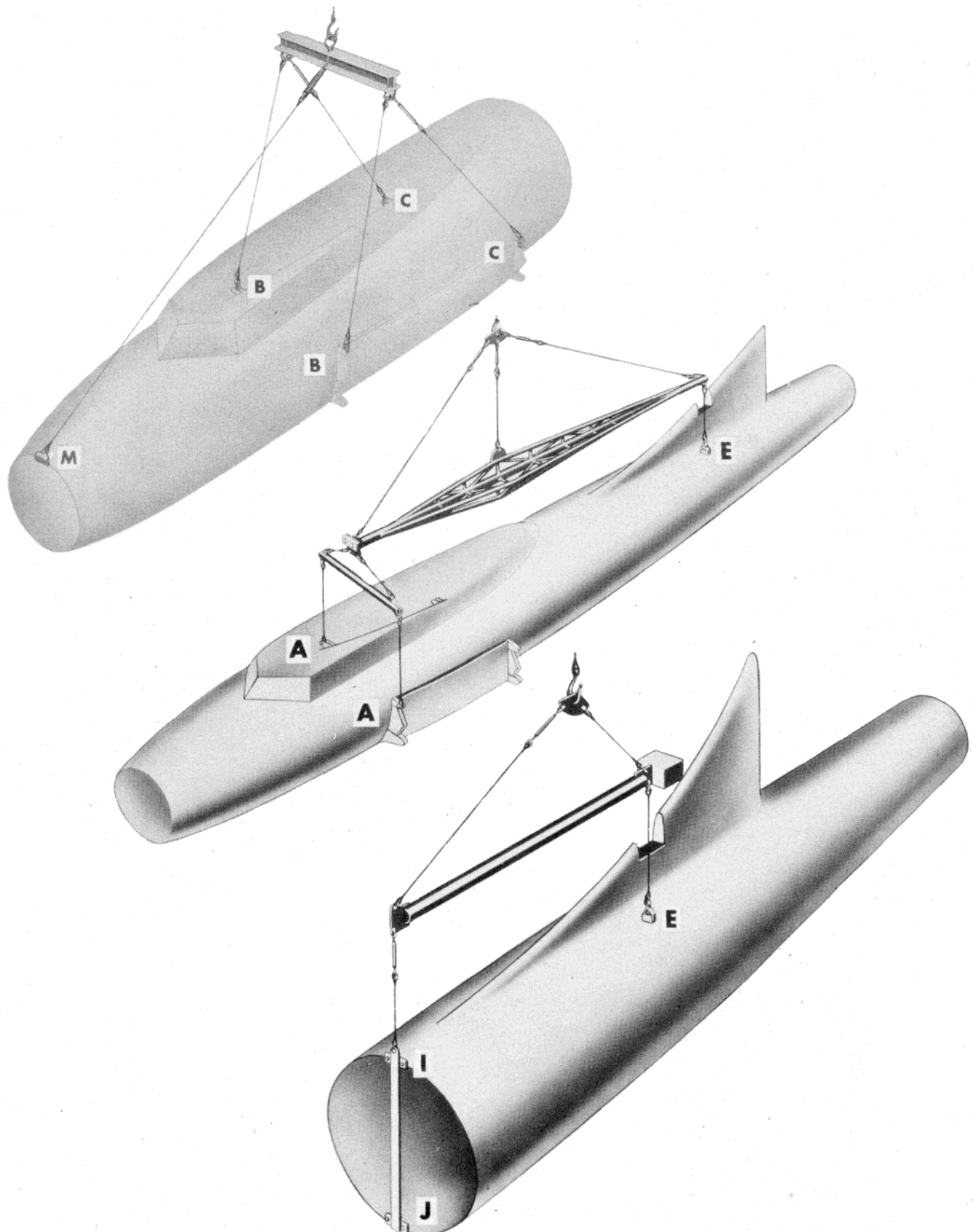


Figure 14—Fuselage Hoisting Slings

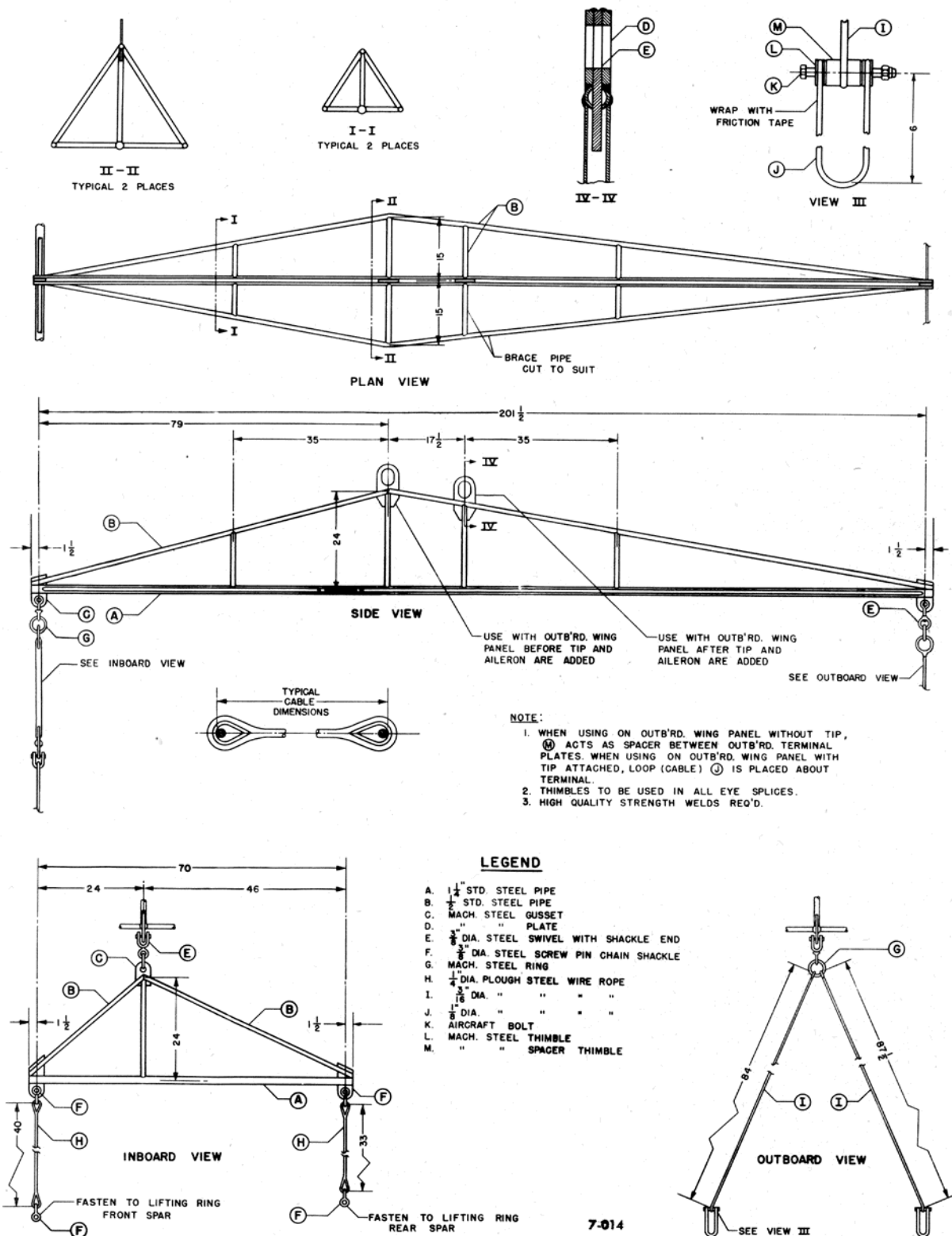
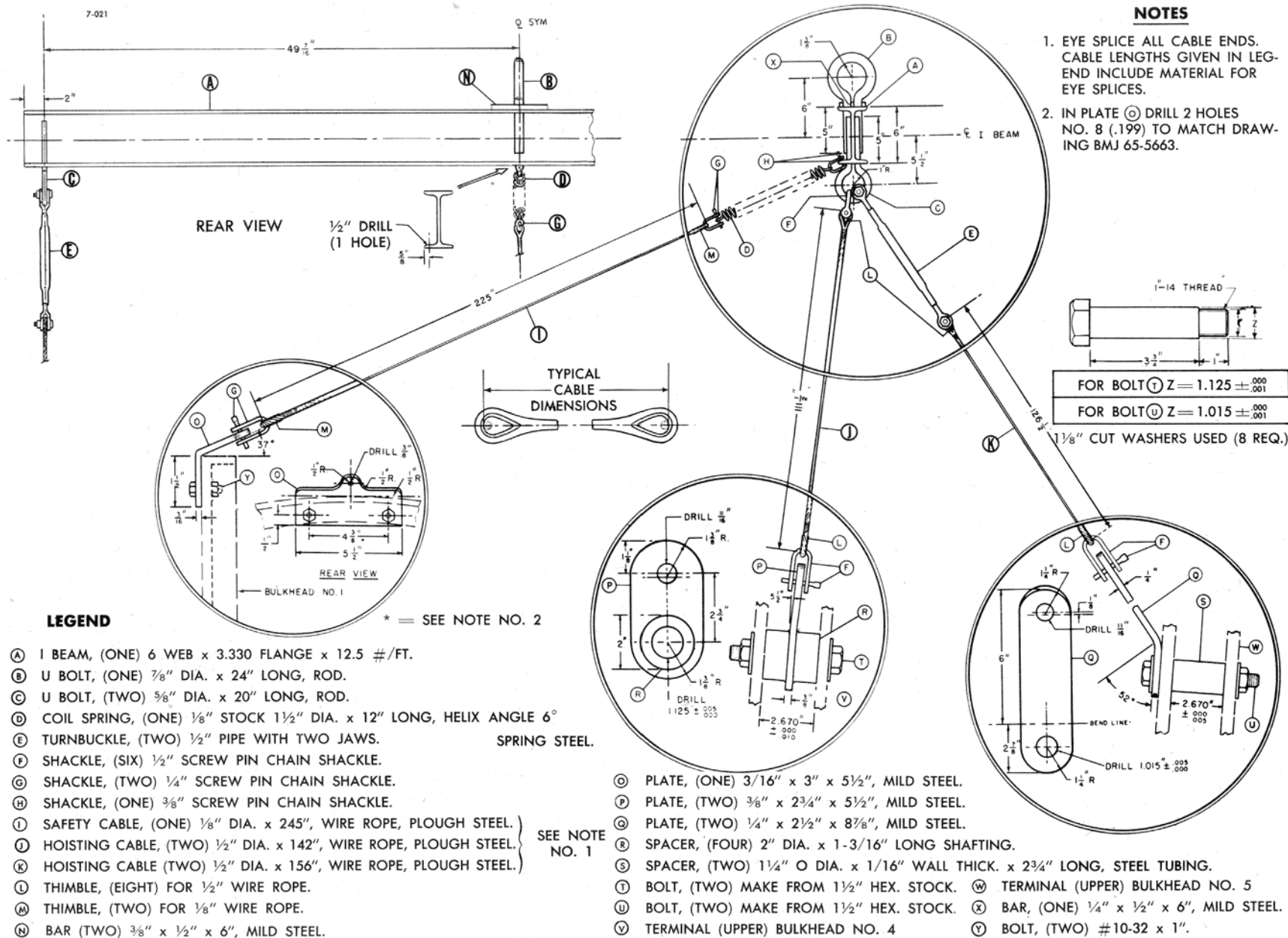


Figure 15—Outboard Wing Panel Hoisting Sling Details





Figure 17—Inboard Wing Panel Hoisting Sling Details, With Engine



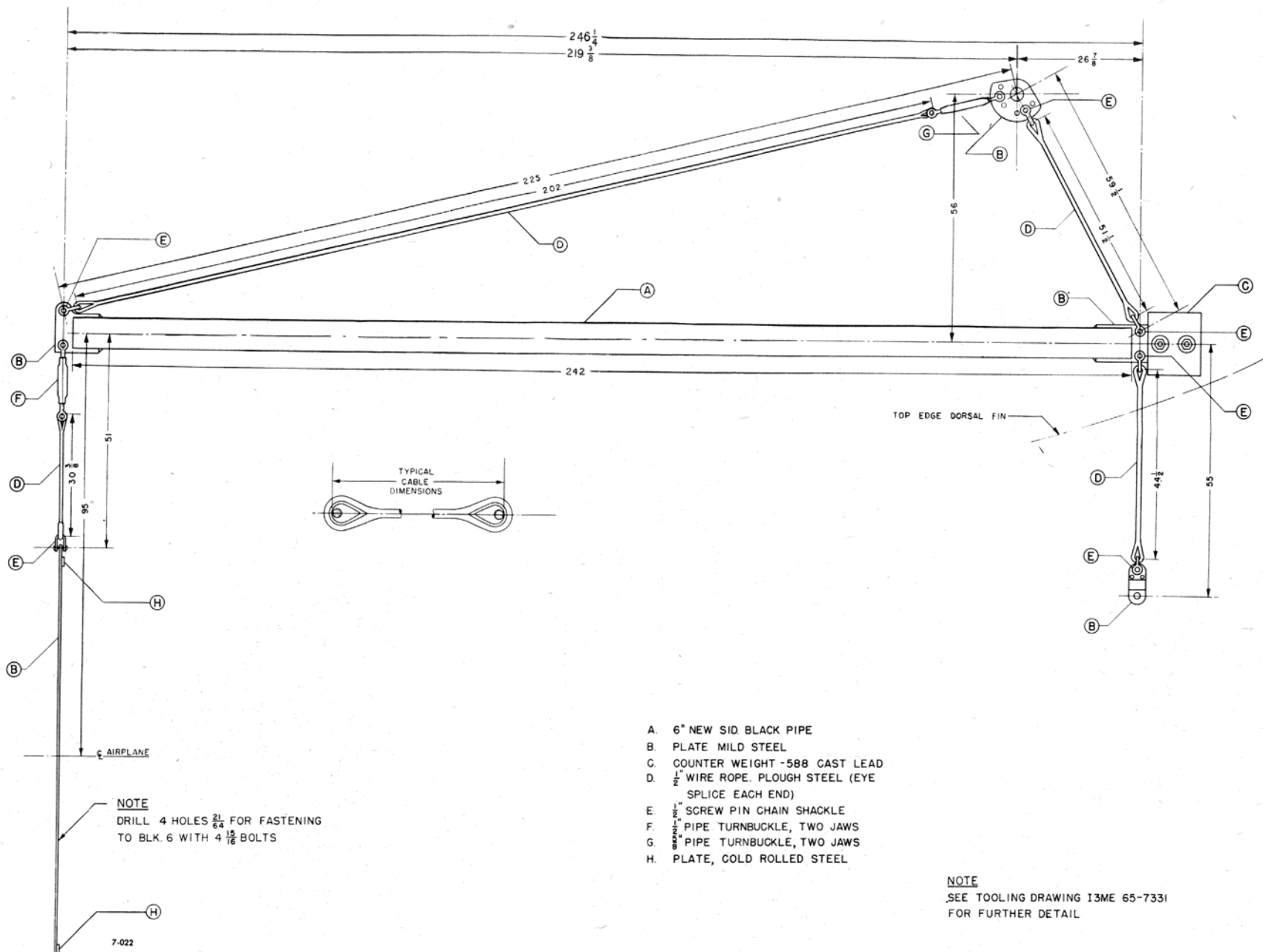


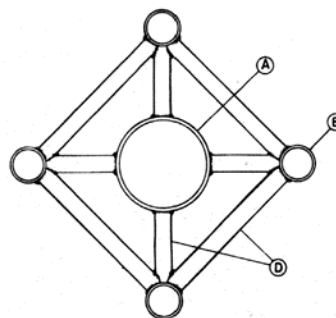
Figure 19—Fuselage Hoisting Sling Details, Stations 6 to 11

LEGEND

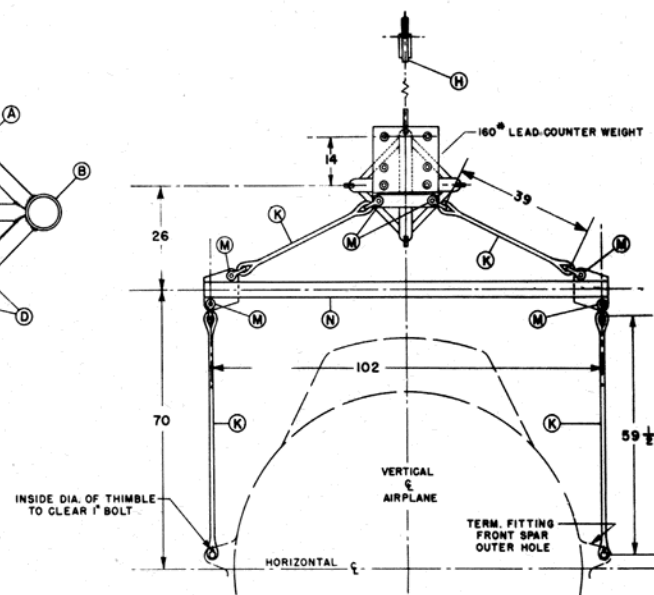
- | | |
|---|--|
| (A) 6" X 1/2" X 253" SHELBY TUBING (2). | (I) 3/8" PLATE (2), MILD STEEL. |
| (B) 2" SHELBY TUBING "H. | (J) 3/8" DIA. WIRE ROPE, PLOUGH STEEL. |
| (C) 2" SHELBY TUBING "H. | (K) 1/2" DIA. WIRE ROPE, PLOUGH STEEL. |
| (D) 1" SHELBY TUBING "H. | (L) 3/4" SCREW PIN CHAIN SHACKLE, STEEL. |
| (E) 1/2" PLATE, MILD STEEL. | (M) 1/2" SCREW PIN CHAIN SHACKLE, STEEL. |
| (F) 1/2" ANGLE (2). | (N) 4" X 1/2" X 104 SHELBY TUBING. |
| (G) 1/2" PLATE, MILD STEEL. | (O) 1" PIPE TURNBUCKLE, WITH 2 JAWS. |
| (H) 3/4" PLATE, MILD STEEL. | (P) 1" PIPE TURNBUCKLE, WITH 2 JAWS. |

NOTES

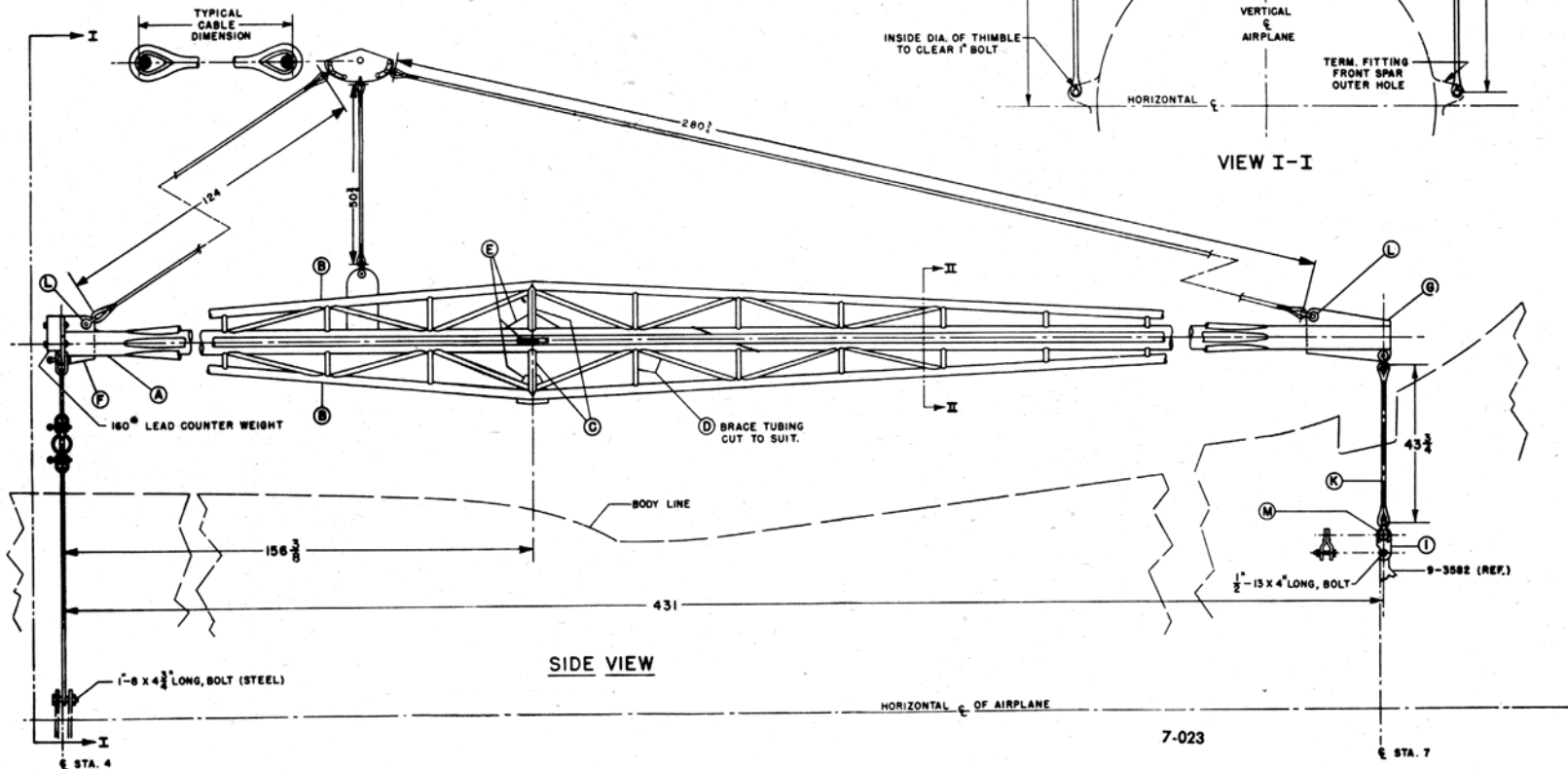
1. EYE SPLICE CABLE ENDS, ALLOW 15" FOR EACH SPICE. USE THIMBLES IN EACH CASE.
2. SEE TOOL DESIGN DRAWING IME 55-7377 FOR FURTHER DETAILS



VIEW II-II
TYPICAL OF
7 SECTIONS



VIEW I-I



SIDE VIEW

Figure 20—Fuselage Hoisting Sling Details, Stations 1 to 11

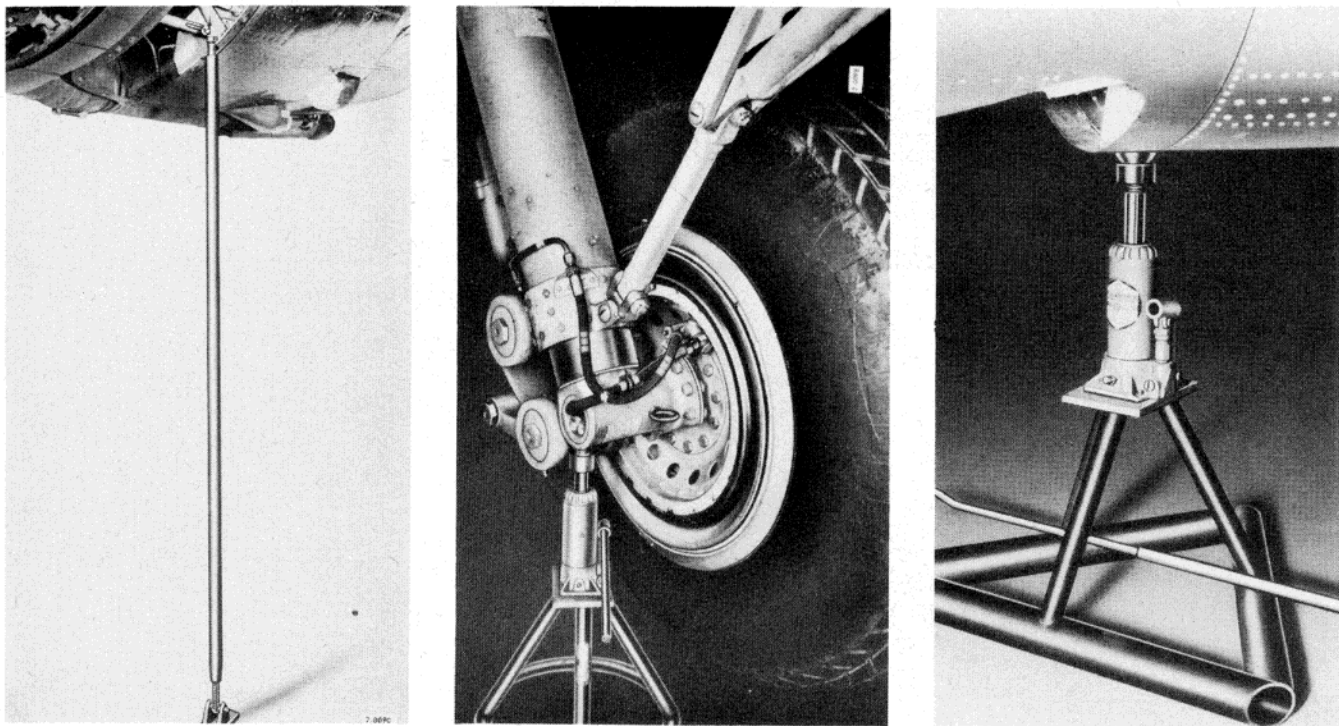


Figure 21—Typical Airplane Jacks

3. Suitably strong benches upon which sand bags have been placed to bear against the wing spars.

(i) In no case shall shoring be placed outboard of the fuselage a distance greater than one-third the

semi-span, or at more than the minimum distance needed to provide clearance for retracting the landing gear.

(j) Overhead hoisting may be used as auxiliary support in conjunction with jacks, or as the initial support in conjunction with jacks, or as the initial support in conjunction with cribbing.

(k) Due to the large vertical tail surface of this airplane, a small side wind may cause a severe side load on the jack. It is important to moor these airplanes when they are on jacks if any perceptible wind prevails.

c. LEVELING.—Leveling lugs are provided in the bomb bay. The fore and aft lugs are attached to the right side of the catwalk truss. The lateral leveling lugs are attached to the door frame at the rear of the bomb bay.

d. TIE-DOWN INSTRUCTIONS.

(1) Lines may be attached at the towing points and also at the rope wells located at station 24 of the front wing spars. The rope wells are designed for a 10,000-pound load acting downward. Moor the airplane with the nose into the wind, set the parking brakes, and lock the rudder, ailerons, and elevators. When attaching the mooring lines at the rope wells in the wings, allow approximately 16 inches slack in the line. This will prevent damage to the structure or loss of mooring control in case a tire goes flat with resultant elevation of the opposite wing. Rudder and elevator locks will withstand gust loads from any direction up to 60 MPH wind velocity.

(2) Where no fixed mooring anchorage is provided, the type D-1 mooring kit will be employed. Screw the

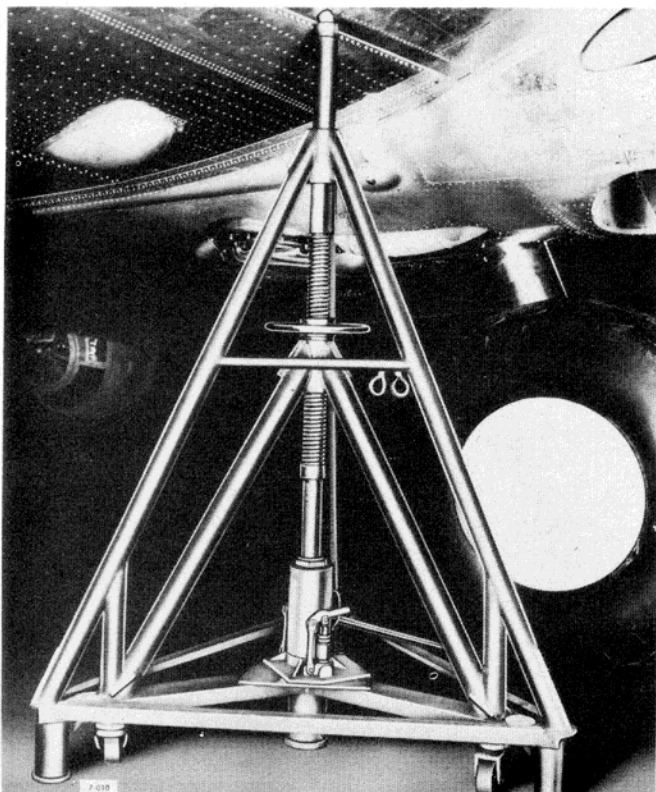
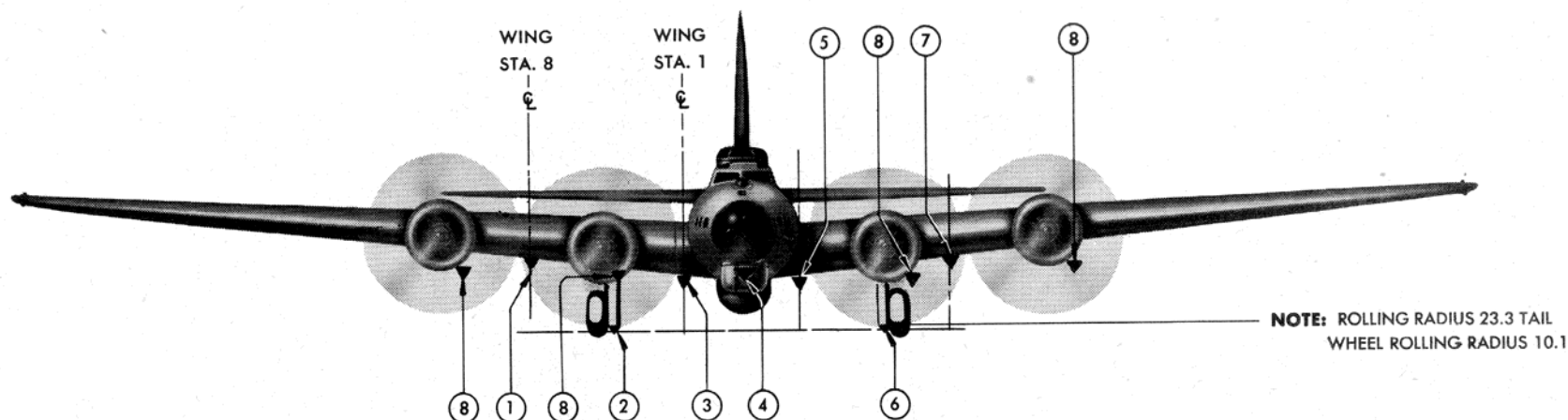


Figure 22—Wing Jack



JACKING CONDITION	RECOMMENDED JACKING CONES	ALTERNATE JACKING CONES
ENTIRE AIRPLANE	3-5-4	1-7-4
LANDING GEAR CHECK	1-7-4	3-5-4, 3-7-4*, 5-1-4*
TIRE CHANGE—BRAKE SERVICING	1-7-4†	3-5-4 2-6-4‡ 3-7-4* 5-1-4*
REMOVING FUEL CELLS (L.H.)	3-5-4-8††	
REMOVING FUEL CELLS (R.H.)	3-5-4-8††	
REMOVAL—WING (L.H. OUTBD.)	1-7-4	3-5-4 or 3-7-4
REMOVAL—WING (R.H. OUTBD.)	1-7-4	3-5-4 or 1-5-4
REMOVAL—WING (L.H. INBD.)	3-5-4-1	
REMOVAL—WING (R.H. INBD.)	3-5-4-7	
REMOVAL—ENGINES (L.H.)	3-5-4	1-7-4 or 3-7-4
REMOVAL—ENGINES (R.H.)	3-5-4	1-7-4 or 1-5-4

NOTES: *WING STA. 8 CONE ON SIDE GEAR, WHEEL OR BRAKE IS CHECKED.
†PARTIALLY RETRACT GEAR.
‡GROSS WEIGHT NOT TO EXCEED 42,000 POUNDS.
††NACELLE JACK AT OUTER NACELLE.

JACKING LOADS				
ALLOWABLE		COMBINATION - 48,726# GROSS		
LOCATION	JACKING LOAD	CONDITION	CONE NO.	LOADS
1. ② WING STA. 8	28,800#	SYM. 3 POINTS	3	22,000#
2. AXLE	20,000#		4	4,726#
3. ② WING STA. 1	36,150#		5	22,000#
4. ② BODY STA. 7	7,450#	SYM. 3 POINTS	1	23,000#
5. ② WING STA. 1	36,150#		4	2,726#
6. AXLE	20,000#		7	23,000#
7. ② WING STA. 8	28,800#	NON-SYM. 3 POINTS	1	10,000#
8. NACELLE	3,200#		4	3,726#
			5	35,000#

7-008

Figure 23—Jacking Diagram

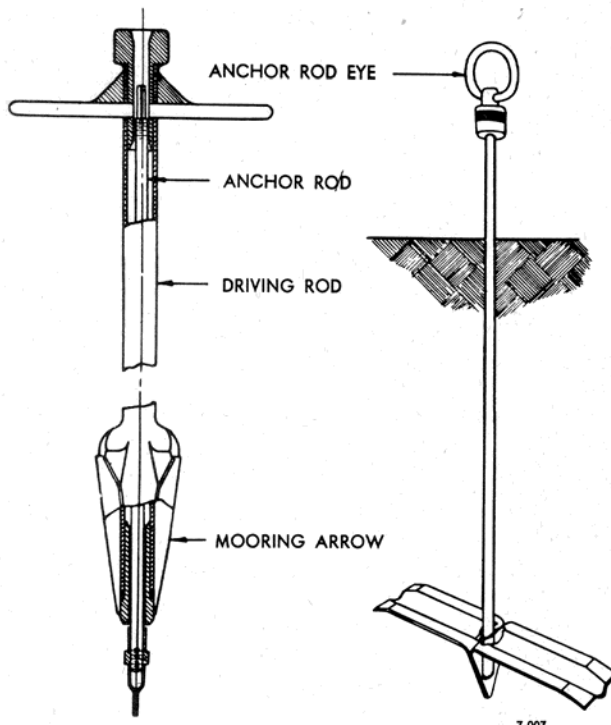
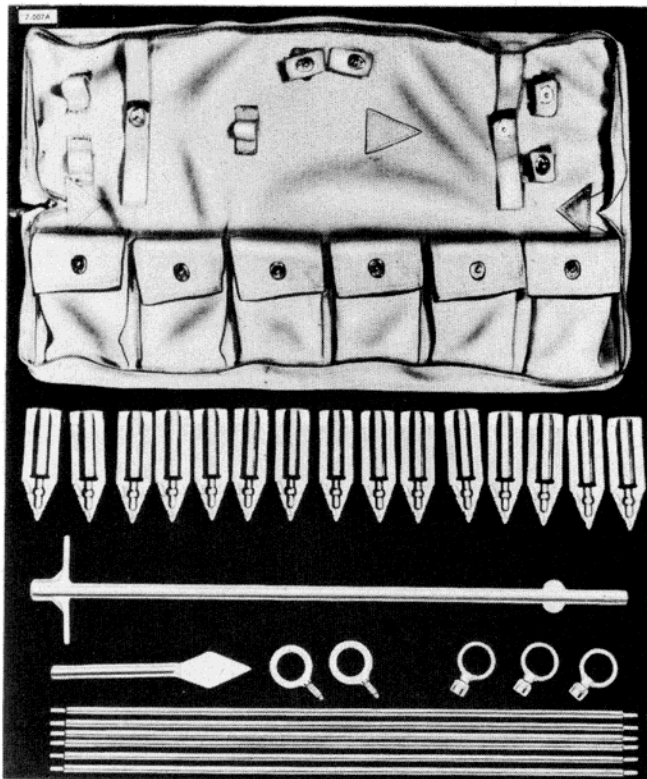


Figure 24-D-1 Mooring Kit

anchor rod into the arrow. Then slip the driving rod over the anchor rod and into the socket of the arrow, with the cam on the driving rod turned so that the arrow prongs will not be spread while driving. If the ground is hard, break the surface by using the ground breaking pin. Align the rod with the point of attachment on the

airplane and drive the arrow into the ground until the driving rod handle is about three inches from the ground. Rotate the handle about 90 degrees and strike the driving rod a sharp blow to spread the arrow prongs. Turn the driving rod back and withdraw it from the ground. Attach the eye assembly and tie one end of the mooring rope to it. Pull upward sharply to set the arrow. Then secure the rope to the mooring fitting on the airplane. To withdraw the rod, unscrew it, leaving the arrow buried in the ground.

e. TOWING.

WARNING

Do not tow the airplane unless a crew member rides in the pilot's compartment to operate the brakes.

(1) Towing lugs are located on the front and rear side of each landing gear knuckle. Each fitting is designed for a direct forward or rearward towing load of 10,000 pounds.

(2) A towing bar (Boeing 48-1190) attaches to lugs on the ends of the tail wheel axle and may be used for guiding the airplane while being towed, or for towing rearward. The tail gear is protected from damage, due to reversals of load when stopping, towing down hill, or pushing as the towing bar fails in compression before the tail gear is damaged. The tail wheel is designed for a 7,000-pound load acting rearward or a 4,000-pound load with the tail wheel swiveled 90 degrees. Lugs will shear at 4,000 pounds. The airplane, at 48,726 pounds gross weight, may be towed rearward up to a maximum



Figure 25—Forward Towing Procedure

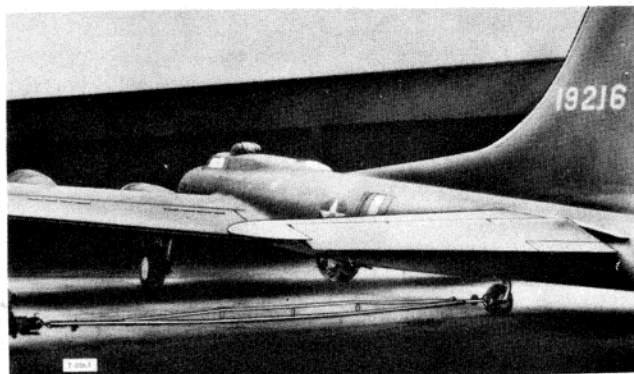


Figure 26—Rearward Towing Procedure

grade of 11 percent. When turning with the towing bar, do not apply the starting load with the tail wheel swiveled the full 90 degrees. The wheel should not be turned more than 45 degrees from the centered position until AFTER the airplane has been set in motion.

CAUTION

Unlock the tail wheel before moving the airplane. A 24ST shear bolt is installed to protect the tail wheel mechanism from undue stresses when excessive side loads are applied as in landing or rough handling while locked. It is therefore imperative that no attempt be made to swivel the tail wheel before unlocking. If the bolt is accidentally sheared, it must be replaced with another of the same material (AN8DD-13, 1/2-20 x 1 3/8-24ST.)

f. PARKING BRAKES.

CAUTION

If an engine start is to be attempted in low temperature, any operations of the hydraulic system must be accomplished with great care. In case the parking brakes have been left on, they must be released and reapplied *very slowly*. Low temperatures cause the rubber expander tubes to become brittle, and sudden expansions or contractions may crack the tubes, thereby rendering the braking system useless. The hydraulic accumulators should be warmed to normal working temperatures if facilities are available. In any case, the air charge in the accumulators must be checked before each flight and replenished if necessary.

(1) The brakes on the main landing wheels are utilized for parking through the use of a mechanism which holds the copilot's brake metering valves open. To set the parking brakes, depress the copilot's pedals and pull the control handle located forward of the copilot. With the handle extended, the brake metering valves are held in the depressed position. The mechanism may be released by depressing both pedals at the copilot's station. The use of the parking brake control for landing is not recommended, as braking effort cannot be readily predetermined.

g. SURFACE CONTROL LOCKS.

(1) The rudder and elevators are locked simultaneously by one control, and the ailerons are locked by insertion of a pin through holes in the pilot's wheel and column. Do not confuse the surface control locking lever with the tail wheel locking lever. Both levers are recessed into the floor aft of the engine control stand. The surface control locking lever is near the pilot's station and LOCKS the surface controls when the lever is in the upward position, whereas the tail wheel locking lever is near the copilot's station and UNLOCKS the tail wheel when the lever is in the upward position. This arrangement places both levers in the downward position and out of the way during flight.

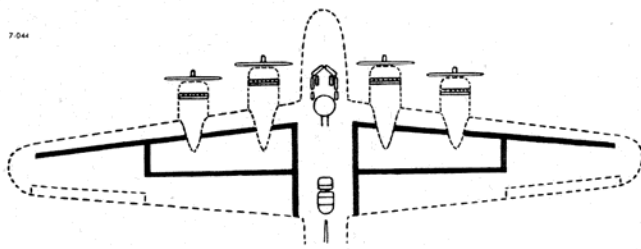


Figure 27—Wing Walkways

(2) The surface control locking lever operates a cable system, placing the housings of two spring-loaded locking pins in position to automatically engage stops on the control surface quadrants when the rudder is moved to the neutral position and the elevator is in the full downward position. Locks are designed to withstand loads produced by wind velocities up to 60 MPH. **DO NOT LASH THE CONTROLS INSTEAD OF USING THE LOCKING SYSTEMS UNDER ANY CONDITION.**

CAUTION

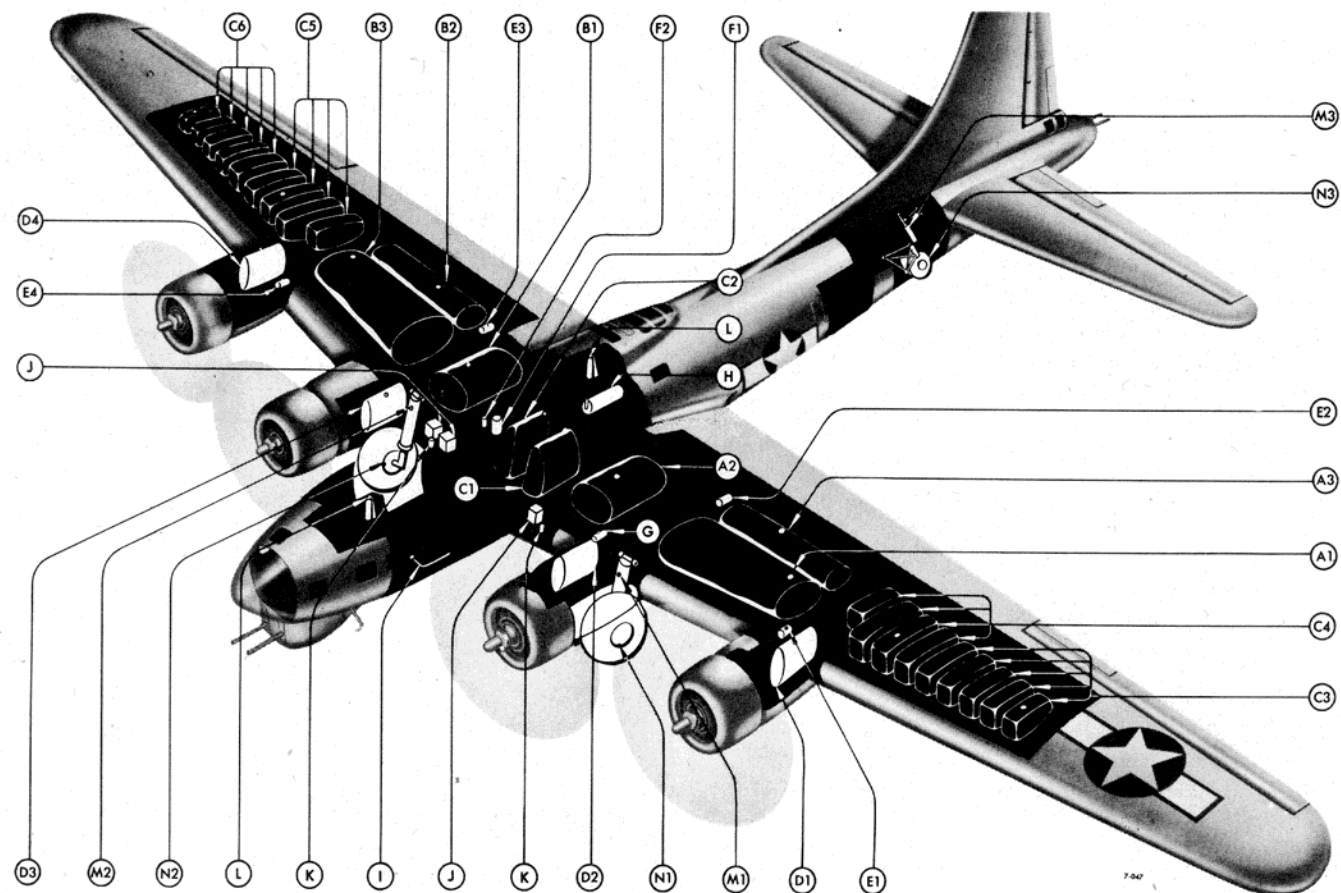
Do not lubricate the notches in the quadrants or the *engaging* portion of the locking pin.

b. STEPS, WALKWAYS AND PROTECTIVE COVERING.

(1) All ribs, brackets, cross members, etc., not usable as steps are plainly labeled "NO STEP." Special care should be taken to avoid any weight on the bomb door ribs.

(2) Walkways on the wing lie directly above the front spar from the wing fillet near station 1 to station 33; on the rear spar from the wing fillet near station 1 to station 19 compression rib; from the front spar to the trailing edge just outboard of the fillet; and from the front spar to the rear spar directly over station 19 compression rib.

(3) A canvas walkway cover is provided for the area from the front spar to the trailing edge along side the wing fillet. It is recommended that a canvas mat, plywood panel or other suitable material be used on the walkways to avoid damage to the surface.



REPLENISHING DIAGRAM LEGEND

ITEM	DESCRIPTION	CAPACITY		SPECIFICATION
		U.S. GALLONS	B. I. G.	
A1	ENGINE NO. 1 FUEL TANK	425	354	NOT LESS THAN 100 OCTANE GASOLINE SPEC. AN-F-22
A2	ENGINE NO. 2 FUEL TANK	213	178	
A3	ENGINE NO. 2 FEEDER TANK	212	177	
B1	ENGINE NO. 3 FUEL TANK	213	178	
B2	ENGINE NO. 3 FEEDER TANK	212	177	
B3	ENGINE NO. 4 FUEL TANK	425	354	
C1	BOMB BAY AUXILIARY FUEL TANK	410	342	AN-VV-0-446a
C2	BOMB BAY AUXILIARY FUEL TANK	410	342	
C3	ENGINE NO. 1 OUTBOARD WING TANKS	270	225	
C4	ENGINE NO. 2 OUTBOARD WING TANKS	270	225	
C5	ENGINE NO. 3 OUTBOARD WING TANKS	270	225	
C6	ENGINE NO. 4 OUTBOARD WING TANKS	270	225	
D1	ENGINE NO. 1 OIL TANK	36.9	30.7	SPEC. #3580-M (RED) FLUID
D2	ENGINE NO. 2 OIL TANK	36.9	30.7	
D3	ENGINE NO. 3 OIL TANK	36.9	30.7	
D4	ENGINE NO. 4 OIL TANK	36.9	30.7	
E1	ENGINE NO. 1 SUPERCHARGER LUBRICATING OIL TANK	1.50	1.26	
E2	ENGINE NO. 2 SUPERCHARGER LUBRICATING OIL TANK	1.50	1.26	
E3	ENGINE NO. 3 SUPERCHARGER LUBRICATING OIL TANK	1.50	1.26	AN-VV-0-366 DRY AIR SEE TEXT AN-F-13
E4	ENGINE NO. 4 SUPERCHARGER LUBRICATING OIL TANK	1.50	1.26	
F1	HYDRAULIC OIL SUPPLY TANK	4.0	3.3	
F2	HYDRAULIC ACCUMULATOR	SEE TEXT	SEE TEXT	
G	HEATING SYSTEM GLYCOL TANK	1.30	1.10	
H	PROPELLER ANTI-ICING TANK	20	16.5	
I	OXYGEN FILLER VALVE	SEE TEXT	SEE TEXT	DISTILLED WATER ONLY SODIUM BICARBONATE CO ₂ AND CARBON TET AF SPEC. #3580 (RED) FLUID AF SPEC. #3580 (RED) FLUID AF SPEC. #3580 (RED) FLUID
J	BATTERIES (3)	SEE TEXT	SEE TEXT	
K	BATTERY VENT BOTTLES	SEE TEXT	SEE TEXT	
L	HAND FIRE EXTINGUISHERS	SEE TEXT	SEE TEXT	
M1	LANDING GEAR OLEO OIL AND AIR FILLER VALVE	SEE TEXT	SEE TEXT	
M2	LANDING GEAR OLEO OIL AND AIR FILLER VALVE	SEE TEXT	SEE TEXT	
M3	TAIL GEAR OLEO AND AIR FILLER VALVE	SEE TEXT	SEE TEXT	
N1	LANDING WHEEL TIRE AIR VALVE	SEE TEXT	SEE TEXT	
N2	LANDING WHEEL TIRE AIR VALVE	SEE TEXT	SEE TEXT	
N3	TAIL WHEEL TIRE AIR VALVE	SEE TEXT	SEE TEXT	

Figure 28—Replenishing Diagram

CAUTION

Do not step on areas other than designated walkways. Should access to these portions of structure be necessary, suitable platforms or scaffolding must be used.

(4) Most airplanes are equipped with canvas protective covers for the fuselage nose, chin turret, the cockpit enclosure (including the upper gun turret), the bottom ball turret, the tail gun emplacement, and the engines. The fuselage nose and engine covers are provided with sleeves to accommodate the prewarming heater duct for cold weather operation. All covers should be attached whenever the airplane is not in immediate service. This is particularly important in areas subject to high winds, extreme temperatures, or prevalent humid conditions.

i. SERVICING.

(1) FUEL TANKS.—Fill the fuel tanks with 100 octane fuel Specification AN-F-28.

WARNING

If the specified fuel is not available, use the next higher grade. Grade 91 fuel, Specification AN-F-26, may be used. Under no circumstances attempt to use fuel of a grade lower than 91.

(a) The main fuel supply is carried in three self-sealing tanks located in each wing in addition to the nine self-sealing outer wing tanks inserted between wing ribs, outboard of the three main tanks. Two releasable auxiliary self-sealing tanks may be installed in the bomb bay. All filler necks are accessible through doors attached with Dzus fasteners in the top surface of each wing. The main fuel tanks for engines No. 1 and 4 have a capacity of 425 U. S. (354 Imperial) gallons each. The five most outboard outer wing tanks when installed, act as a unit supplying a total of 270 U. S. (225 Imperial) gallons to engines No. 1 and 4. Filler neck access doors for the main tanks are between spars just inboard of the outboard engine nacelle fairing. The filler neck access door for the five outboard outer wing tanks is between spars in the outboard wing section.

CAUTION

Make sure that the E-5 transfer valves are closed before refueling. This is to prevent overflow of the inner wing tanks if the outer wing tanks are filled first.

(b) The main tanks for engines No. 2 and 3 have a capacity of 213 U. S. (177 Imperial) gallons each. The filler neck access door is about midway between the spars and inboard of the inboard nacelle. A feeder tank of 212 U. S. (177 Imperial) gallons in each wing supplements the inboard engine's main tank, raising the fuel supply to 425 U. S. (354 Imperial) gallons. The filler neck access door for the feeder tank is between spars aft and inboard of the access door for the outboard engine's main fuel tank. The four inboard cells of the outer wing

tank installation supply a total of 270 U. S. (225 Imperial) gallons to each feeder tank. The filler neck access door for the four cells is between the spars aft of the landing lights. The two auxiliary or bomb bay fuel tanks have a capacity of 410 U. S. (341 Imperial) gallons and are installed in the bomb bay by slings which are attached to the bomb rail by type B-7 bomb shackles. Since these tanks are releasable in exactly the same manner as the bombs, the switches in the bomb bay should be turned off and the installation checked before filling the tanks. The filler necks are located on the upper inboard side of each tank aft of the bomb racks. Access is from below through the bomb doors.

(c) Generally the fuel supply hose will reach all three main tank fillers in one wing if it is brought up over the leading edge of the wing between nacelles. The wing area between spars may be walked on with reasonable caution, but the skin should be protected by quilts, canvas, or plywood panels in order to prevent scratching.

WARNING

Do not permit the filler hose to make contact with the inner liner of the self-sealing tanks. The nozzle may puncture the liner and allow fuel leakage into the sealant layer, rendering the tank useless in a short time.

CAUTION

Do not drag servicing hose over deicer shoe.

(d) If bomb bay fuel tanks are installed, check for proper installation, security of mounting, and "OFF" position of bomb release control switch on the side in which the tank is installed. The filler necks are located on the upper inboard side of each tank, aft of the bomb racks, and access will be from below through the bomb bay doors.

DANGER

The airplane must be thoroughly grounded before attempting the refueling operation. If fuel is supplied from an underground tank, an electrical ground must be made near the gasoline pit. If the airplane is refueled from a truck, both the airplane and the truck must be grounded. Failure to apply proper grounding will permit the accumulation of static electricity, with the consequent hazard of explosion or fire. Since the use of a covering ordinarily insulates a man from the structure and thus permits static charges to be built up in his body, it will be positively necessary in every case to drag a hand over the metal surface of the wing for a considerable distance before touching the airplane adjacent to an open filler neck. See that all fuel tank caps are secured after filling the tanks.

(2) OIL TANKS.—Fill the engine oil tanks with lubricating oil, Specification AN-VV-O-446.

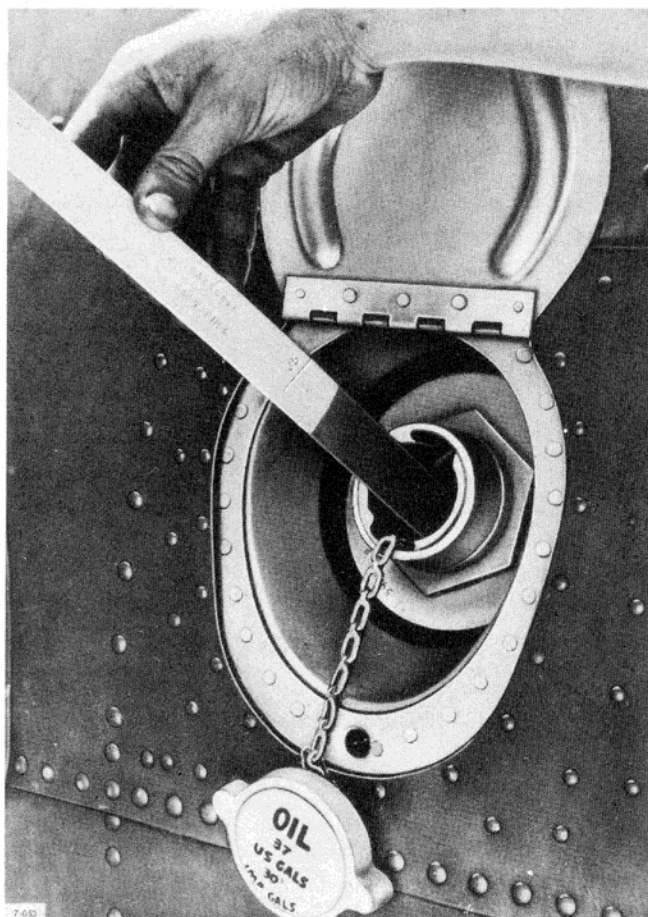


Figure 29—Oil Tank Dip Stick

(a) The filler necks for the oil tanks in No. 1 and No. 4 nacelles are reached through access doors on the outboard sides of the nacelles, and the filler necks for the oil tanks in No. 2 and No. 3 nacelles are reached through access doors on the inboard sides of the nacelles. A stick type gage, graduated to indicate proper oil level for 850 and 1700 U. S. (708 and 1416.1 Imperial) gallons of fuel, is carried on the inboard side of No. 3 nacelle, immediately aft of the oil tank.

(b) The following table lists the three grades of engine oil in general use with recommended operating temperature ranges.

Grade Oil	Air Temperature At Ground	Safe Maximum "Oil-In" Temp.	Safe Minimum "Oil-in" Temp.
1120	Above 4°C (40°F)	95°C (203°F)	20°C (68°F)
1100	-7° to +27°C (20° to 80°F)	85°C (185°F)	10°C (50°F)
1080	Below 10°C (50°F)	75°C (167°F)	0°C (32°F)

By employing the oil dilution system to facilitate starting in cold weather, the airplane can be operated in all temperature conditions with grade 1120 oil. However, grade 1100 oil may be used at the discretion of the engineering officer when ground temperatures are below 4 degrees C (40 degrees F). Oil lighter than

grade 1100 should not be required when using the oil dilution system.

(c) See that oil tank caps are secured after filling tanks.

(3) **TURBO SUPERCHARGER LUBRICATING OIL TANKS.**—Fill with oil Specification No. AN-VV-O-446, grade 1065. For cold weather operation, ground temperature below -9.4° C (+ 15° F) fill supply tank with hydraulic fluid Specification AN-VV-O-366.

(a) The outboard supercharger lubricating oil tanks may be serviced through the access door in the upper surface of each outboard nacelle. Inboard tanks must be serviced through the access door on the lower surface of the wing immediately aft of the rear spar. Access to the inboard tanks is limited and necessitates use of a one-quart container. A funnel should be used in either case to prevent spillage.

WARNING

Extreme care will be taken when servicing, to prevent foreign matter from entering the supercharger lubricating oil. The smallest particle of dirt or grit can cause supercharger bearing failure. A closed container must be used to protect the oil from sand or other foreign matter.

(4) **HYDRAULIC TANK AND ACCUMULATOR.**—The hydraulic fluid supply tank has a capacity

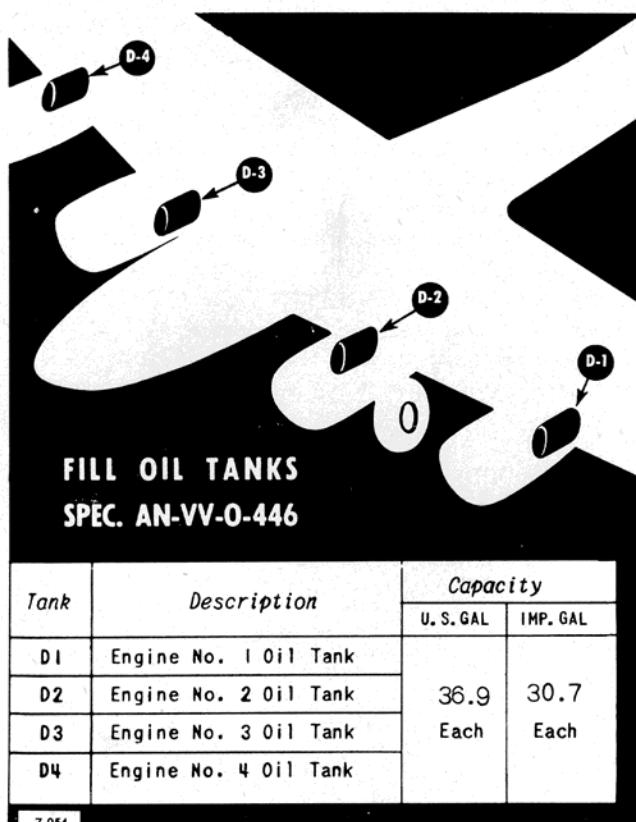


Figure 30—Oil Tank Replenishing Diagram

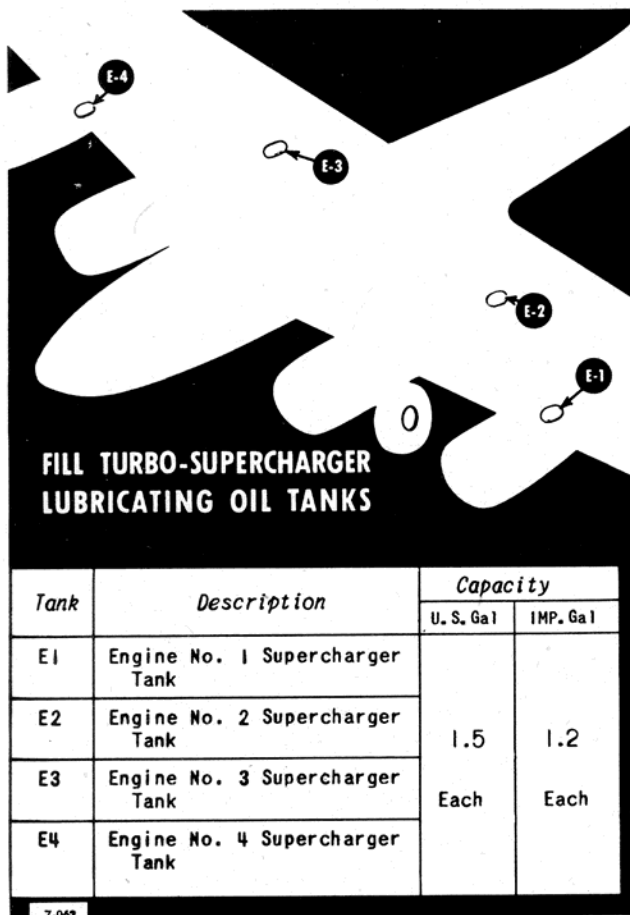


Figure 31—Supercharger Oil Tank Replenishing Diagram

of 4.0 U. S. (3.3 Imperial) gallons and is located above the hydraulic panel on the rear bulkhead of the pilot's compartment.

Note

The total fluid capacity of the hydraulic system is approximately 5.25 U. S. (4.37 Imperial) gallons or 5.75 U. S. (4.79 Imperial) gallons for airplanes equipped with hydraulic gun chargers on the chin turret.

(a) The tank must be kept filled to its proper level as indicated on the stick gage, with clean hydraulic oil. Specification AN-VV-O-366. Normal pump operation is intermittent, excessively high temperatures may be expected should continuous operation occur during hot weather. The accumulator air charge *must* be checked as outlined in the paragraphs below and brought within the limits of 325 to 375 pounds per square inch, and 800 pounds per square inch hydraulic pressure must be built up in the system before checking the fluid level.

CAUTION

Under no circumstances will any other fluid or oil be substituted for the specified hydraulic fluid.



Figure 32—Replenishing Test—Supercharger Oil Tank

(b) When replenishing the hydraulic system, there are two specific conditions which must be avoided.

1. ENTRANCE OF AIR INTO THE PUMP SUPPLY LINE.—This condition may occur if the hydraulic fluid supply in the tank is depleted either through loss of hydraulic fluid in the system or loss of air in the accumulator.

2. OVERFLOW OF THE SUPPLY TANK.—If the system has been properly serviced and is operating satisfactorily, the tank will not overflow. Therefore, if overflow does occur, it will indicate the presence of air in the system.

(c) The accumulator, located above the hydraulic panel on the lower right hand side of the pilots' compartment, should be charged with reasonably dry air at 350 ± 25 pounds per square inch, with the hydraulic fluid pressure at zero. The air valve is installed on the lower end of the accumulator. Bottled carbon dioxide or

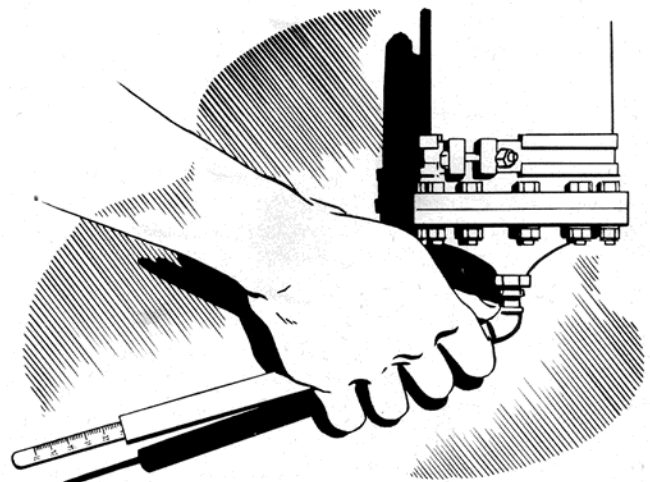


Figure 33—Inflation Pressure Test—Hydraulic Accumulator

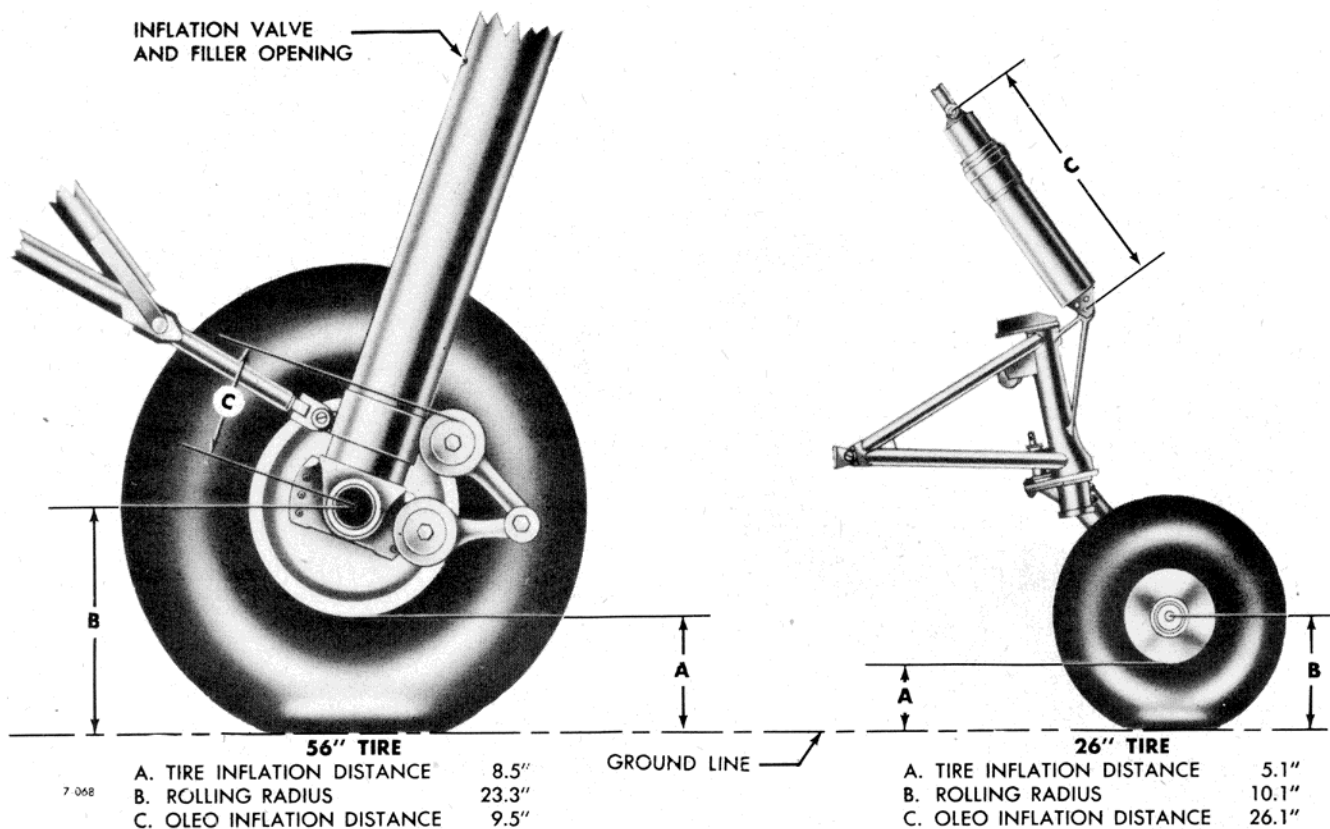


Figure 34—Landing and Tail Gear Inflation Diagram

nitrogen may be used in an emergency, but their continued use is not recommended.

DANGER

Do not use oxygen for inflation!

(d) Although there should be little or no fluid in the air chamber if proper care is taken with inflation, it is recommended that the air chamber be bled each time inflation is accomplished. Remove the valve cap and use the bleeder tool until the discharge is free of fluid. Increasing amounts of hydraulic fluid during successive bleeding operations indicate improper piston ring seal. To remedy this condition follow the procedure outlined in section IV, paragraph 7. c. If an air pressure gage, similar to a tire gage, of suitable range is used to check the air charge, it will be necessary to check the approximate drop in accumulator pressure, caused by the use of such a gage. The amount of this drop should be added to the desired inflation pressure in order to get the proper gage reading. If such an air gage is not available, the accumulator inflation pressure may be checked by means of the hydraulic pressure gage in the cockpit. This is done by disconnecting the cannon plug at the pressure switch on the hydraulic panel and bleeding the hydraulic pressure with repeated applications of the brakes until the gage on the instrument panel suddenly falls to "zero." Since the air pressure of the charged accumulator must equal the gage pressure plus the static head of the fluid from the accumulator to

the gage, the last reading on the gage before the sudden "drop-off" to zero will closely approximate the inflation pressure. This is true because the fluid pressure must drop to zero the instant that the accumulator piston has reached the limit of its travel. The inflation pressure as determined in this manner then may be checked by operating the hand pump. The first two or three strokes of the hand pump will start to charge the accumulator and since the hydraulic pressure necessary to force the fluid into the accumulator must exceed the inflation pressure, the gage reading must jump from zero to charging pressure. The hydraulic fluid gage cannot be considered as accurately readable closer than ± 25 pounds per square inch, and inflation pressures thus determined should be accomplished with extreme care.

(5) LANDING AND TAIL GEAR INFLATION.

—To obtain satisfactory operating characteristics, tire inflation pressures should vary with airplane gross weight so as to maintain the prescribed rolling radius of the tires. It is recommended that preflight pressures be checked carefully, since the lighter landing weight, with depleted fuel and military load, has the effect of exaggerating any over-inflated condition.

(a) The main landing gear tires are designed to operate at a rolling radius of 23.3 inches. Inflate the tires until the inflation marks are tangent to the ground line when the airplane is resting on a smooth level surface, and with the airplane loaded approximately as it will be

flown. In the absence of these markers, inflate the main tires until the lowest point on the inboard side of the wheel rim is 8.50 inches above the ground. If the measurement is taken on the outboard side of the wheel the rim will measure nine inches above the ground due to the camber of the axle.

(b) The tail wheel tire is designed to operate at a rolling radius of 10.1 inches. The inflation valve is inside the cover plate on the tail wheel. Inflate the tail wheel tire until the inflation marks are tangent to the ground line when the airplane is resting on a smooth level surface. In the absence of these marks inflate until the lowest point of the wheel rim is 5.10 inches from the ground line.

(c) Inflate the shock struts with compressed air only. The inflating device must be capable of developing pressure up to 800 pounds per square inch. A compressed air cylinder of approximately 2,000 pounds per square inch pressure is satisfactory, but must be handled carefully in order to avoid too rapid inflation. CO₂ may be substituted in emergencies, but its continued use is not recommended.

DANGER

Inflammable gases—such as hydrogen, oxygen, and acetylene—must never be used for inflation or serious accidents may result.

(d) The MAIN LANDING GEAR SHOCK STRUT should be kept filled to the level of the filler opening. It is recommended that hydraulic fluid, Specification 3580M, be used under all temperature conditions. To fill, remove the rubber grommet and loosen the air valve body sufficiently to release the air SLOW-

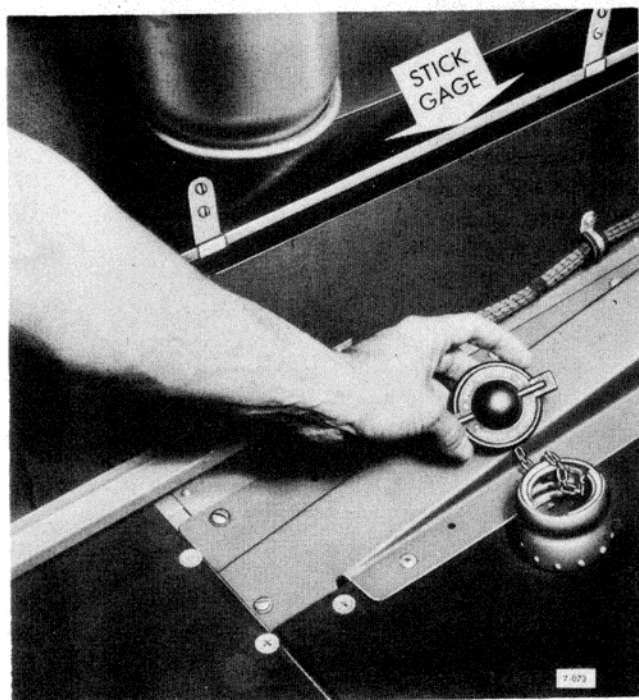


Figure 35—Filler Neck—Anti-Icer Tank

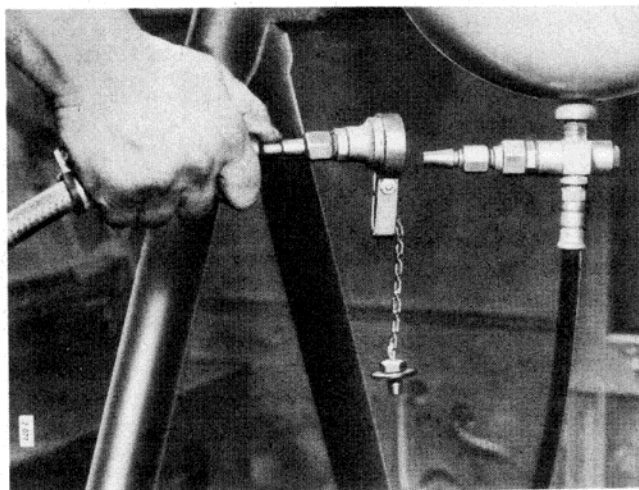


Figure 36—Connection—Oxygen Filler Valve

LY. After deflation, remove the valve body entirely, check the fluid level, and replenish if necessary. Replace the valve body and the rubber grommet.

(e) Inflate the main landing gear strut until the centerline of the axle is extended 9.50 inches below the upper edge of the lower collar. The end of the strut cylinder butts against the axle knuckle and may be distinguished by the difference in finish between the two parts.

CAUTION

DO NOT INFLATE THE MAIN LANDING GEAR SHOCK STRUT BEYOND THE 9½ INCH DIMENSION PRESCRIBED. The strut is designed to operate from that portion for all airplane loadings and should be inflated or deflated as required for each particular loading. OVER-INFLATION will cause excessive stiffness, and the tough taxiing condition will be aggravated at landing because of the reduced weight of the airplane at the end of the flight.

(f) The instructions for replenishing the air and hydraulic fluid in the main landing gear shock strut also apply to the TAIL WHEEL GEAR SHOCK STRUT. The air and hydraulic fluid filler valve is located on the upper left side of the cylinder assembly. The fluid should be level with the filler valve with the airplane in the taxiing position.

(g) The air pressure required for the tail wheel gear shock strut inflation is from 400 to 500 pounds per square inch, depending upon the gross weight of the airplane. Inflate the strut until the oleo is extended 26.10 inches, the length being measured between the strut attaching pin centers. Maintain this dimension by inflation or deflation for the different conditions of airplane gross weight.

(h) After inflation, check the VALVE CORES AND BODIES for leakage.

(6) PROPELLER ANTI-ICER.—The supply tank has a capacity of 20 U. S. (16.7 Imperial) gallons and is located below the right side of the radio compartment floor. Replenishing is accomplished through the filler neck which extends above the floor. To avoid spilling, the use of a large funnel or a non-drip can is recommended. Fill with anti-icer fluid, Specification AN-F-13 (isopropyl alcohol). A stick type gage is attached to the right side of bulkhead 5, directly forward of the tank.

(7) OXYGEN CYLINDERS.—A single filler system serves all four oxygen distributing systems in the airplane, through a filler valve located near the forward hatch (on stiffener 3-C) and check valves at each storage cylinder. Some airplanes have a relief valve in the filler system which is also located near the forward hatch on stiffener 3-A.

DANGER

Due to the danger of combustion, extreme caution must be exercised when handling oxygen equipment. Keep the oxygen system clean and free of any oil or grease. Be sure hands and clothes are free from oil.

LOW PRESSURE OXYGEN CYLINDERS

<i>State of Charge</i>	<i>Pounds Pressure</i>
Full	400
4/5	330
3/5	260
1/2	225
2/5	190
1/5	120
Empty	50

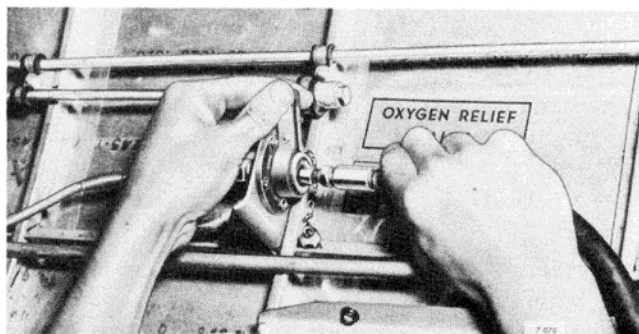


Figure 38—Disconnection—Oxygen Filler Valve

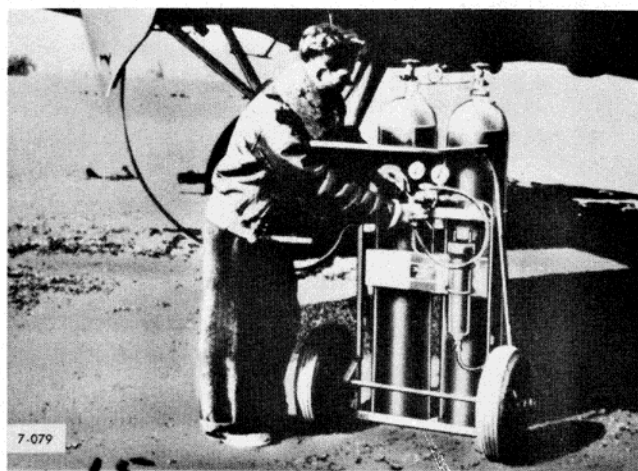


Figure 39—Oxygen Recharging Equipment

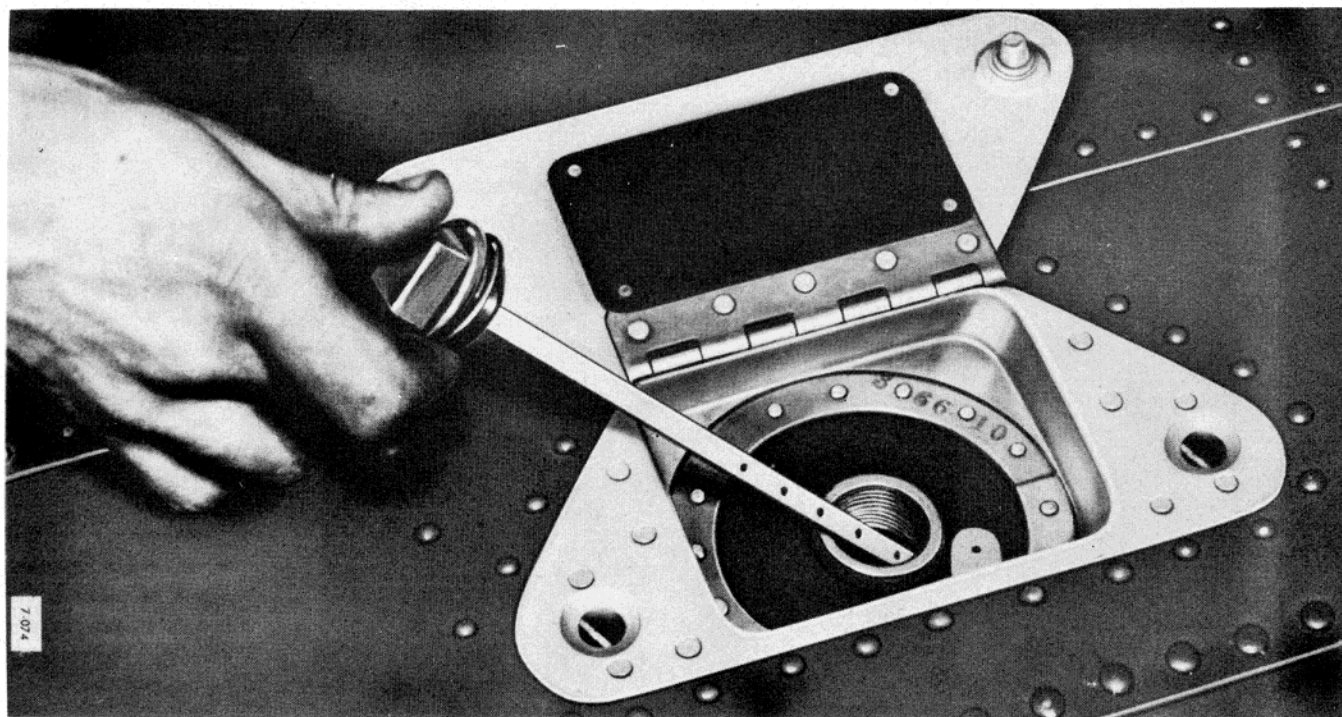


Figure 37—Glycol Tank Dip Stick

Note

The airplane oxygen cylinders will become quite warm while being charged. System pressure will drop 20 to 30 pounds per square inch when the cylinders cool to normal temperature.

(a) Charge the oxygen system with grade A, dry oxygen, Specification AN-O-1. Attach the flexible hose connections to the two auxiliary cylinders at the power turrets. Connect a portable supply of oxygen (low pressure oxygen recharger) to the system filler valve, pushing the adapter directly into valve until it snaps securely into place. Fill the system by slowly increasing the pressure with the regulator on the recharging equipment. When the regulator gage gives a constant reading of 425 pounds per square inch, completely close the pressure regulator, and disconnect the recharging equipment by turning the outer collar of the filler valve about one-eighth turn. Since pressure will blow the adapter out, hold the end of the hose securely when making the disconnection. Before disconnecting the oxygen servicing unit from the filler valve, check all portable units in the airplane and recharge those that do not show full pressure.

(b) After filling the airplane's oxygen system, be sure all filler valve plugs are installed.

(8) GLYCOL TANK.—Check the proper level of fluid in the glycol supply tank which is located in the upper rear portion of the No. 2 nacelle. The filler well is accessible through a door in the nacelle skin on the upper surface just forward of the front spar. Fill the supply tank to the "FULL" on the stick gage. If the system is being replenished, run the engine until the glycol has filled the system, then add fluid to fill the tank to the "FULL" on the stick gage. The tank holds one U. S. (.80 Imperial) gallon and has expansion space of .30 U. S. gallon. The fluid mixture for use in the heating system is roughly designated "glycol" because it is a mixture of glycol compounds. However, the fluid used must conform to definite physical characteristics in order to prevent malfunctioning of the system and serious damage to the equipment. The approved mixture may change slightly in characteristics with continued use and, as instructed in section IV, should be replaced with a fresh solution after 100 hours of service. If the fluid becomes black in color before 100 hours have elapsed, the system should be flushed and refilled with fresh solution.

(a) The approved fluid mixture for use in the glycol system has the composition shown below in percentage ratios by weight. Proportions must be held to close tolerances for satisfactory operation under extreme temperature conditions.

Composition:

- 55% Diethylene glycol.
- 45% Ethylene glycol.

Boiling Point: 204°C (400°F).

Freezing Point: -45°C (-50°F).

WARNING

Any fluid other than that described above *must never be used*. It is particularly important that water or any anti-freeze solution *must never be added* to the glycol fluid, as this would destroy the usefulness of the approved mixture.

(b) In the event that the indicated mixture is not available, no other fluid shall be used. To prevent damage to equipment caused by the system running dry, the glycol pump must be removed from the engine. Should this condition exist in excess of 25 hours of engine operation, the glycol heaters must be removed from the exhaust and replaced with steel plates to cover the holes.

CAUTION

If the glycol tank is filled too full and boiling occurs, the vapor pressure may cause overflow and serious loss of the heating fluid.

(9) BATTERIES.—Three 24-volt batteries are located in the nose section of the wing, two in the right wing and one in the left, adjacent to the fuselage. Access doors attached by Dzus fasteners are provided for servicing the batteries.

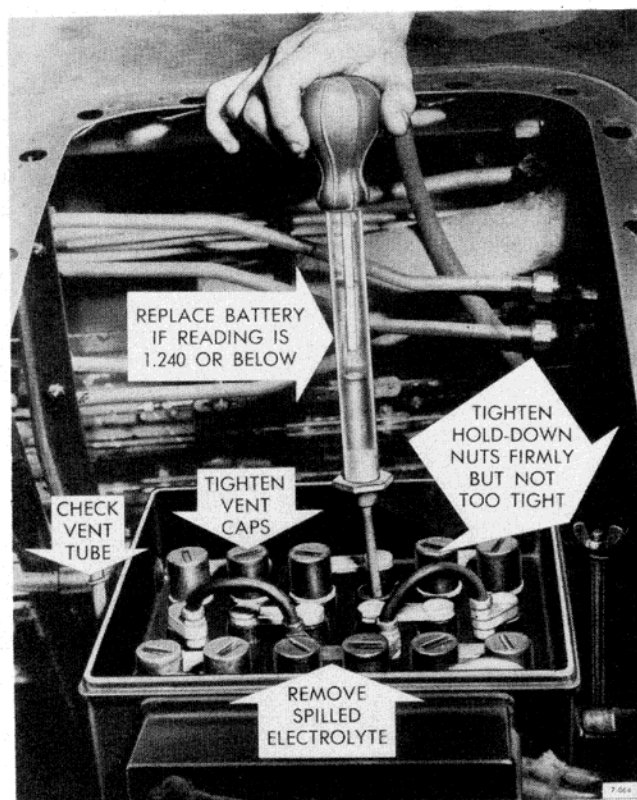


Figure 40—Battery Servicing

WARNING

Personnel handling batteries should avoid inhaling battery fumes, as these fumes are extremely toxic. In case battery electrolyte is spilled on aluminum alloy parts of the airplane, wash off immediately with dilute sodium bicarbonate solution (one tablespoon to one pint of water). Flush thoroughly with water after fizzing stops. If sodium bicarbonate is not available use soap and water.

(a) Take hydrometer readings on at least two cells of each battery. The following are hydrometer readings for commonly used aircraft batteries:

Low (discharged) 1.200 and below.

Medium (partially discharged) 1.250.

High (fully charged) 1.275 to 1.300.

Always return fluid to the cell from which it was withdrawn.

(b) If any reading corrected for temperature is below 1.240 or above 1.310 turn battery in for recharge and test.

(c) Add distilled water as necessary; *never add electrolyte or acid*. In adding water to Presto-Lite batteries, bring the electrolyte up to the star level in the battery cover. In filling Exide batteries, do not exceed the level obtained by the use of a self-leveling syringe.

(d) Electrolyte in batteries will freeze if exposed to low temperatures when partially or fully discharged, or if water is added and the battery is exposed before the water has been thoroughly mixed with the electrolyte by charging. Do not add water when the temperature is below freezing, unless the airplane is to be operated within a few hours. Internal expansion caused by freezing will usually burst the case and destroy both plates and separators. A frozen battery may be saved, if the freezing has not progressed to the point that breakage occurs, by placing in a room of normal temperature and allowing it to thaw slowly. Where low temperatures are to be encountered, batteries must be kept fully charged.

WARNING

Personnel handling batteries should avoid spilling battery electrolyte on the hands and body, as it may cause painful burns.

(10) FIRE EXTINGUISHERS.

(a) **ENGINE FIRE EXTINGUISHER.**—Check the red inspection discs of CO₂ engine fire extinguisher system for indication of rupture of the cylinder safety diaphragms. These discs are located on the lower surface of the right wing fairing, aft of the rear spar, and may be checked visually from the outside of the airplane. If discs indicate discharge, access for replacement of cylinders is through two removable panels in the web of the right side body compression strut. The bottom gap cover may also be removed for access to the outboard side of the cylinders. Disconnect the control cables and the tubing and remove the straps for replacement of the cylinders. Install charged cylinders, replace straps, and resafety.

WARNING

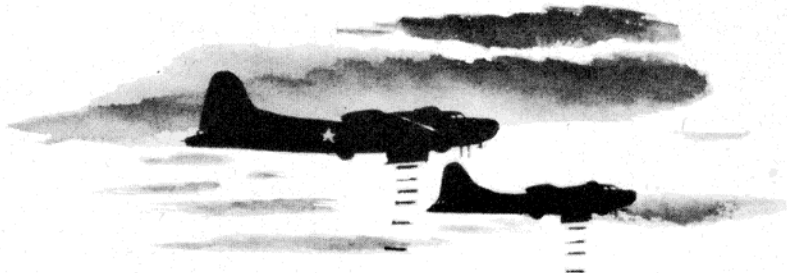
If the release handle of the engine section fire extinguisher is tripped, complete emptying cannot be prevented. White discharge from CO₂ fire extinguishers is dry ice. Avoid frost bite. Do not permit extended contact with skin.

(b) **HAND FIRE EXTINGUISHERS.**—Check all extinguishers for security of mounting.

3. GROUND OPERATING INSTRUCTIONS.

Note

The following instructions list the operations performed by the pilot and copilot in starting and stopping the engines. For ground operation, these may be performed by qualified mechanics. Engines will not be left running unless a pilot or qualified mechanic is seated in the pilots' compartment. Excepting in an emergency, engines will not be run on the ground for warm-up or test unless chocks are placed in front of the wheels of the airplane.



BEFORE STARTING ENGINES

WARNING

If fuel has been spilled during refueling operations, move the airplane a safe distance from that vicinity.

Suggested starting order—1-2-3-4.

Remove dust excluder plugs from the air intake ports at the leading edge of the wings and from the exhaust stacks.

Pilot	Copilot
(1) Airplane balance—check aerial engineer's report to be sure that the center of gravity is between 19 percent and 35 percent of the mean aerodynamic chord.	(1) Check crew location, ballast, doors closed, hatches closed.
(2) Order combustion chambers cleared (All engines "OFF").	(2) No action.

WARNING

Ignition plugs at fire walls *must* be connected to insure proper grounding of magnetos before propellers are pulled through.

(3) Turn master ignition switch "ON." Check each battery switch separately with either inverter operating. Then turn all three battery switches "ON" with the hydraulic pump switch in the "AUTO" position and check the system pressure—600 to 800 PSI.	(3) No action.
(4) Unlock flight controls, check visually, and operate through the full range to insure proper movement.	(4) Open cowl flaps and return valves to "LOCKED" position.
(5) Set Cabin heat control in "OFF" or "COLD" position.	(5) No action.

Note

If the system pressure is below 200 ± 25 PSI, the pump switch must be held in the "MANUAL" position until this pressure is exceeded before automatic regulation is possible.

(6) Move supercharger controls to "0" (No boost).	(6) Fuel transfer valves and pump should be "OFF."
(7) Check that the fuel shut-off valves are "OPEN."	(7) If engine fire extinguisher is installed, set selector valve to engine being started. Auxiliary external extinguishers should be available nearby.
(8) Crack throttles (approximately 1,000 RPM).	(8) Move carburetor temperature controls (intercooler) to "COLD."

Pilot	Copilot
(9) Direct copilot to place carburetor air filter controls in "ON" (filtered air) position.	(9) Place carburetor air filter controls in the "ON" position when directed by pilot.
(10) Set propeller controls for "HIGH RPM."	(10) Move mixture controls to "ENGINE OFF."
(11) No action.	(11) Set primer to "OFF" position.
(12) No action.	(12) Start No. 3 fuel booster pump for primer pressure—should be 6-8 lb./sq. in.

STARTING ENGINES

CAUTION

Do not start engines with nacelle cowling removed, since it may then be impossible to extinguish engine fires with the CO₂ system, on airplanes so equipped.

Pilot	Copilot
(1) No action.	(1) Start fuel booster pump for engine affected.
(2) Direct copilot to energize starter.	(2) When directed by pilot, move meshing switch to "START" position and hold for approximately 30 seconds.
(3) No action.	(3) While starter switch is in "START" position, unlock primer, set to engine affected, and expel air from line by pumping until a solid charge of fuel is obtained.
(4) Direct copilot to mesh starter. When the propeller has made at least one complete revolution, turn the ignition switch for the engine being started to "BOTH."	(4) When directed by pilot, move meshing switch to "MESH" position while holding the starter switch depressed.
(5) When engine fires, move mixture control to "AUTOMATIC RICH."	(5) When the starter is meshed, prime with quick strokes (to atomize the primer charge) until the engine fires.

CAUTION

Do not advance throttles as lean mixture and backfire will result.

Note

To prevent damage to the starting system, release the "START" and "MESH" switches when the starter motor drops to a constant low speed. Repeat steps 2, 3, and 4 for a re-start.

(6) No action.	(6) If necessary to keep engine running, pump primer with several slow strokes.
(7) No action.	(7) Shut off booster pump if fuel pressure from engine pump remains steady.

CAUTION

Return primer to "OFF" position.

Pilot	Copilot
(8) No action.	(8) If engine stops, return mixture to "ENGINE OFF" immediately, cut magneto switch, and repeat starting procedure.
(9) If no oil pressure is indicated within one-half minute after start, direct copilot to stop engine with mixture control. Cut ignition and investigate.	(9) After engine starts, check for indication of oil pressure. Notify pilot if no pressure is indicated within one-half minute. Move mixture control to "ENGINE OFF" when directed by pilot.
(10) When oil temperature begins to rise and oil pressure is 50 lb./sq. in., open throttles to 1,000-1,250 RPM.	(10) Notify pilot when oil temperature begins to rise and oil pressure is 50 lb./sq. in.
(11) When engines are thoroughly warmed, RPM may be increased for instrument check as required.	(11) Notify pilot when maximum temperature and pressure values are reached.
CAUTION 2500 RPM must not be maintained for more than 1/2 minute and the following values must not be exceeded: Fuel pressure 16 lb./sq. in. Oil pressure 75 lb./sq. in. Oil temp. 88°C (190.4°F) Cylinder temp. 260°C (500°F)	

STOPPING ENGINES

Pilot	Copilot								
(1) Idle engines at approximately 800 RPM until cylinder temperatures drop to 170°C (338°F).	(1) No action.								
(2) If the airplane is to remain outside overnight or if an engine start is anticipated in temperatures below 4°C (40°F), order copilot to dilute oil in accordance with the following: <table> <tr> <td>Anticipated Lowest Outside Air Temperature</td><td>Dilution Time Minutes One Period</td></tr> <tr> <td>4° to -12°C (40° to 10°F)</td><td>2</td></tr> <tr> <td>-12° to -29°C (10° to -20°F)</td><td>5</td></tr> <tr> <td>-29° to -46°C (-20° to 50°F)</td><td>7</td></tr> </table> For each 5°C (9°F) below -46°C (-50.8°F), add one minute to the time given. A complete redilution of the engine is required only after 1/2 hour or more of operation at normal oil temperature, as this is the time required to boil off the gasoline.	Anticipated Lowest Outside Air Temperature	Dilution Time Minutes One Period	4° to -12°C (40° to 10°F)	2	-12° to -29°C (10° to -20°F)	5	-29° to -46°C (-20° to 50°F)	7	(2) Idle the engine until the oil temperature falls to about 40°C (104°F). Run engines at 1000 to 1200 RPM. It is impossible to dilute the oil unless the engines are running. Maintain oil temperature less than 50°C (122°F) and an oil pressure above 15 lb./sq. in. If oil temperature rises or oil pressure falls beyond these limits, shut down and allow engines to cool. If the airplane has an automatic dilution switch installed, simply dilute as instructed on the placard. If the airplane has the manual dilution switch, hold the switch in the "ON" position for the period ordered by pilot, at the end of the period, keep the switch on until the engine is stopped. During the last two minutes of the dilution period depress propeller feathering switch until drop of 400 RPM is observed. Pull out switch and allow RPM to return to normal. Repeat this operation three times.
Anticipated Lowest Outside Air Temperature	Dilution Time Minutes One Period								
4° to -12°C (40° to 10°F)	2								
-12° to -29°C (10° to -20°F)	5								
-29° to -46°C (-20° to 50°F)	7								

Pilot	Co-Pilot
-------	----------

WARNING

Keep the oil temperature between 30° and 50°C (86° and 122°F) while diluting.

(3)	(3)
Set propellers to "HIGH RPM."	No action.

(4)	(4)
Run engines at 1200 RPM for 30 seconds before directing copilot to stop engines with mixture control.	At command from pilot, stop engines by moving mixture controls to "ENGINE OFF."

Note

To prevent internal damage to the engine and engine accessories due to sand and dust entering the air intake ducts and exhaust stacks, dust excluder assemblies will be installed in the air intake ducts and exhaust stack as soon as possible after the engine has been stopped.

BEFORE LEAVING AIRPLANE

Pilot	Copilot
(1)	(1)
Cut off all switches—radio, deicer, cockpit, central control panel, pilot's control panel.	Make necessary entries in AAF Form No. 1.

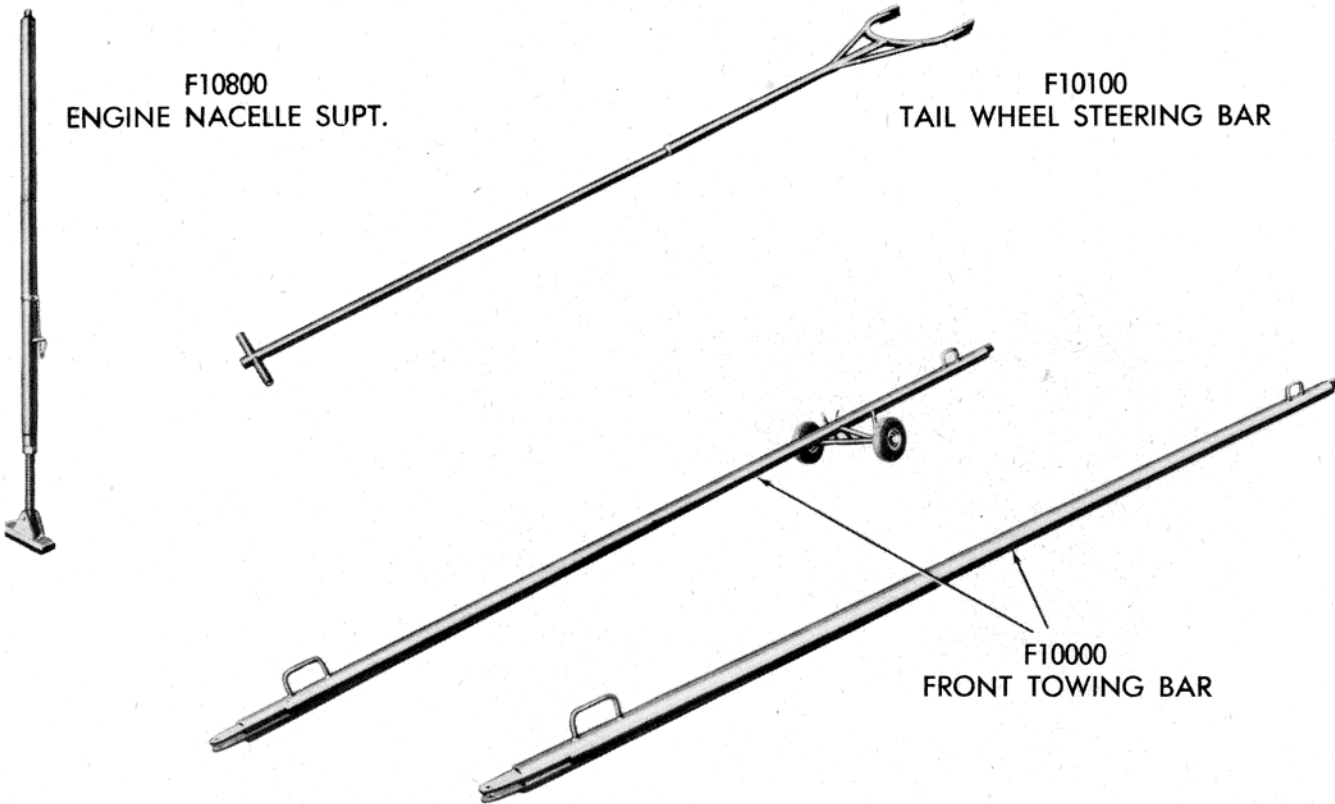


Figure 41—Ground Handling Equipment (Sheet 1 of 3)

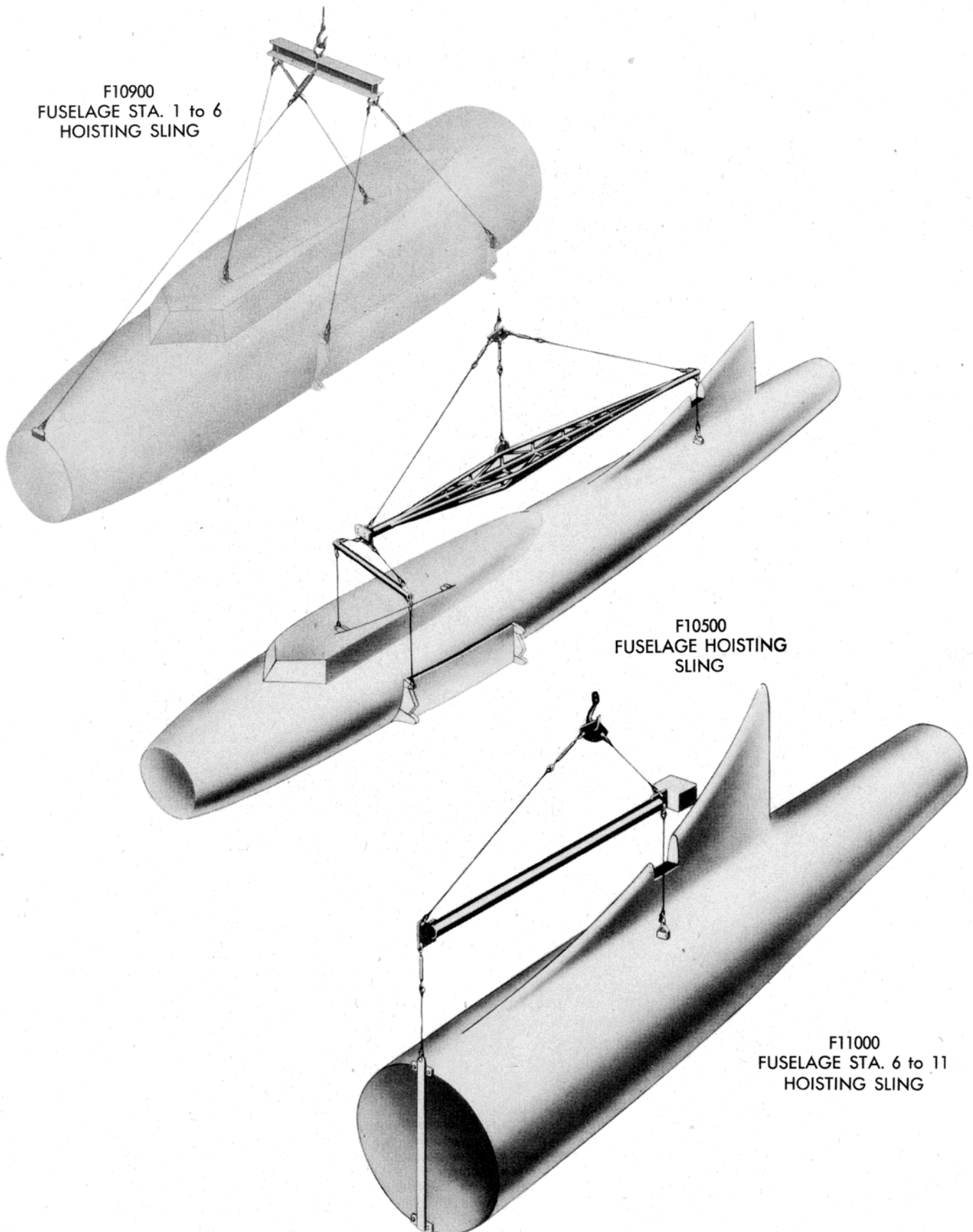
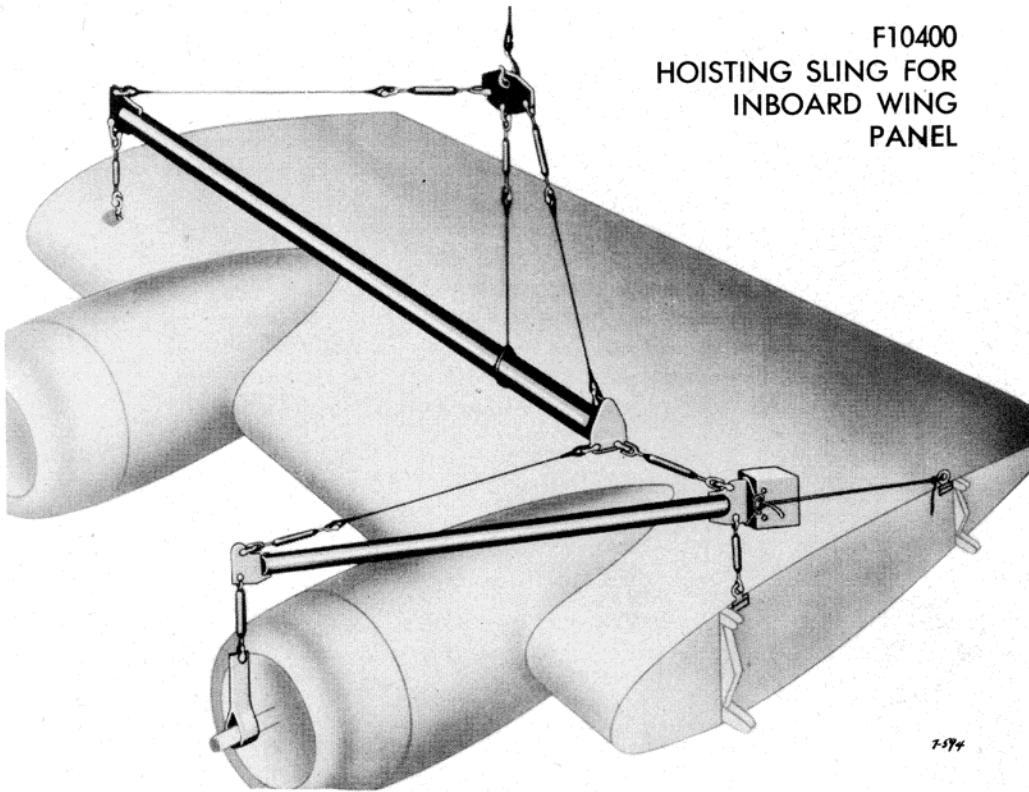


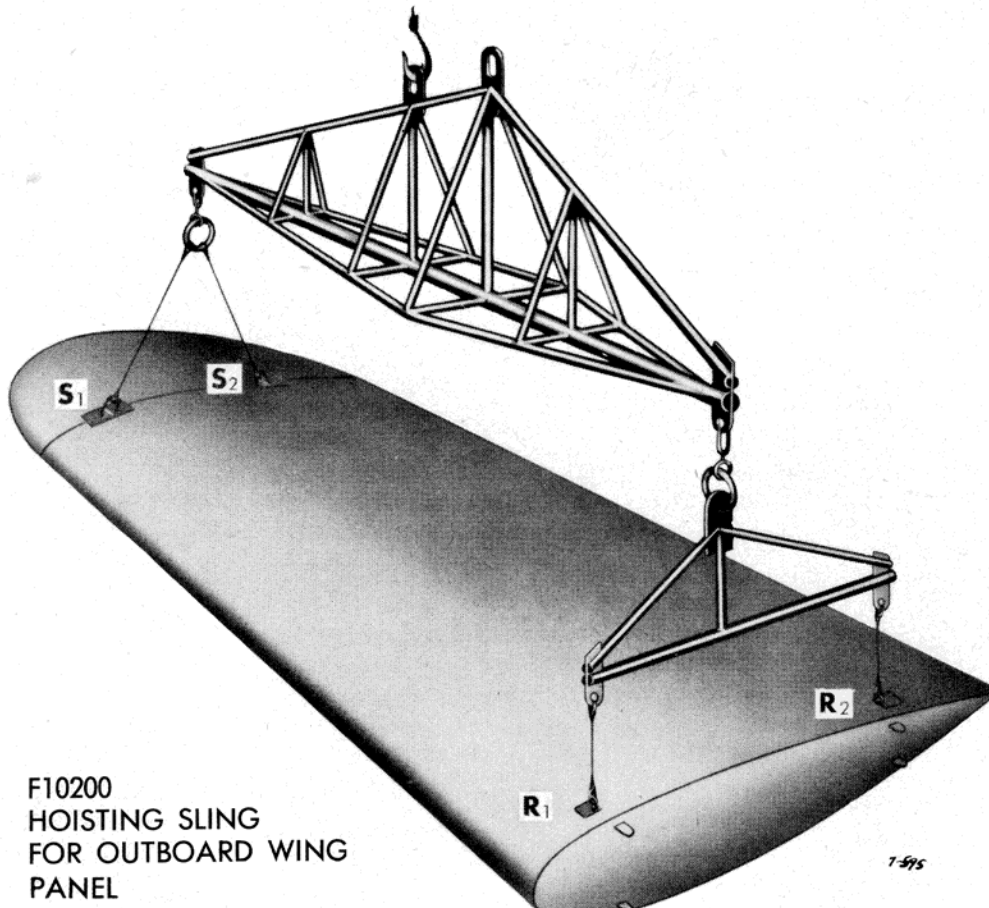
Figure 41—Ground Handling Equipment (Sheet 2 of 3)

RESTRICTED
AN 01-20EG-2

F10400
HOISTING SLING FOR
INBOARD WING
PANEL



7-574



7-575

F10200
HOISTING SLING
FOR OUTBOARD WING
PANEL

Figure 41—Ground Handling Equipment (Sheet 3 of 3)

RESTRICTED



F22700
DEICER BOOT SCREW HOLDER



F20000
HYDRAULIC
ACCUMULATOR
BLEEDER



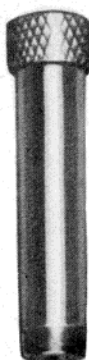
F21601
STA. 19 WING
ALIGNMENT PIN



F21701
HORIZONTAL
STABILIZER
ALIGNMENT
PIN



F21602
INBOARD WING
ALIGNMENT PIN



F21603
STATION 1 WING
ALIGNMENT PIN

F21802
1/2 x 12 ALIGNMENT
PUNCH



7-596

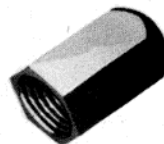
Figure 42—Special Tools (Sheet 1 of 7)



F21001
5/16-24
No. 4

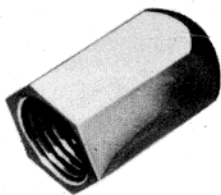


F21002
3/8-24
No. 5

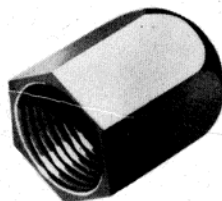


F21004
9/16-18
No. 8

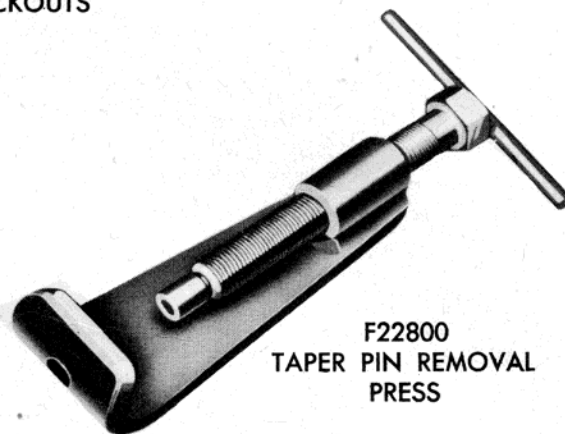
TAPER PIN KNOCKOUTS



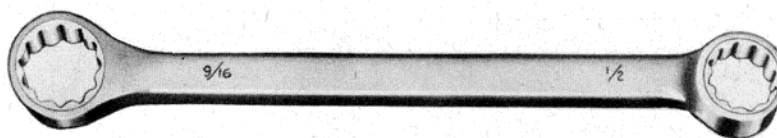
F21005
3/4-16
No. 9



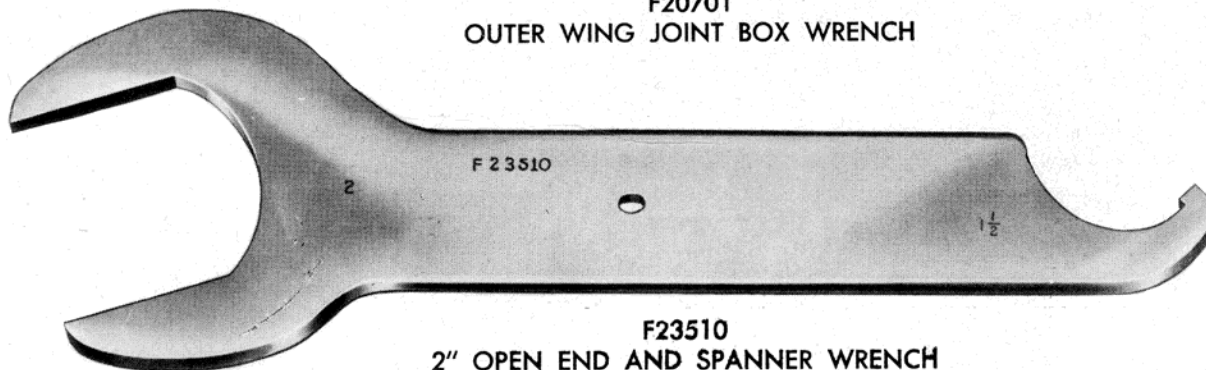
F21006
7/8-14
No. 10



F22800
TAPER PIN REMOVAL
PRESS



F20701
OUTER WING JOINT BOX WRENCH



F23510
2" OPEN END AND SPANNER WRENCH
(FOR CONDUIT FITTINGS)

7-598

Figure 42—Special Tools (Sheet 2 of 7)

7-599



F23105
No. 5



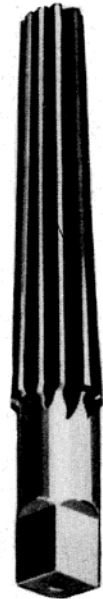
F23106
No. 6



F23108
No. 8



F23109
No. 9



F23110
No. 10

STRAIGHT FLUTE TAPERED REAMERS

PILOT ROUGHING REAMERS



F23004
15/32



F23007
1 - 1/8



F23001
1 - 1/64



F23002
7/8



F23003
23/32

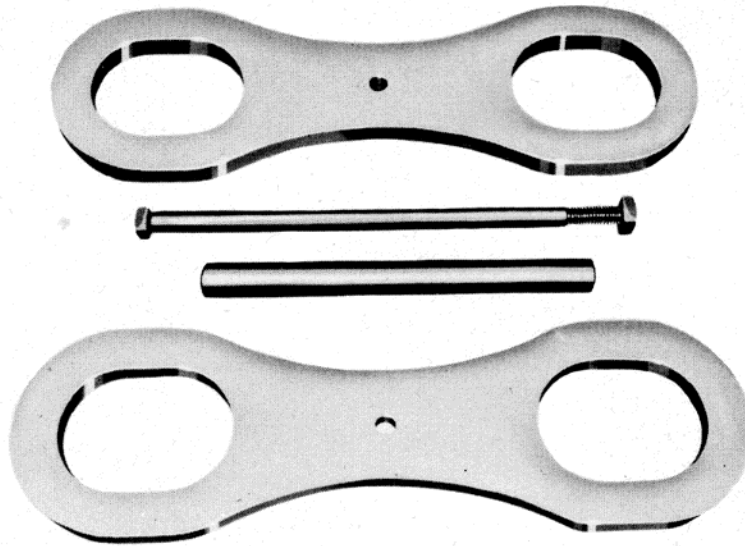


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27/64

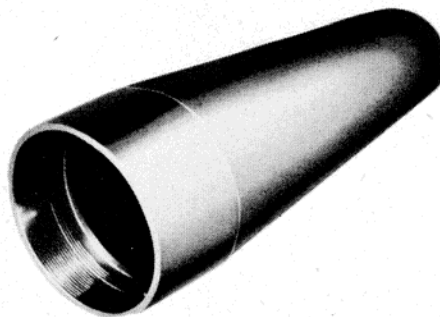


F23006
21/64

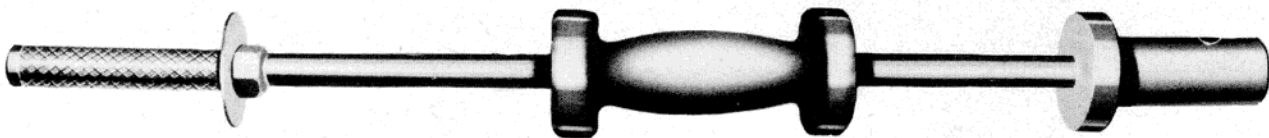
Figure 42—Special Tools (Sheet 3 of 7)



F20900
MAIN OLEO RETAINING LINK SCISSORS



F22200
LANDING GEAR WHEEL
INSTALLATION TOOL



F22600
LANDING GEAR PIN INSERTER AND PULLER

7-600

Figure 42—Special Tools (Sheet 4 of 7)



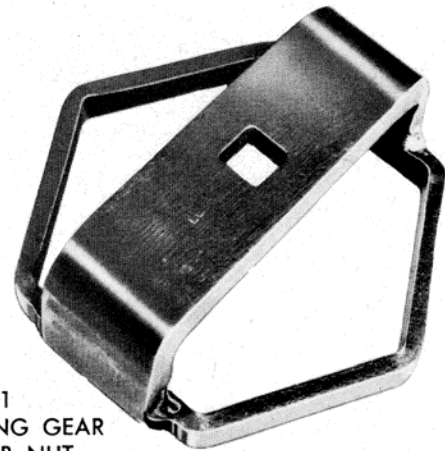
F20200
FUEL TANK
FILLER NECK
SPANNER WRENCH



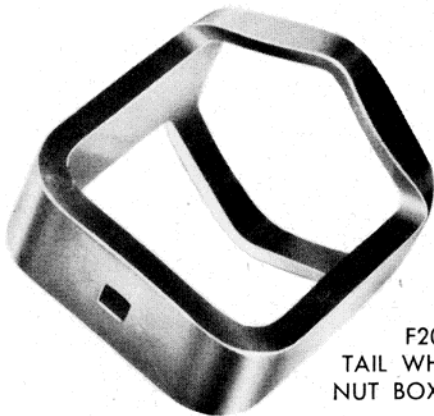
F21300
MAIN LANDING GEAR
RETRACTING SCREW
NUT PILOT SPANNER
WRENCH



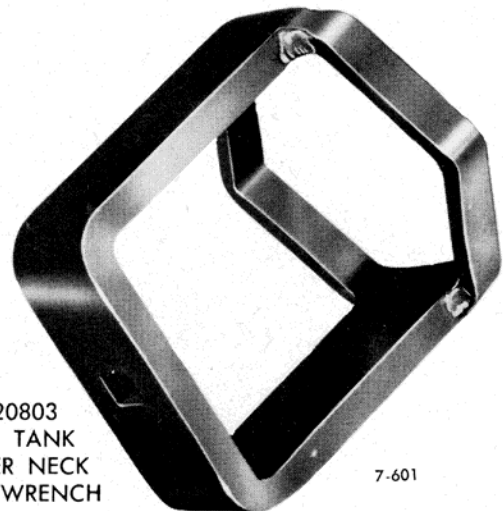
F20801
GLYCOL TANK
FILLER NECK
BOX WRENCH



F20601
MAIN LANDING GEAR
WHEEL HUB NUT
BOX WRENCH



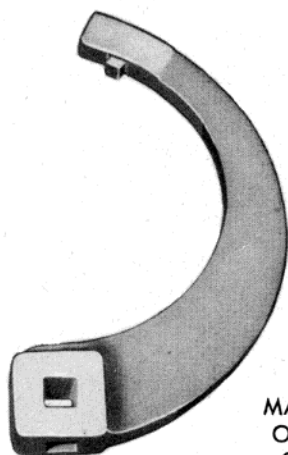
F20802
TAIL WHEEL AXLE
NUT BOX WRENCH



F20803
OIL TANK
FILLER NECK
BOX WRENCH

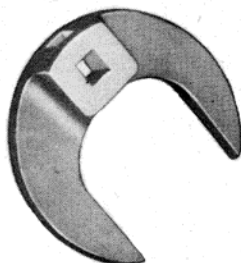
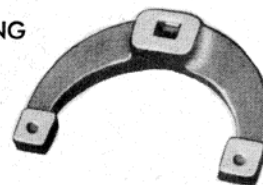
7-601

Figure 42—Special Tools (Sheet 5 of 7)



F20410
MAIN LANDING GEAR
OLEO PACKING NUT
SPANNER WRENCH

F20510
RETRACTING GEAR HOUSING
CAP SPANNER WRENCH

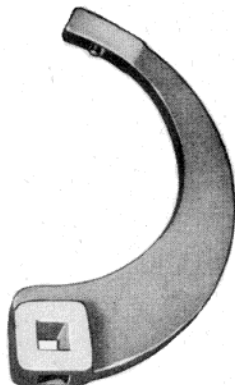


F21126
OIL RETURN
LINE CROW-
FOOT WRENCH

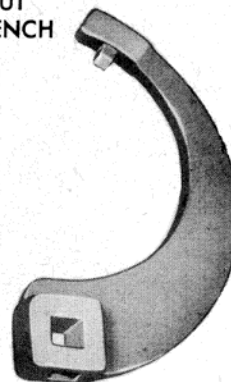
F20411
MAIN LANDING GEAR
OLEO LOCK RING
SPANNER WRENCH



F20412
TAIL WHEEL OLEO
LOCK RING SPANNER WRENCH



F20413
TAIL WHEEL OLEO
PACKING NUT
SPANNER WRENCH



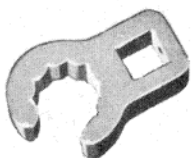
F20301
STARTER AND GENERATOR
CROWFOOT WRENCH

7-602

Figure 42—Special Tools (Sheet 6 of 7)



F21901
9/16



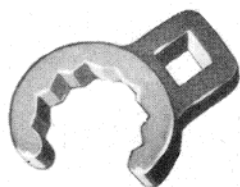
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5/8



F21903
11/16



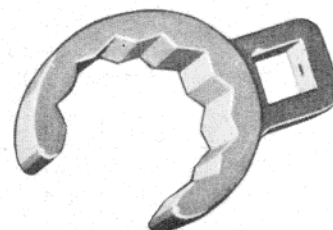
F21904
7/8



F21905
1



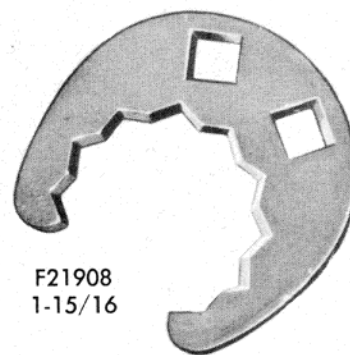
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1-3/16



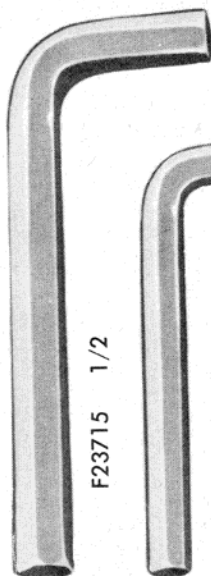
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1-1/2



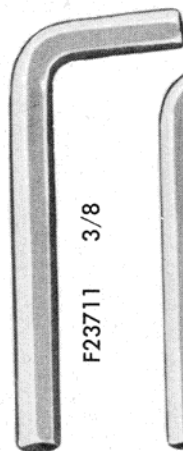
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15/16



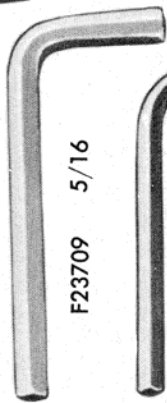
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1-15/16



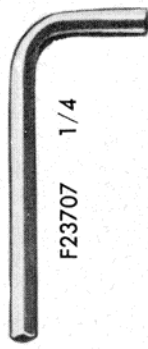
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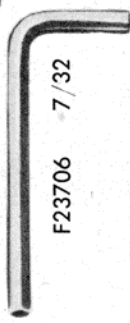
F23711
3/8



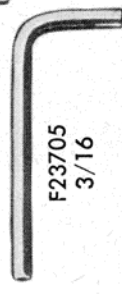
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5/16



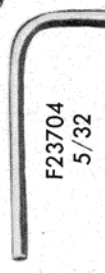
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1/4



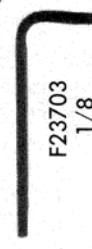
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7/32



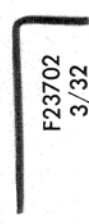
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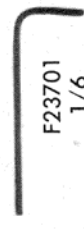
F23704
5/32



F23703
1/8



F23702
3/32



F23701
1/6

7-603

Figure 42—Special Tools (Sheet 7 of 7)

LUBRICATION INSTRUCTIONS

- 1—PINNED JOINTS, EXPOSED UNIVERSALS, DOOR HINGES AND LATCHES, SPLINES, ETC. LUBRICATE WITH LOW TEMPERATURE OIL SPECIFICATION NO. AN-0-6.
- 2—ZERK FITTINGS—APPLY LOW TEMPERATURE LUBRICATING GREASE, SPECIFICATION NO. AN-G-3, SPARINGLY. DO NOT LUBRICATE GEAR BOXES BY ZERK FITTINGS, FOLLOW INSTRUCTION FIVE.
- 3—RETRACTING SCREWS—INSPECT MECHANISM FOR DIRT AND OTHER FOREIGN MATTER IN LUBRICANT, AND FOR SUFFICIENT LUBRICATION. WHERE NECESSARY, CLEAN THOROUGHLY AND APPLY A LIGHT COAT OF LOW TEMPERATURE LUBRICATING GREASE, SPECIFICATION AN-G-10.
- 4—ENCASED UNIVERSALS—CLEAN THOROUGHLY AND RE-LUBRICATE WITH LOW TEMPERATURE LUBRICATING GREASE, SPECIFICATION AN-G-3, TO 1/3 CAPACITY.
- 5—GEAR BOXES—INSPECT REPRESENTATIVE GEAR BOXES FOR LOSS OF AND GENERAL DETERIORATIONS OF THE LUBRICANT AND FOR EVI-

DENCE OF MOISTURE. WHEN NECESSARY, CLEAN AND RE-LUBRICATE TO 1/3 CAPACITY WITH LOW TEMPERATURE LUBRICATING GREASE, SPECIFICATION AN-G-3.

- 6—BEARINGS—CLEAN THOROUGHLY AND RELUBRICATE TO 1/3 CAPACITY AS FOLLOWS. LUBRICATE ROLLER BEARINGS IN WHEELS WITH GREASE, SPECIFICATION NO. 3560, MEDIUM GRADE. LUBRICATE ALL OTHER BALL AND ROLLER BEARINGS WITH GREASE SPECIFICATION AN-G-3.
- 7—FLEXIBLE SHAFTING—DISASSEMBLE, CLEAN THOROUGHLY AND IF EXPOSED TO LOW TEMPERATURES APPLY A LIGHT COAT OF GREASE, SPECIFICATION AN-G-3.
- 8—CLEAN THOROUGHLY AND COAT PARTS LIGHTLY WITH GREASE AN-G-3.

▶ IT IS IMPORTANT THAT THE EXCESS GREASE BE REMOVED FROM THE ACTUATING SCREWS TO PREVENT FREEZING AND STICKING AT EXTREME LOW TEMPERATURES.

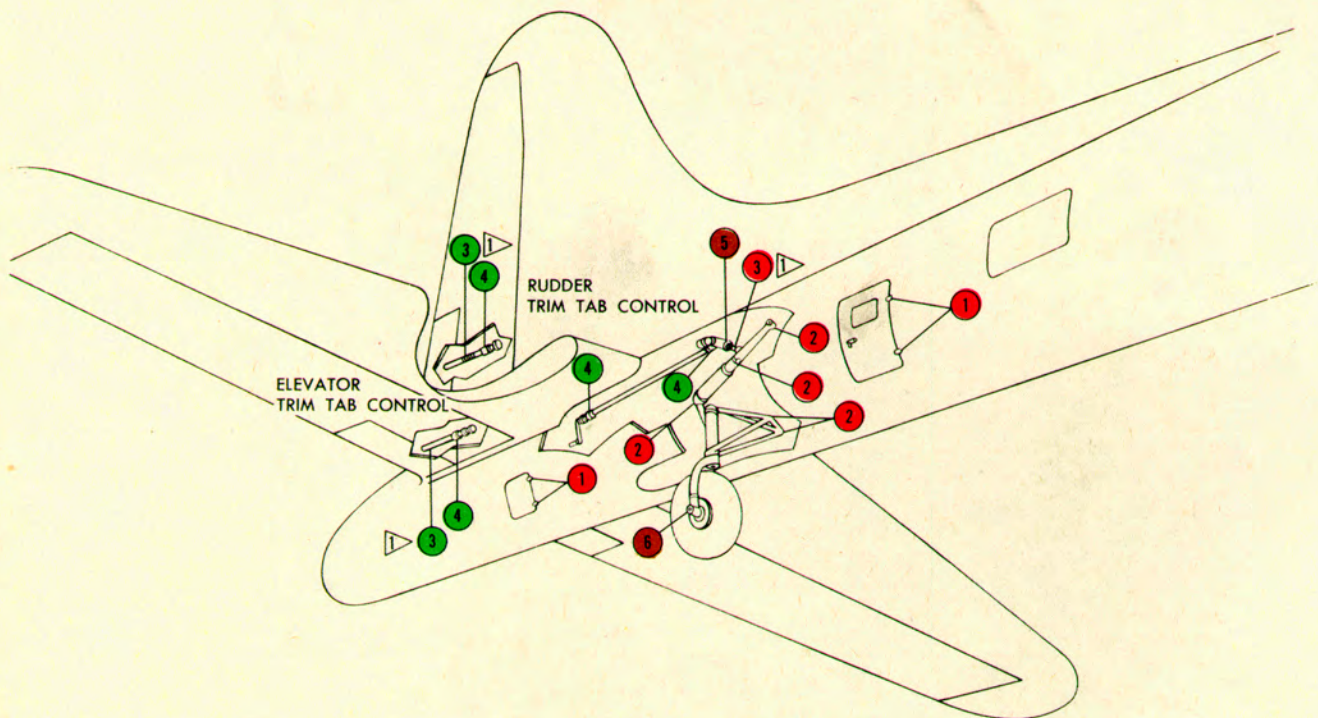
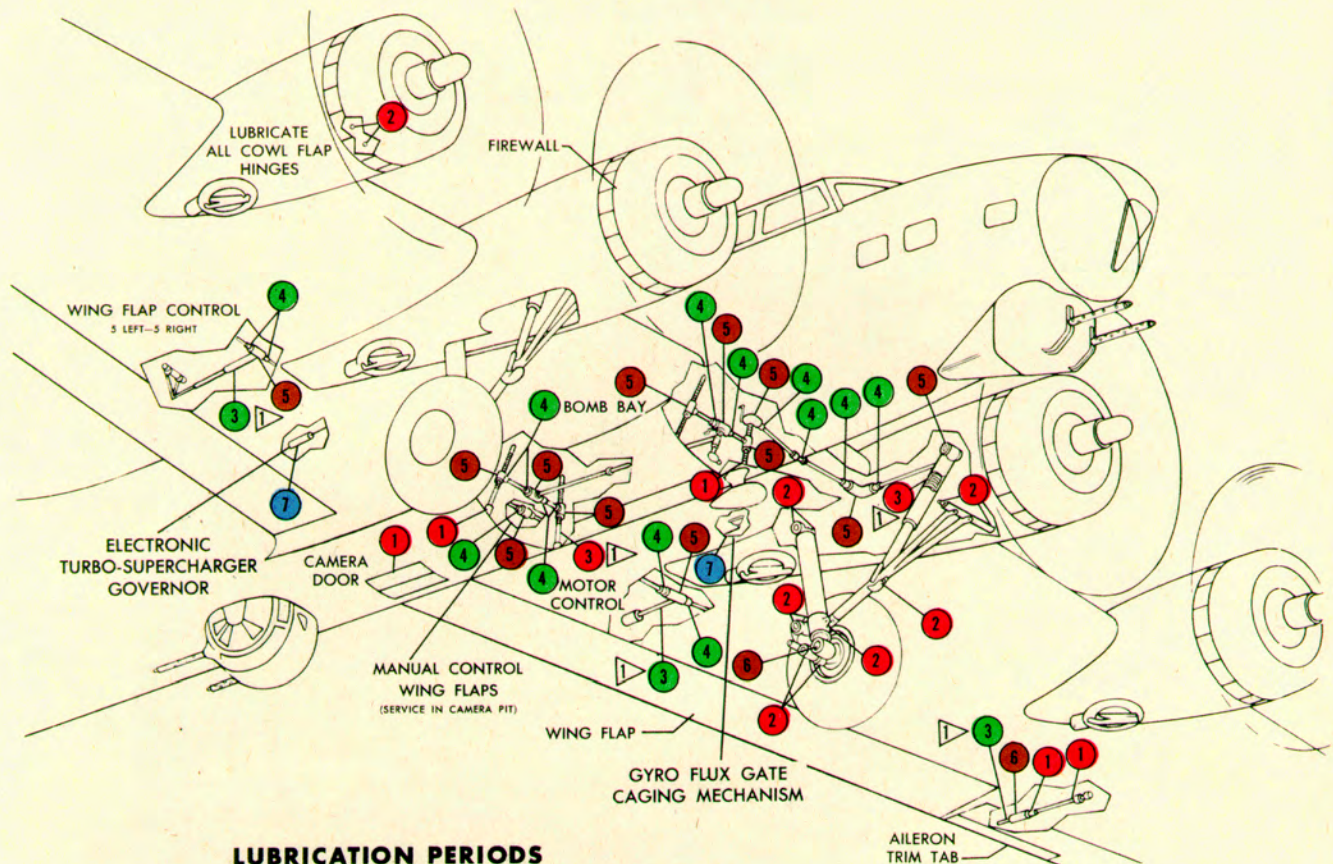


Figure 43—Lubrication Chart (Sheet 1 of 2)



LUBRICATION PERIODS

SYMBOL	PARTS	LOCATION
25 HOURS ●		
1	EXPOSED UNIVERSALS	AILERON TRIM TAB CONTROL
1	TERMINAL ASSEMBLY	BOMB DOOR RETRACTING SCREWS
1	FOOT PEDAL STIRRUPS	CONTROL CABIN (NOT SHOWN)
1	PEDAL AND BRAKE ROD CONTROLS	CONTROL CABIN (NOT SHOWN)
1	PEDAL ADJUSTMENT GUIDE	CONTROL CABIN (NOT SHOWN)
1	HANDLE ASSY. STARTER CONTROL	CONTROL CABIN (NOT SHOWN)
1	RUDDER AND ELEVATOR LOCK PINS	CONTROL CABIN (NOT SHOWN)
1	(CAUTION: DO NOT LUBRICATE ENGAGING AREAS OF LOCK PIN.)	
1	DOOR HINGES AND LOCKS	
1	AILERON, RUDDER AND TAB INDICATOR	TAIL ASSEMBLY
1	ALL OTHER EXPOSED UNIVERSALS	
2	PINNED JOINTS AND LATCHES	
2	ZERK FITTINGS	
3	RETRACTING SCREWS	BOMB BAY
3	RETRACTING SCREWS	MAIN LANDING GEAR
3	RETRACTING SCREWS	TAIL WHEEL GEAR

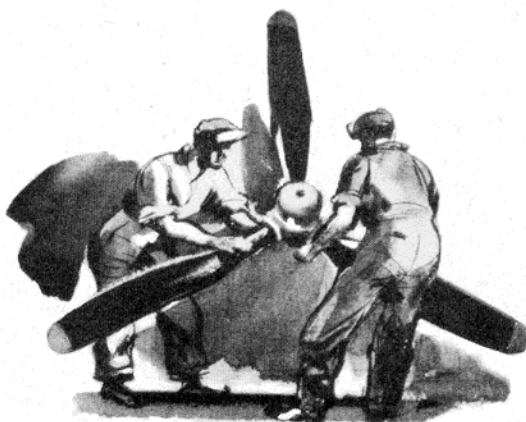
SYMBOL	PARTS	LOCATION
100 HOURS ●		
5	GEAR BOXES	SEE DIAGRAM
6	BEARINGS	SEE DIAGRAM
200 HOURS ●		
7	TACHOMETER SHAFTS	NACELLE 1, 2, 3, AND 4
8	CABLES (NOT SHOWN)	PULLEY GROOVES AND FAIRLEADS
500 HOURS ●		
3	RETRACTING SCREWS	WING FLAP
3	RETRACTING SCREWS	AILERON TRIM TAB
3	RETRACTING SCREWS	ELEVATOR TRIM TABS
4	ENCASED UNIVERSALS	SEE DIAGRAM
7	CONTROL INSTALLATION	BOMB RACKS AND DOORS

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Figure 43—Lubrication Chart (Sheet 2 of 2)

SECTION IV

MAJOR COMPONENT PARTS AND INSTALLATIONS



1. GENERAL.

a. SCOPE.—This section covers the removal, installation, and repair (other than structural) for the major component parts of the airplane. Detailed instructions for repairing and overhauling the engines, accessories, instruments, and other installed equipment can be found in Technical Orders specifically covering those items.

b. TAPER PIN JOINTS.

(1) Taper pin joints are all critical structural parts. Any disassembly or replacement operation involving dismantling at a taper pin joint must be accomplished with extreme care. Removal of taper pins that have been in service may become a difficult operation, resulting in serious damage to the parts if not performed correctly. The taper pin replacement procedure diagram (see figure 48) indicates a safe and efficient method for removal of taper pins.

(2) In any case where half of the original fitting is to remain in use and the other half is to be replaced, the reaming operation on the new part must be performed with the joint assembled. Since the new part has a straight hole and the old part has a taper reamed hole, a special operation is necessary to secure proper alignment of the parts. This is best accomplished by inserting, in the old part, bushings tapered on the outside to match the reamed hole, but with a straight hole on the inside to match the straight hole on the terminal. After these bushings have been inserted in the female terminal with the reamed holes, and fitted snugly into place, cut out the exposed portion of the bushing in the slot of the terminal. Assemble the joint with straight bolts or primary pins as shown in the diagram. The

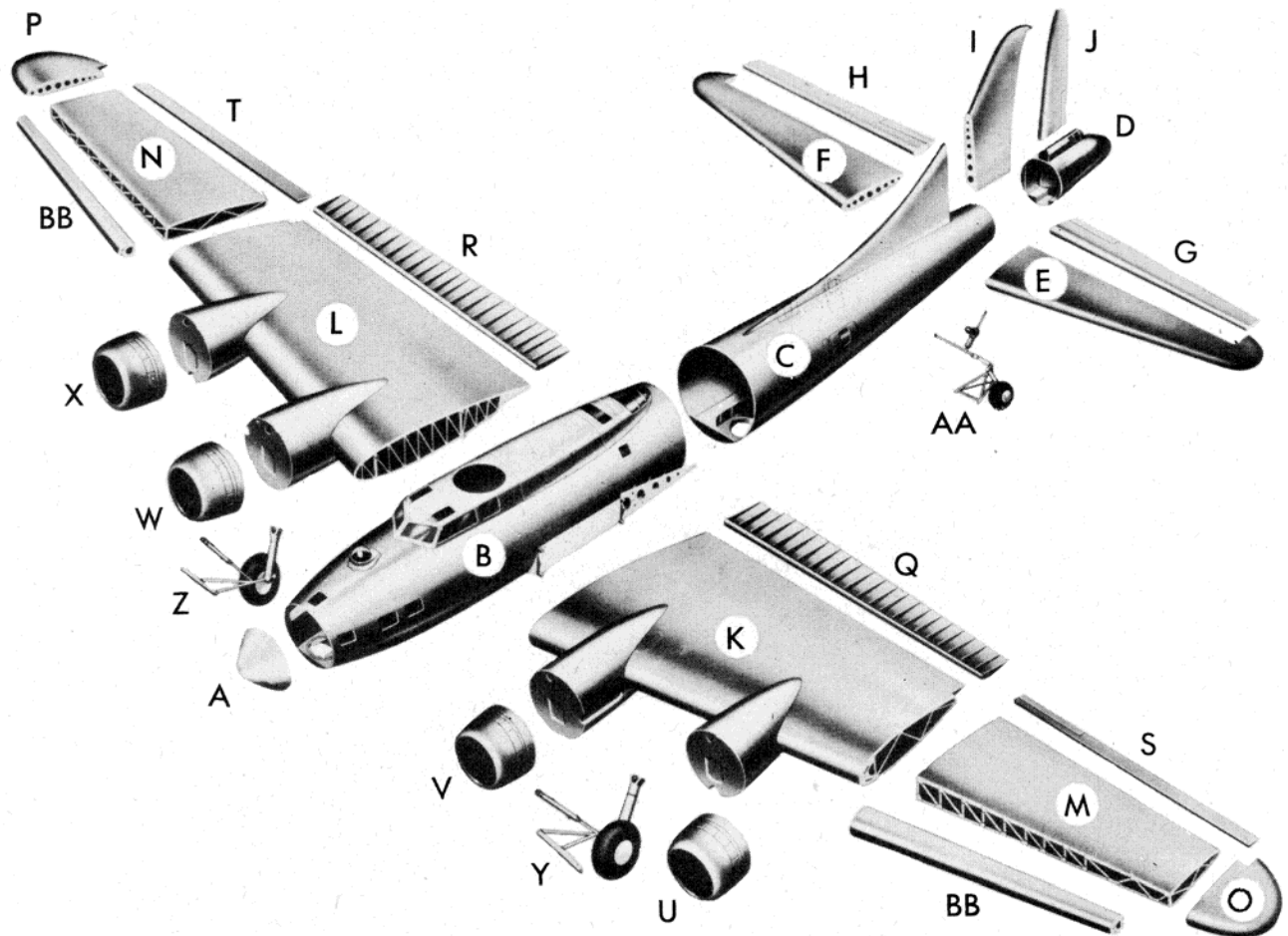
holes may then be reamed individually for the taper pins, exactly as in any reaming process. The reaming process is complete when the bushing is entirely reamed away concentrically without enlarging the holes in the terminals. If this operation is performed with care, the original half of any terminal may be fitted with a new mating half an indefinite number of times before being rendered useless through enlargement of the holes. The maximum and minimum values for hole diameter and edge margin shown on the taper pin data chart (see figure 50) must be observed. The location of all structural taper pins in the airplane is indicated on the taper pin location diagram (see figure 46).

c. SKIN PATCHES AND STRINGER SPLICES.—Stressed skin construction is employed in the design of this airplane and therefore skin patches must be considered as structural repair. Full information regarding skin patches, stringer and longeron splices is contained in T. O. No. 01-20E-3, the "Handbook of Instructions for Structural Repair" for this airplane.

2. WING GROUP.

a. GENERAL.

(1) STRUCTURE.—The wing is fabricated in three sections, consisting of a tip, an outer panel containing the aileron, and an inner panel containing the wing flap and the engine nacelles. Two truss-type spars extend the length of each wing to the tip connection. Each spar is attached to the body bulkheads at either end of the bomb bay by means of an upper and a lower steel terminal and a steel shear connection. The nacelles are built integrally with the inner panel. The engine mounts, attached by means of four 5/8-inch bolts at the fire walls, are interchangeable.

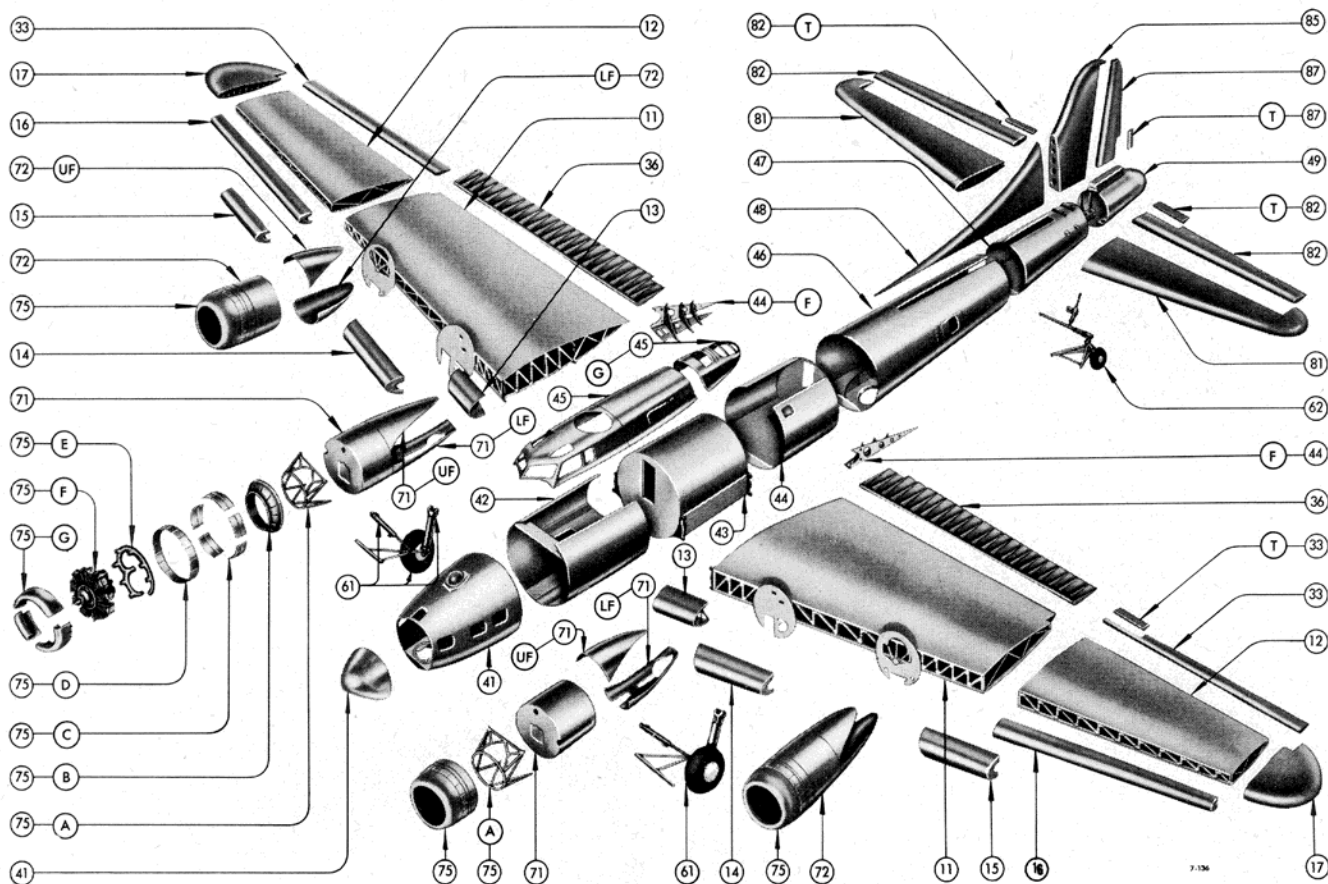


7-135

A—Nose Inst.	15-7991	O—Wing Tip Assy. L.H.	75-3590
B—Fuselage Assy. Sta. 1 to 6	55-7330	P—Wing Tip Assy. R.H.	75-3590
C—Fuselage Assy. Rear Section	65-7331	Q—Flap Assy. L.H.	75-5127
D—Tail Gun Enclosure	15-7360	R—Flap Assy. R.H.	75-5127
E—Stabilizer Assy. L.H.	15-7025	S—Aileron Assy. L.H.	58-784
F—Stabilizer Assy. R.H.	15-7025	T—Aileron Assy. R.H.	58-784
G—Elevator Assy. L.H.	15-7026	U—Engine Inst. L. H. Outbd.	65-7359
H—Elevator Assy. R.H.	15-7026	V—Engine Inst. L.H. Inbd.	65-7359
I—Fin Assy.	15-7023	W—Engine Inst. R.H. Inbd.	63-7359
J—Rudder Assy.	15-7024	X—Engine Inst. R.H. Outbd.	65-7359
K—Wing Assy.—Inbd. L.H.	15-7975	Y—Landing Gear and Brakes Inst. L.H.	* { 75-4801
L—Wing Assy.—Inbd. R.H.	15-7975	Z—Landing Gear and Brakes Inst. R.H.	
M—Wing Assy.—Outbd. L.H.	85-4772	AA—Tail Gear Inst.	55-7470
N—Wing Assy.—Outbd. R.H.	85-4772	BB—Nose Inst. Sta. 19½ to 33 L.H. & R.H. Wing	15-7475

*—Airplanes with Dual Duplex Brakes 15-10414

Figure 44—Major Assembly Breakdown



LEGEND FOR SUB-ASSEMBLY BREAKDOWN

11	Inboard Wing Assy. L.H. or R.H.	15-7975	49	Tail Gun Enclosure	15-7360
12	Outboard Wing Assy. L.H. or R.H.	85-4772	61	Landing Gear and Brakes Inst. L.H. or R.H.	75-4801
13	Wing Nose Inst.—Wing Sta. 1 to 3 L.H. or R.H.	74-1831	62	Tail Gear Inst.	55-7470
14	Wing Nose Inst.—Wing Sta. 7 to 11 L.H. or R.H.	55-7483	71	Inboard Nacelle Assy. and Inst. L.H. or R.H.	85-4805
15	Wing Nose Inst.—Wing Sta. 15 to 19 L.H. or R.H.	15-7476	71 UF	Upper Fairing Inst.—Inboard Nacelle	15-6333
16	Wing Nose Inst.—Wing Sta. 19½ to 33 L.H. or R.H.	15-7475	71 LF	Lower Fairing Inst.—Inboard Nacelle	55-5929
17	Wing Tip Assy. L.H. or R.H.	75-3590	72	Outboard Nacelle Assy. and Inst. L.H. or R.H.	85-4806
33	Aileron Assy. L.H. or R.H.	58-784	72 UF	Upper Fairing Inst.—Outboard Nacelle	55-5962
33 T	Aileron Trim Tab L.H. Only	58-784	72	Outboard Nacelle Assy. and Inst.	
36	Wing Flap Assy. L.H. or R.H.	75-5127	75	Engine Inst. Assy.—All Alike	65-7359
41 N	Fuselage Nose Inst.	15-7991	75 A	Engine Mount	55-6185
41	Fuselage Assy.—Fwd. Sec.—Sta. 1 to 3	55-7330	75 B	Inner Cowling—Fixed	15-7666
42	Fuselage Assy.—Fwd. Sec.—Sta. 3 to 4	55-7330	75 C	Outer Cowling—Removable	15-7667
43	Fuselage Assy.—Fwd. Sec.—Sta. 4 to 5	55-7330	75 D	Cowl Flaps	55-7655
44	Fuselage Assy.—Fwd. Sec.—Sta. 5 to 6	55-7330	75 E	Exhaust Collector Ring	55-6194
44 F	Fairing Inst.—Rear Wing Fillet L.H. or R.H.	95-3684	75 F	Engine	—
45	Pilot's Compt.—Enclosure	15-8785	75 G	Cowl Ring Inst.	65-7616
45 G	Top Gun Emplacement Fairing	55-6612	81	Horizontal Stabilizer Assy. L.H. or R.H.	15-7025
46	Fuselage Assy.—Rear Sec.—Sta. 6 to 7	65-7331	82	Elevator Assy. L.H. or R.H.	15-7026
47	Fuselage Assy.—Rear Sec.—Sta. 7 to 11	55-7331	82 T	Elevator Trim Tab, L.H. or R.H.	15-2073
48	Dorsal Fin. Inst.	15-7027	85	Vertical Fin Assy.	15-7023
			87	Rudder Assy.	15-7024
			87 T	Rudder Trim Tab	14-2043

Figure 45—Subassembly Breakdown

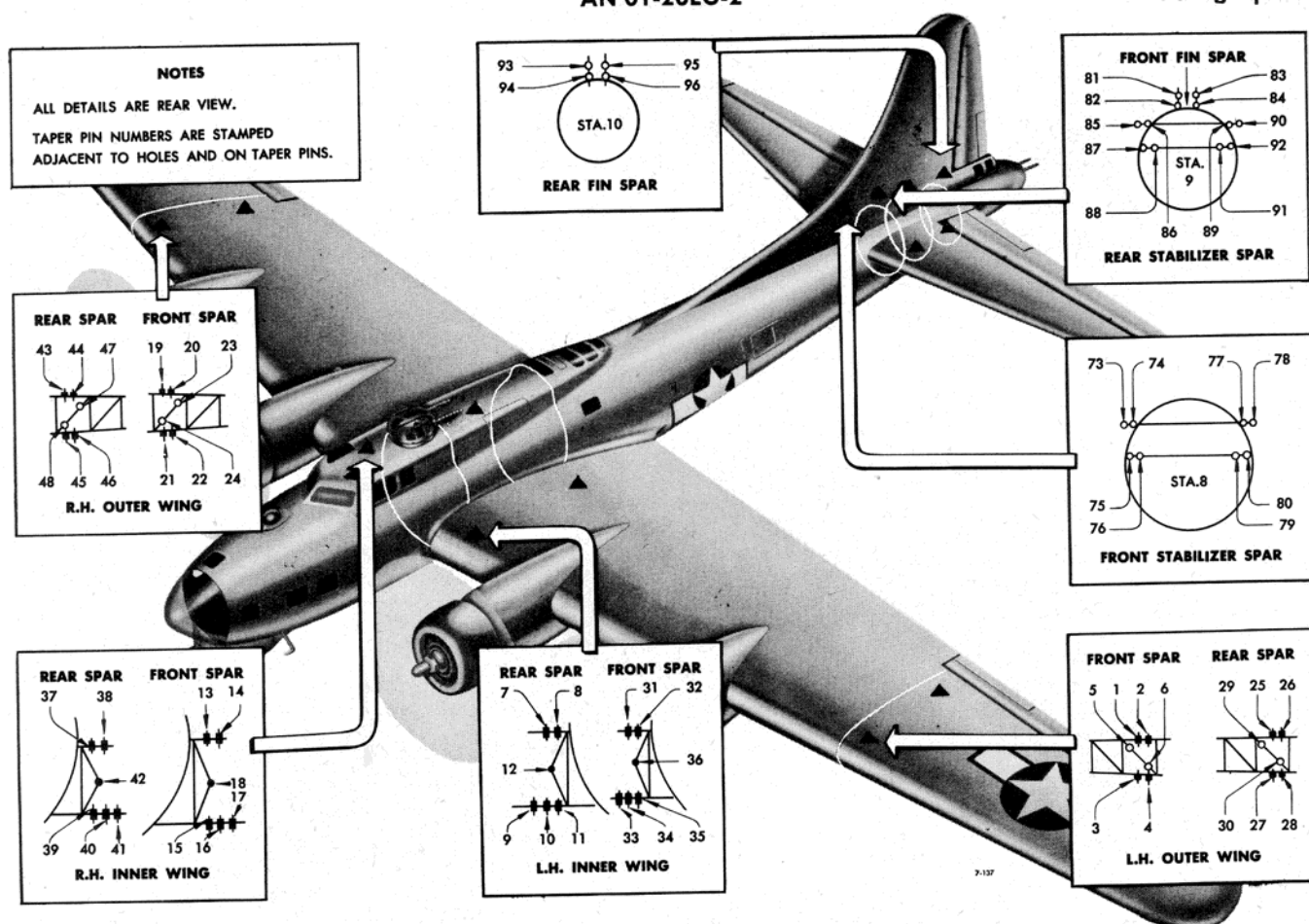


Figure 46—Taper Pin Location Diagram

(a) The wing flap is of the split trailing edge type and extends the full length of the inner wing panel. Attachment at five points is by means of two connecting rods hinged at both the flap and wing ends which operate to extend the flap backward as well as downward. Refer to the wing flap actuating mechanism diagram (see figure 256) for details of flap operation. Operation of both flaps is accomplished simultaneously by means of an electric motor-driven retracting screw located in the trailing edge at the inboard end of the left wing.

(b) The aileron extends slightly over each end of the outboard wing panel and is attached by hinges at four points. Control is accomplished through a cable, quadrant, and push rod linkage located at the central portion of the aileron. A trim tab is provided on the inboard end of the left aileron only.

(c) Nacelles are built integrally with the wing, and are not designed for removal from the wing. Engine mounts are attached at the nacelle fire wall by means of four 5/8-inch steel bolts and normally will be removed with the engines.

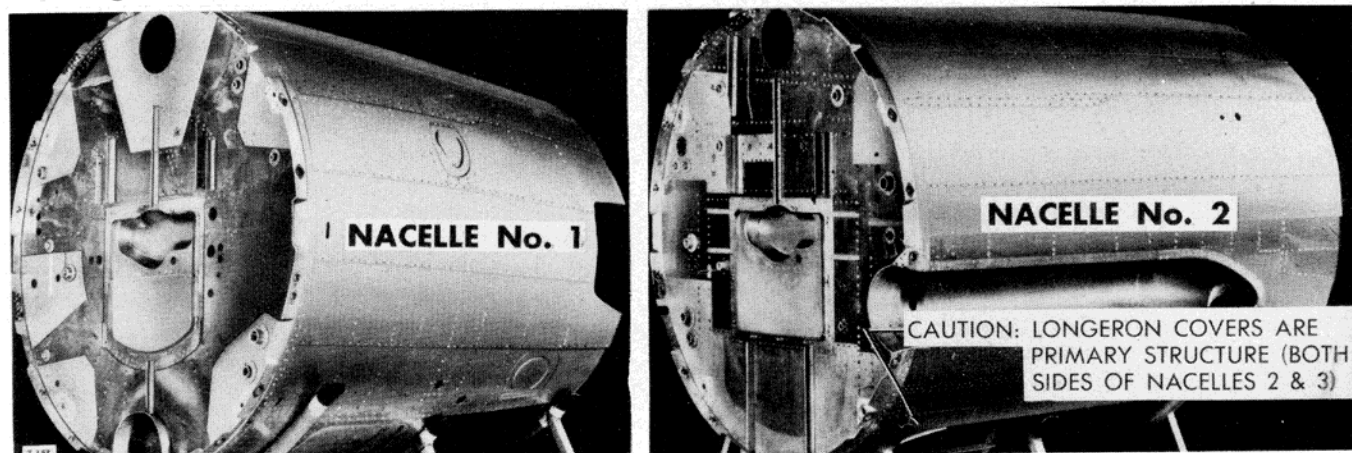
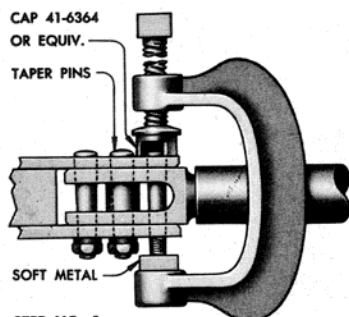


Figure 47—Nacelles Complete

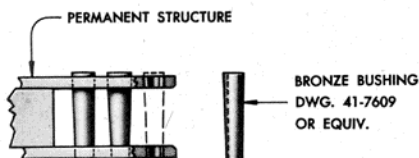
Section IV Paragraph 2

RESTRICTED
AN 01-20EG-2



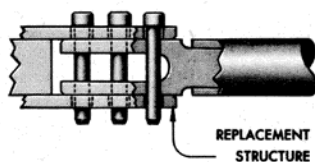
STEP NO. 1

REMOVE TAPER PINS AS SHOWN. DO NOT DRIVE OUT.
CAUTION: USE CARE TO AVOID INJURY IF PIN "POPS" OUT. LIGHT TAPPING AGAINST BOTTOM OF "C" CLAMP IS PERMISSIBLE



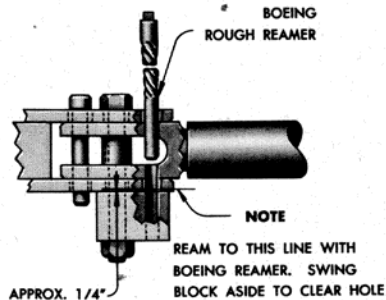
STEP NO. 2

MALE FITTING REMOVED, INSERT BUSHINGS IN THE PERMANENT STRUCTURE AND TRIM AS REQUIRED.



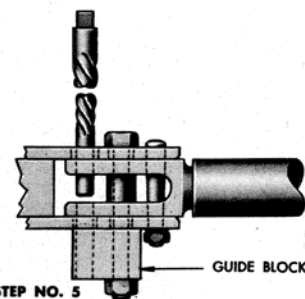
STEP NO. 3

SUPPORT REPLACEMENT STRUCTURE IN POSITION. INSERT PRIMARY PINS (ALL FITTINGS).



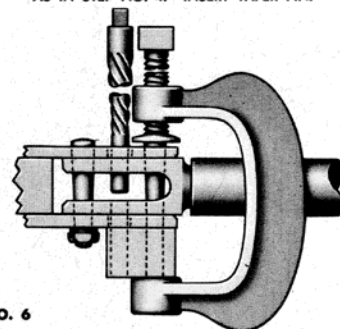
STEP NO. 4

REMOVE TWO PRIMARY PINS AND ATTACH GUIDE BLOCK AS SHOWN. REAM BUSHINGS ENTIRELY AWAY. INSERT TAPER PIN.



STEP NO. 5

ATTACH GUIDE BLOCK AS SHOWN. REAM AS IN STEP NO. 4. INSERT TAPER PIN.



STEP NO. 6

REMOVE TAPER PIN NUT AND ATTACH GUIDE BLOCK AS SHOWN. REAM AS IN STEP NO. 4. INSERT TAPER PIN. LOCK ALL NUTS.

GENERAL NOTES

PROCEDURE IS TYPICAL OF ALL TAPER PINS AND TERMINALS. DO NOT ALLOW HOLE LOCATIONS TO CREEP WHILE REAMING.

DO NOT REAM HOLES ANY LARGER THAN NECESSARY TO OBTAIN PROPER FIT WITH PINS. DO IF MALE FITTING IS SOLID, SPACER IS NOT NEEDED TO PREVENT DEFLECTION.

Figure 48—Taper Pin Replacement Diagram

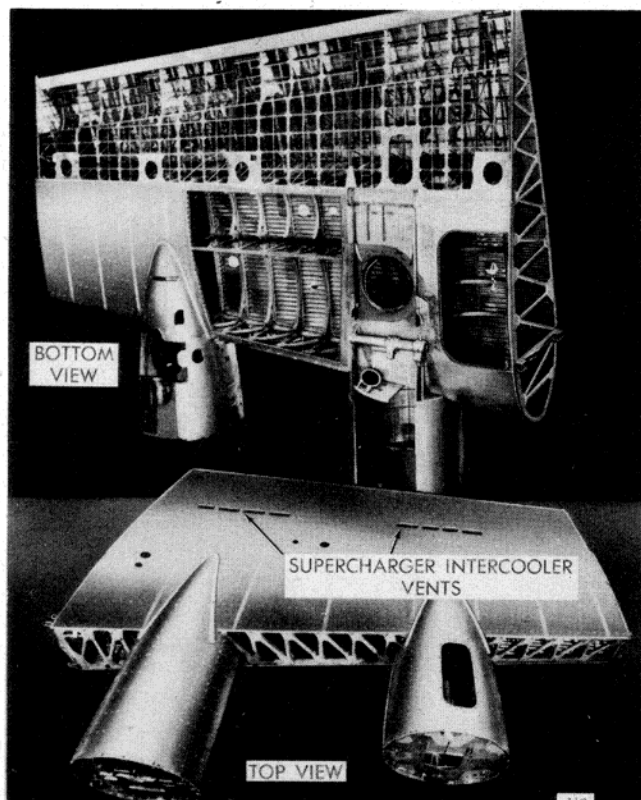


Figure 49—Left Inboard Wing Panel Details

(2) **ASSEMBLY AND INSTALLATION.**—Procedure for assembly will follow in general the reverse of the disassembly procedure. For assembly of the cable and mechanism connections, refer to the applicable cable diagrams and instructions. For the complete installation, refer to instructions contained in this section regarding the various systems and equipment items.

(3) **REPLACEMENTS.**—Removable parts and assemblies should be replaced by new parts or parts repaired in accordance with instructions given in T. O. No. 01-20E-3, "Handbook of Instructions for Structural Repair" for this airplane. Replacement of terminals at outer wing and body connections will require in some cases the reaming of a new terminal to mate with the one already reamed. Instructions for proper procedure on reaming are contained in section IV, paragraph 1.

(4) **ADJUSTMENTS.**—Instructions for the adjustment of ailerons, aileron tabs, and wing flap will be found in section IV, paragraph 7. *b.*

b. INBOARD WING PANEL.

(1) REMOVAL AND DISASSEMBLY.

(a) Before removal of the inner panel the airplane must be securely jacked at four points. Support the airplane at the two jacking cones at body station 4 and the cone at body station 7. Then support the wing on the opposite side by placing a jack at wing station 8. Secure the master battery switch in the "OFF" position

LEGEND

	LOC. NO.		TAPER PIN AC STD.	TERM. DWG. NO.	D ₁	E ₁	S ₁	TERM. DWG. NO.	D ₂	E ₂	S ₂	ROUGHING REAMER A-2070	DIA. OF BOEING REAMER	FINISH REAMER B & S NO.
	L.H.	R.H.												
WING F.S. STA. 19	1	20	386-6-14	3-11720	.768	.441	.554	3-11721	.750	.605	.562	-8	.469	6
	2	19			.768	.646			.750	.605	.562	-8	.469	6
	3	22	386-6-14	3-11720	.768	.441	.554	3-11721	.750	.605	.562	-8	.469	6
	4	21			.768	.646			.750	.605	.562	-8	.469	6
	5	23	386-5-24	7-1361	.766	.367	.679	3-8760	.751	.375	.686	-9	.422	5
WING F.S. STA. 1	6	24	386-5-27	74-1433	.782	.359	.669		.768	.366	.676	-9	.422	5
	7	14	386-10A-30	6-3851	1.501	.500	.624	66-5531	1.479	.448		-14	1.125	10
	8	13		46-3851	1.501	.850			1.479	.260	.385			
	9	17	386-9-32	46-3852	1.262	.369	.494	66-5532	1.231	.822		-5-1/2	.875	9
	10	16		56-3852	1.262	.619			1.231	.585				
WING R.S. STA. 19	11	15			1.262	.819			1.231	.385	.510			
	12	18	386-8-24	6-3850	1.070		.528	46-5891	1.056		.535	-6-1/2	.719	8
	25	44	386-6-14	3-11720	.768	.441	.554	3-11721	.750	.605	.562	-8	.469	6
	26	43			.768	.646			.750	.450				
	27	46	386-6-14	3-11720	.768	.441	.554	3-11721	.750	.605	.562	-8	.469	6
WING R.S. STA. 1	28	45			.768	.646			.750	.450				
	29	47	386-5-24	6-8249	.766	.367	.554	3-8761	.751	.375	.561	-9	.422	5
	30	48	386-5-27	3-8748	.782	.359	.546		.768	.366	.553	-9	.422	5
				64-1434										
	31	38	386-10-29	6-3854	1.393	.479		66-5529	1.374	.438		-2-1/2	1.016	10
STAR. F.S.	32	37		46-3854	1.393	.804	.553		1.374	.313	.438			
	33	41	386-8-31	46-3855	1.104	.448	.573	66-5530	1.080	.710		-6-1/2	.719	8
	34	40	386-9-31	56-3855	1.254	.663			1.230	.510		-5-1/2	.875	9
	35	39	386-9-31	56-3855	1.254	.842			1.230	.385	.445	-5-1/2	.875	9
	36	42	386-8-24	6-3856	1.070		.528	46-5882	1.056		.535	-6-1/2	.719	8
STAR. R.S.	73	78	386-5-23A	6-9204-2	.749	.186	.286	8-1268	.712	.519		-9	.422	5
	74	77			.749	.501			.712	.354	.256			
	75	80	386-5-23A	6-9204-2	.749	.186	.286	8-1268	.712	.519		-9	.422	5
	76	79			.749	.501			.712	.354	.256			
	81	83	386-5-17A	6-9204	.719	.201	.301	8-1266	.695	.373		-9	.422	5
FIN F.S.	82	84			.719	.531			.695	.263	.203			
	85	90	386-5-23A	6-9204-3	.749	.186	.286	8-1264	.712	.519		-9	.422	5
	86	89			.749	.501			.712	.354	.256			
	87	92	386-5-23A	6-9204-2	.749	.186	.286	8-1264	.712	.519		-9	.422	5
	88	91			.749	.501			.712	.354	.256			
FIN R.S.	93	95	386-4-9A	8-1273	.584	.268	.208	8-1267	.574	.338		-11-1/2	.328	4
	94	96			.584	.428			.574	.223	.200			

MALE FITTING

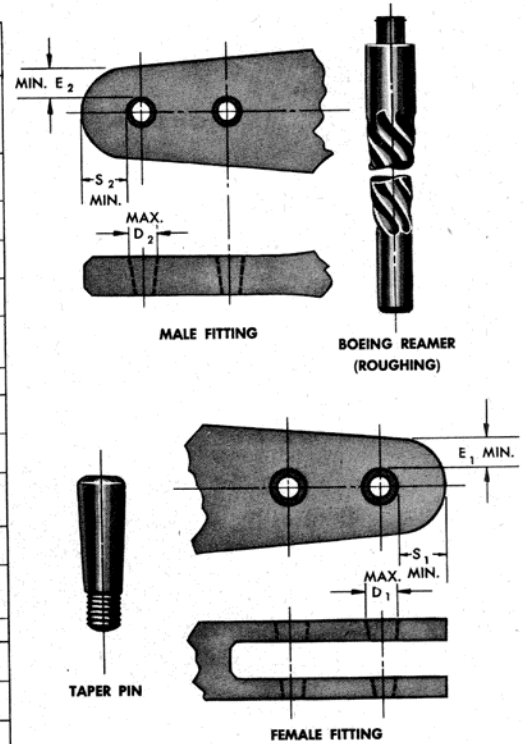
BOEING REAMER (ROUGHING)

TAPER PIN

FEMALE FITTING

NOTES

TAPER PIN MATERIAL: 2330 STEEL, SPEC. AN-QQ-S-689
 ALTERNATE: 4130 STEEL, SPEC. AN-QQ-S-684
 MINIMUM T.S. 125,000 LBS. PER SQUARE INCH.



NOTES
TAPER PIN MATERIAL: 2330 STEEL, SPEC. AN-QQ-S-689
ALTERNATE: 4130 STEEL, SPEC. AN-QQ-S-684
MINIMUM T.S. 125,000 LBS. PER SQUARE INCH.

Figure 50—Taper Pin Data

and ground the airplane structure. Drain the fuel tanks through the access doors in the bottom of the wing. Relieve the pressure in the hydraulic system by opening the bleed valve on the hydraulic panel.

(b) Remove the wing gap cover and body fairing and disconnect all control cables.

CAUTION

All cables must be lashed, taped, or otherwise secured when disconnected to prevent tangling on drums or slipping off pulleys.

(c) Disconnect the landing gear hand-operated retracting mechanism at the universal joint and the wing flap mechanism at the coupling in the wing gap. Disconnect and cap hydraulic tubing and disconnect the engine fire extinguisher and deicer tubing and fuel transfer lines. On the left wing it will also be necessary to disconnect the heating and ventilation system ducts. Disconnect electrical wiring at the wing connector panel and at the flap motor sway braces at the wing compression rib lower chord. Disconnect all vent lines. Attach the wing hoist equipment to support the wing for final removal, as required. Hoisting procedure will vary, depending upon whether the engines and mounts are removed with the wing panel or separately. Refer to the hoisting diagram (figure 6) for hoisting provisions. Take the wing load off the terminals by means of the

hoist and remove the taper pins as described in the taper pin replacement procedure diagram. (See figure 48.) Remove the bolts at the shear connections at the front and rear spars and disengage the wing slowly by moving straight outward from the body with the hoist.

(2) ASSEMBLY AND INSTALLATION.

See general instructions, paragraph 2. a. (2) preceding.

c. OUTBOARD WING PANEL.

(1) REMOVAL AND DISASSEMBLY.

(a) REMOVAL.—Loosen the inboard end of the deicer shoe and remove the gap covers. If the outer wing tanks are installed, carefully ground the deicer shoe and drain the cells through the main tanks, or disconnect the fuel lines at the tee on the inboard tank of each of the two groups of outer wing tanks. Disconnect all hoses and tubing, and seal their ends to prevent entrance of foreign matter. Disconnect all control cables and electrical wires and lash or tape the ends to the structure. (Refer to paragraph 7. b.) Attach hoisting equipment. (See figure 6.) Remove the panel bolts in the butting splice angles at the skin connections. Remove the taper pins in the terminals. (See figure 48.) Move the wing panel slowly outward until the aileron clears the inner panel.

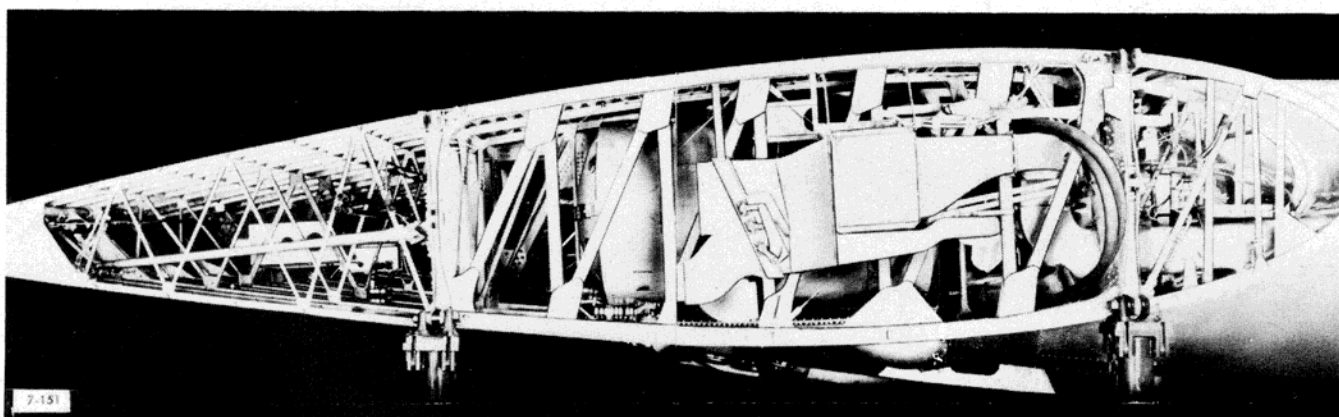
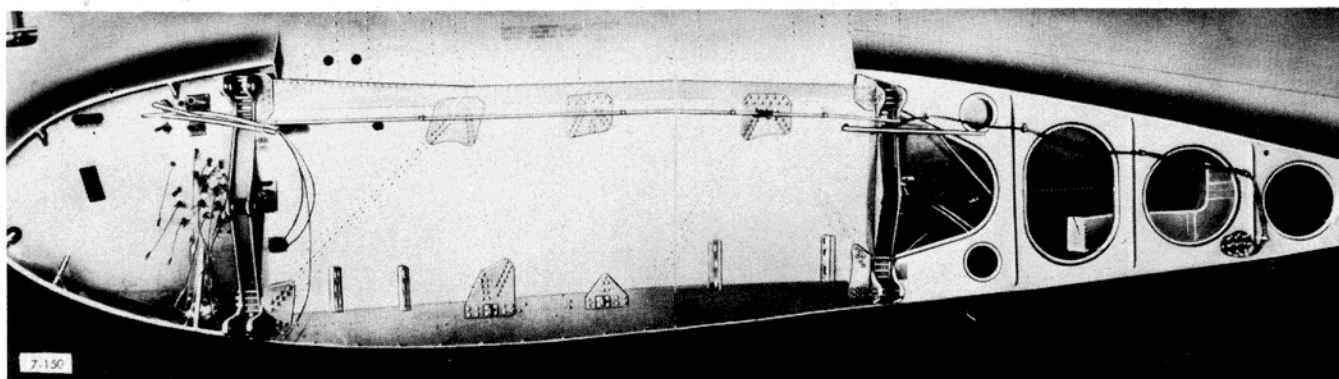


Figure 51—Removal of Inboard Wing at Fuselage (Left Side)

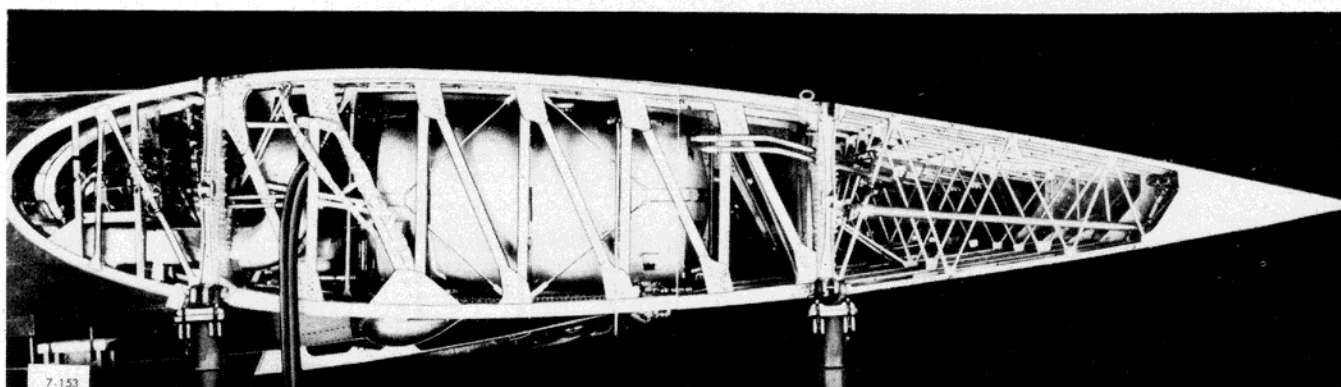
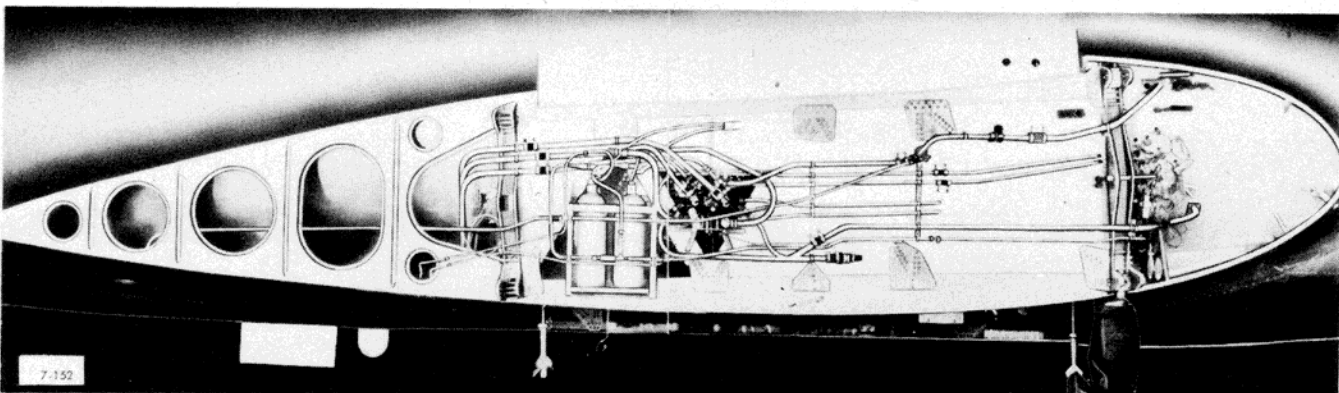


Figure 52—Removal of Inboard Wing at Fuselage (Right Side)

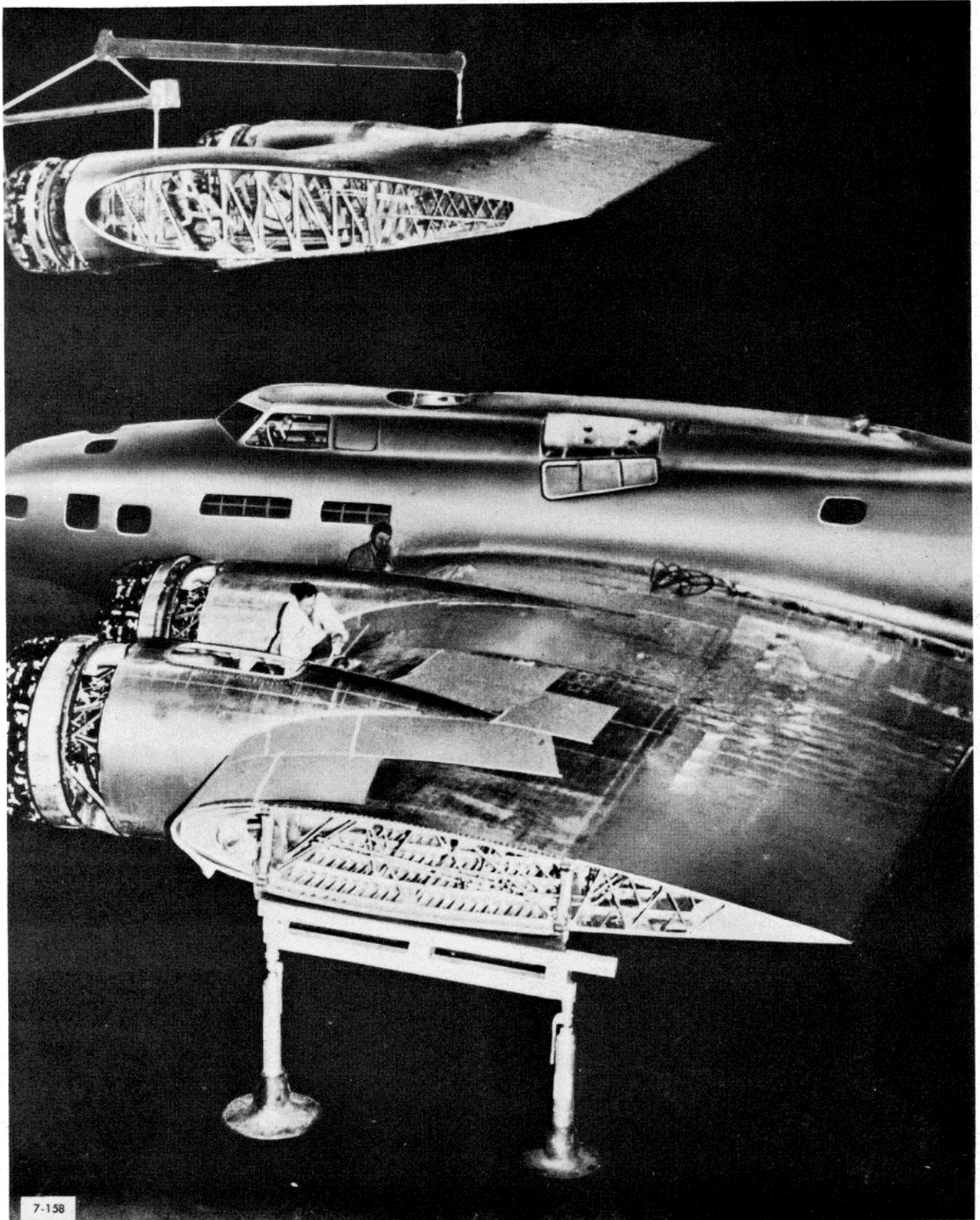


Figure 53—Inboard Wing Panel Installation

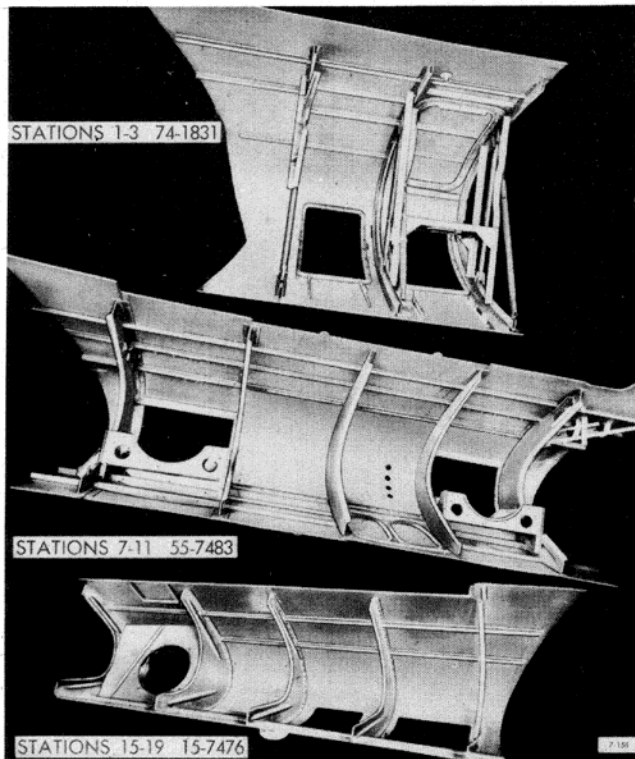


Figure 54—Inboard Wing Nose Sections

(b) DISASSEMBLY.—The nose section of the outer panel is attached at the upper and lower chords of the front spar by means of terminals at each nose rib, and by a row of screws along the spar caps. After disconnecting the portion of the deicer shoe that extends over the wing tip, remove the gap covers at each end of the panel, and disconnect the deicer tubes at the inboard end; then the nose section may be removed as a unit. Remove the two screws on each side of each nose rib pin. This enables each pin retainer shim to be slid out. Then, using a mallet or hammer, lightly rap the skin around the pin. In many cases the pins will work out to where they can be lifted easily with a screwdriver and removed with a pliers. The pins can also be pounded out by employing a piece of 1/8-inch drill rod about 20 inches long. The rod has a concave end so it will fit over the pointed end of the pin. The rod is pushed through one of the openings left by the screws to the end of the pin on the opposite side of the nose rib and tapped with a hammer. For those pins that cannot be removed with the above methods, it is necessary to get under the head with a screwdriver in some manner and then withdraw the pin with pliers specially ground to grip the head. This procedure often results in damage to the skin and surrounding structure and usually an excessive amount of wasted time. If the pins are stuck it may be necessary to drill out the head of the pin and knock it through.

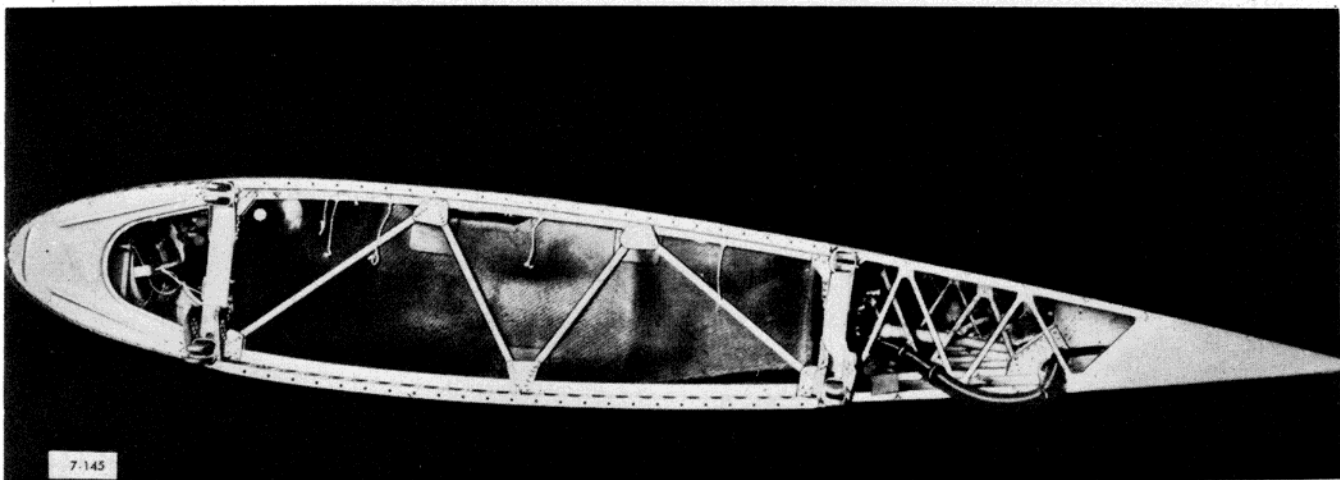
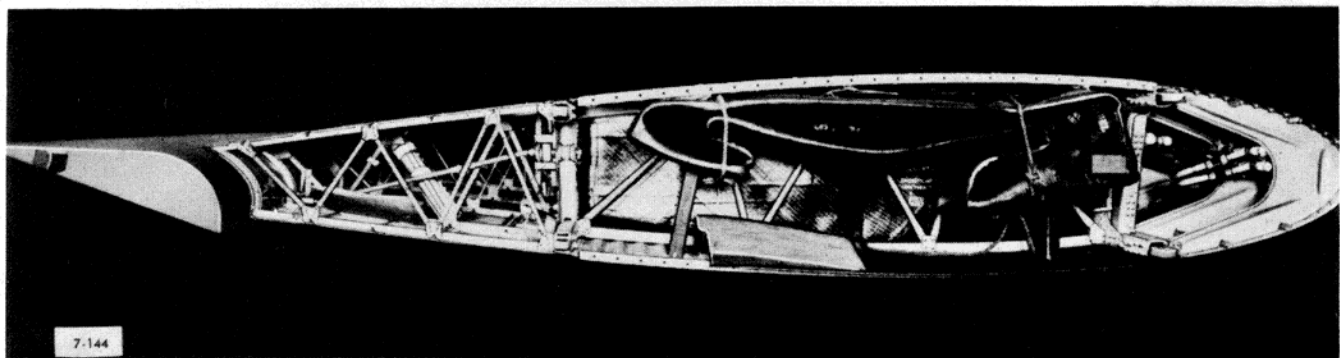


Figure 55—Removal of Outboard Wing

Extreme care must be taken when drilling the head out to avoid damage to the skin. After all the pins are removed, the remainder of the screws holding the leading edge to the spar cap should be removed. To facilitate the procedure for removing the outboard wing nose section, a light may be led into the wing through the access door on the lower surface of the wing tip.

(2) ASSEMBLY AND INSTALLATION.

(a) When installing a new outboard wing panel, it will be necessary to ream the terminals for the taper pins as indicated in the taper pin replacement procedure diagram (see figure 48).

(b) The shear splice bolt holes in the replacement panel are jig-drilled at the factory and mating of the parts should offer little difficulty. In extreme cases an accumulation of shop tolerances may result in minor misalignment of some of the holes. For this condition it will be permissible to enlarge *not more than* 18 holes in the upper splice to a maximum diameter of .437 inch. The close tolerance holes and the enlarged holes *must be evenly spaced* over the splice to provide the required distribution of shear stresses. These values retain sufficient structural strength for normal tactical operations. Any increase in the hole diameters from those given

above, or uneven distribution of the close tolerance holes, will seriously reduce the effectiveness of the joint.

d. WING TIPS.

(1) REMOVAL.—To remove the wing tip it is necessary to loosen the outer end of the deicer shoe and then remove the gap cover. After disconnecting the electrical wiring through the access door in the under side of the wing tip, remove the single bolt in each terminal. The wing tip may be handled manually without the use of a hoist.

(2) INSTALLATION.—See paragraph (2). (a) preceding.

e. AILERONS.

(1) REMOVAL.

(a) Place the aileron in the full downward position so the control rod is accessible through the opening in the leading edge of the aileron. Disconnect the control rod and the counterweight through this opening.

CAUTION

Support the counterweight while disconnecting it at the aileron, and when disconnected, place it carefully on the lower surface of the wing. Considerable damage will result if the weight is allowed to drop against the skin.

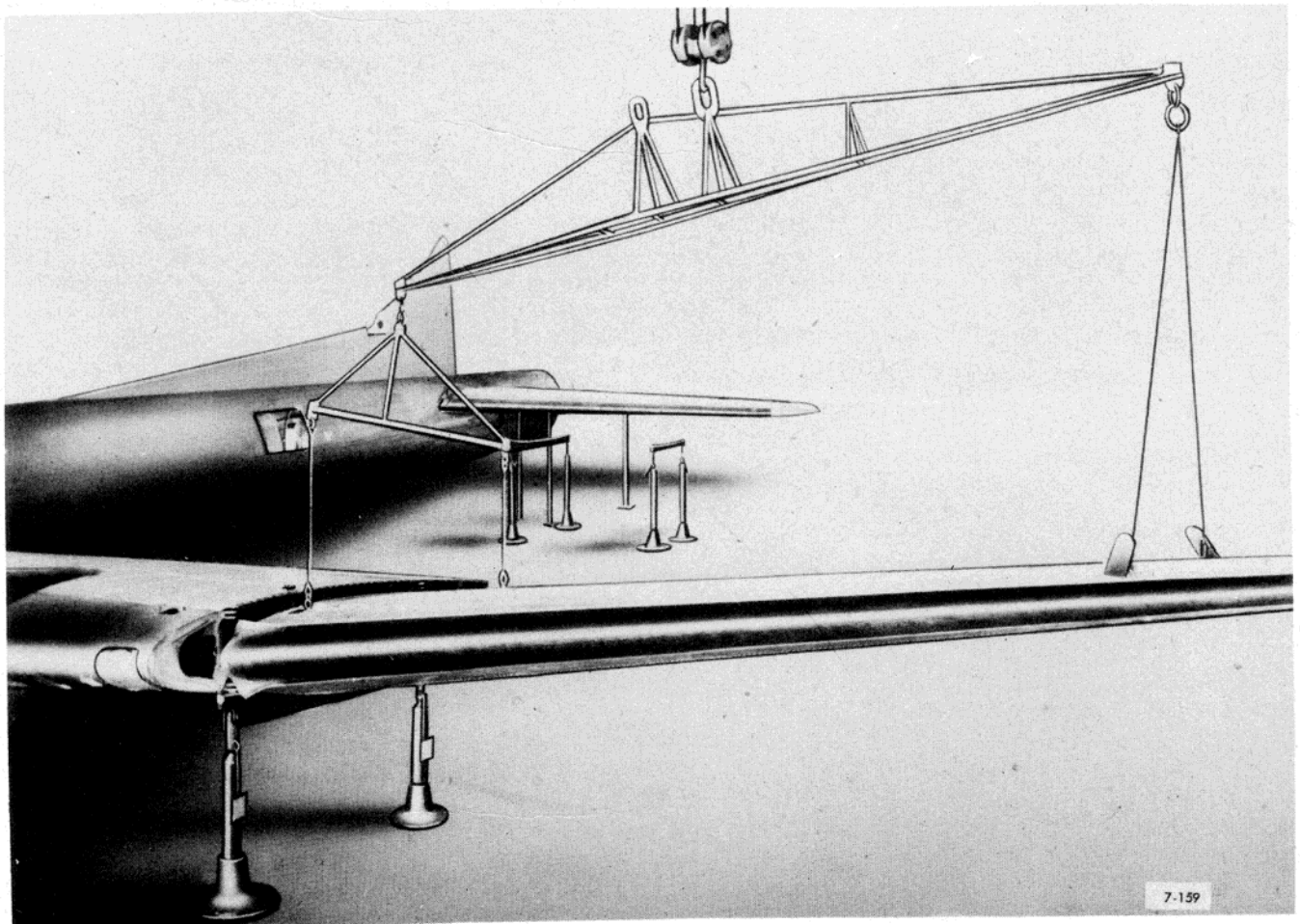


Figure 56—Outboard Wing Panel Installation

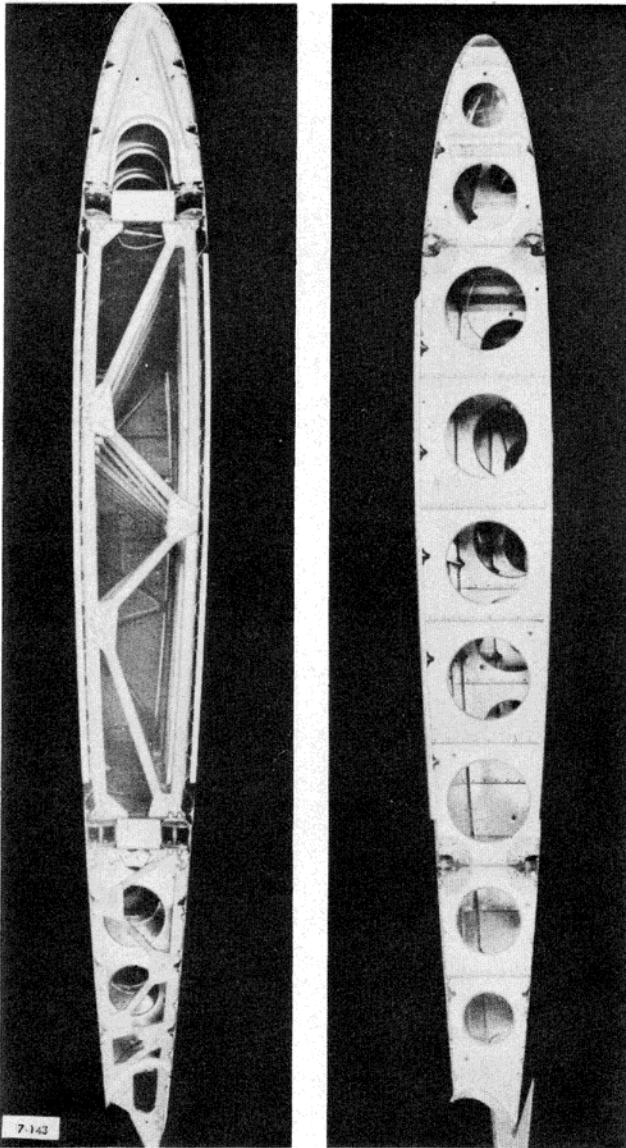


Figure 57—Removal of Wing Tip at Outboard Wing

(b) Disconnect the trim tab control rod by removing the taper pin just forward of the universal joint located on the aileron hinge line. Remove the four access

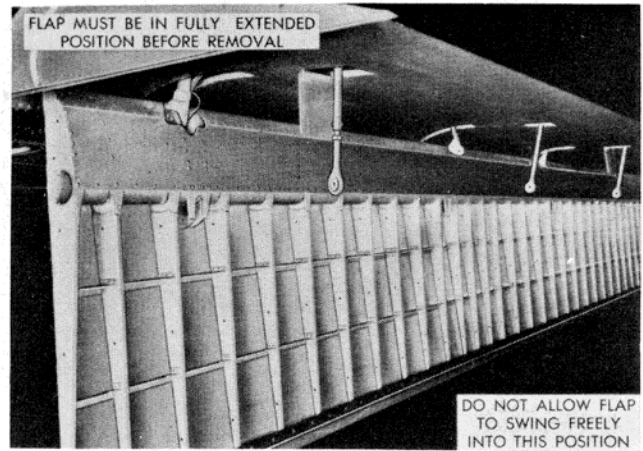


Figure 59—Removal of Wing Flaps

doors on the under side of the wing at the hinge points and remove the hinge bolts. In withdrawing the aileron, support and guide the trim tab control rod to avoid damage to the fabric.

(c) AILERON TRIM TAB (left wing only).—

Operate the trim tab control to place the tab in the full downward position and disconnect the tab control rod at the inboard end of the tab. Remove the three hinge bolts through the openings in tab top and disengage tab.

(2) INSTALLATION.—Refer to paragraph 2. a.

(2) preceding.

(3) ADJUSTMENTS.

See aileron control system diagram (see figure 241 for rigging tension.

f. WING FLAP.

(1) REMOVAL.—Operate flaps to the full downward position, remove the rear hinge bolts at the flap end and allow the flap to hang from the front hinges. Disconnect the electrical bonding at the front hinge bolts to complete the disengagement of the flaps.

Note

This procedure will leave the flap mechanism in adjustment, and unless their repair is necessary the hinge rods should be left exactly as disconnected.

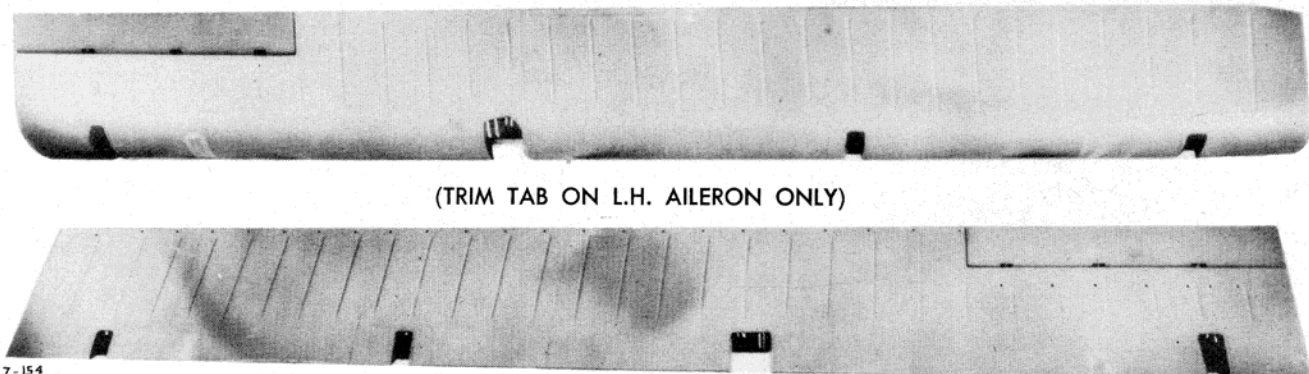


Figure 58—Aileron Complete

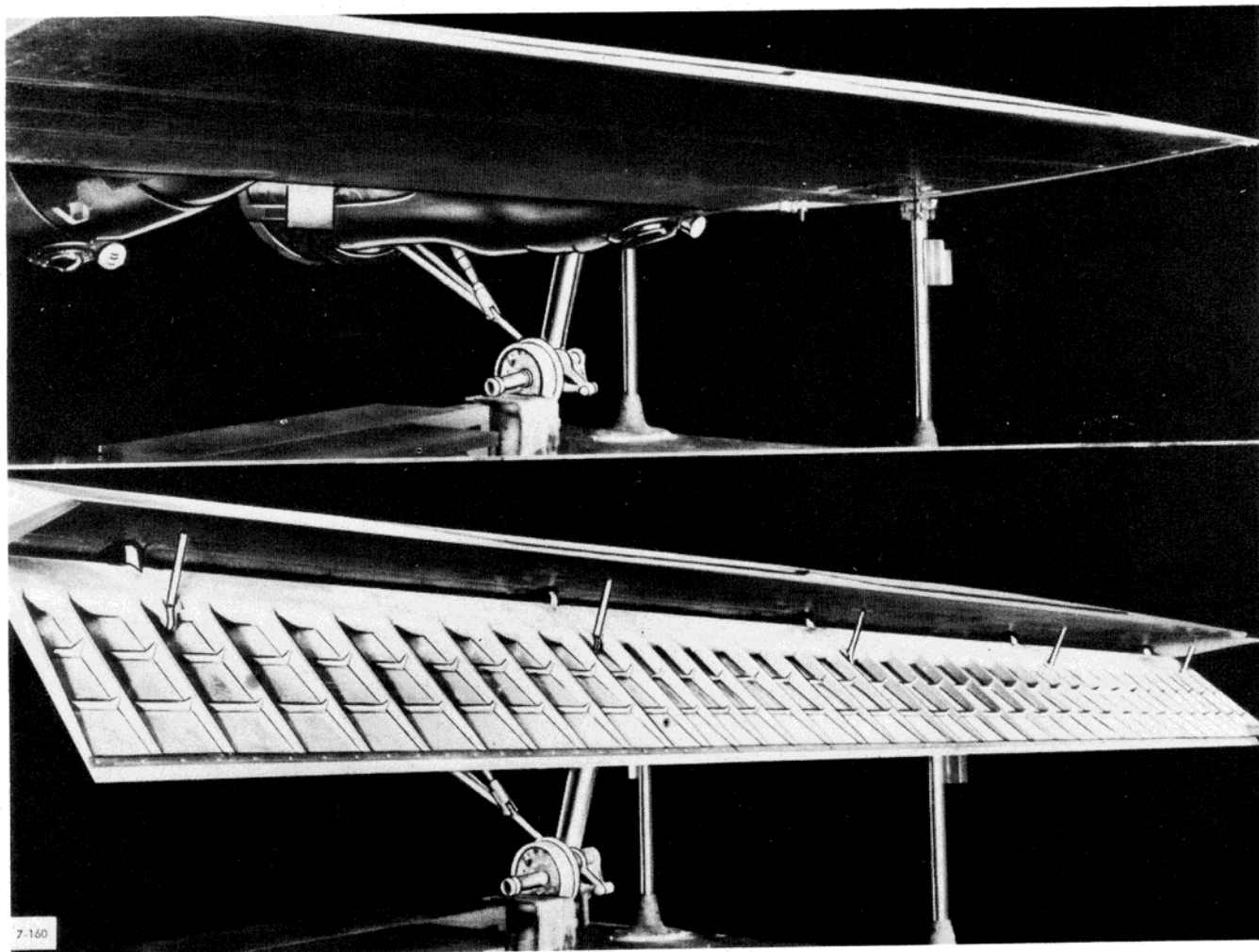


Figure 60—Wing Flap Installation

(2) INSTALLATION.

(a) If a new or extensively repaired flap is to be installed, the hinges will generally require realignment. This will necessitate disconnection of the drive shaft couplings between the actuating mechanism gear housings. Attach the flap at the front hinge on each end and then swing it into place to check for alignment with the trailing edge of the wing and for clearance with the rear edge of the under surface of the wing.

(b) In some cases, it may be necessary to adjust both the extension of the actuating screw (by turning the shaft at the gear housing) and the length of the rear hinge rod to obtain satisfactory alignment. After locating the flap properly, center the remaining three front hinges in the slots and connect. For satisfactory flap operation, the front hinge connections must be lined up so that the flap will swing freely, after which the drive shaft couplings between gear housings should be reconnected.

(c) The final connection of the rear hinge rods at the flap end will require adjusting of the rod length in order to obtain proper contact pressure in addition

to full contact along the flap trailing edge. This is accomplished by turning the hinge at the flap end of the rod until the desired length is reached. After reconnection to the flap, the lock nut should be tightened. Proper contact pressure will be determined by checking the rotation of the hand crank from initial contact of the flap and the wing trailing edges to the completely retracted position of the mechanism. This should be approximately $1/4$ turn. Since the effort required for complete retraction is comparatively great, it will be necessary to check for contact of the stops on the motor drive mechanism. This can be done through the access door on the retracting screw cover, with the aid of a mirror.

(3) ADJUSTMENTS.—Instructions for adjusting the wing flap operating mechanism will be found in section IV, paragraph 7. *b.*

3. EMPENNAGE (TAIL GROUP).

a. GENERAL.—The empennage consists of a fixed vertical stabilizer or fin, with a rudder and trim tab, and a fixed horizontal stabilizer with an elevator and trim tab, on each side. Full cantilever construction is employed. The fin and stabilizers are of stressed metal skin

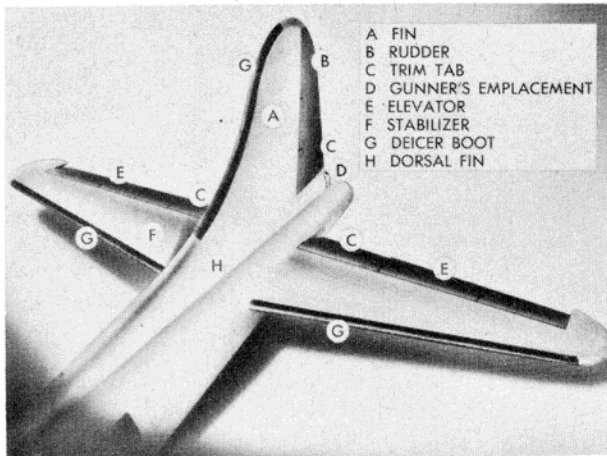


Figure 61—Empennage

construction, rudder and elevators are fabric covered and trim tabs are constructed of aluminum alloy. The fin and stabilizers are constructed with two truss-type spars. Attachment to the terminals on the fuselage is accomplished with steel taper pins. The fin area is increased by extension of its leading edge along the body to form a "dorsal fin." The dorsal fin, however, though attached to the fuselage through terminals at the ribs, is riveted to the body at the fairing and is joined to the fin by gap covers at station 8.

(1) REPLACEMENTS.—Replacement of damaged parts of the empennage, rather than repair, is recommended in order to maintain both strength and balance. In no case should refinishing be allowed to destroy the original balance of the control surfaces. Replacement of terminals at the body connections will involve, in some cases, the reaming of a new terminal to mate with the one already reamed. Instructions for proper procedure on reaming are contained in section IV, paragraph 1. Of interest in the matter of replacement is the interchangeability of the left and the right hand stabilizer assemblies. These assemblies have been made completely interchangeable by provisions which permit the installation of the formation lights on the under as well as the upper surface of the stabilizer and by reaming the taper pin holes so that all taper pins are installed in the same direction (large end of the taper pin forward). Access holes are allowed in the under side only.

(2) ASSEMBLY AND INSTALLATION.

(a) Before the installation of tail surfaces, carefully level the airplane about both longitudinal and transverse axes. Install the vertical surfaces first in order to facilitate handling and access. If the original surface is to be reinstalled, hoist into place and insert each numbered taper pin in its respective hole.

CAUTION

Do not place straight temporary pins in reamed taper pin holes without first inserting a tapered bushing, since damage to the original hole decreases the structural strength of the

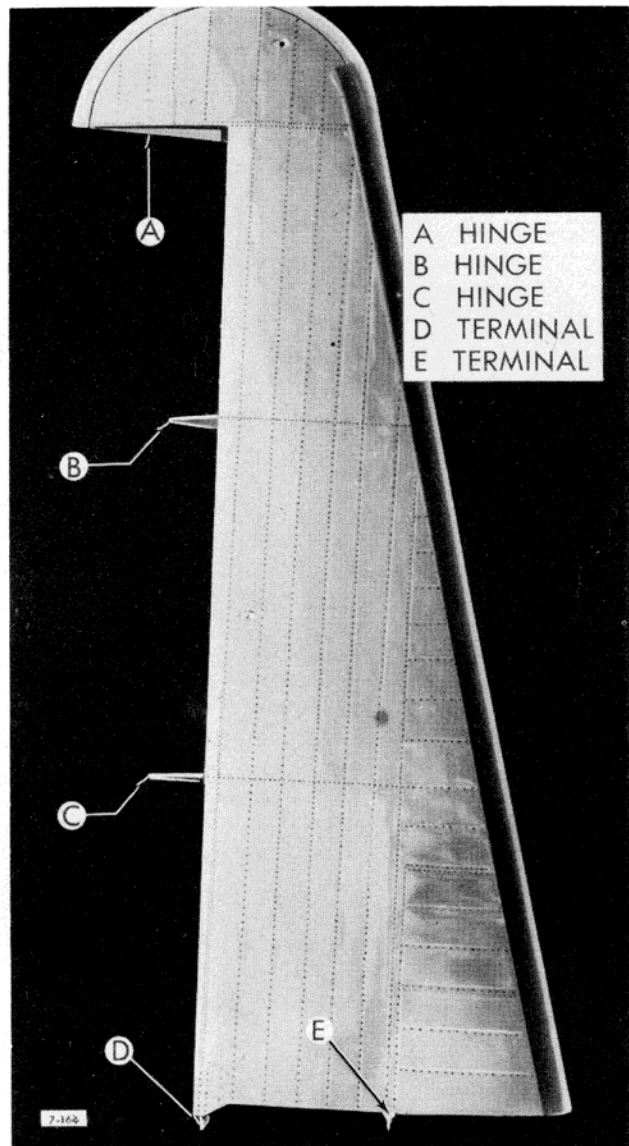


Figure 62—Horizontal Stabilizer Complete

terminal. Any taper pin that is to be reinstalled should be carefully inspected for abrasion or tool marks on the bearing surfaces and for misalignment. If such a condition exists, the pin must be replaced by a new one.

(b) If new or reworked terminals are to be used, follow instructions for reaming as indicated in (1) above. After completing all installations, check rigging of controls and the electrical connections before applying gap strips or fairing. Refer to applicable diagrams in section IV, paragraph 7. b., for rigging instructions and tolerances. Operate all controls through their full ranges and ascertain that fair-leads are properly installed, all cables properly thread the pulleys, and that all clamps and lashings are removed. In general, all units are assembled and installed by reversing removal procedure.

(c) Most B-17G horizontal stabilizers may be used on either the right or left side of the airplane. The

units are equipped with light outlets and suitable covers for both upper and lower surfaces. The only changes necessary to install either stabilizer on the opposite side are refitting the light receptacles.

(3) ADJUSTMENTS.—Refer to section IV, paragraph 7. *b*.

b. HORIZONTAL STABILIZER.

(1) REMOVAL.—Remove the stabilizer by first placing a tail wheel jack under the jacking cone at station 7 and a cradle under the stabilizer tip to steady it. Extreme caution must be exercised in removing the eight steel taper pins fastening the stabilizer onto the fuselage. If special taper pin clamps are not available, the pins will have to be knocked out. Remove the cup washers and nuts. Use a soft metal knockout pin. Buck up the terminal joint on the other side with something solid and drive the pins out, being very careful not to damage the threads. The inside pins are difficult to reach so care must be taken not to damage the structural members around the taper pins. After the eight pins have been removed pull the stabilizer out of the joints and lower it.

(2) INSTALLATION.

(*a*) The installation procedure for the stabilizer is primarily dependent upon the condition of its terminals. Installing a new stabilizer whose terminals have not been reamed, requires definite care. Factory procedure for installing a stabilizer calls for leveling the stabilizer with a transit to insure alignment with the opposite stabilizer. This is recommended if the instrument is available. The stabilizer will usually line up satisfactorily if the terminal holes are carefully aligned. A suggested method of checking the alignment of stabilizers before reaming is to bolt the elevators in position. The outer ends of the stabilizers should be supported to relieve the strain. If the stabilizer assemblies are not properly aligned the elevator hinges will bind when removed. This is true because the elevator torque tube is in one continuous straight line. Place a taper pin bushing in each of the eight holes in the fuselage terminals. Drive them in until they are very snug so there is no chance of their turning while being reamed. Cut the protruding end off with a hacksaw, also the portion of the bushing between the two steel terminals. Smooth the inside with a file so the stabilizer will slip in and fit perfectly. Do not scratch or damage any of the metal. Paint any exposed metal with primer.

(*b*) After all the bushings have been installed the next step is to install the stabilizer. After cleaning the terminals of all grease and dirt, move the assembly into place and work it into the terminal joints until all holes are aligned. When the stabilizer is in place, install one primary straight pin, usually cold rolled, in each joint, four in all. These holes are not standard size and this stock must be turned down to fit. After the primary pins have been installed, and a cradle is put under the stabilizer tip to steady it, it is ready for ream-

ing. Reaming by hand is a very tedious job and definite care must be maintained to ream the bushing and stabilizer material out until the original tapered hole is reached. If the same pin or same sized pin is to be used, extreme care must be exercised to not ream any more material out. If this is not adhered to, the pin will protrude too far, exceeding the limit which is approximately $\frac{3}{32}$ of an inch. The amount of pin protruding through the joint is determined by the depth of the cup washer. A clearance of $\frac{1}{32}$ of an inch must be main-

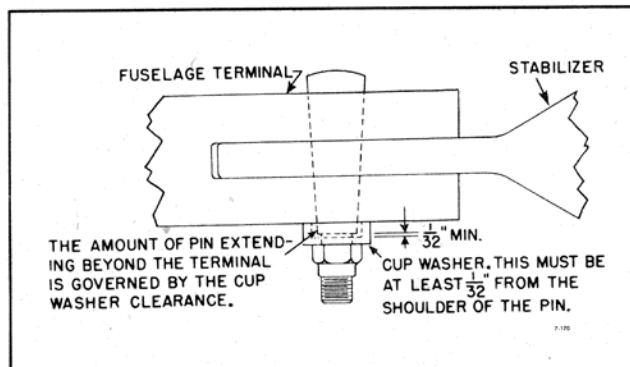


Figure 63—Stabilizer—Terminal Fitting

tained. A near perfect fit is required. Either Prussian Blue or a light oil may be used to determine the fit. In case the fit is such that the same size pin cannot be used, but an oversize must be used instead, more material must be reamed to receive the pin. Maximum size holes and clearances are given in the taper pin data diagram (see figure 139). Hand reaming these holes is a painstaking job unless the reamer is new or very sharp, so some method of actuating the reamer should be used if available. A slow speed motor is very advantageous. A high speed motor will chatter the reamer and render it useless immediately in addition to damaging the hole.

(*c*) Installing a stabilizer that has been formerly reamed requires less reaming but more care to insure the proper alignment of holes. Oversize taper pins are available at all main depots. Standard oversize pins should be used whenever possible, and the practice of manufacturing pins from larger pins in machine shops should be attempted only in cases of extreme emergency. It is difficult to improvise a means of temporarily holding the holes for reaming if the two existing reamed holes do not match. In that case, the stabilizer should be

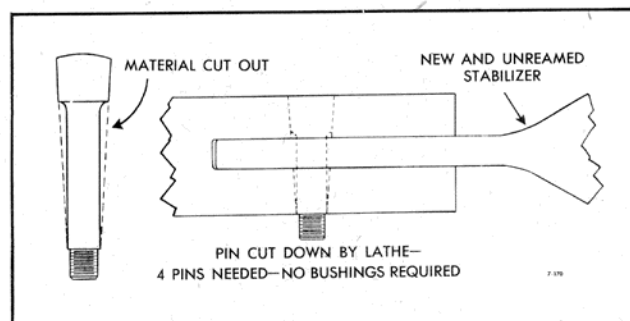


Figure 64—Pin Installation—Stabilizer Terminal Fitting

blocked and clamped at the terminals to insure no movement while reaming the first holes. Usually the holes match so closely that very little reaming is necessary. No bushings are necessary in this case. In the case where a repaired stabilizer is to be installed, the installation can usually be made without reaming.

(d) All taper pins that are worn or scratched should be discarded and new ones substituted. Factory procedure recommends 80 percent minimum bearing fit. *This should be adhered to.* There are various methods of fitting stabilizers where hand reaming has to be used and the use of bushings greatly lengthens the job. One method that can be employed is to cut down a taper pin to fit the size of the unreamed stabilizer hole while the large end of the pin is left to size. This necessitates very careful reaming of the stabilizer as there is no bushing to guide the reamer, but it will save much tedious hand reaming of taper pin bushings.

c. ELEVATOR.

(1) REMOVAL.—The first step in the removal of the elevators is to secure the elevator trim tab cables and drums before disconnecting them, unless the trim tabs and controls have been previously removed. It is very important that this be done to prevent the cables from slipping on the drums. There are two ways that the removal may be accomplished.

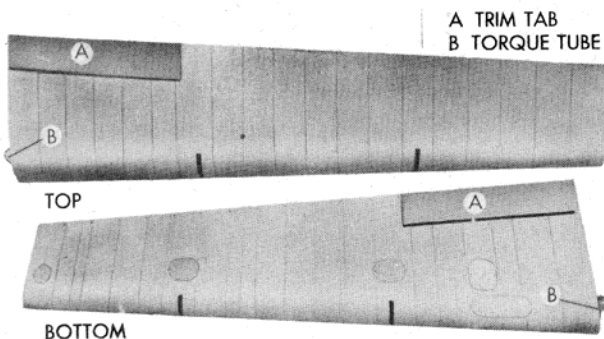


Figure 65—Left Elevator Complete

(a) One method is to first turn the trim tabs to a full down position and fasten the two elevator trim tab control cables at any fairlead in the rear fuselage. These two cables run through the same fairlead and are next to each other. An easy way to do this is to use two pieces of wood or fiber held together with a single bolt and clamp them on the cables next to a fairlead. This prevents the cable drum in the cockpit from loosening or slipping. The messenger cables connecting the right and left hand trim tab cable drums are next fastened together near the center with a turnbuckle. By turning the trim tabs down, the turnbuckle will travel from inside the elevator torque shaft out into the left hand stabilizer where the turnbuckle may be disconnected.

CAUTION

In all cases when a tensiometer is not available, the number of turns on the turnbuckle

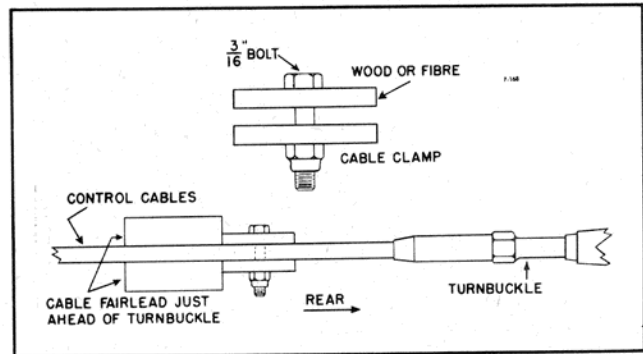


Figure 66—Cable Stop

should be noted so the same tension will be on the cables upon reassembly. (This turnbuckle can be seen through an inspection door on the left stabilizer.)

Next disconnect the trim tab cable at the last turnbuckle inside the fuselage towards the tail. In order to pull the trim tab cable out of the fuselage, four pulleys must be removed in the tail. After the pulleys have been removed the elevator is ready for removal. Remove the torque tube boot, and the 3/16-inch bolts attaching the elevator torque tube. Then remove the hinge bolts and lower the elevator.

(b) The second method of removing the cables is to first secure the trim tab control cables at a fairlead as suggested before, then wrap all the cable drums excepting the one in the elevator to be removed. Then, instead of disconnecting the cables at the turnbuckle, remove the other taper pin in the messenger cable drum. Exercise care in removing this or any other taper pins as the threads are easily damaged. If no special tool or taper pin removing clamp is available put the nut on backwards until the nut is flush with the end of the pin and knock it out either with a soft piece of metal or a hammer. Unwind the drum remembering exactly the number of turns and the position of the cable. Remove the drum and slide the shaft back thus lifting the trim tab up until it can be disconnected at the yoke. Then turn the shaft and drum around until the cable is free. The elevator is then ready for removal. After the hinge and torque tube bolts have been taken out, lower the elevator.

(2) INSTALLATION.—Refer to paragraph 3. a. (2) preceding.

d. VERTICAL FIN.

(1) REMOVAL.—Loosen the upper end of the deicer shoe, remove the side and bottom gap covers and disconnect the antenna on the leading edge of the fin. The electrical leads are detached at the connector panel on bulkhead 9. Support the surface and remove the eight taper pins at the body connections. The fin may also be handled manually.

(2) INSTALLATION.—Refer to paragraph 3. a. (2) preceding.

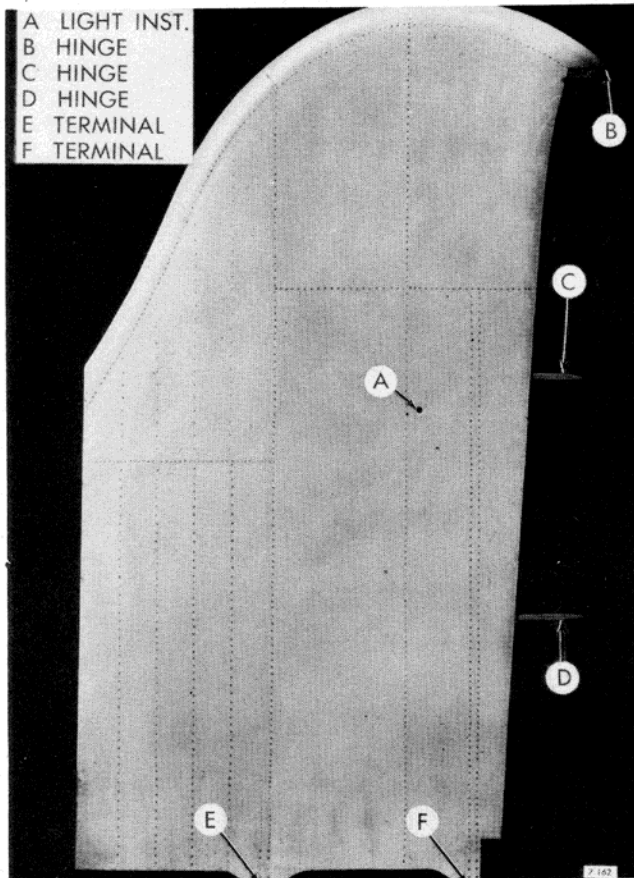


Figure 67—Vertical Stabilizer Complete

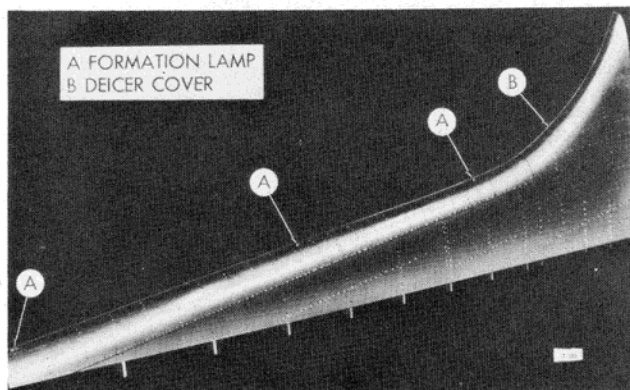


Figure 68—Dorsal Fin Complete

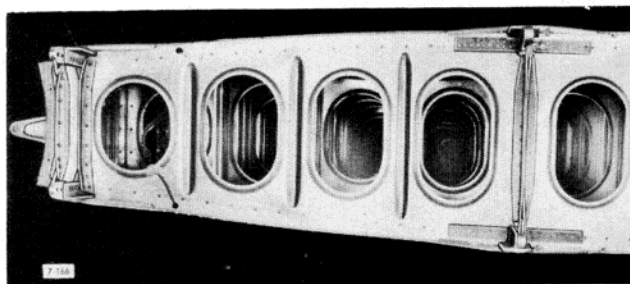


Figure 69—Vertical Fin Removed From Fuselage

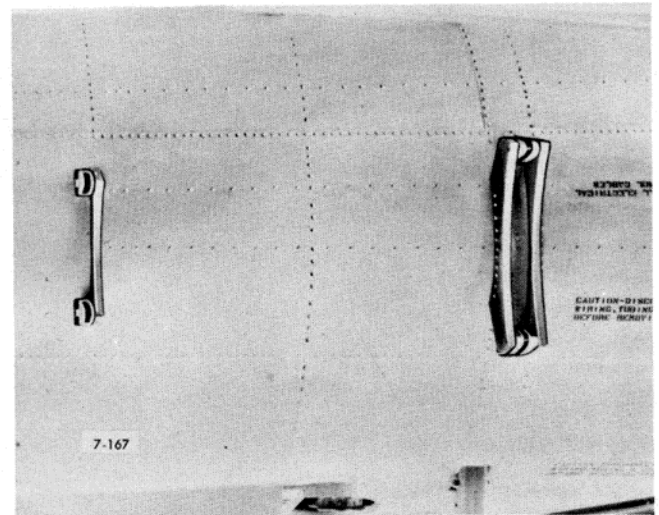


Figure 70—Vertical Fin Fuselage Attachments

e. RUDDER.

(1) REMOVAL.

(a) Remove the fairing forward of the tail gunner's emplacement to provide access to the torque tube boot, which may then be detached.

WARNING

Do not disconnect the torque tube joint until provision has been made to secure the lower portion of the torque tube against the tension of the control cables. Failure to do so will result in damage to the rudder quadrant mount. However, the cables may be disconnected if adequate facilities are available to determine proper rigging tension at reassembly.

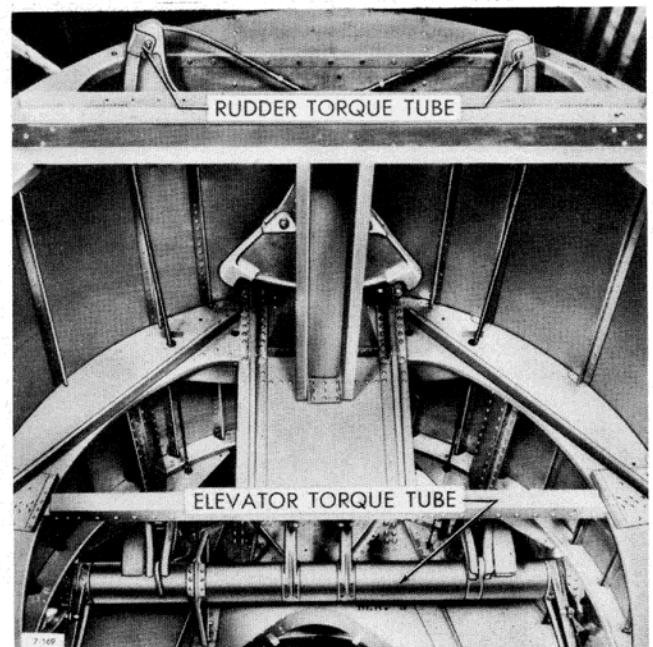


Figure 71—Rudder and Elevator Torque Tube Installation

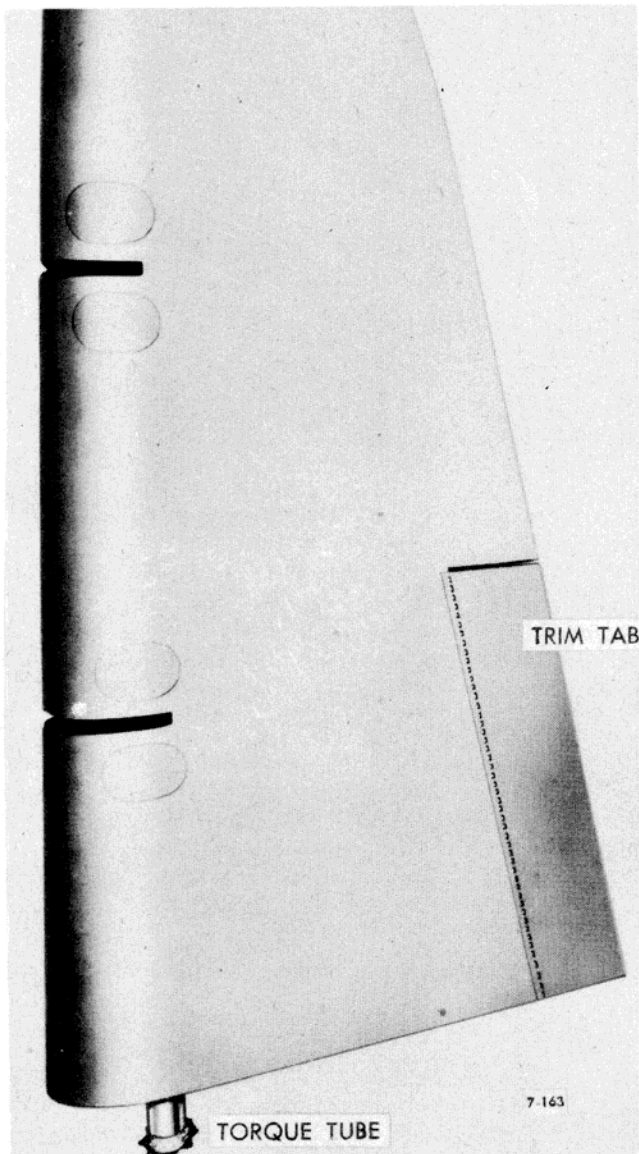


Figure 72—Rudder Complete

(b) Clamp or lash the control and tab cables on the forward side of the link or turnbuckle to be disconnected and clamp the trim tab cables at the bottom rib of the rudder. Remove the bolts at the torque tube joint and disconnect the electrical bonding. Relieve the hinges of the rudder weight and remove the hinge bolts through the access doors. The rudder may be supported and handled manually if proper scaffolding is available.

(2) INSTALLATION.—Refer to paragraph 3. a. (2) preceding.

(a) RUDDER TRIM TAB.—The rudder trim tab may be removed by disconnecting the control rod at the tab and removing the hinge screws. Removal of the trim tab actuating mechanism may be accomplished by the following procedure: Disconnect the trim tab control cables near bulkhead 7, unscrew and withdraw the

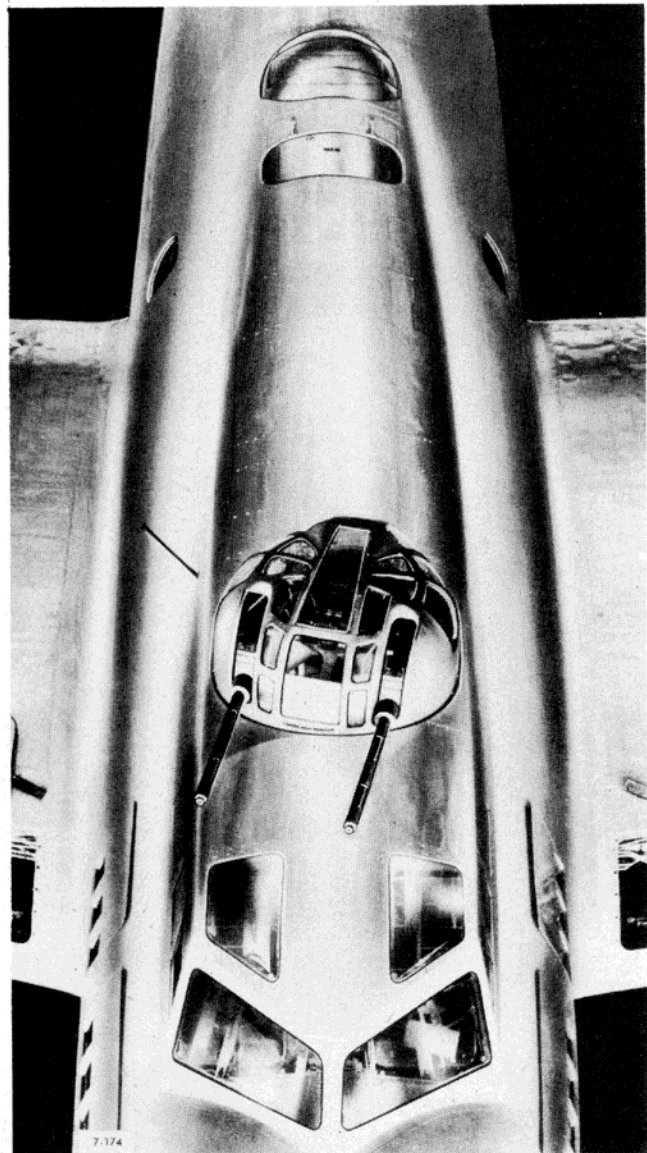


Figure 73—Pilots' Cockpit Enclosure

rear portion of the control rod, remove the access door and unscrew the mounting bolts near the trim tab drum. The forward portion of the mechanism may then be removed through the access door.

f. ELEVATOR TRIM TAB.

(1) REMOVAL.—The procedure for removing the rudder trim tab applies also to the removal of the elevator trim tab.

(2) INSTALLATION.—Refer to paragraph 3. a. (2) preceding.

4. FUSELAGE. (BODY GROUP)

a. GENERAL.

(1) STRUCTURE.—The fuselage is an all-metal semi-monocoque design employing extruded longitudinal and formed circumferential stiffeners and smooth

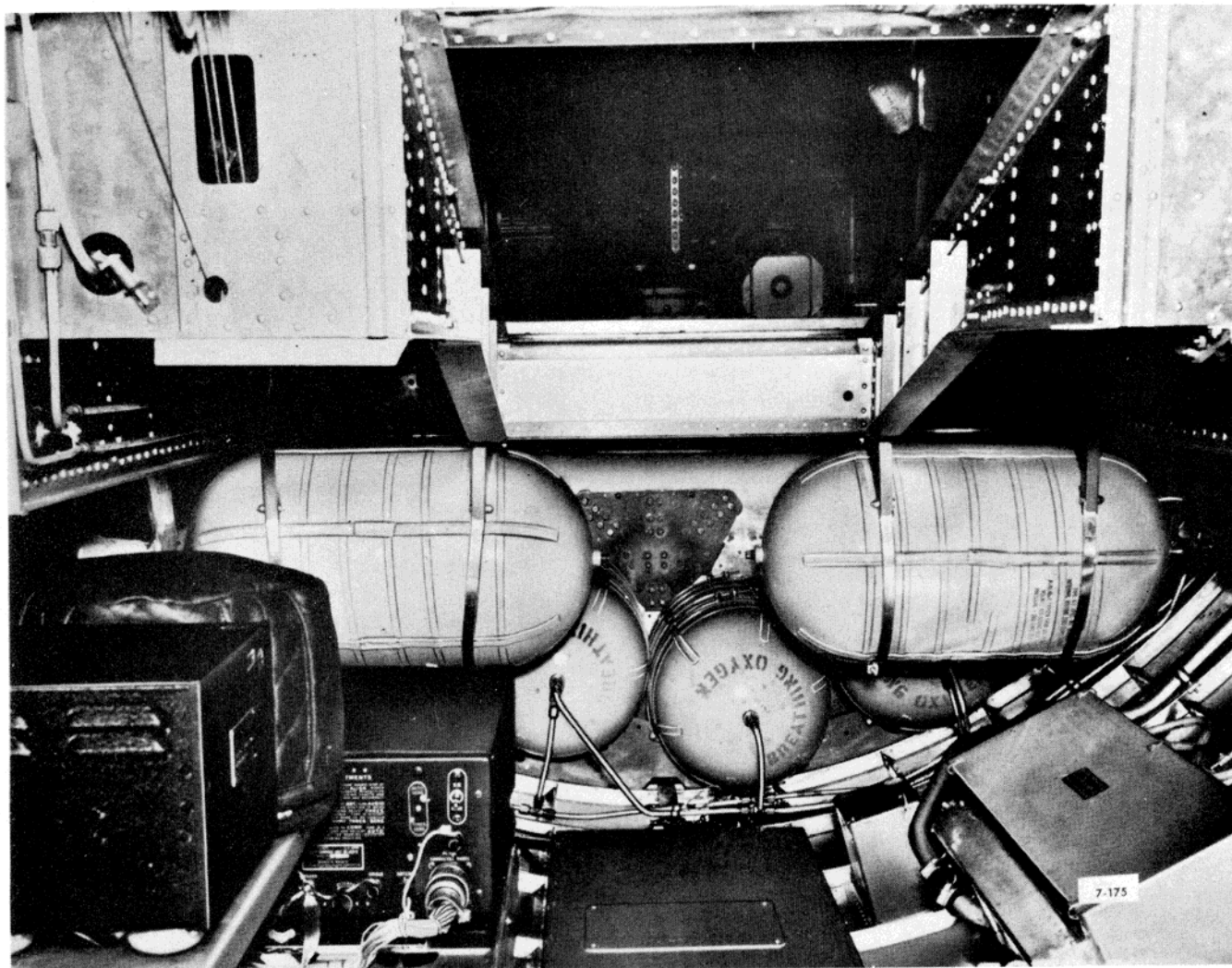


Figure 74—Lower Fuselage Compartment

aluminum-alloy stressed skin. Three longerons of extra cross section reinforce the construction from station 1 to station 4, and four similar longerons are located between station 4 and station 6-D. Other smaller longitudinal sections are included from nose to tail and are fastened to formed circumferential stiffeners at short intervals. At stations 3, 4, 5, 6, and 9 structural bulkheads are installed for added strength and to serve as partitions. The center section, to which the wing spars are attached, contains steel chords to carry the loads between wings and is provided with a truss-type compression strut on each side to carry the loads between spars. In addition, a truss is installed between bulkheads 4 and 5 in this section in order to support the inboard bomb rails.

(2) **NOSE SECTION.**—A molded, transparent plastic shell, incorporating a plate glass bomb sight panel, forms the nose of the airplane and provides wide vision for the bombardier. This unit is bolted to the fuselage at station 1. The forward compartment contains the bombardier and navigator stations and extends from the nose to station 3. Most airplanes have two flexible .50-caliber cheek gun installations mounted on either

side of this compartment. The chin turret, mounting two .50-caliber machine guns, is installed in the lower part of the nose section directly aft of plastic nose. Mounts and brackets are provided for instruments requiring special accommodations. Entrance to the lower accessory compartment under the pilots' floor is through a door in bulkhead 3.

(3) **PILOTS' COMPARTMENT.**—The pilots' cockpit and top gun turret are located in an elevated compartment between stations 3 and 4. This compartment contains the pilot, copilot, and top gunner positions, all flight controls and instruments, some radio remote control equipment and a portion of the oxygen supply. Entrance is from either the bomb bay, through a door in bulkhead 4, or from the lower accessory compartment through a folding hatch in the floor between the pilots' stations.

(4) **LOWER ACCESSORY COMPARTMENT.**—The lower accessory compartment contains the forward C-1 auto pilot units, oxygen bottles, control cables and brackets, emergency bomb door release "dog-leg" mechanism and other accessories. Also, it provides per-

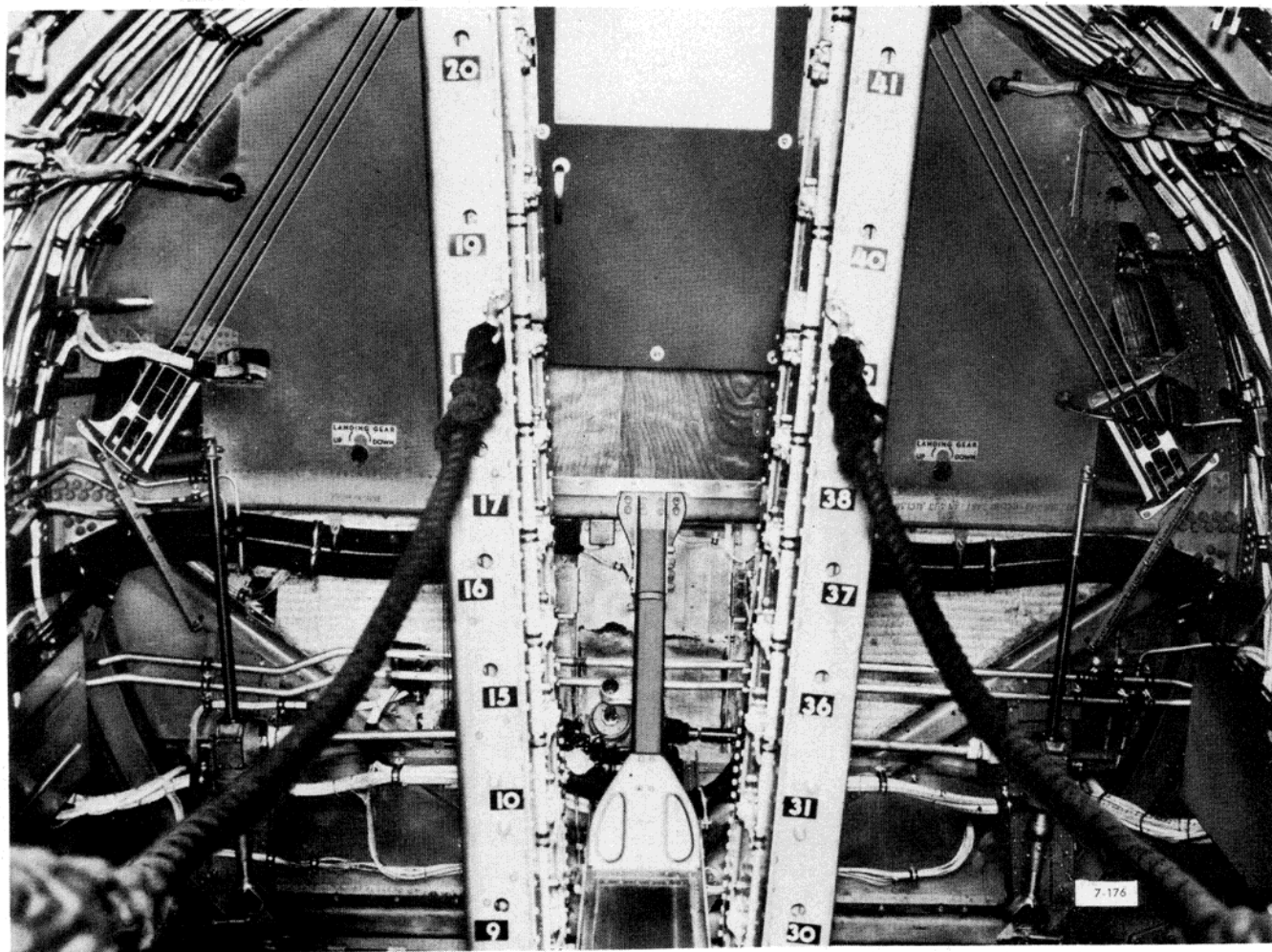


Figure 75—Bomb Bay (Forward)

sonnel transition between the bombardier-navigator compartment and the remainder of the airplane. Exit from the airplane may be made at the forward end of the compartment through a hatch equipped with releasable hinge pins which permit quick and complete removal of the door in an emergency.

(5) BOMB BAY.—Immediately aft of the pilots' compartment is the bomb bay, between stations 4 and 5. Bulkheads at these stations provide structural attachment of the front and rear wing spars to the fuselage. The bomb bay utilizes the entire interior of the fuselage at this location, and is designed to carry bombs or auxiliary fuel tanks. A catwalk along the center line of the airplane between the doors in the bulkheads is also the supporting truss for the inboard bomb rails. The outboard bomb rails are supported at the bottom by compression trusses on each side of the fuselage, and are attached to circumferential stiffeners at the top. The bottom surface of the bomb bay between the spar bulkheads and between the side body compression struts is composed of two doors. The doors are hinged at the sides and open simultaneously for bombing operations or for use as an emergency exit. Equipment installed

permanently in the bomb bay includes the bomb rails, which reinforce the compression and bomb trusses, the fuel transfer pump, two bomb rack selector switches and the bomb door retracting mechanism.

(6) RADIO COMPARTMENT.—Between bulkheads 5 and 6, just aft of the bomb bay, is the radio compartment. On some airplanes there are three seats for crew members; others have a seat for the operator only, sometimes having a bench on the right hand side of the compartment. The camera pit, under the radio compartment floor, is covered by a hatch when not in use. Additional space under the floor is used for accessories and oxygen equipment. A top observation station covered by a removable frame with a transparent plastic panel is incorporated in the rear streamlined portion of the cockpit enclosure. A .50-caliber machine gun is mounted on a sliding yoke at this observation window. A life raft compartment is provided on each side of the enclosure, immediately forward of the removable window. Release handles for the inflatable life rafts are accessible from the radio compartment.

(7) REAR FUSELAGE COMPARTMENT.—The rear fuselage compartment extends from the bulkhead

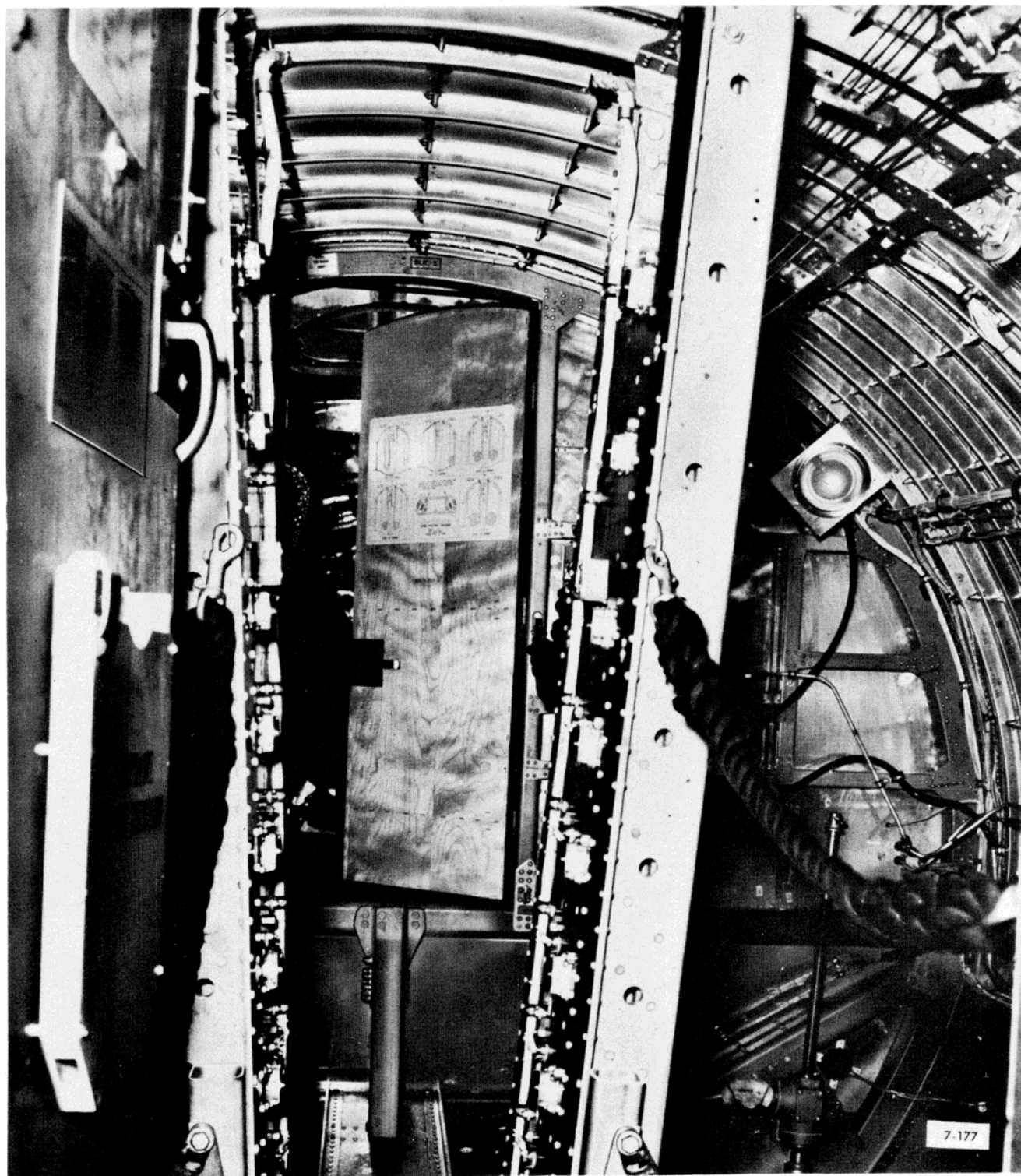
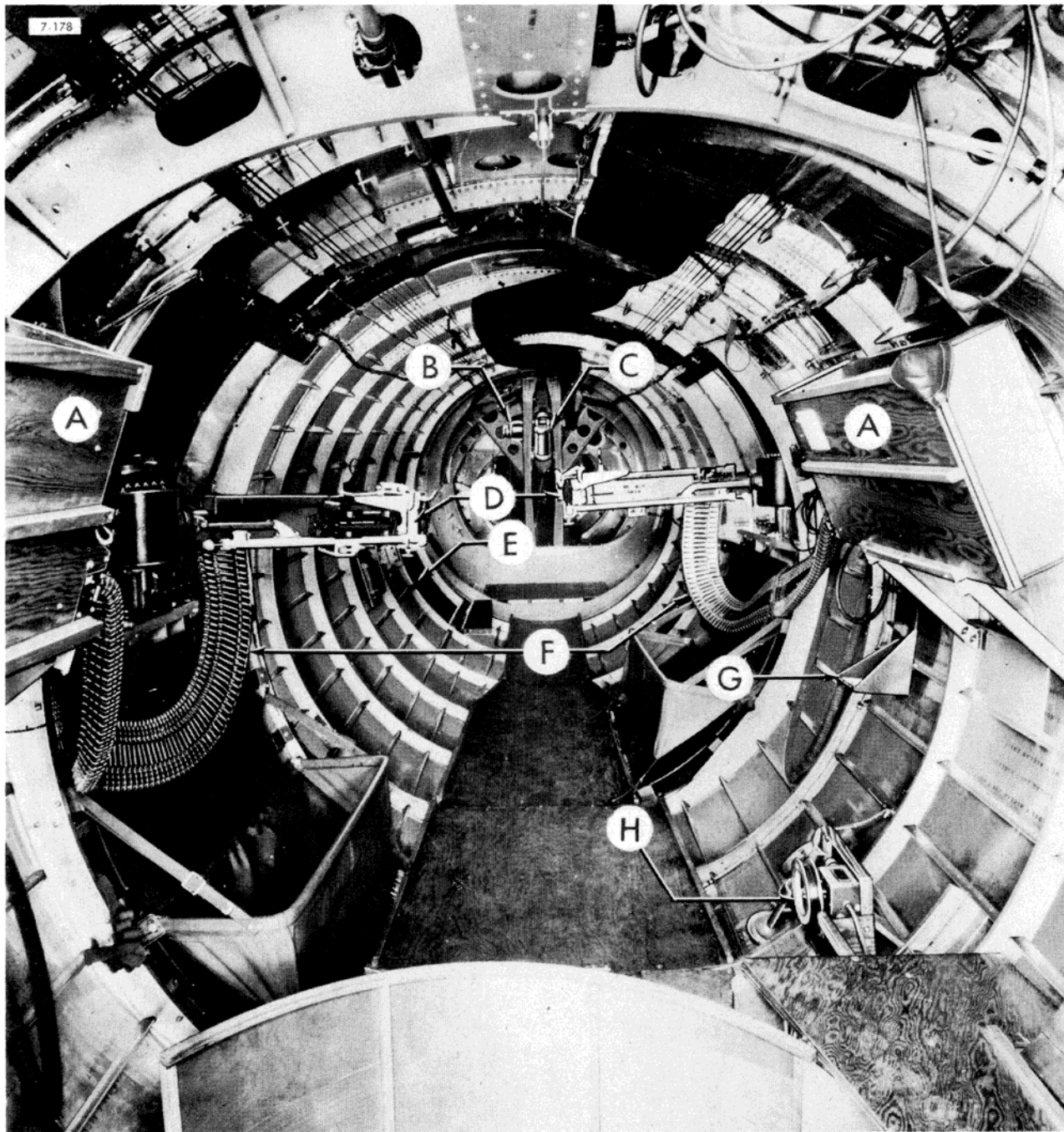


Figure 76—Bomb Bay (Aft)

at station 6 to station 11. This portion of the airplane contains the lower ball gun turret, the main entrance door, space for limited quantities of stowed cargo (refer to the loading chart in AN 01-1-40), the tail gear mechanism, two single .50-caliber machine gun installations at the side windows, and the rear C-1 autopilot opera-

tion units. The lower ball gun turret is suspended from a bracket at the top of two circumferential stiffeners at the forward end of the compartment, and revolves within a ring gear mounted on the floor. The main entrance door, equipped with releasable hinge pins for quick emergency exit, is located in the right rear side,



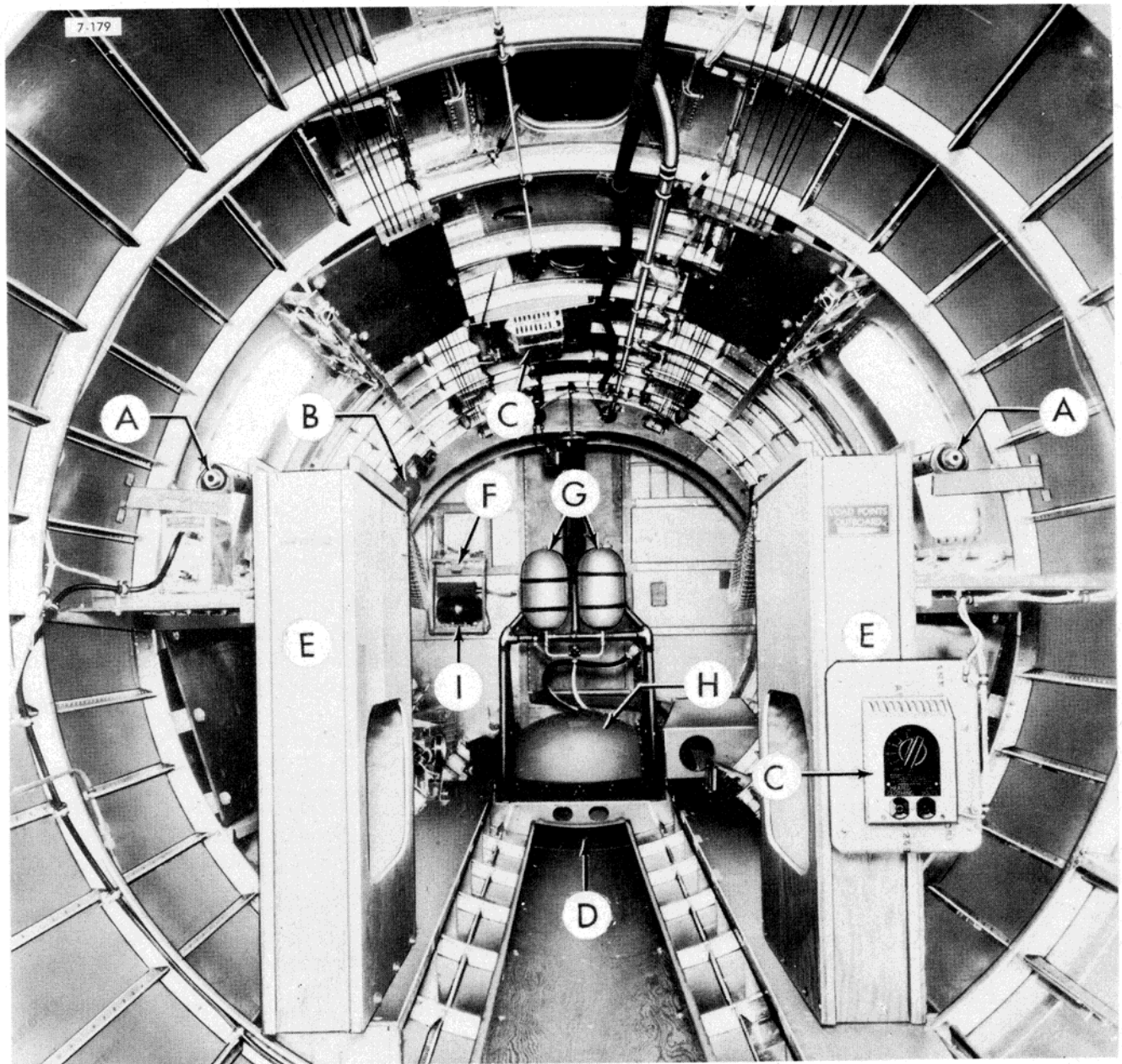
A—Ammunition Boxes.
B—Tail Wheel Retracting Motor.
C—Tail Wheel Oleo.
D—Side Guns.

E—Entrance Door.
F—Flexible Feed.
G—Bracket—Portable Oxygen Bottles
H—Antenna Reel.

Figure 77—Rear Gunner's Compartment (Staggered Waist Guns)

forward of station 7. The tail wheel housing and retracting motor are located aft of the main entrance door. A large sliding window on each side of the fuselage, forward of the main entrance door, provides the opening for the side gun installations. A spoiler (deflector) is

provided forward of each window on some airplanes to eliminate interference from the slip stream during gunnery operations. An auxiliary direct current generator unit (energizer) is bolted to the floor opposite the main entrance door, or in some airplanes may be stowed in the radio compartment.



A—Side Gun, .50 Cal.
B—Portable Oxygen Bottle.
C—Suit Heater Rheostat and Outlet.
D—Bottom Turret Window Clean-Off Door.
E—Side Gun Ammunition Box.

F—Bracket—I.F.F. Radio.
G—Oxygen Bottles (Type F-1)
H—Bottom Turret.
I—Dynamotor—Liaison Radio Transmitter.

Figure 78—Rear Gunner's Compartment

(8) **TAIL GUNNER'S COMPARTMENT.**—The tail gunner's compartment, located aft of station 11, is accessible from the rear fuselage compartment. An emergency escape hatch equipped with releasable hinge pins is provided for the tail gunner on the right side of the airplane, just below the elevator.

b. REMOVAL AND DISASSEMBLY.

(1) **REMOVAL.**—Removable portions of the fuselage are considered as those parts attached with bolts, screws, or quickly releasable fasteners. Removal operations do not require special tools and may therefore be readily accomplished. All other parts, including doors

attached with riveted hinges, are not considered removable. For discussion of these items refer to T. O. No. 01-20E-3, "Handbook of Instructions for Structural Repair" for this airplane.

(a) NOSE SECTION.—The nose section is an integral unit of transparent plastic with a plate glass insert for the bombardier's window. Removal is accomplished by carefully slipping the lining from the retaining clips, thus exposing the 32 mounting bolts in the circumferential flanges at station 1. The part may be lowered manually but care must be taken to protect the surface from abrasion, rough handling or contact with petroleum compounds.

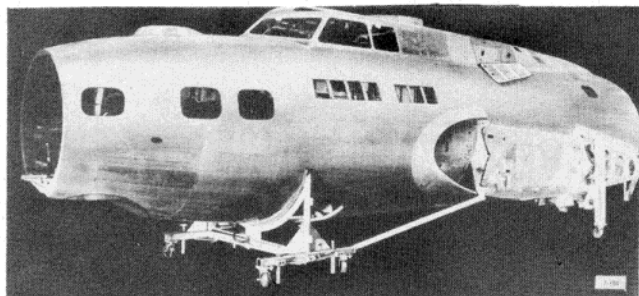


Figure 79—Fuselage Section Complete (Stations 1 to 6)

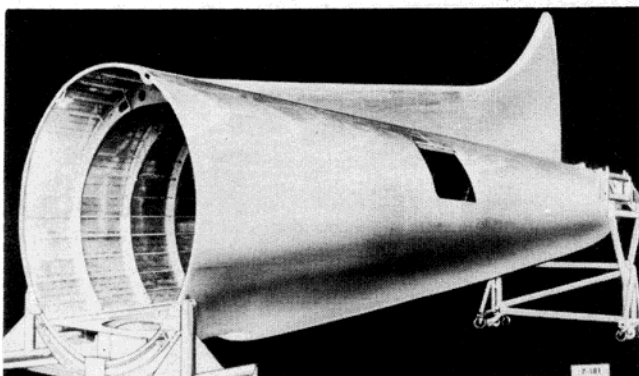


Figure 80—Fuselage Section Complete (Stations 6 to 11)

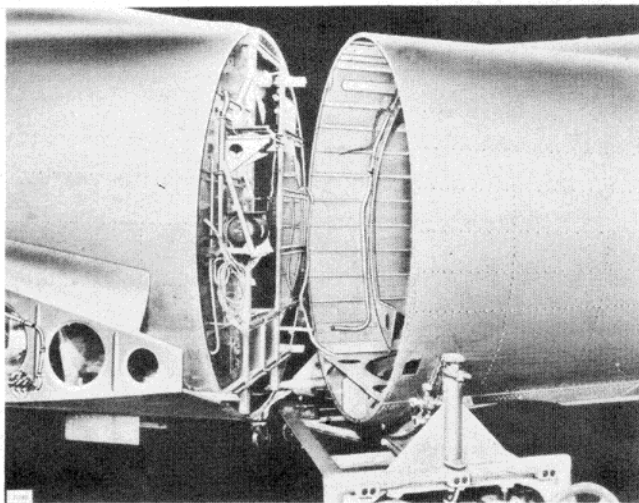


Figure 81—Disassembly of Fuselage at Station 6

(b) WINDOWS.

1. GENERAL.—Window material is of two types: laminated glass and transparent plastic. The bomb sight window, the cockpit windshield, the side windows, and the tail gunner's sighting window are all laminated shatterproof glass construction. Double pane antifrost construction is applied at the bombsight window, the cockpit windshields, and the sliding windows. All defroster panels are made of transparent plastic laminations between plate glass panels.

2. REMOVAL.—All window panels may be removed for replacement by removal of the screws in the retainers. The sliding windows in the rear fuselage compartment may be removed from the rails by removing the stops at the forward end and sliding the window assembly off the rails. The waist gun windows in airplanes with staggered waist guns are to be removed for replacement only.

3. MINOR REPAIR AND REPLACEMENT.—Damaged windows will be repaired only as a temporary measure and will be replaced as soon as possible. If unable to replace with a factory-prepared part, match the original part for material and installation. Window retainers are fastened with washer head screws from the outside, and the sealing strips must be adjusted carefully before tightening the screws in order to prevent leaks. If it should become necessary to repair the side gun window rails, use a jig to maintain the rail alignment. When adjusting the window, set the stops at the aft end of the rails to center the window frame over the opening. Disconnect the intermediate closing arms and adjust at the four corners for proper contact and tight fit, with the arms at right angles to the body contour. Then adjust the remaining closing arms to suit.

4. DEHYDRATOR UNITS.

a. The dehydrator unit is designed to assure complete absence of moisture in the air or gas trapped between the panels and the success of the defroster equipment depends upon the maintenance of a dry air condition. Presence of moisture in the dehydrating compound is indicated by a color change from normal dark blue or dry condition to a white or light pink.

b. If more than one-half of the total volume of crystals is found to be light blue or pink, re-activation is required, and may be accomplished by removing the crystals from their container, spreading them evenly over the surface of a flat pan, and heating them until color becomes a dark blue. Stir occasionally to secure even heating.

5. FUSELAGE PANELS.—All remaining panels in the fuselage are removed from the inside after removing the retaining rims. The attaching screws extend from the outside through the skin and window frame, thus necessitating two mechanics for the removal operation.

(c) BOMB DOORS. (Refer to section V, para-

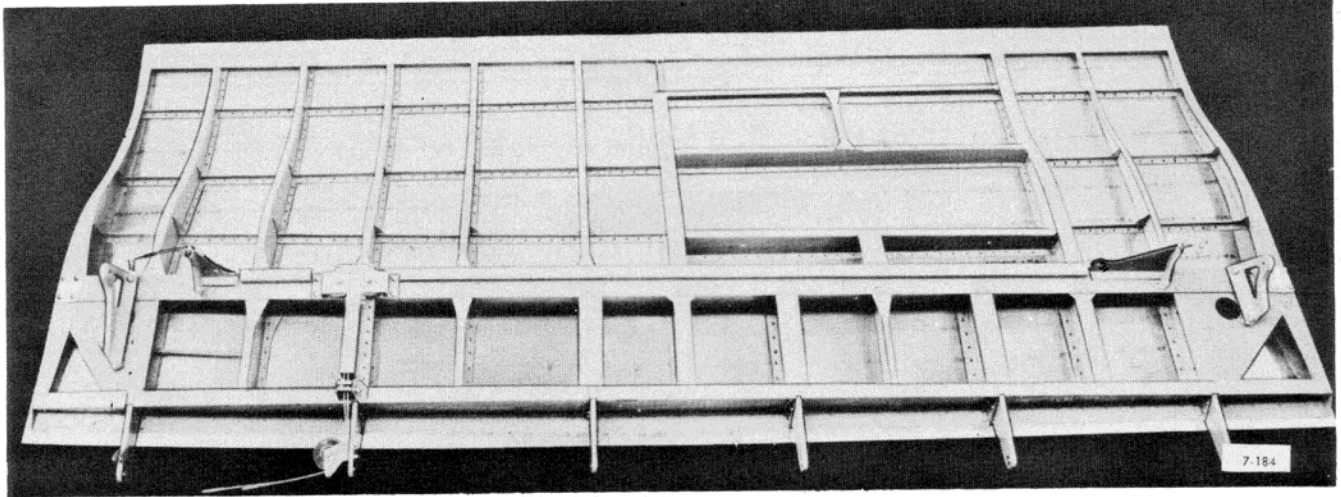


Figure 82—Bomb Bay Door Complete

graph 5. a.)—Open the bomb doors after a careful check for clearance with the ground or other obstacles. Remove the cable guards at the forward ends of the doors and disconnect the turnbuckles on the emergency release cables. Disconnect the other ends of the cables at the latches and disconnect the retracting screws at the clevises on the doors. Secure the retracting screws so that they will not turn while disconnected. Disconnect the four door checks at the terminals on the doors. On the forward end of the left-hand door, the tie-rod between the door and the mechanical interlock in the bomb control system must be disconnected at the door. At the fourth hinge from the front on the left door, the tripping rod for the bomb door safety switch should be detached to prevent inadvertent damage to the structure. Disconnect the electrical bonding on each door at the fifth hinge from the front. After removal of the six hinge bolts on each side, doors may be removed. Special care should be taken in the handling of the left door to prevent damage to the safety switch.

(d) BOMB DOOR RETRACTING MOTOR.—To remove the bomb door retracting motor, disconnect the wires at the motor and the clutch. Remove the shield from the end of the motor and remove the bolts in the motor mounting flange.

(e) FLOORING.—Removable plywood panel flooring is provided in the nose compartment, the pilot's cockpit, and the radio compartment. The sheet metal floor panels in the side gunners' compartment are removable. In some airplanes, an access door through which the ball turret windows may be cleaned while in flight is provided under the floor panel immediately aft of the turret.

(f) TAIL GUN ENCLOSURE.—The tail gun enclosure may be lowered by removing 12 bolts around the periphery of bulkhead 11, and six screws in the skin splices at the fin fairing. Disconnect all oxygen tubing and electric wiring before removing this compartment. Since hoist fittings are not provided, it is recommended that a carriage or dolly be provided for handling.

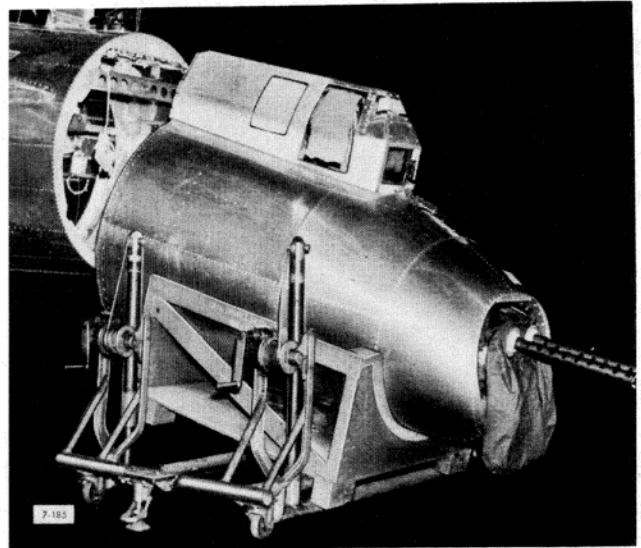


Figure 83—Removal of Tail Gun Enclosure

(2) DISASSEMBLY.—Disassembly of the fuselage at station 6 is not contemplated due to the combined use of rivets and bolts required for fabrication. Disassembly of the fuselage at other than bolted connections should be accomplished in accordance with the "Handbook of Instructions for Structural Repair" (T.O. No. 01-20E-3).

c. REPLACEMENTS.

(1) BOMBARDIER'S WINDOW.—Before replacing the bombardier's window, dehydration of the panel must be accomplished in accordance with instructions given in section IV, paragraph 7. f. of this Handbook. The replacement panel must be clean and free from defects.

(2) NOSE SECTION.

(a) Before replacing the nose section in the airplane it should be cleaned carefully. Traverse the chin turret to move the guns out of the way and bolt the nose section in place.

CAUTION

Use only soap and water, kerosene, or naphtha to clean the surfaces of the transparent plastic panels. **DO NOT USE ACETONE, BENZENE, LACQUER THINNER, OR ABRASIVE CLEANERS.**

(b) Inspect the mounting bolt holes for indication of vibrational wear, cracking, tool marks, or other defects. Edges of the gun mount holes should be inspected for minute cracks which may later endanger the installation. Check the seams in the plastic for signs of separation or deterioration. If any serious defects are found, the part should be replaced.

(3) **WINDOWS.**—Damaged cockpit windows and fuselage panels will be repaired only as a temporary measure and will be replaced with new parts when possible. Windows should be inspected and cleaned, observing the caution above.

(4) **BOMB DOORS.**—Damaged bomb doors must be replaced with new assemblies or the doors repaired in accordance with instructions given in the "Handbook of Instructions for Structural Repair of the Model B-17F" (T.O. No. 01-20E-3).

(5) **BOMB DOOR RETRACTING MOTOR.**—One set of spare brushes is supplied for each retracting motor. Replace the motor brushes when worn 3/16 inch from a new length of 9/32 inch or when the brush spring tension has been reduced by 2/3 of the original amount.

(6) **FLOORING.**—Damaged plywood flooring should be replaced by new panels or material equivalent in strength. In case the rubber mat is torn or loosened, it may be replaced in the following manner:

(a) Clean with a gasoline-dampened cloth.

(b) Brush one coat of Specification AN-C-54 cement on each surface.

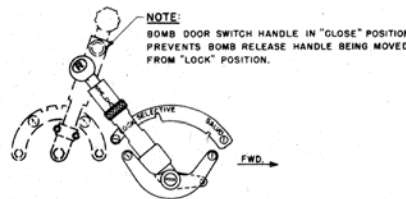
(c) Allow to dry until tacky (4 to 10 minutes).

(d) Press or roll both surfaces firmly together.

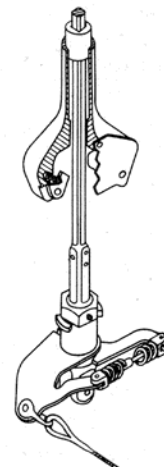
(e) Allow to dry 24 hours before use.

(7) **TAIL GUN ENCLOSURE.**—Replacement of tail gun enclosure should be made with a new assembly or with a unit repaired as directed in the "Handbook of Instructions for Structural Repair of the Model B-17F" (T.O. No. 01-20E-3).

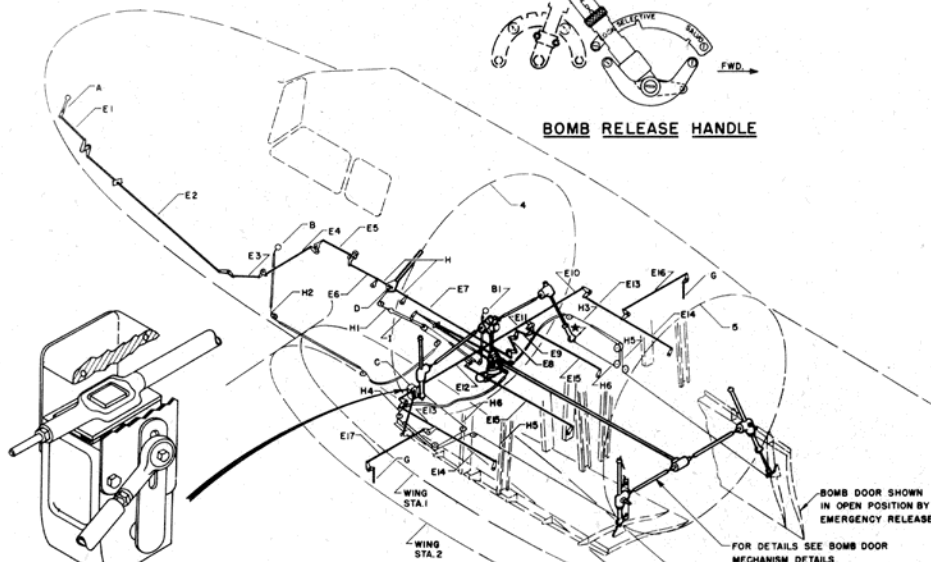
NOTE: FOR INFORMATION CONCERNING THE ALL-ELECTRIC BOMB CONTROL SYSTEM—SEE THE ALL-ELECTRIC BOMB CONTROL CIRCUIT.



BOMB RELEASE HANDLE



★ TERMINAL ASSY.



MECHANICAL INTERLOCK

PART	PART NO.
A - BOMB RELEASE HANDLE	6-10433
B - EMERGENCY RELEASE HANDLE	*059628
BI - EMERGENCY RELEASE HANDLE	*059628
C - MECHANICAL INTERLOCK	43-8148
D - "DOG LEG" SLIDE MECHANISM	7-1029-11
E1 - ROD ASSEMBLY	3-15520-1
E2 - ROD ASSEMBLY	3-15521-11
E3 - ROD ASSEMBLY	3-15521-2
E4 - ROD ASSEMBLY	3-15521-3
E5 - ROD ASSEMBLY	3-15522-1
E6 - ROD ASSEMBLY	3-15521-4
E7 - ROD ASSEMBLY	3-15521-7

LEGEND

PART	PART NO.
E8 - ROD ASSEMBLY	3-15522-2
E9 - ROD ASSEMBLY	3-15520-3
E10 - ROD ASSEMBLY	3-15519-1
E11 - ROD ASSEMBLY	1-22987-1
E12 - ROD ASSEMBLY	41-239-11
E13 - ROD ASSEMBLY	3-15521-8
E14 - ROD ASSEMBLY	3-15521-9
E15 - ROD ASSEMBLY	3-15521-10
E16 - ROD ASSEMBLY	6-11058-48
E17 - ROD ASSEMBLY	6-11058-51
F - JOINT ASSEMBLY	46-4057
G - BEARING ASSEMBLY	3-16944

PART	PART NO.
H1 - CABLE ASSEMBLY	1-16733-11-7
H2 - CABLE ASSEMBLY	75-5716-501
H3 - CABLE ASSEMBLY	BAC1779-120-OL
H4 - CABLE ASSEMBLY	BAC1779-95-2L
H5 - CABLE ASSEMBLY	**1-16650-98-1
H6 - CABLE ASSEMBLY	**1-16650-43-1
I - BOMB SLIDE RELEASE MECHANISM	44-764

* GOVERNMENT FURNISHED
** B.A.C. INSTALLATION DWG. NO. 49-2710

NOTES

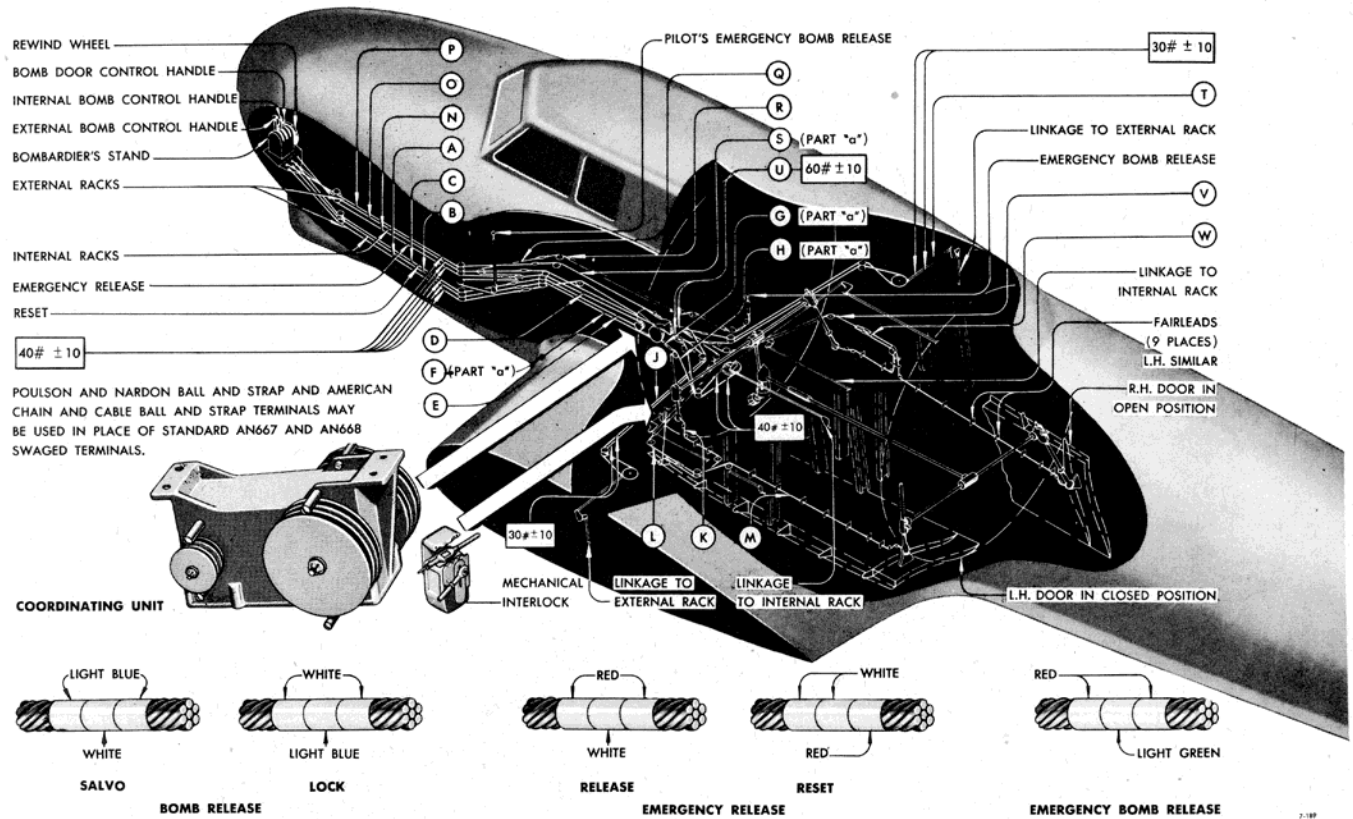
FOR BOMB CONTROL RIGGING
SEE TEXT

ALL CABLES $\frac{3}{16}$ FLEX. STL. SPEC
AN-RR-C-43

APPROXIMATE CABLE TRAVEL AT
EMERGENCY RELEASE HANDLE "12".


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Figure 84—Bomb Door Control System Diagram (Rod Operated)



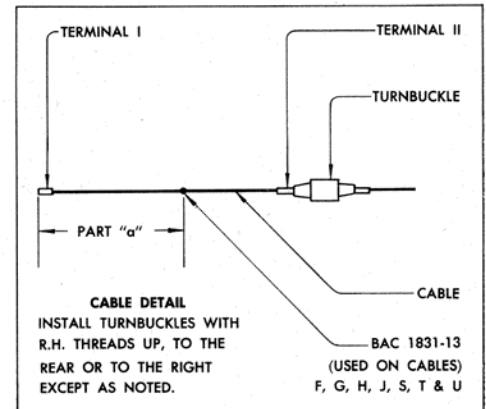
NOTE: FOR INFORMATION CONCERNING THE ALL-ELECTRIC BOMB CONTROL SYSTEM, SEE THE ALL-ELECTRIC BOMB CONTROL CIRCUIT.

LEGEND FOR BOMB AND BOMB DOOR CONTROLS

CODE	CABLE ASSEMBLY						TURNBUCKLE 	TURNBUCKLE EYE
	TERMINAL I	LENGTH*		CABLE		TERMINAL II		
		TOTAL	PART "a"	DIA.	TYPE			
A.	BAC 1828-34	117.8	—	3/32	7X7	AN669-L3 L.H.	AN155-16L	—
B.	BAC 1828-34	117.3	—	3/32	7X7	AN669-S3 L.H.	AN155-16S	—
C.	AN668-3	126.0	—	3/32	7X7	AN669-S3 L.H.	AN155-16S	—
D.	AN668-3	57.4	—	3/32	7X7	BAC 1828-34	—	—
E.	AN669-S3 R.H.	57.8	—	3/32	7X7	BAC 1828-34	—	—
F.	AN669-S3 R.H.	103.5	56.3	3/32	7X7	AN669-S3 R.H.	—	—
G.	AN669-S3 L.H.	26.5	15.0	3/32	7X7	AN669-S3 L.H.	AN155-16S†	—
H.	AN669-S3 R.H.	115.0	60.6	3/32	7X7	AN669-S3 R.H.	—	—
J.	AN668-3	170.3	85.3	3/32	7X7	AN668-3	—	—
K.	AN100-4	43.0	—	3/32	7X7	AN669-S3 R.H.	AN155-16S	AN165-16S
L.	AN668-3	87.5	—	3/32	7X7	AN668-3	—	—
M.	AN100-4	98.2	—	3/32	7X7	AN669-S3 R.H.	AN155-16S	AN165-16S
N.	AN668-3	132.3	—	3/32	7X7	AN669-S3 L.H.	AN155-16S	AN165-16S
O.	BAC 1828-34	120.8	—	3/32	7X7	AN669-S3 L.H.	AN155-16S	—
P.	BAC 1828-34	124.1	—	3/32	7X7	AN669-L3 L.H.	AN155-16L	—
Q.	BAC 1828-34	95.8	—	3/32	7X7	AN669-S3 L.H.	AN155-16S	—
R.	AN669-S3 L.H.	129.8	—	3/32	7X7	BAC 1828-34	—	—
S.	AN669-L3 R.H.	98.1	54.0	3/32	7X7	AN669-L3 R.H.	—	—
T.	AN669-S3 L.H.	233.2	116.9	3/32	7X7	AN669-S3 L.H.	AN155-16S†	AN165-16S
U.	AN669-S3 L.H.	26.1	14.7	3/32	7X7	AN669-S3 L.H.	AN155-16S†	AN165-16S
V.	AN668-3	117.0	—	3/32	7X7	AN668-3	—	—
W.	AN100-4	43.0	—	3/32	7X7	AN669-S3 R.H.	AN155-16S	AN165-16S
X.	AN100-4	98.2	—	3/32	7X7	AN669-S3 R.H.	AN155-16S	AN165-16S

* FOR TERMINAL AN668, THE CABLE ASSEMBLY LENGTH IS MEASURED TO CENTER OF BOLT HOLE.
FOR TERMINALS AN669 AND AN100-4, THE ASSEMBLY LENGTH INCLUDES FULL LENGTH OF TERMINALS.
FOR BAC 1828, THE ASSEMBLY LENGTH DOES NOT INCLUDE THE TERMINALS.

† ON BOTH ENDS OF CABLE



CABLE TRAVEL			
INTERNAL RACKS—			
FWD. OF COORDINATING UNIT	3.92	TOTAL TRAVEL	
AFT OF COORDINATING UNIT	1.96	TOTAL TRAVEL	
EXTERNAL RACKS—			
FWD. OF COORDINATING UNIT	3.92	TOTAL TRAVEL	
AFT OF COORDINATING UNIT	1.96	TOTAL TRAVEL	
BOMB DOORS—AFT OF COORDINATING UNIT			
EMERGENCY RELEASE HANDLES	25.44	TOTAL TRAVEL	
EMERGENCY REWIND	12.72	TOTAL TRAVEL	

Figure 85—Bomb Door Control System Diagram (Cable Operated)

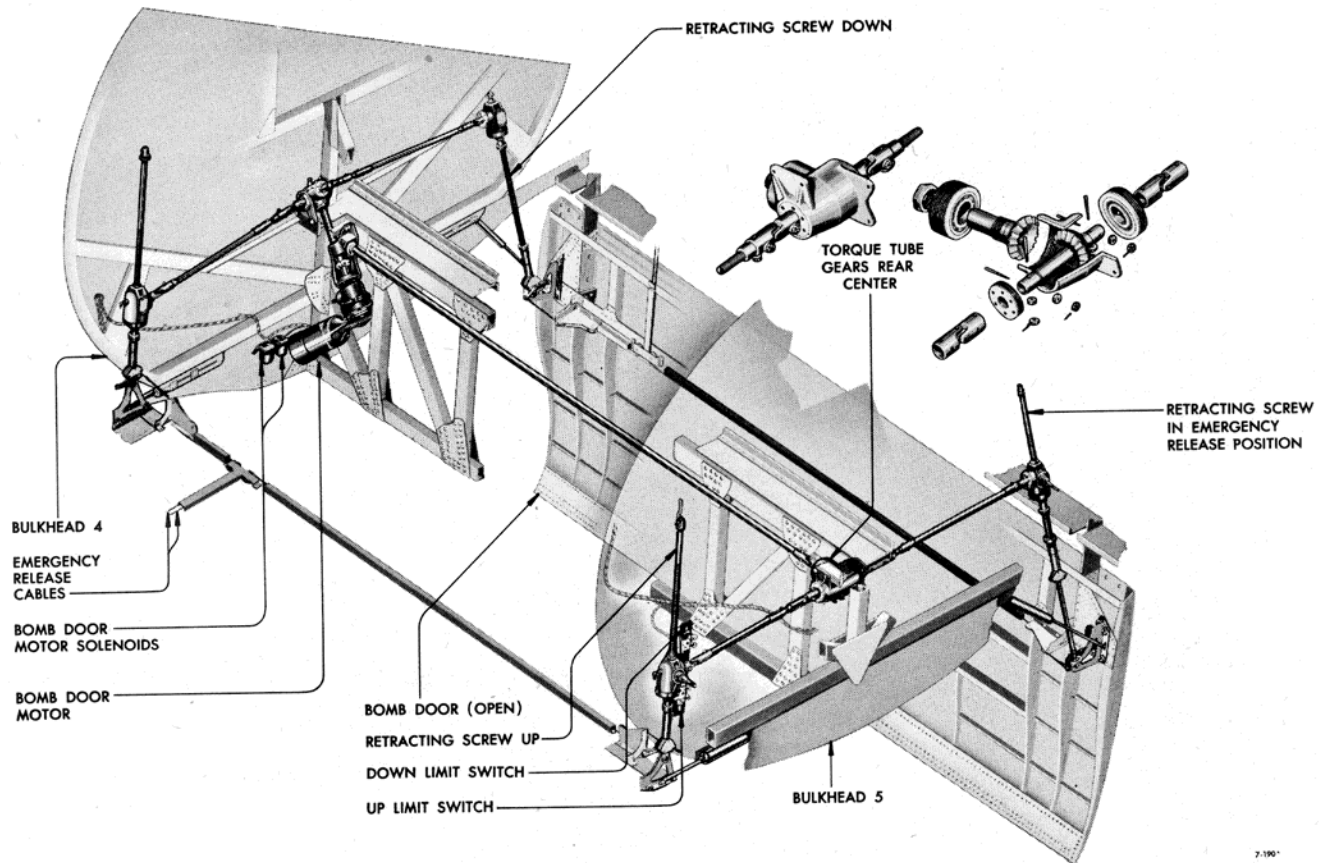


Figure 86—Bomb Door Retracting Mechanism

d. ADJUSTMENTS.

(1) BOMB DOOR RETRACTING MOTOR.—

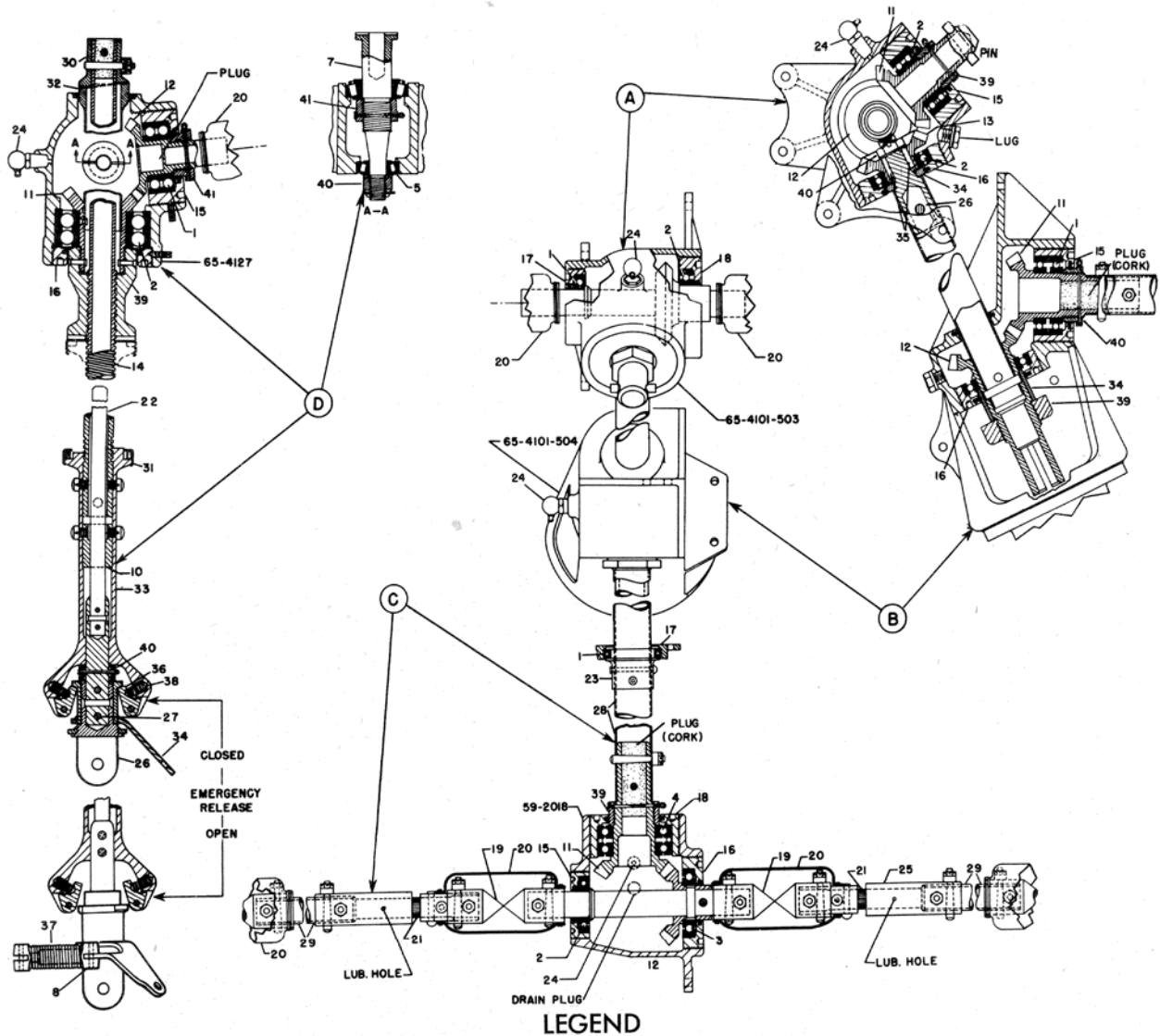
The time required for raising the bomb doors should be approximately 25 seconds when operating on 28.5 volts. A longer operating time indicates clutch slippage. Set the clutch at 1200 pound-inches torque. This torque setting should be made on the basis of *breakaway torque*. Adjust the setting by starting the motor with the test stand brake loose and with the motor and clutch at room temperature. Tighten the brake until the motor clutch starts to slip. This is evidenced by stoppage of the output shaft. The maximum torque reached before the shaft stops shall be taken as the clutch setting. The clutch setting will be considered acceptable when within five percent of the specified 1200 pound-inches. To prevent excessive temperature increase, do not permit the clutch to slip any longer than necessary. Readjust the clutch if the breakaway torque is not in accordance with the specified value. Allow the motor to stand a minimum of 30 minutes from the time of the first check before checking again. Recheck as instructed above. If additional adjustments are necessary, they shall each be followed by a cooling period and rechecked again. Adjust clutch settings for reverse travel as outlined above. No attempt should be made to adjust clutch settings without the use of an adequate torque measuring device.

(2) BOMB DOOR LIMIT SWITCHES.

(a) The airplane may be equipped with either the B-15 (39A3756) or the WZ-R31 Micro instantaneous opening type switches. The B-15 switches are on the coupling shaft between the front and rear operating shafts; a screw and traveling nut operate these switches. The Micro (WZ-R31) type limit switches are installed on the left rear door retracting screw mechanism. Both types of limit switches must be adjusted so that the electrical cutoff is 1-3/4 to two turns of the *handcrank* before the engagement of the mechanical stops. This setting is to be used for both door positions—"OPEN" and "CLOSED", and for both types of retracting motors—Eclipse and General Electric.

(b) The bomb door safety switch at the hinge on the left door should be adjusted to close when the bottom of the door is four inches from the fully opened position. The bomb door light on the bombardier's panel is turned on when the switch is closed.

(c) On airplanes equipped with rod operated or cable operated bomb controls, a bomb door lock switch is mounted at the bottom of the bombardier's panel and is operated by a striker on the bomb release lever rod or cable. The "UP" control circuit of the bomb door retracting motor is wired through the switch so that the doors cannot be retracted electrically unless the bomb



LEGEND

ITEMS	NO.	A	B	C	D
FAFNIR BEARINGS	1	S- 8-FT.	S-12-FT.	A542	5205
FAFNIR BEARINGS	2	S-10-FT.		S- 8-FT.	5207
FAFNIR BEARINGS	3			S-10-FT.	
FAFNIR BEARINGS	4			S-12-FT.	
TIMKEN BEARINGS	5				A4050
TIMKEN BEARINGS	6				07087
SHAFT	7				21-9683
GUIDES	8				21-9860
GUIDES	9				21-9861
GUIDES	10				41-6826
GEARS	11	21-9881-1	43-7853-400	41-7949	3-7934-1
GEARS	12	41-7995	43-7853-401	41-7995	3-7934-2
GEARS	13	43-7863-400			
SCREW	14				3-7936
RETAINER	15	21-9511	21-9490-5	21-9492-1	21-9672-1
RETAINER	16	21-9511-1	29-9490-1	21-9491-1	41-9892
RETAINER	17	21-9492-1		41-9882	
RETAINER	18	21-9491-1		51-476	
UNIVERSAL JOINT	19	270-B16		270-B16	270-B16
UNIVERSAL BOOT	20	21-9751-16A		21-9751-16A	21-9751-16A
SPLINE BOOT	21			53-7977-403	

ITEMS	NO.	A	B	C	D
RETRIEVING ROD	22				6-8130-7
SLEEVE	23			41-6608-2	
LUBRICATORS	24	286-4	286-4	286-4	286-4
SLEEVE	25			53-7977-402	
TERMINALS	26	41-8217			6-8130-2
TERMINALS	27				68130-4
TUBES	28		41-8216-1	41-6608	
TUBES	29			53-9777-400-401	
STOPS	30				21-9677
STOPS	31				41-7584
STOPS	32				41-9966
STOPS	33				6-7198
COLLARS	34	21-9579	21-9457		3-9778
KEYS	35	BAC-1002-10			
CATCH	36				21-9682
SPRINGS	37				21-9678
SPRINGS	38				21-9886
NUTS	39	41-8267-1	AN-320-20	41-7956	21-9674
NUTS	40	AN-320-8	41-7956		41-6825
NUTS	41				41-8267

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Figure 87—Bomb Door Actuating Mechanism

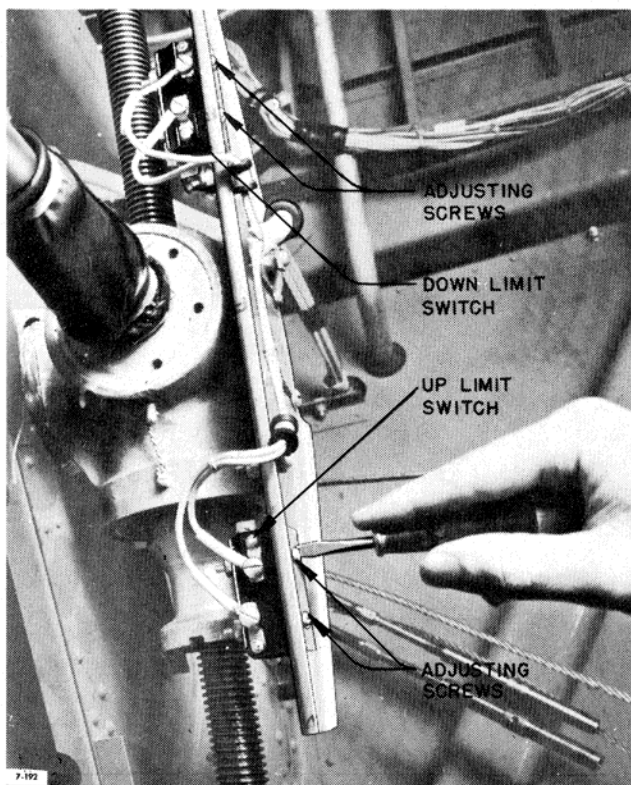


Figure 88—Limit Switch—Bomb Door

release lever is in the "LOCK" position. In the "SELECTIVE" position, the switch supplies power to the bomb sight, bomb release switch, external rack selector switches, bomb arming switch, and the formation signal lights. The switch is adjusted to operate when the bomb release lever is 1/4 inch from the "LOCK" position. For checking purposes, the bomb arming lamp can be used to indicate the operation of this switch; turn on the bomb arming switch. When the release lever is moved, the bomb arming lamp will light when the bomb door lock switch closes.

e. ASSEMBLY AND INSTALLATION.

(1) At installation of the nose section and tail gun enclosure make certain that all previous sealing compound has been removed from both surfaces before applying fresh compounds. Complete instructions on the use of sealing compounds are contained in section VII of this Handbook. After connection of the oxygen tubing in the tail gun compartment, check for leakage as instructed in section V, paragraph 2.

(2) In assembling all windows use a generous amount of sealing compound to insure rain-tightness of window seams. In tightening the mounting screws or bolts enough pressure should be applied to firmly seat the mating parts. However, avoid excessive pressures which may dimple the retaining strips or distort the plastic material.

5. LANDING GEAR.

a. MAIN LANDING GEAR.

(1) GENERAL.

(a) A retractable landing gear assembly is installed beneath each inboard nacelle. The assemblies are of the cantilever type, each consisting of an air-oil shock strut assembly, torsion link, drag and retracting struts, and a wheel and brake. Electrical retraction, controlled by a single switch from the cockpit, is accomplished simultaneously for both main landing gear assemblies and for the tail wheel gear. Emergency manual operation is provided for each wheel separately. The hand crank torque connections for the main gear are on each side of the forward wall in the bomb bay.

Note

The direction of rotation of the hand crank for the main landing gear may be either clockwise or counterclockwise depending on the type of the motor installed. Be sure to place the proper decal at the hand crank of the main landing gear and tail gear when the motor is replaced.

	Retraction Motor Make	Hand Rotation Main Gear	Hand Rotation Tail Gear	Motor Turns Hand Crank
B-17 Mfg. Boeing & Douglas	Eclipse	Counter- clockwise Down	Clockwise Down	Yes
Vega	General Electric	Clockwise Down	Counter- clockwise Down	No

(b) The Hayes wheels are equipped with dual duplex expander tube brakes and 56-inch tires.

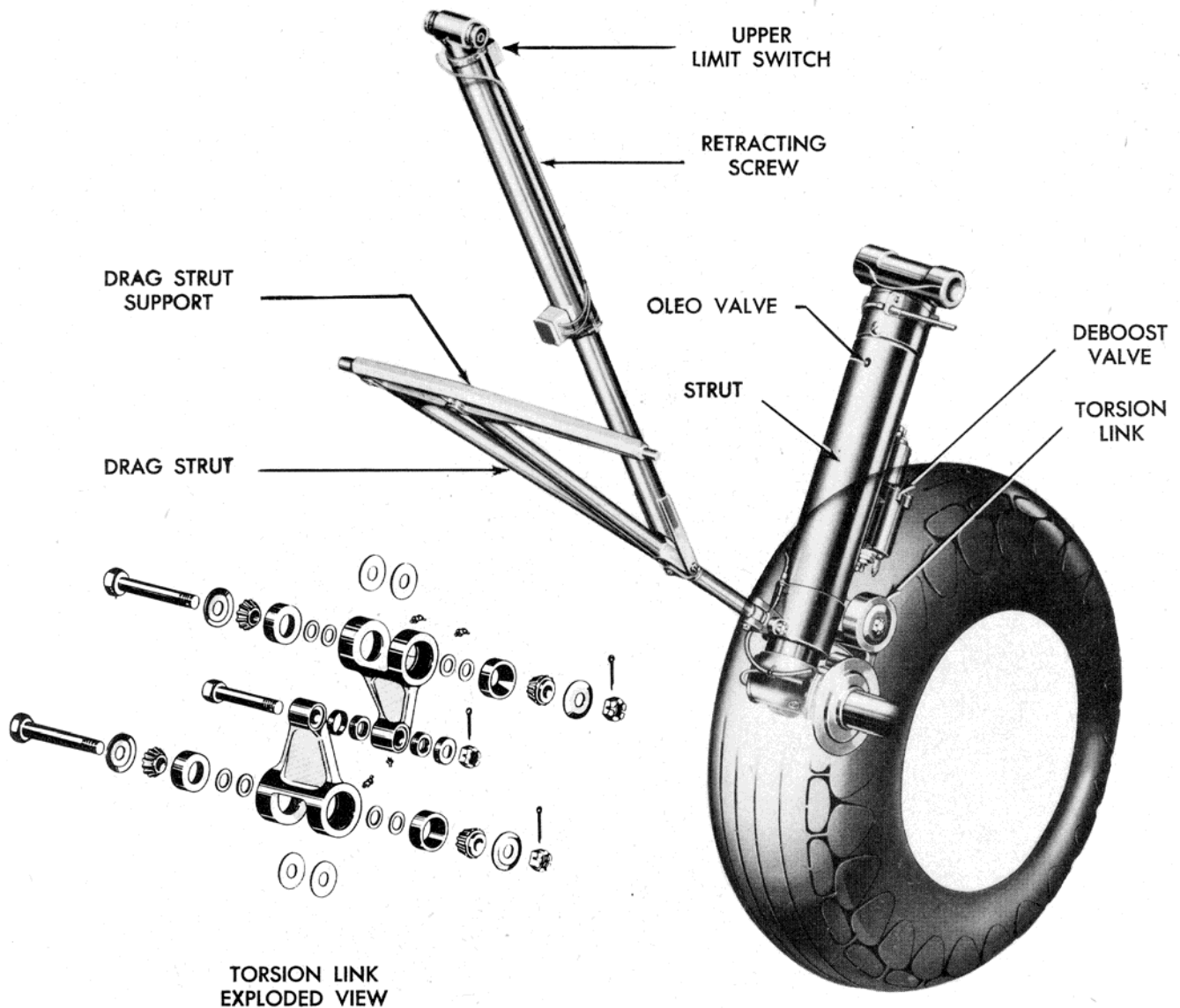
(2) REMOVAL AND DISASSEMBLY.

(a) REMOVAL.

1. LANDING GEAR.—Before removing the landing gear, release the air in the shock absorber strut slowly by loosening the air valve body. Attach a retaining plate at the torsion link fittings to prevent extension of the strut cylinder. Support the airplane securely on jacks at both cones on bulkhead 4 and at the cone on bulkhead 7. Stabilizing jacks should also be applied at wing station 8 or at outboard engine mounts. Raise the airplane sufficiently to lift the front wheels clear of the ground. Retract the wheels approximately four inches to avoid damage to the limit switches after removal of the retracting strut.

2. RETRACTING MOTOR.—To remove the main landing gear retracting motor, disconnect the manual control coupling aft of the universal joint. Remove the connector shield cover, disconnect the wires, and remove the shield from the end of the motor. Disconnect the wire to the solenoid clutch at the clutch housing. It will be necessary to use a socket wrench with an extension from the inboard side to reach the forward mounting bolts. The unit may then be removed by disconnecting the supporting strap around the motor frame.

3. RETRACTING AND DRAG STRUTS.—Remove the retracting and drag struts. Do not allow the drag strut to swing forward against the forward edge of the wheel well. Disconnect the brake lines at the flexible hose attachments above the shock strut and



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Figure 89—Landing Gear Assembly

seal all hose and tube ends. Remove all fairing around the trunnion pin, at the base of the strut, and remove the trunnion pin retaining bolts. In order to remove the trunnion pin a hooked bar may be inserted in one of the bolt holes through the center of the pin. The holes are reamed for bearing bolts, however, and the end of the hooked bar must be smooth to avoid damaging the hole.

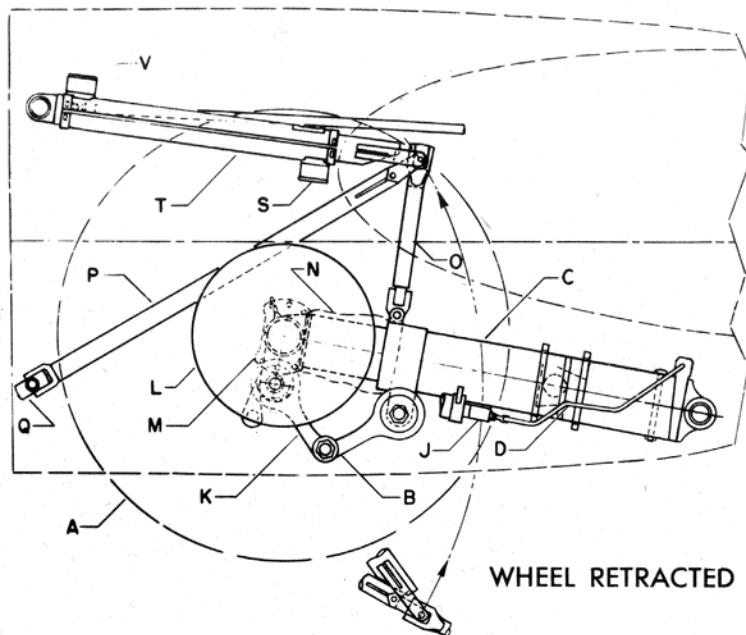
Note

The shock absorber may be removed without removing the strut from the trunnion by following the instructions given in paragraph (b) (4) below.

(b) DISASSEMBLY.

1. **TIRE.**—Removal of the tire and tube is accomplished by deflating the tire, forcing the tire bead and side casting ring inward to facilitate removing the retaining ring, and lifting the side casting ring from the assembly. The operation is then completed in the standard manner prescribed for any drop-center wheel. Care must be taken to prevent damage to the beads or tubing removal.

2. **WHEEL.**—Remove the cover plate on outboard side of the wheel. Disconnect the brake line hose at the quick disconnect fitting. Remove the two lock nuts holding the wheel ring nut in place. Remove the ring nut washer and pull the outboard brake and torque



LEGEND

- A TIRE
- B TORSION LINK ASSY.
- C STRUT ASSY.
- D FUEL TRANSFER PUMP BRACKET
- E OLEO ASSY.
- F LANDING GEAR SUPPORT (STA. 4)
- G LANDING GEAR SUPPORT (STA. 5)
- H LANDING GEAR SUPPORT (STA. 6)
- J RETURN BOOSTER VALVE
- K TORSION LINK ASSY.
- L WHEEL AND BRAKE ASSY.
- M KNUCKLE ASSY.
- N BOOT ASSY.
- O UNIVERSAL DRAG LINK ASSY.
- P DRAG STRUT ASSY.
- Q DRAG STRUT SUPPORT
- R BEARING ASSY.
- S LOWER LIMIT SWITCH—SHIELD ASSY.
- T RETRACTING GEAR MECHANISM
- U RETRACTING SCREW SUPPORT
- V UPPER LIMIT SWITCH—SHIELD ASSY.

NOTES:

LEFT HAND SIDE VIEW SHOWN
TIRE IS 55 x 19.00, 16 PLY, NON-SKID TREAD
ROLLING RADIUS OF TIRE IS 23.00 INCHES

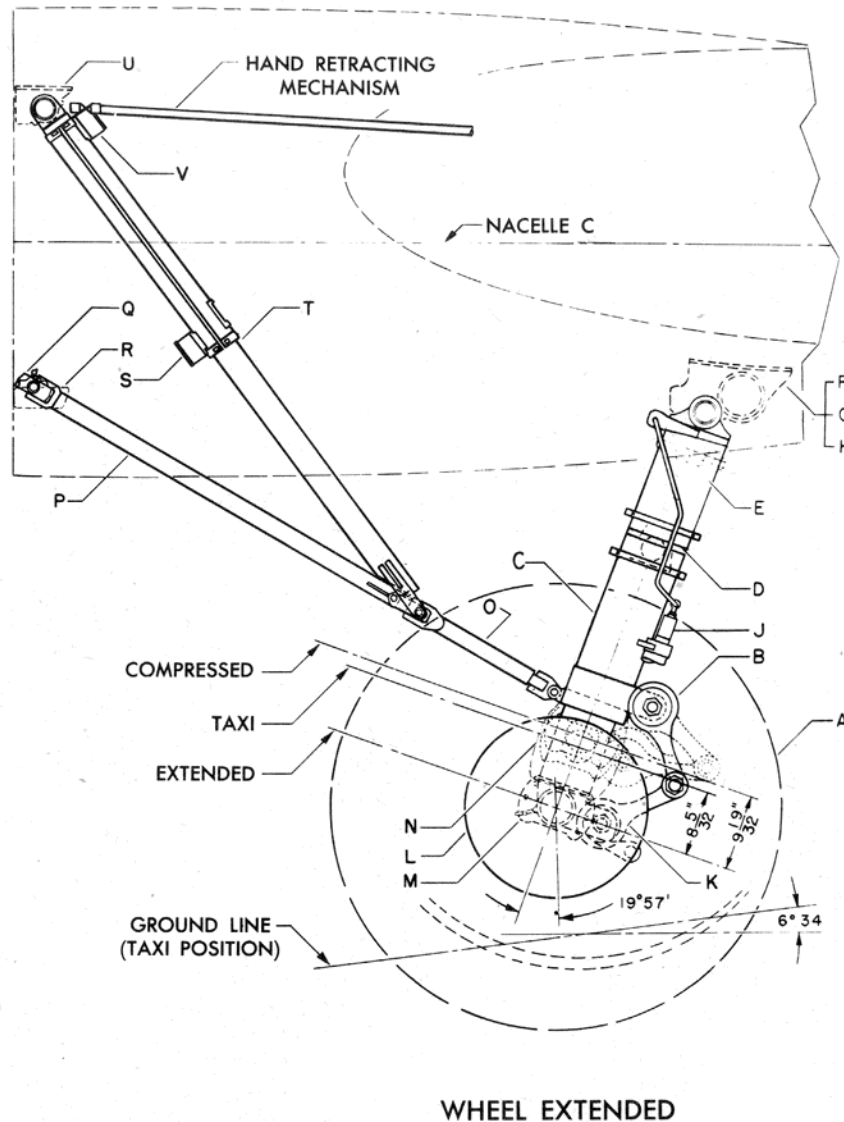
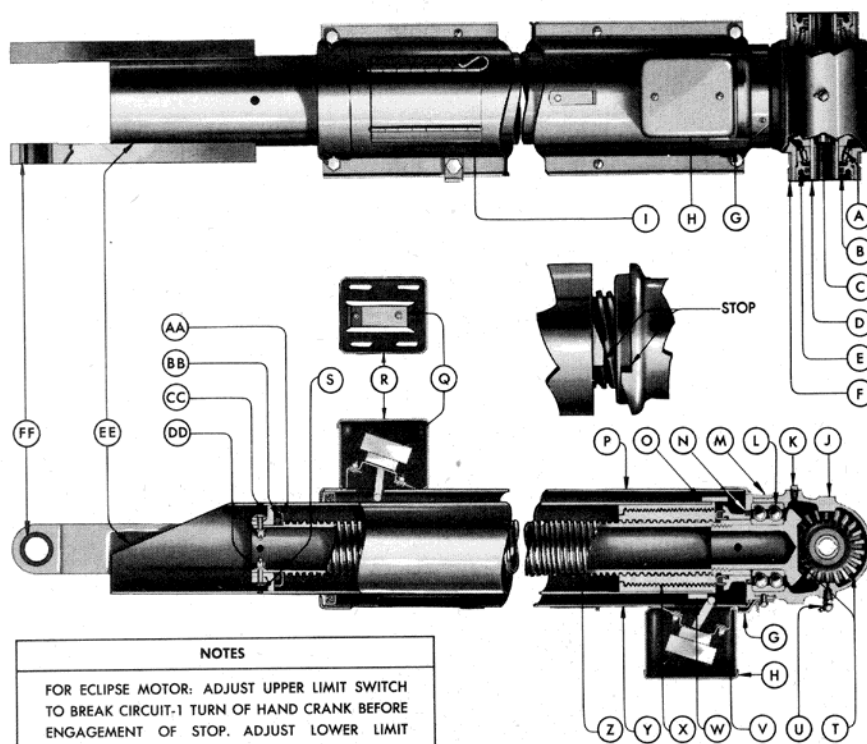


Figure 90—Landing Gear Installation Diagram

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NOTES

FOR ECLIPSE MOTOR: ADJUST UPPER LIMIT SWITCH TO BREAK CIRCUIT-1 TURN OF HAND CRANK BEFORE ENGAGEMENT OF STOP. ADJUST LOWER LIMIT SWITCH TO BREAK CIRCUIT 2-3/4 TURNS OF HAND-CRANK OR 1-3/8 ON SCREW BEFORE ENGAGEMENT OF STOP.
FOR G.E. MOTOR: ADJUST LIMIT SWITCH SUCH THAT RUBBER BUMPER OF 64-1498 IS COMPRESSED TO A DEGREE REQUIRING 20 5 LBS. ON HAND RETRACTING CRANK TO LOOSEN.

CAUTION

CURRENT FOR THESE ADJUSTMENTS
MUST BE ——— 24-28 VOLTS D.C.

PART	A. O. SMITH NO.	B.A.C. NO.
A. TIMKEN ROLLER BEARING ASSY.	ALG-254-A	07100 CONE 07196 CUP
B. LOCK RING	ALG-220	41-4778
C. KEY RETAINER		1-29387
D. RETRACTING GEAR SHAFT	AOS 505	
E. RETAINER ASSY.	ALG-213-A	41-2817
F. BUSHING		51-289
G. COVER LOCK ASSY.		3-20433
H. UPPER LIMIT SWITCH SHIELD ASSY.	AOS-2-642-2 L.H. AOS-2-641-2 R.H.	3-11996-15
I. INSPECTION DOOR		
J. GEAR HOUSING ASSY.	ALG-210-A	46-8053
K. PLUG		AC895-70
L. FAFNIR BEARING ASSY.	ALG-255-A	5208
M. GEAR HOUSING CAP	ALG-215	21-5136
N. UPPER STOP ASSY.	ALG-237-A	21-9839
O. STRIKER-LOWER LIMIT		
P. LOWER COVER ASSY.	ALG-241-A	9-3082-2
Q. LOWER LIMIT SWITCH	8909-K-520	(CUTLER- HAMMER)
R. LOWER LIMIT SWITCH SHIELD ASSY.	AOS-2-648-2 L.H. AOS-2-647-2 R.H.	3-11996-15
S. ACCESS HOLE-LOWER STOP ASSY.		
T. GEAR SET (MATCHED)	ALG-230 ALG-231	3-9288
U. LUBRICATOR		AN286-3
V. UPPER LIMIT SWITCH	8909-K-520	(CUTLER- HAMMER)
W. STRIKER-UPPER LIMIT		
X. RETRACTING NUT	ALG-235-1	3-15124
Y. UPPER COVER ASSY.	ALG-240-A	9-3082-1
Z. RETRACTING SCREW		3-15118
AA. LOWER BUMPER CAP	ALG-226	21-9841
BB. LOWER BUMPER	ALG-227	64-1498-502
CC. LOWER STOP ASSY.		3-21937
DD. WASHER-BALL SEAT	ALG-115	21-9588
EE. TUBE ASSY.	ALG-238-A	48-591
FF. BUSHING	ALG-228-10	51-428

NOTE: SCREW SHOWN FULLY RETRACTED; RIGHT HAND PART SHOWN. MAKE LEFT HAND BY REVERSING UPPER GEAR AND SHAFT.
FOR LUBRICATION SEE LUBRICATION CHART.

Figure 91—Landing Gear Retracting Screw

plate off. Remove the outer roller bearing. Pull the wheel outboard until it clears the axle. Remove the inner bearing and race; then replace the ring nut to protect the threads on the axle.

3. **BRAKES.**—Disconnect the hydraulic hose connection at the brake, disconnect the copper outboard brake tube connection for the fitting, and seal the end of the hose. Remove the twelve bolts holding the brake assembly to the brake spacer and pull the brake assembly outward.

4. **AIR-OIL SHOCK ABSORBER.**

a. Before removing the shock absorber from the strut, unscrew the air valve body slowly and release all air from the cylinder. Disconnect the brake hose at the brake and remove the torsion link bolt at the joint. Remove the top bolt of the shock strut, release the retaining plate at the torsion link fittings, and draw the complete shock absorber assembly from the strut. Remove the air valve body, pour the oil from the cylinder and remove the packing nut. Draw the piston slowly from the cylinder, taking care to avoid damage to the packing rings. Should the packing be set tightly enough to prevent removal of the piston by hand, replace the nut and engage it approximately 1/4 of the available thread distance. Then replace the air valve and inflate the cylinder only enough to loosen the packing. Release the air and continue the disassembly procedure.

After separating the two parts, the packing and adapter rings may be slipped from the top of the piston. The metering rod may be removed, if necessary, by disconnecting the shock absorber cylinder from the axle knuckle. However, disassembly to this extent is not recommended except as part of the complete overhaul operations. The cylinder is threaded to the knuckle and locked by means of two recessed head pipe plugs which are soldered in place.

b. Do not disassemble the torsion link roller bearing connections on the axle and the strut unless repair or replacement appears necessary. If these joints must be disassembled, take care to maintain the parts of each bearing assembly in a separate group so that when replaced, the bearing alignment will match the original installation. Complete instructions on alignment procedure are contained in paragraph (5) (d) below.

(3) **MINOR REPAIR AND REPLACEMENT.**

(a) **AIR-OIL SHOCK ABSORBER.**

1. If correct shock absorber inflation cannot be maintained, check the air valve core and body for leakage. Replace the gasket and valve core with new parts if necessary. Do not use standard air valve cores, as contact with the oil will render them useless very quickly. The valves are equipped at the factory with Schrader valve core No. 1939 and replacements must be made with cores identical to the original equipment.

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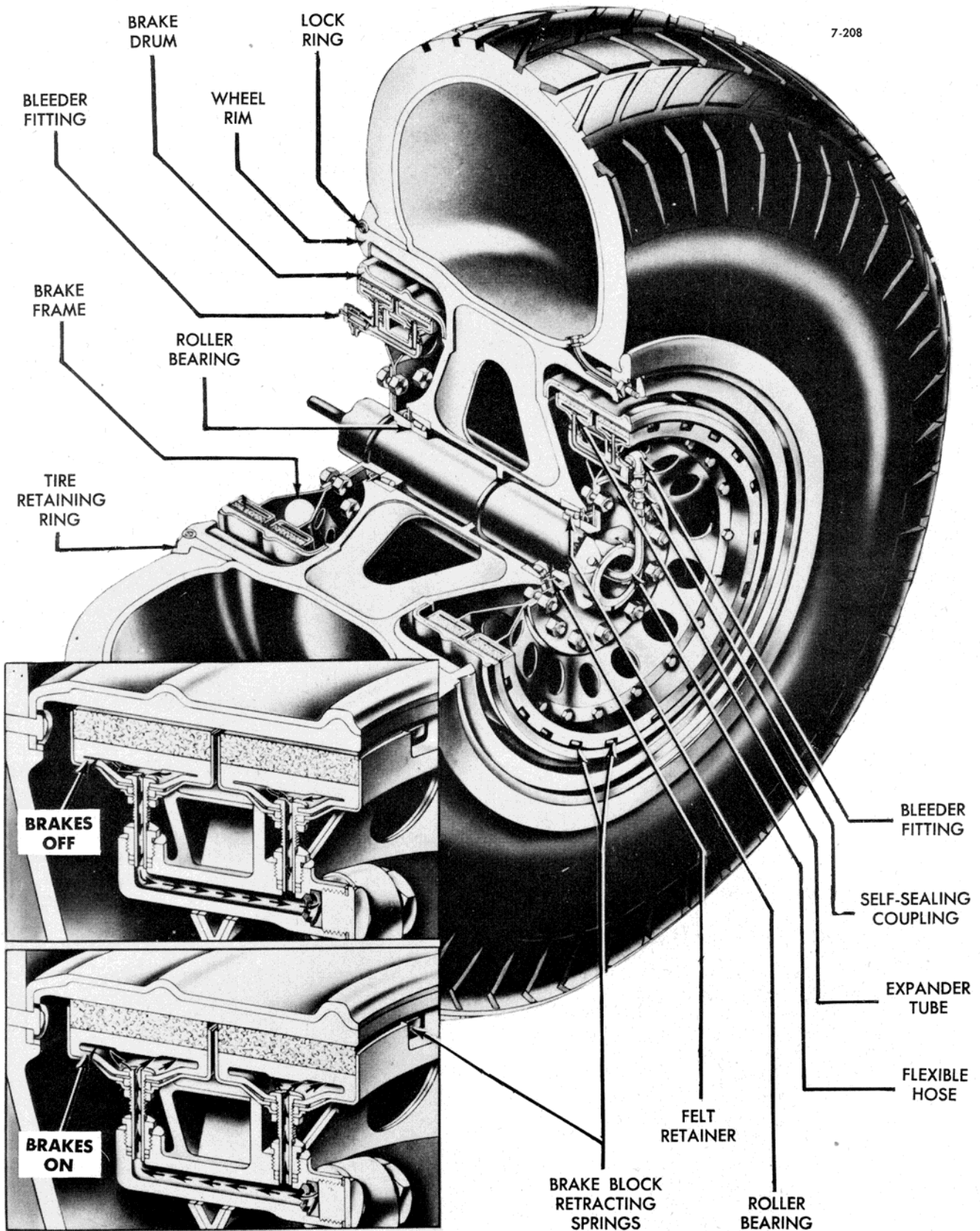


Figure 92—Brake Expander Tube Diagram

2. Continued loss of inflation with no leakage apparent at the air valve is an indication of oil leakage. Remove the shock absorber assembly from the strut, loosen the lock nut, and tighten the packing nut. Do not use excessive force, or damage to the packing rings will result. One-half turn is usually sufficient. If necessary, disassemble the unit and inspect the packing. Frayed or notched edges of the chevron packing rings will indicate the necessity for replacement. Refer to the packing installation diagram for the landing gear shock strut, and use a sheet metal sleeve as directed to avoid damage to the packing ring sealing surfaces.

(b) LANDING GEAR STRUT.

1. The bronze collar at the lower end of the landing gear strut provides a guide for the cylinder. Clearance between the cylinder and the collar must not be less than .011 inch on the diameter, to prevent galling of the surfaces. If the clearance exceeds .03 inch, the collar should be replaced with a new part.

2. Should it become necessary to replace the brake return boost valve mounting bolts, replace only with bolts 1/2 inch long. A longer bolt will protrude on the inside of the strut, against the cylinder, with consequent scoring of the surface.

(c) BEARINGS.—Heavy duty antifriction bearings have been provided to reduce maintenance to a minimum and bronze bushings are installed on all other moving parts. Refer to the bushing chart for bushing instructions.

(d) RETRACTING MOTOR.—One set of spare brushes is supplied for each retracting motor. Replace the motor brushes when worn 3/16 inch from a new

length of 9/32 inch or when the brush spring tension has been reduced by 2/3 of the original amount.

(4) ADJUSTMENTS.

(a) LANDING GEAR LIMIT SWITCHES.—

Two types of retracting motors are used interchangeably on the main landing gear. One type is manufactured by Eclipse and the other by General Electric. The design of the motors requires a different procedure in setting the limit switches. However, the two types of limit switches, B-15 (39 A3756) "momentary off" type and the Cutler-Hammer (8909-K-520) "instantaneous opening" type, are adjusted similarly. Be sure that the airplane battery disconnect switches are "OFF." The limit switches must be set with the airplane jacked up and wheels free from the floor. Refer to the landing gear limit switch test circuit diagram, figure 93, for the recommended method of adjusting the limit switches. Set up the test circuit and proceed as follows:

1. ECLIPSE MOTOR INSTALLATION.

a. Extend the wheel fully with the hand crank until the stops are in contact and note the position of the crank.

b. Retract the wheel *two to four turns* of the *hand crank*.

c. After loosening the four switch shield mounting screws for the lower limit switch, adjust the shield in the slotted holes until the switch opens the circuit at this position of the landing gear.

d. Tighten the mounting screws in the shield and partially retract the landing gear by means of the hand crank. Then, extend it again slowly and note the position of the crank when the test light goes out. The gear should engage the stops at two to four turns of the *hand crank* after the test light goes out. Repeat the check by retracting and extending the gear several times to be sure the switch works freely and opens the circuit at the same position of the crank. The warning switch is in the same shield with the lower limit switch and is automatically adjusted with the setting of the limit switch.

e. Retract the gear fully with the hand crank until the stops are in contact and proceed with setting the upper limit switch in the same manner except that the upper limit switch should open the circuit *one turn* of the *hand crank* before engagement of the upper stop.

f. After both the upper and lower limit switches for each landing gear have been adjusted satisfactorily, operate the mechanism electrically, using the external power supply with the voltage adjusted to 28.5 volts. The stops should definitely make solid contact at each extreme position, but should not strike violently. Further slight adjustments may be necessary due to differences in friction in the mechanisms.

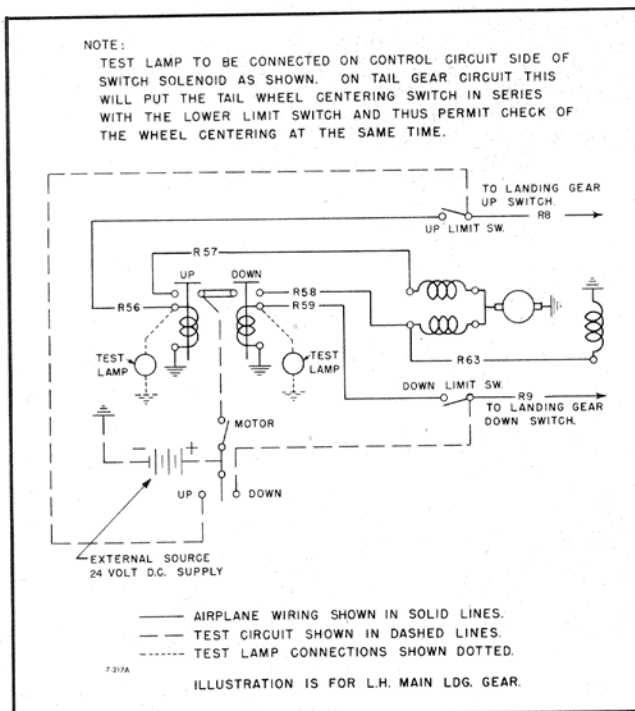


Figure 93—Landing Gear Limit Switch Test Circuit

2. GENERAL ELECTRIC MOTOR INSTALLATION.

a. On airplanes equipped with G. E. retracting motors, the upper limit switch must be set to break the circuit at $1\pm 1/8$ turns of the handcrank before engagement of the stops. The lower limit switch must be set to break the circuit at $1/2\pm 1/8$ turns of the handcrank before engagement of the stops.

Note

The following method makes it unnecessary to crank the entire wheel up and down by hand and also makes it easier to get at the limit switches. Disconnect the landing gear strut from the retracting gear before making the adjustments. Jack up the airplane until the wheels are free. Deflate the shock strut, and hand retract the gear until the joint at the drag links and "V" drag strut is broken. Place a jack under the jacking cone to hold the weight of the wheel, and remove the aft bolt through the universal at the junction of the retracting screw, "V" drag strut, and drag link. With the universal disconnected, reinsert the bolt through the retracting screw and drag strut to prevent the screw from turning, as indicated by the arrow on figure 94. Adjust the up and down limit switches, reassemble the universal joint, inflate the shock strut, and check the adjustment with an external power supply.



Figure 94—Drag Link Disconnected

WARNING

Do not operate the landing gear retracting mechanism with the handcrank unless the landing gear switch is in the "OFF" position.

(b) RETRACTING MOTOR.

1. The time required for retracting the landing gear should be approximately 45 seconds, operating on 28.5 volts. A longer operating time indicates clutch slippage.

2. The proper clutch setting torque is 1200 pound-inches for the Eclipse type 1073, 1050 pound-inches for the G. E. type 5BA50FJ2B, and 850 pound-inches for the Eclipse type 785 and the G. E. type 5BA50FJ2A retracting motors. These clutch setting values are for *breakaway* torque. Adjust the clutch setting with the motor at room temperature by starting the motor with the test stand brake loose and tightening the brake until the motor clutch starts to slip. This is evidenced by stoppage of the output shaft. The maximum torque reached before the shaft stops shall be taken as the clutch setting. Acceptable settings shall be as specified for the unit in question \pm five percent. To prevent excessive temperature increase, do not permit the clutch to slip any longer than necessary. Readjust the clutch if the breakaway torque is not in accordance with the specified values. Allow the motor to stand a minimum of 30 minutes from the time of the first check before checking again. Recheck as instructed above. If additional adjustments are necessary, they shall each be followed by a cooling period and rechecked again. Clutch settings for reverse travel should also be checked as outlined above. No attempt should be made to adjust clutch settings without a torque measuring device.

(5) ASSEMBLY AND INSTALLATION.

(a) LANDING GEAR SHOCK ABSORBER.

1. All parts should be thoroughly cleaned and inspected before reassembling. The outside of the piston tube assembly and inside of the cylinder must be smooth and should be examined carefully. These parts should be lapped to remove any scratches. The bushing in the bearing nut assembly should be checked for wear and replaced if necessary.

2. Insert the piston head into the cylinder, allowing the lower ring and the bottom packing adapter to drop into place. The packing must be installed one ring at a time, making sure that each ring is properly seated before installing the next. A mixture of graphite and oil, or a light grease, applied on each ring will assist in its installation. Care must be exercised when installing these rings that the inside and outside sealing edges do not become damaged. A thin metal sleeve may be used to protect the packing rings against damage from the cylinder threads, as illustrated in figure 99. Slide the top packing adapter and upper ring into place and screw on the bearing nut. When the packings become snug in the stuffing box, further tighten the bearing nut approximately $1/2$ turn. Use care in tightening the

nut to avoid excessive friction or damage to the packing. Replace the lock nut and tighten to security. With the piston fully compressed in the cylinder, fill the strut up to the level of the air valve with hydraulic fluid as specified by the identification tag or instruction plate on the strut. To insure that no air has been trapped within the strut, work the piston up and down several strokes. Check the fluid level with the piston fully compressed before installing the air valve parts. To insure proper gland packing adjustment with minimum friction, the strut should be "run-in" about 200 to 300 strokes at the rate of 20 to 30 strokes per minute with the packing nut loosened. Retighten the nut gradually until all evidence of fluid seepage disappears.

(b) LANDING GEAR STRUT.—The trunnion assemblies are not interchangeable and therefore bear serial numbers in addition to part numbers. The serial number will be found on the end of the trunnion pin and on the outboard side of the stationary portion of the trunnion. In order to match the bolt holes it will be necessary to install the pin so that the serial numbers are adjacent to each other.

(c) DRAG STRUT.—When installing the universal joint at the connection between the drag strut and the drag strut link, care must be taken to place the universal joint so that the pin through the fitting on the link will be on the forward side of the pin through the fitting on the drag strut. Reversal of these positions would have the effect of lengthening the drag strut link, which would result in misalignment of the landing gear. In connecting the drag strut link to the terminal on the shock strut collar, place the head of the bolt inboard so that it may be removed if necessary without removing the tire.

(d) TORSION LINKS.

1. The function of the torsion link on the landing gear is to transmit the torsional loads from the cantilever axle to the landing gear strut. It is therefore extremely important that this link be properly installed to prevent failure of its thrust bearings.

2. The torsion link is composed of two link assemblies which are provided with ball thrust bearings at their common "knee" joint and Timken roller bear-

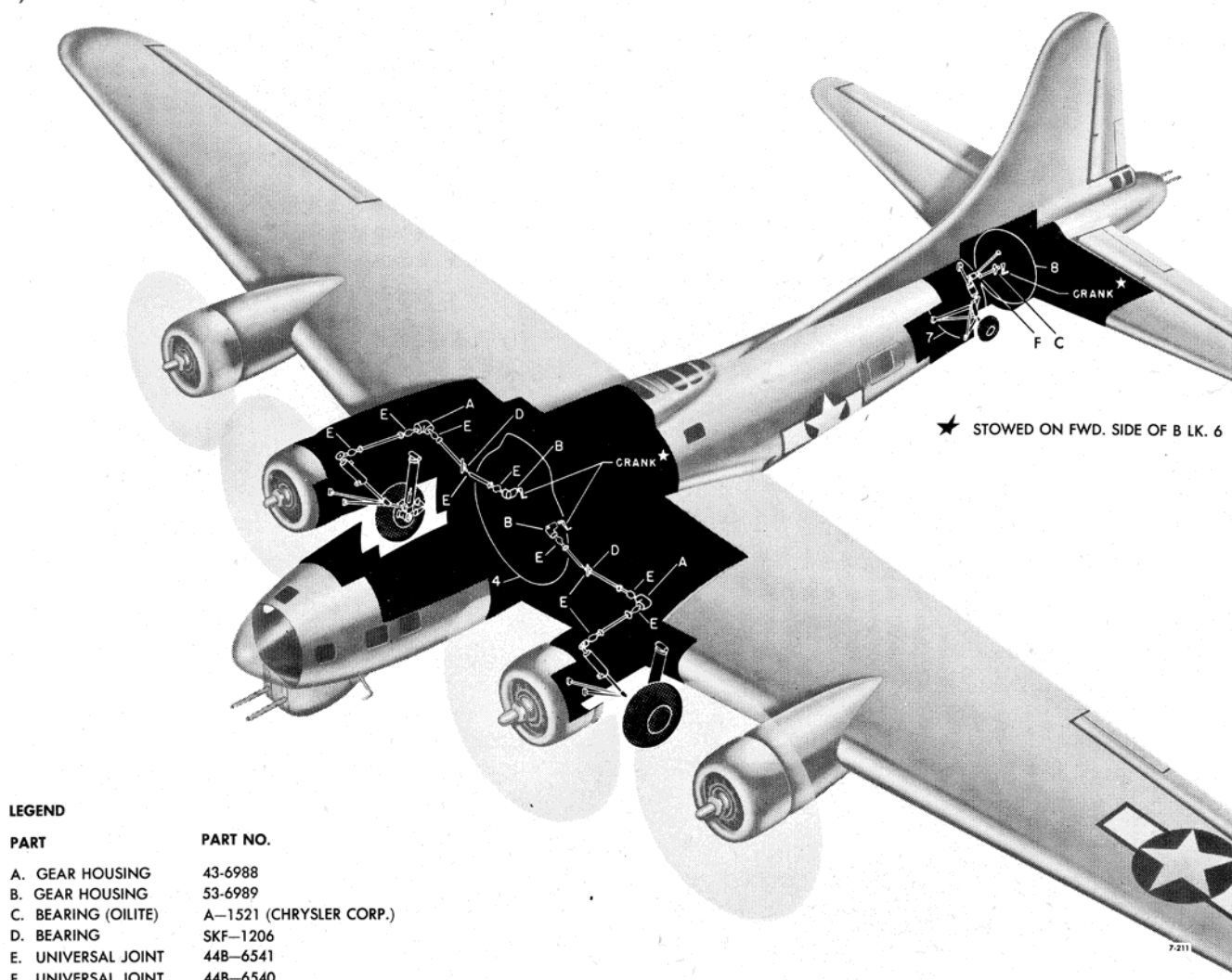
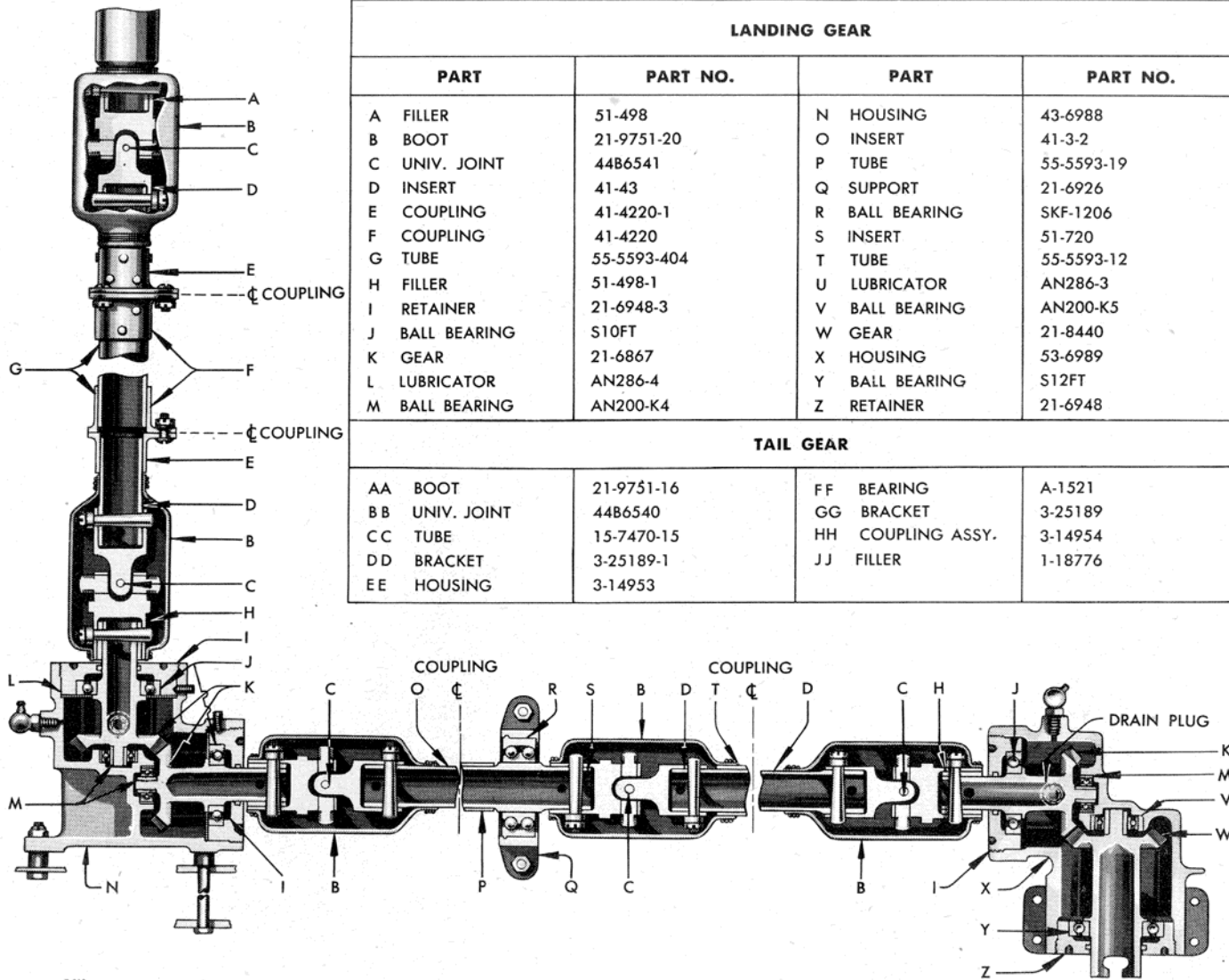
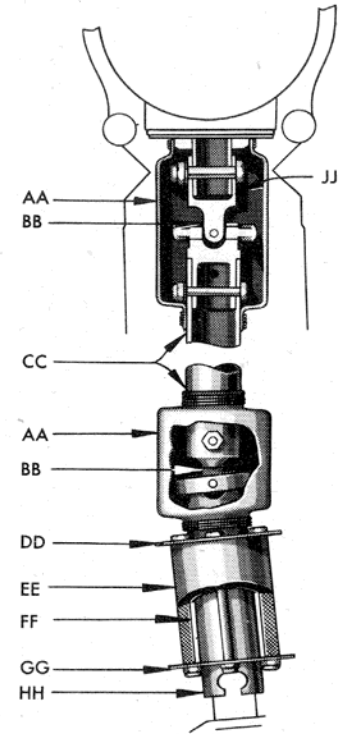


Figure 95—Landing and Tail Gear Retracting Diagram

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PLAN VIEW
TAIL GEAR
55-7470

PLAN VIEW
LANDING GEAR
55-5593

Figure 96—Landing and Tail Gear Retracting Mechanism

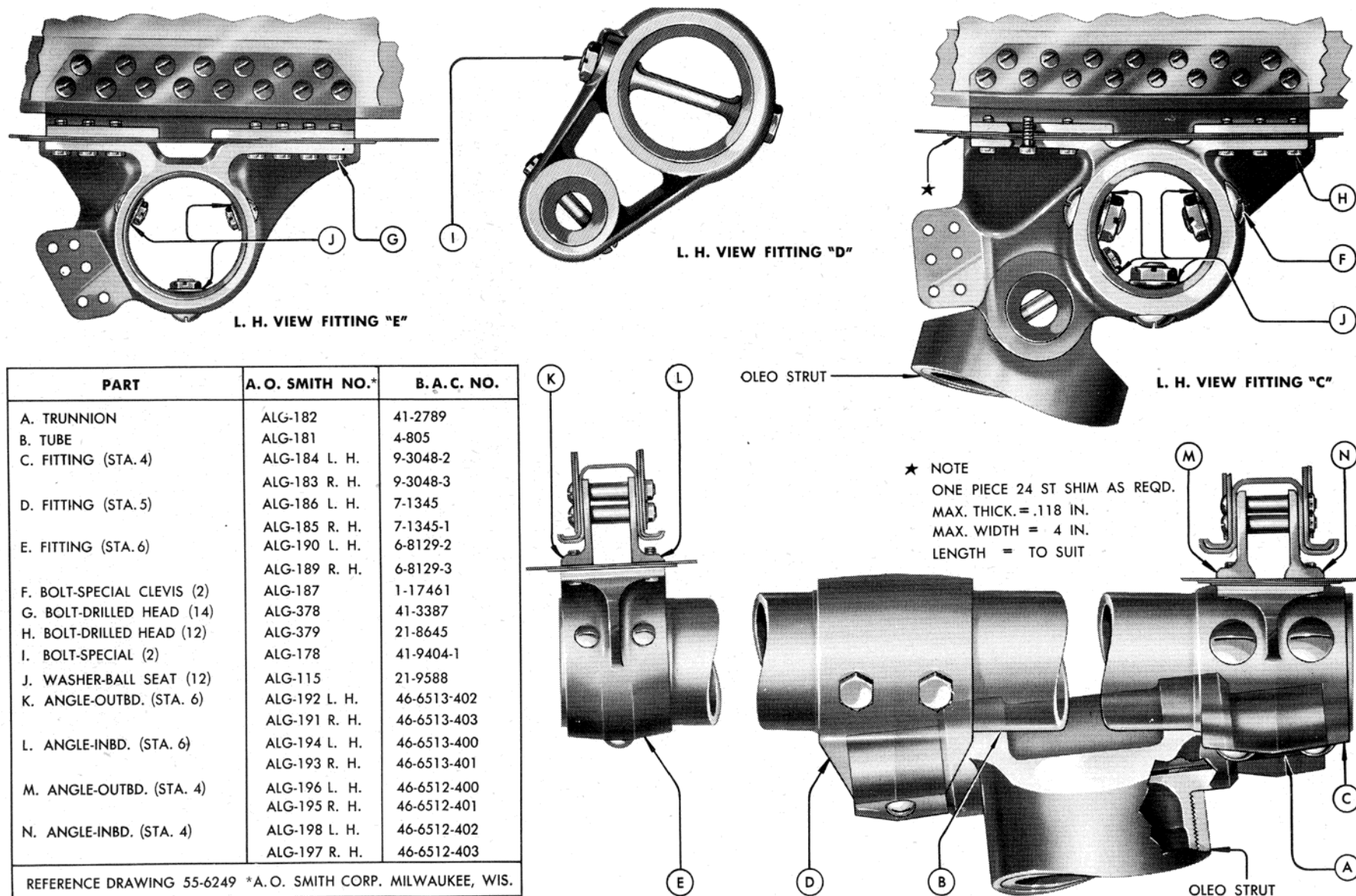
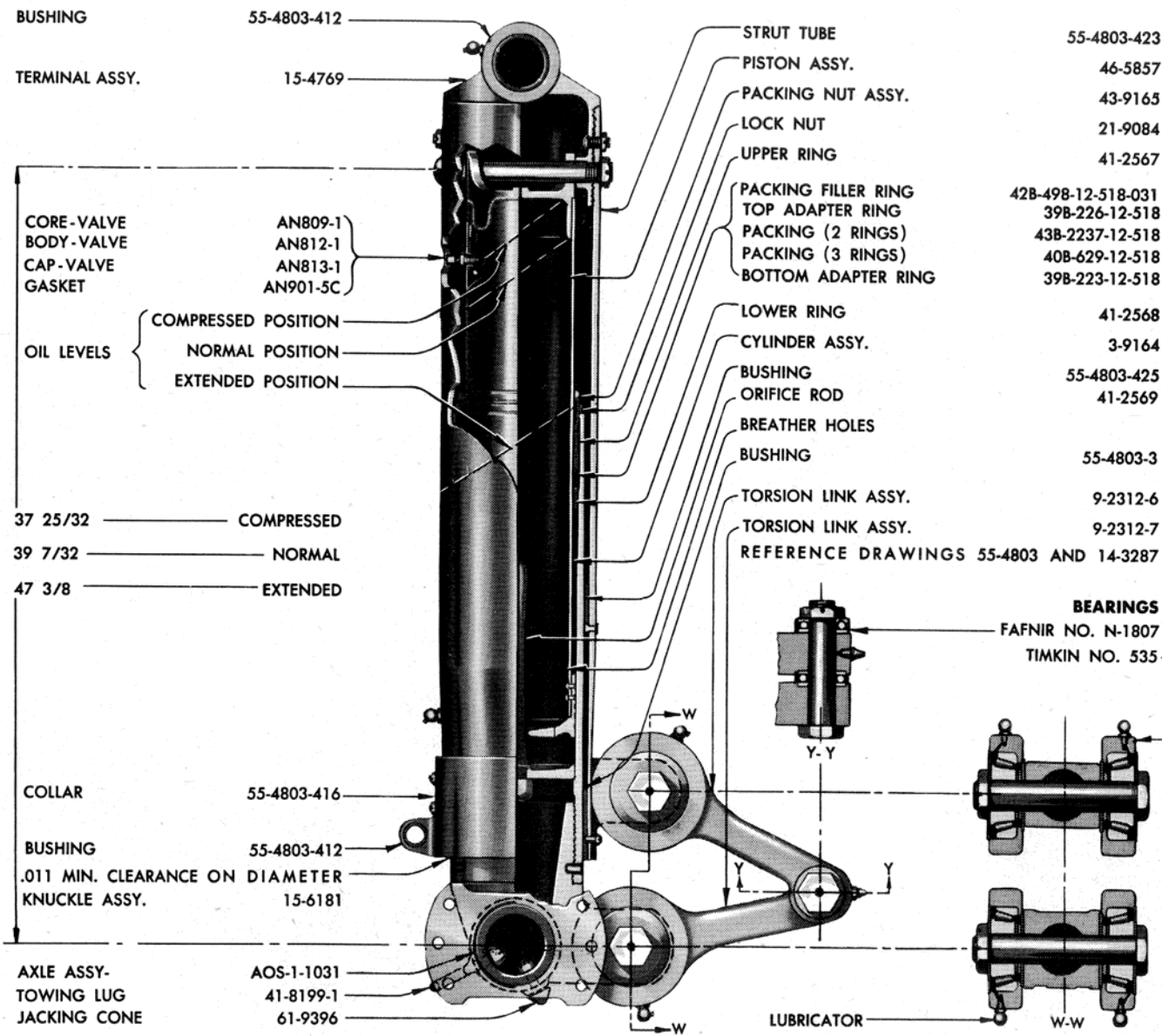


Figure 97—Landing Gear Support Installation



INSTRUCTIONS FOR SERVICING

KEEP OLEO FILLED TO AIR VALVE WITH APPROXIMATELY 2.3 U.S. (1.9 B.I.) GALLONS, AF SPECIFICATION NO. 3580 (RED) FLUID. AFTER FILLING ADJUST AIR PRESSURE TO EXTEND CENTERLINE OF AXLE 9 1/2 INCHES BELOW UPPER EDGE OF LOWER COLLAR, FULL NORMAL LOAD.

WARNING

RELEASE AIR IN STRUT BEFORE DISASSEMBLING

AIR VOLUME

COMPRESSED	== 38 CU. IN.
NORMAL	== 73 CU. IN.
EXTENDED	== 268 CU. IN.

Figure 98—Landing Gear Oleo Assembly

TOOLS
FOR INSTALLING
PACKING RINGS

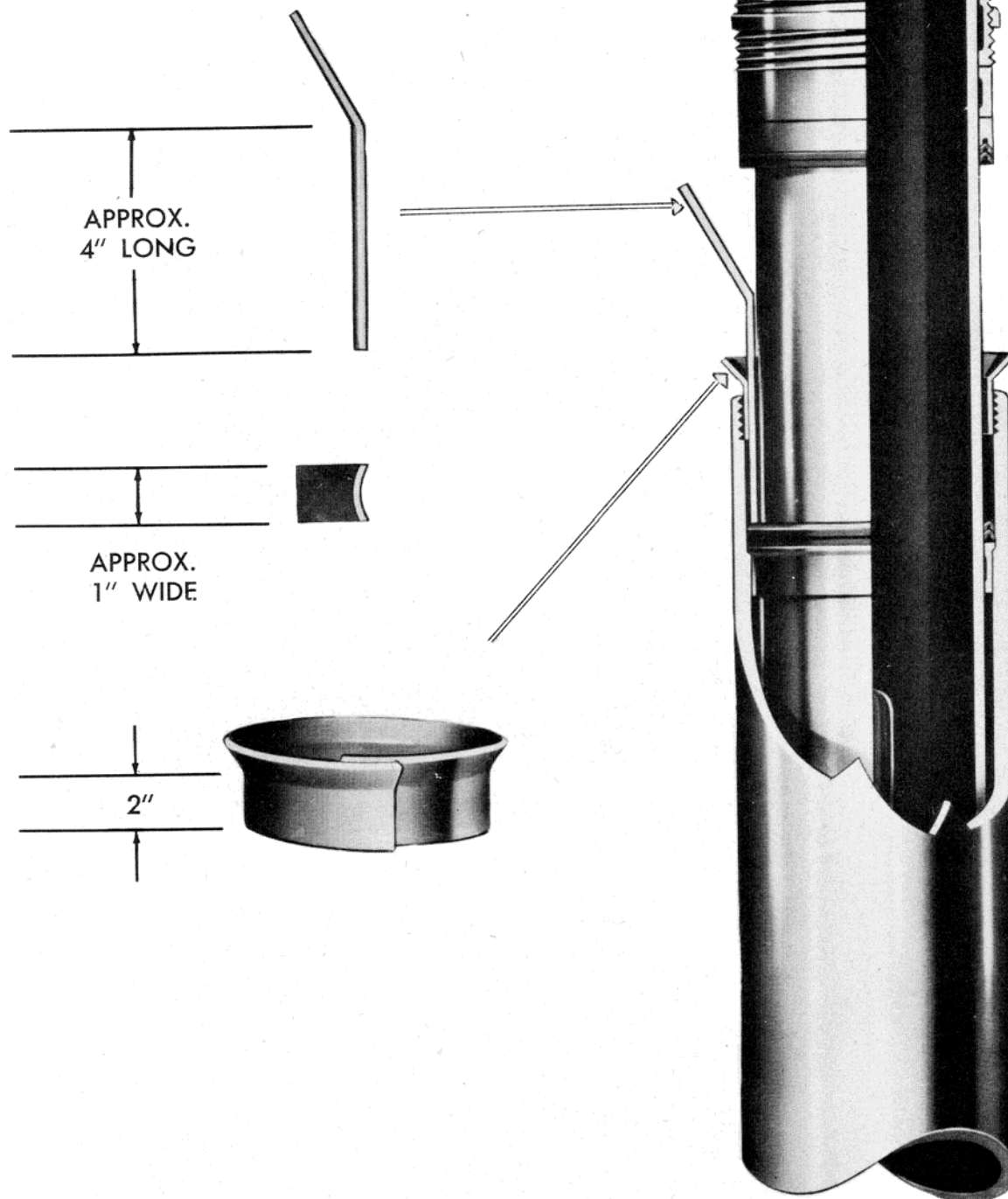


Figure 99—Landing Gear Bushing Chart and Packing Installation

Section IV
Paragraph 5

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ings at their connections to the knuckle and the landing gear strut. The link assemblies are identical except for a grease fitting at the knee. This fitting is used only on the link which assumes the outboard position at the knee.

3. In order to maintain perfect alignment of the thrust bearings it is essential to assemble the roller bearing connections exactly as originally installed. Replace the shims in the same quantity and in the same places as on the original installations. Install the bolts with heads inboard so that removal is possible without removing the tire or wheel. In case new shims are required or if realignment of the links is necessary, the roller bearing joints must be fitted by peeling the laminated washers so that there is no bearing clearance when the bolts are drawn up tight. These joints are subjected to a rocking motion, which will not cause overheating, but the torsion loads would cause severe hammering if bearing clearance were allowed. The fit should permit a slow swing of the link, under the influence of its own weight, with the bolt drawn up tight.

4. All three bolts in each complete torsion link installation should be installed with the bolt heads inboard.

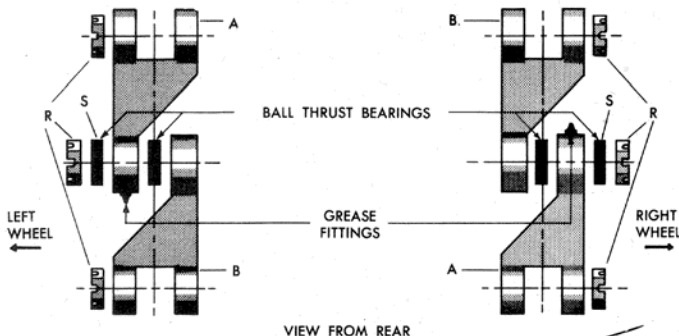
5. There is no adjustment provided for alignment of wheels because, with the torsion link properly

aligned, the wheels will be well within the required limits for operation. The following step-by-step assembly procedure is recommended for proper alignment of the torsion link:

a. *Step 1.*—Assemble the roller bearing joint of one link at the terminal on the axle knuckle. For left wheels, install a link *WITHOUT* the grease fitting on the knee end, and for right wheels install a link *WITH* the grease fitting. Adjust during the fitting so that the clearance between the leg of the link and the face of the terminal on the knuckle is the same on each side of the terminal.

b. *Step 2.*—Assemble the roller bearing joint of the other link at the terminal on the strut collar. For left wheels, install a link *WITH* the grease fitting on the knee end, and for right wheels install a link *WITHOUT* the grease fitting. Adjust during the fitting so that the clearance between the leg of the link and the face of the terminal on the collar is the same on each side of the terminal.

(e) *DEBOOST VALVE.*—When mounting the deboost valve on the shock strut, the ends of the bolts must not protrude through the strut far enough to make contact with the shock cylinder. When tightening the flexible hose adapter in the return boost valve, be careful



NOTES

1. DIAGRAM SHOWS RELATIVE POSITION OF PARTS WHEN PROPERLY INSTALLED. NUTS "R" AND THRUST BEARINGS "S" MUST BE OUTBOARD.
2. SECTIONAL VIEW BELOW SHOWS RIGHT HAND UPPER LINK. SEE TEXT FOR ALIGNMENT PROCEDURE.

LEGEND		
PART	A. O. SMITH NO.*	B.A.C. NO.
A. TORSION LINK ASSY.	ALG-165-A-1	9-2312-6
B. TORSION LINK ASSY.	ALG-166-A-1	9-2312-7
C. KNEE BOLT—SPECIAL	ALG-113	21-9391
D. RING—GREASE SEAL	ALG-109	21-9388
E. THRUST BEARING (FAFNIR)	ALG-100	N-1807
F. CAP—GREASE SEAL	ALG-110	21-9389-1
G. NUT—SPECIAL	ALG-108	21-9414
H. BEARING—CAP (TIMKEN)		532A
J. BEARING RACE—CONE (TIMKEN)	ALG-168	542
K. NUT—SPECIAL	ALG-112	21-9415
L. OUTER DUST COVER	ALG-111-1	41-671
M. INNER DUST COVER	ALG-116-11	21-2366-238-98
N. THICK WASHER	ALG-117-10	41-9684-152-98
O. LAMINATED WASHER AND SHIMS	ALG-125-10	21-6385-152-98
P. LUBRICATOR	AN286-4	AN286-4
Q. BOLT—SPECIAL	ALG-114	3-7833

*A. O. SMITH CORP., MILWAUKEE, WIS.
REFERENCE DRAWING—15-10414

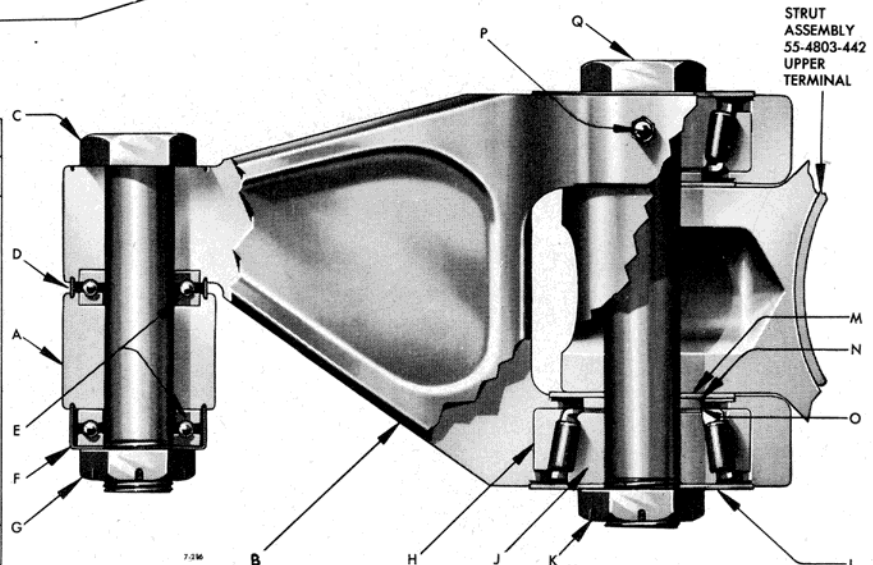


Figure 100—Torsion Link Bearing Details

not to apply too much torque, as the aluminum alloy casting may be easily cracked. Before tightening the flexible hose between the return boost valve and the brake, twist the hose at the left wheel 1/2 turn clockwise and at the right-hand wheel 1/2 turn counter-clockwise so that the hoses will clear the side of the wheel wells. Refer to section IV, paragraph 7. c. for servicing information.

(f) **SHOCK ABSORBER INFLATION.**—After the landing gear has been completely installed, replenish the oil and air in the shock strut with the gear in the normal taxiing position, as directed in section III.

b. TAIL WHEEL GEAR INSTALLATION.

(1) GENERAL.

(a) The retractable tail wheel gear is installed immediately aft of bulkhead 7. It is of the single shock absorber, cantilever type, and consists of a treadle and spindle assembly, anti-shimmy brake, shock absorber, and wheel. Provisions are made for full 360 degree swiveling, with cockpit control of the lock for taxiing, and the electrical centering control for retracting. Electrical retraction is accomplished simultaneously with the main landing gear by the single control switch in the cockpit. The starter crank is used with connection provided aft of the retracting mechanism for manual operation.

(b) The Hayes wheel is equipped with a 26-inch smooth contour tire.

(2) REMOVAL AND DISASSEMBLY.

(a) REMOVAL.

1. Before removing the tail gear, place a jack securely under the cone provided at body station 7. Release the air in the shock strut and remove the tail gear boot. Disconnect the lock cable at the turnbuckle on the lower rear side of bulkhead 7. Remove the pulley bolt and move the pulley aside to allow the swaged end of the cable to pass through the pulley fitting. Disconnect the tail wheel lock and centering switch wiring at the switch boxes, secure the ends to avoid their slipping back through the flex conduit, and remove the entire flex conduit from the treadle assembly. Unscrew the air valve body slowly, releasing all air from the cylinder. Disconnect the attaching pins at both ends and remove the treadle assembly hinge bolts at bulkhead 7. The treadle and tail wheel group is then removed from the airplane as a unit.

2. To remove the tail wheel retracting motor, disconnect the hand crank mechanism at the coupling forward of the universal joint. Disconnect the wires at the motor and clutch. Disengage the unit by removing the bolts in the mounting flange.

3. The gear housing and retracting screw may be removed as a unit.

(b) DISASSEMBLY.

1. **TIRE.**—Removal of the tire and tube is ac-

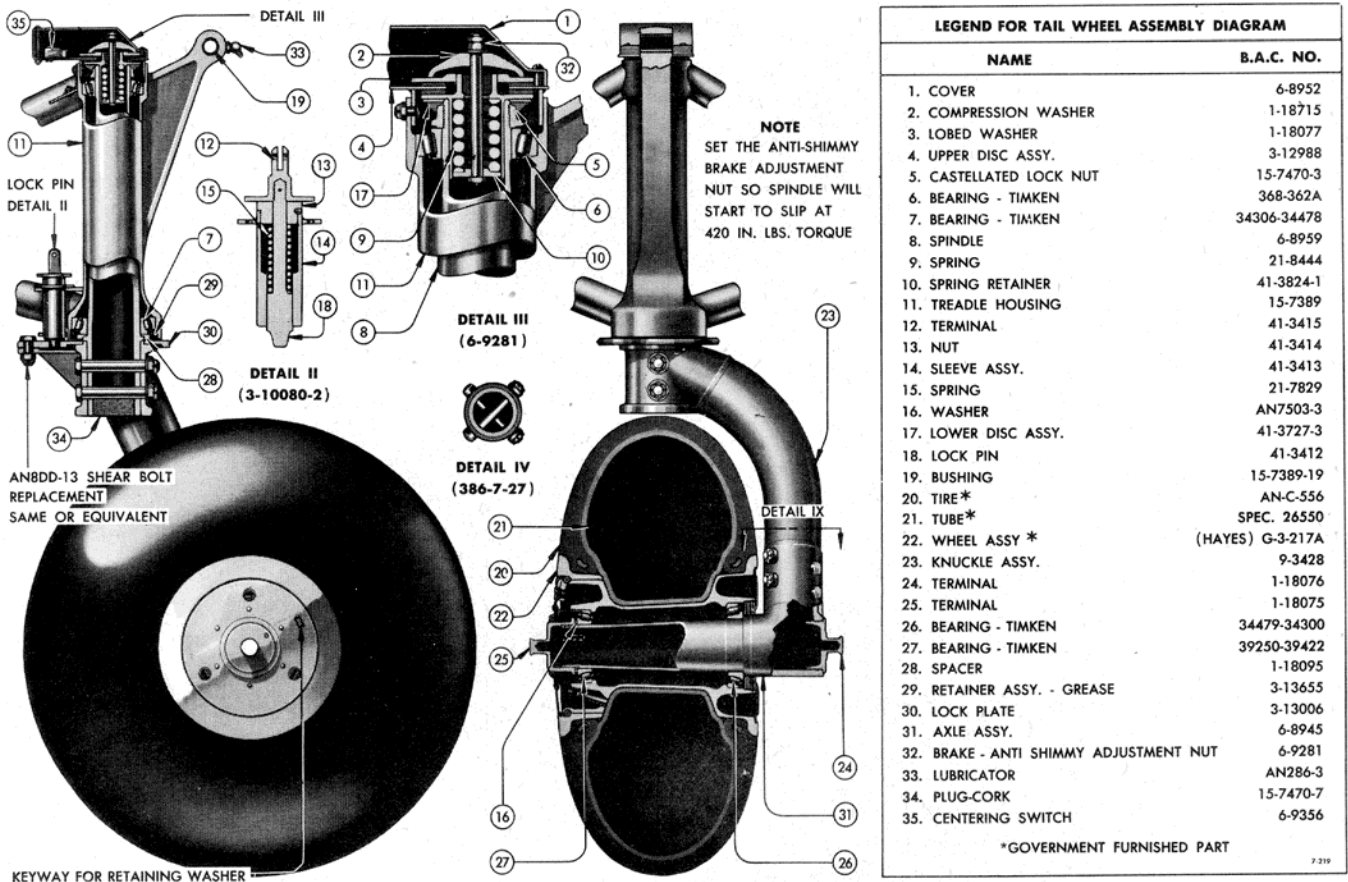


Figure 101—Tail Wheel Assembly Diagram

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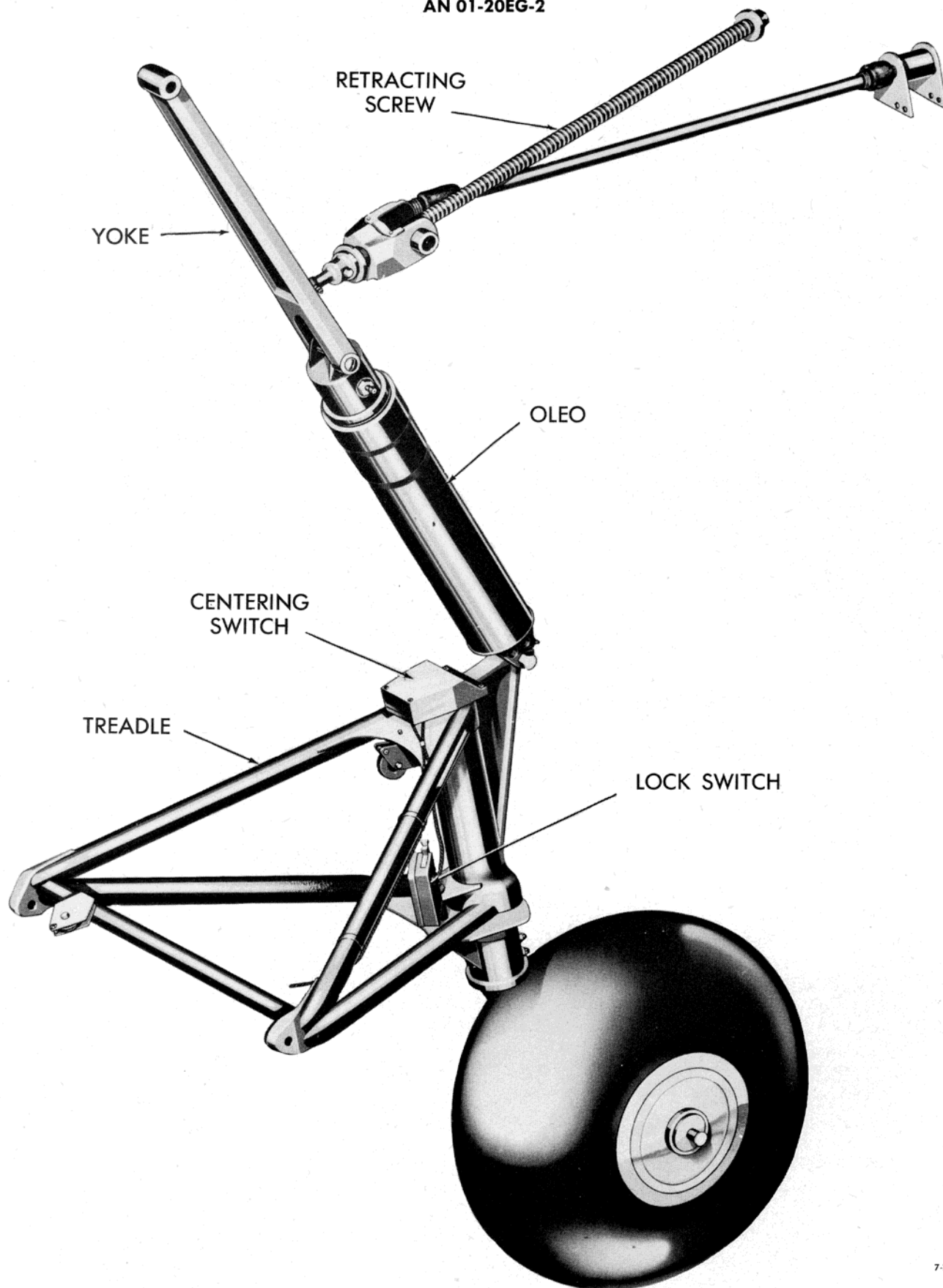


Figure 102—Tail Gear Installation

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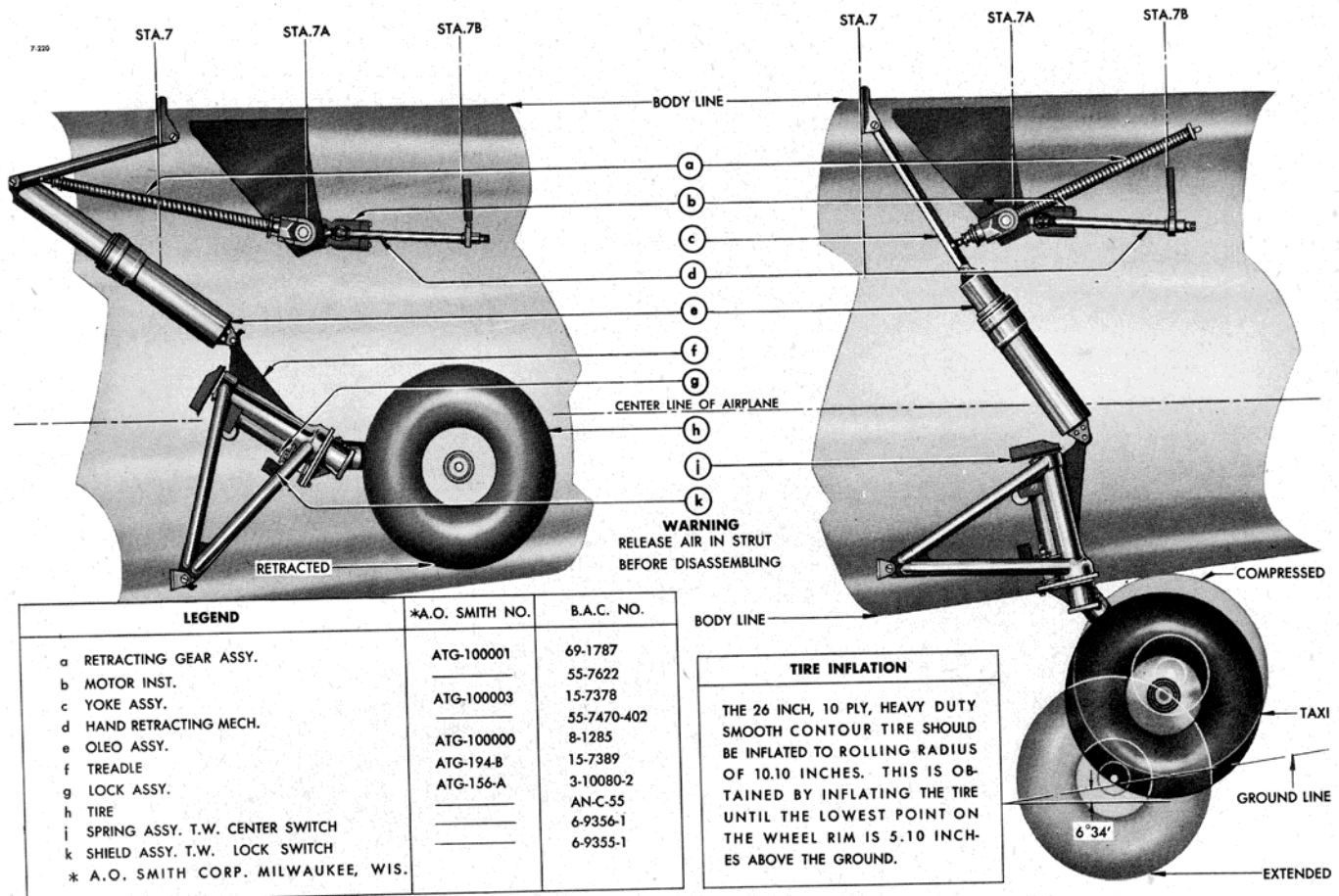


Figure 103—Tail Gear Retracting Mechanism

complished by deflating the tire and forcing the tire bead and side casting inward to facilitate removing the retaining ring. The side casting ring is then lifted from the assembly. The operation is completed in the standard manner prescribed for any drop-center wheel.

2. WHEEL.—The wheel is removed by removing the fairing plate, hub cap, and retaining washer and sliding the wheel off of the axle.

3. AIR-OIL SHOCK ABSORBER.—Before disassembling the shock strut, check to be certain that the air pressure has been completely relieved and then remove the air valve body. Pour all oil from the structure, loosen the packing nut on the upper part of the cylinder, and slip the piston assembly from the cylinder. Do not remove the metering rod unless absolutely necessary. If necessary, remove the lock screw which is soldered in place at the bottom of the cylinder and unscrew the rod. The base of the rod is 1-1/4 inch hex.

4. TREADLE ASSEMBLY AND ANTI-SHIMMY BRAKE.

a. Remove the cover above the anti-shimmy brake, disconnect the keeper, and remove the brake as a unit. Loosen the nut at the upper end of the knuckle shaft, remove the Timken bearing assembly and the shear bolt on the lower part of the treadle, and slip the spindle from the housing.

b. To disassemble the anti-shimmy unit, loosen the nuts on the top of the assembly. Care must be taken to protect the brake lining or friction surfaces from tool marks, moisture, and grease.

5. RETRACTING LINK.—To assure a position stop at all times, the stop assembly is attached to the retracting screw by left-hand threads. Remove the stop and take the screw assembly from the housing. Loosen the set screw holding the retracting nut in place in the housing, and unscrew the cap from the housing. Detach the sheet metal cover protecting the gears. Remove the gear from the motor spindle and slip the retracting gear nut from the housing.

(3) MINOR REPAIR AND REPLACEMENTS.

(a) WHEEL.—When the wheel casting becomes damaged to a point where excessive distortion is noted, or cracks appear in the casting at any point, no attempt should be made to repair the wheel casting. Other than replacement of the fairing, fairing screws, grease retainers, and bearing assemblies, there is very little repair that can be made to the wheel itself.

Note

All Hayes wheels are equipped with Timken tapered roller bearings and should be properly lubricated when they are installed. Excessive

grease should not be used, but grease should be carefully worked in the rollers of the bearing. Always see that the felt retaining washers are in good condition so that the grease will not work out from the hub and dirt will not work into the bearings.

(b) AIR-OIL SHOCK ABSORBER.

1. Leakage of fluid in the shock absorber cylinder is usually indicated by continual loss of air pressure, although the filler valve may be functioning satisfactorily. Should this be the case, proceed as follows: Completely deflate the cylinder, loosen the lock ring and tighten the packing nut. One-half turn is usually sufficient and excessive wrench forces should be avoided. Tighten the lock ring and check the cylinder for proper quantity of oil. If necessary, replenish with fluid as indicated in section III, Preflight Inspection.

2. Inspect the packing rings for signs of deterioration or wear, and replace where necessary. The bronze bushings attaching the cylinder to the yoke and treadle assembly may be replaced if excessive wear has occurred from faulty lubrication or presence of foreign matter.

(c) TREADLE ASSEMBLY AND ANTI-SHIMMY BRAKE.

1. Servicing of the anti-shimmy brake is usually confined to cleaning and buffing the brake lining

and adjusting the torque on the mechanism. The brake lining should not appear bright or polished, either partially or as a whole. The friction surfaces should indicate contact over the entire bearing area. By use of emery cloth or other buffing material, remove polished or smooth portions of the brake lining. In case the brake lining is encrusted with grease or other foreign matter, it should be washed thoroughly in gasoline or other suitable solvent. If the brake disc is warped or uneven, it must be refaced or replaced.

2. The shear bolt provided in the treadle assembly for protection against extreme side loads should be inspected for signs of excessive wear or near failure, and replaced if necessary. The Timken roller bearings are to be inspected and replaced as required. This is unlikely, except in cases of damage caused by unusual operating conditions.

3. The compression spring in the anti-shimmy brake must be replaced should it lose resilience and be unable to develop proper braking torque.

(d) RETRACTING LINK.—Inspect the bronze retracting nut for signs of galling, cracks, or excessive wear, and replace if necessary.

(e) BEARINGS.—Heavy duty antifriction bearings have been provided to reduce maintenance to a minimum, and bronze bushings are installed on all other moving parts. Refer to the bushing chart 106 for bushing instructions.

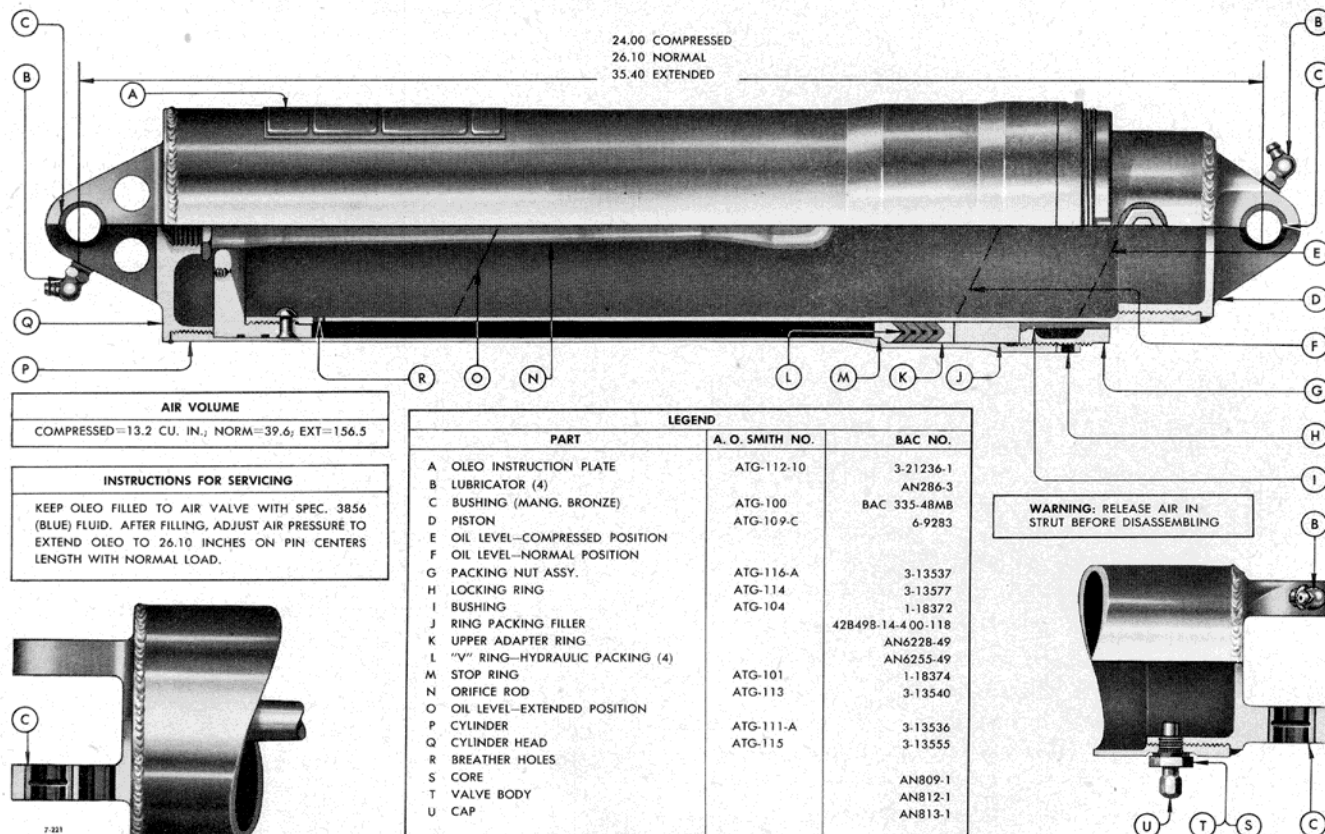


Figure 104—Tail Gear Shock Strut Assembly

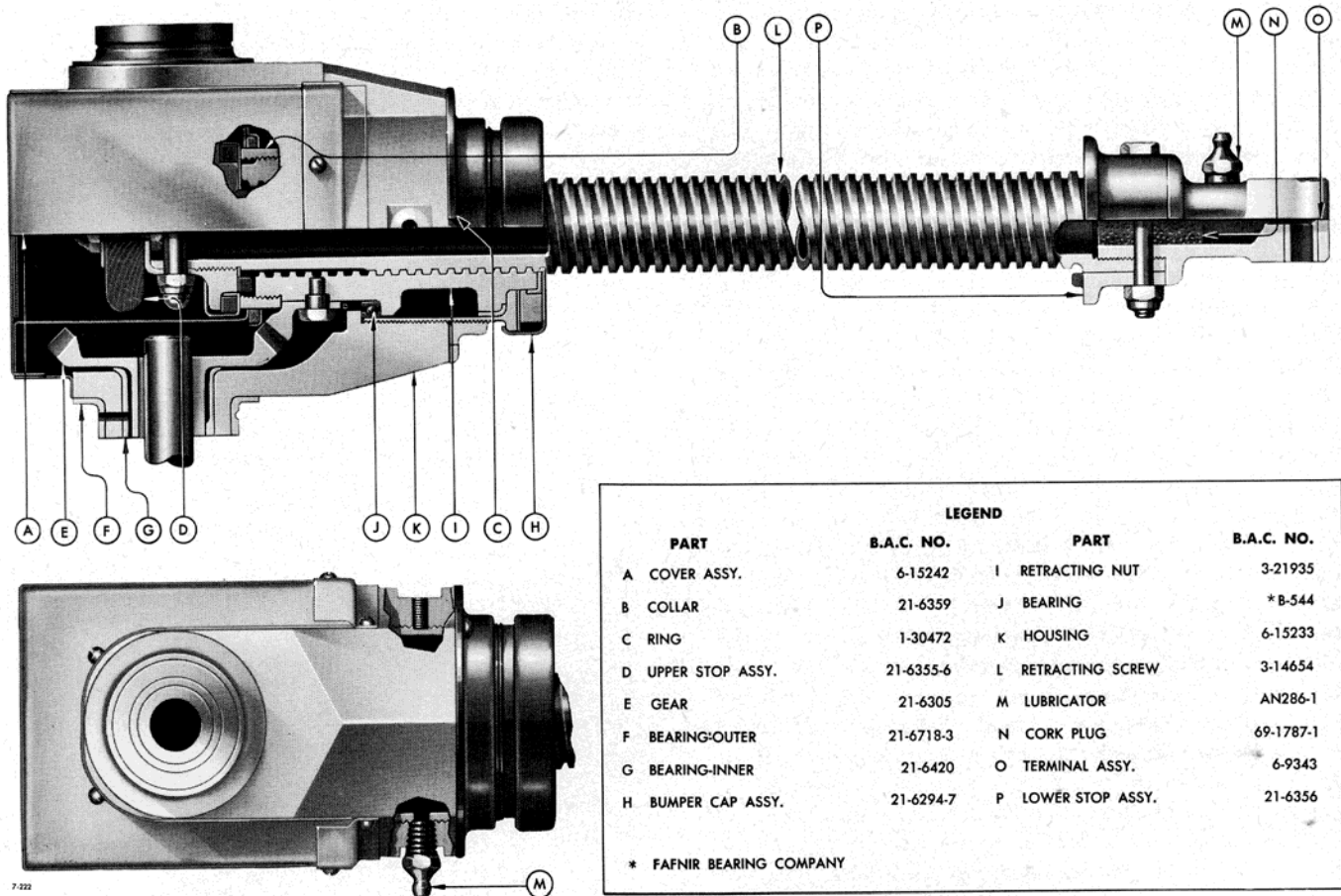


Figure 105—Tail Gear Retracting Screw

(f) RETRACTING MOTOR.—One set of spare brushes is supplied for each retracting motor. Replace the motor brushes when worn 3/16 inch from a new length of 9/32 inch, or when the brush spring tension has been reduced by two-thirds of the original amount.

(4) ADJUSTMENTS.

(a) ANTI-SHIMMY BRAKE.—Tighten the nut on top of the assembly until a force of 420 inch-pounds is necessary to turn the spindle.

(b) LIMIT SWITCHES.

1. There are two types of limit switches. Some airplanes are equipped with a B-15 (Air Corps Drawing 39A3756) single pole single throw, momentarily off type and some use the Micro Switch WZ-3RW2 instantaneous opening, 3/16 inch overtravel type, while the later planes are equipped with a WZ-R31 Micro Switch.

2. The procedure for setting the tail gear limit switch is the same as that for the main landing gear, except as follows: For the Eclipse motor installation and the three different type switches set the up limit switch to open the circuit at one turn of the handcrank before engagement of the stops. Set the down limit switch to open the circuit at 2-1/2 turns minimum and three turns maximum of the handcrank before engagement of the stops. For the General Electric motor installation

and all types of limit switches, set the upper limit switch to open the circuit at $1 \pm 1/8$ turns of the handcrank before engagement of the stops. Set the lower limit switch to open the circuit at $1/2 \pm 1/8$ turns of the handcrank before the engagement of the stops. Setting of the tail gear limit switches is accomplished by adjusting screws in the switch actuating arms. The wheel must be locked during adjustment to close the limit switch circuit. At the time during which the tail gear limit switches are being checked or adjusted, the decal at the handcrank receptacle should be inspected to insure that it indicates *correctly* the direction of operation for tail gear UP or DOWN.

WARNING

Handcranking of the tail gear mechanism must not be attempted unless the landing gear switch is in the "OFF" position.

3. The tail wheel warning switch is the same type as the limit switch. It must be adjusted separately and should be set to open the warning light circuit 1/4 to one turn after the down limit switch opens.

4. The tail wheel centering switch may be checked by pulling the locking pin up by hand and then turning the wheel toward center from either side. With power applied to the circuit, make sure that the switch

does not close before the locking pins drop in place. This switch should not work out of adjustment, but could be thrown out of adjustment by damage to the parts. If the operating arm has been bent excessively, replace it rather than risk loss of control over the tail wheel retraction. This switch must be carefully adjusted to close the circuit to the tail gear retracting motor relay when the locking pin is centered in the retaining slot.

(c) **RETRACTING MOTOR.**—The retracting time for the tail wheel should be approximately 45 seconds, operating on 28.5 volts. A longer operating period indicates clutch slippage. Set the clutch at 400 pound-inches *breakaway* torque (General Electric, type 5BA50FJ3A or Eclipse type 1227-1). Adjust the clutch setting with the motor at room temperature by starting the motor with the test stand brake loose and tightening the brake until the motor clutch starts to slip. This is evidenced by stoppage of the output shaft. The maximum torque reached before the shaft stops shall be taken as the clutch setting. Acceptable settings shall be as specified—within five percent. To prevent excessive temperature increase, do not permit the clutch to slip any longer than necessary. Readjust the clutch if the breakaway torque is not in accordance with the specified values. Allow the motor to stand a minimum of 30 minutes from the time of the first check before checking again. Recheck as instructed above. If additional adjustments are necessary, they shall each be followed by a cooling period and rechecked again. Clutch settings for reverse travel should also be checked as outlined above. No attempt should be made to adjust clutch settings without a torque measuring device.

(d) **TAIL WHEEL LOCK SIGNAL.**—Adjust the external bolt near the tail wheel locking pin so that the red light on the instrument panel is illuminated when the tail wheel locking lever (located in the floor near the copilot's station) reaches the midposition of its upward travel. This setting must be made with the pin engaged, since the circuit is closed when the tail wheel is unlocked.

(5) ASSEMBLY AND INSTALLATION.

(a) **TREADLE ASSEMBLY AND ANTI-SHIMMY BRAKE.**—At assembly of the treadle and wheel group, take care to remove excess grease from the anti-shimmy brake well. To adjust end thrust, tighten the nut until initial drag is observed, then loosen the nut one, castellation. Insert the anti-shimmy brake and install the keeper. Install the brake cover, taking care to get a snug fit in order to keep the brake clean and dry.

(b) **RETRACTING ASSEMBLY.**

1. The tail wheel is extended and retracted through the motion of the screw in a rotating nut. The limit switches on the structure are actuated by the yoke and are located so that allowance is made for the inertia of the complete assembly. It is essential that, in the extended position, the stop on the screw be not more than two turns of the rotating nut away from the stop on the nut when the electrical circuit is broken. This is equivalent

to four complete turns of the hand crank. The bumper installed in the end of the housing will keep the nut from creeping if full contact is made at the stops. If the neoprene bumper becomes fatigued and fails to prevent creeping, or permits unrestricted contact of the stops, it must be replaced with a new part.

Note

Before installation, tail gear retracting screws should be carefully inspected to ascertain that the stops on the retracting nut mate properly with upper and lower stops on the retracting screw. If proper contact is not made by the stops, it may be necessary to restart the nut on the retracting screw 180° from the original starting position to permit proper mating of the stops.

2. Install the yoke and retracting assembly with the screw extended. Install the retracting motor and adjust the limit switches as directed in paragraph 5. a. (4).

(c) **AIR-OIL SHOCK ABSORBER.**

1. All parts should be thoroughly cleaned and inspected before reassembly. The outside of the piston tube assembly is hard chrome plated for wear and corrosion resistance. If this plating should become cracked or worn in spots, it is advisable to replate. The bearing nut assembly should be checked for wear and the bushing replaced if necessary.

2. The packings must be installed one ring at a time, making sure that each ring is properly seated before installing the next. A mixture of graphite and oil, or a light grease, applied on each ring will assist in its installation. Care must be exercised when installing these rings that the inside and outside sealing edges do not become damaged. A thin metal sleeve should be used to protect the packing rings against damage from the cylinder threads. (See figure 107.) When the packings become snug in the stuffing box, further tighten the bearing nut approximately 1/2 turn. Use care in tightening the nut to avoid excessive friction or damage to the packing. Replace the lock ring and tighten securely. With the piston fully compressed in the cylinder, fill the strut with hydraulic fluid, AAF Specification No. 3580M, up to the level of the air valve. To insure that no air has been trapped within the strut, work the piston up and down several strokes. Check the oil level with the piston fully compressed before installing the air valve assembly and gasket. To insure proper gland packing adjustment with minimum friction, the strut should be "run-in" about 200 to 300 strokes at the rate of 20 to 30 strokes per minute with the packing nut loosened. Retighten the nut gradually until all evidence of oil seepage disappears.

3. Install the strut between the yoke and the terminal, check the oil level, and replace the valve body and gasket. Inflate the air-oil shock absorber as directed in section III of this Handbook.

(d) **WHEEL.**—Install the wheel and bearing assembly on the axle. Install the tongued washer and nut. Adjust the nut until the bearings begin to drag, then back off until drag is just relieved. Install bearing cover and fairing plate. Bearings should be lubricated before installation.

6. POWER PLANT GROUP.

a. ENGINE AND ACCESSORIES.

(1) **GENERAL.**—The airplane is powered by four 1200 HP Wright Cyclone engines, model R-1820-97. These engines are nine cylinder radial air cooled type, with a 16:9 gear ratio from crankshaft to propeller shaft.

(a) The engines, located in nacelles along the leading edges of the wings, are mounted on engine mounts constructed of X4130 steel, with X4130 steel forgings at the four fire wall connections. The mounts are fabricated by means of electric arc welding, and are interchangeable. The engine is attached to the engine mount by nine Lord dynafocal rubber suspension mounts. See figure 130.

(b) Each engine is equipped with a Bendix Stromberg injection carburetor, model PD 12H2, and two American Bosch magnetos, model SF-9LU3.

(2) CYLINDERS.

(a) The exhaust port boss faces toward the rear of the engine and is provided with four studs for attaching the exhaust stacks. The intake port boss is located at the rear of the cylinder head and faces to the right and downward. Rubber packing is used between the intake pipe flange and the cylinder head to form a tight seal.

(b) The intake and exhaust rocker boxes of each cylinder are provided with four studs for securing the rocker box covers. Bosses are cast integral with the cylinder at the front and rear of each rocker box and are equipped with studs for attaching the engine cowl-

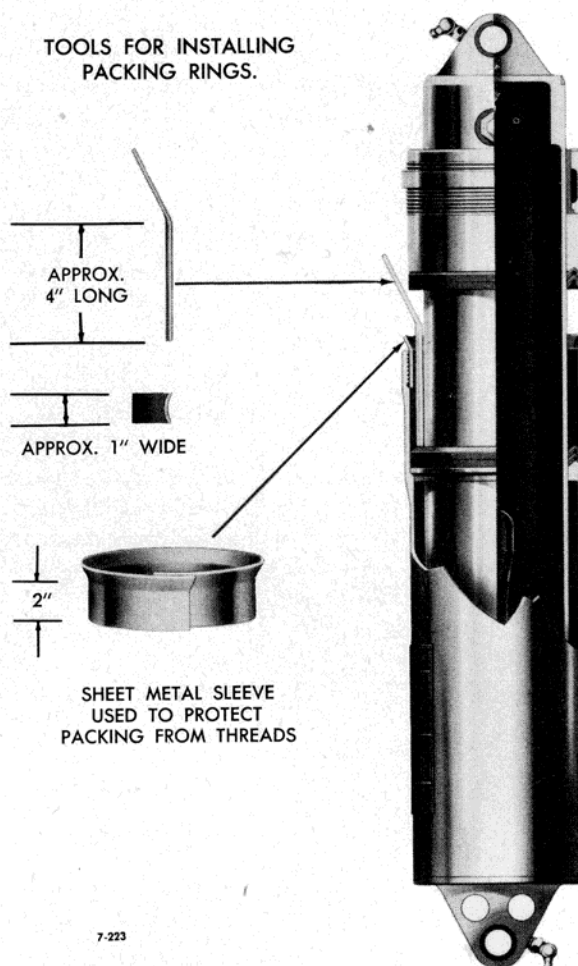


Figure 107—Packing Installation—Tail Gear Shock Absorber Strut

ing. Push rod housing connecting sleeves are screwed into the forward end of the rocker boxes, forming oil-tight seals.

TAIL GEAR BUSHINGS

BUSHING NO.	LOCATION	REAMING DIMENSIONS	
		BEFORE BUSHING	AFTER BUSHING
BAC 335-76MB	L.H. and R.H. Terminals (See Treadle Assy. 15-7389)	.9345 $\begin{smallmatrix} +.000 \\ -.001 \end{smallmatrix}$ Dia.	.750 $\begin{smallmatrix} +.001 \\ -.000 \end{smallmatrix}$ Dia.
BAC 335-118MB	Terminal, Housing 15-7389-17 (See Treadle Assy. 15-7389)	.9345 $\begin{smallmatrix} +.000 \\ -.001 \end{smallmatrix}$ Dia.	.750 $\begin{smallmatrix} +.001 \\ -.000 \end{smallmatrix}$ Dia.
BAC 327-64MB	Terminal Retracting Screw (See Retracting Assy. 69-1787)	.4355 $\begin{smallmatrix} +.000 \\ -.001 \end{smallmatrix}$ Dia.	.3125 $\begin{smallmatrix} +.001 \\ -.000 \end{smallmatrix}$ Dia.
BAC 292-48ST	Upper Fitting to Blk. 7 (See Tail Gr. Inst. 55-7470)	.9375 $\begin{smallmatrix} +.001 \\ \end{smallmatrix}$ Dia.	.750 $\begin{smallmatrix} +.001 \\ -.000 \end{smallmatrix}$ Dia.
BAC 335-48MB	Oleo Cylinder and Rod Terms. (See Tail Gr. Oleo 8-1285)	.9345 $\begin{smallmatrix} +.000 \\ -.001 \end{smallmatrix}$ Dia.	.750 $\begin{smallmatrix} +.001 \\ -.000 \end{smallmatrix}$ Dia.

Figure 106—Tail Wheel Bushing Chart

(c) A boss, located just forward of the intake pipe flange on each cylinder intake port, is drilled and tapped to receive either a priming line fitting, or a plug.

(3) VALVES AND VALVE SPRINGS.

(a) The intake valves are of the tulip type and the exhaust valves are of the mushroom type. Both types of valves are machined from forgings of heat-resisting steel. The valve face angles are 44 degrees 15 minutes to 44 degrees 30 minutes for both intake and exhaust.

(b) Exhaust valves are hollow and are partially filled with sodium to assist in conducting heat from the valve head. Intake valve stems are smaller in diameter than the exhaust valves, and are of a solid cross section. To insure long life, stellite is welded on the seat of the valve.

(c) Intake and exhaust valves are fitted with three concentric coil springs which are interchangeable with each other. The inner spring seats on a shoulder of the valve guide, while the intermediate and outer spring seat on the flat steel washers which rest on machined surfaces of the cylinder head. A shouldered steel washer is provided at the outer end of the springs and the assembly is locked at the valve tip by a tapered, split lock ring.

(4) CRANKSHAFT AND PROPELLER SHAFT CONSTRUCTION.

(a) The crankshaft is of two-piece construction, single throw type, and is machined from alloy-steel forgings.

(b) The rear section of the crankshaft includes a dynamic damper which is, in principle, a pendulum counterweight, and is supported on two floating pins which pass through the extended portion of the crank cheeks. The bushings in the rear dynamic damper as-

sembly are of the floating type and are lubricated by two oil passages drilled in the rear crank cheek. The component parts of the dynamic damper assemblies are locked to the crank shaft by stops bolted to the crank cheeks, which also limit the movement of the damper weights.

(c) The crankshaft is supported in the crankcase by a roller bearing, directly forward of the front crank cheek, and by a roller bearing directly behind the rear crank cheek. Both bearings are of the demountable type, the front bearing incorporating 16 rollers and the rear bearing 18 rollers.

(d) The propeller shaft is machined from a steel alloy forging and is hollow throughout its length. The shaft is supported by two steel-backed, copper-lead bushings which ride on journals of the crankcase shaft from extension. A steel sleeve, shrunk in the propeller shaft between the two bushings, forms with the front bushing, an annulus from which the high pressure oil is taken for the operation of the hydromatic propeller. The propeller shaft is threaded on its outside diameter near the midsection for the thrust nut and at its front end for a propeller hub nut. The shaft is also splined at its front end to receive an SAE No. 50 propeller hub.

(5) REDUCTION GEAR ASSEMBLY, .5625
(16:9) REDUCTION GEAR RATIO.

(a) The reduction gear consists essentially of a large internal driving gear splined and shrunk to the crankshaft; a propeller shaft assembly having planetary type pinion gears mounted on a carrier ring, which is bolted to the propeller shaft flange; a stationary reduction gear support, which is bolted to the crankcase front section; and a stationary reduction gear meshing with the stationary reduction gear support and pinion assembly.

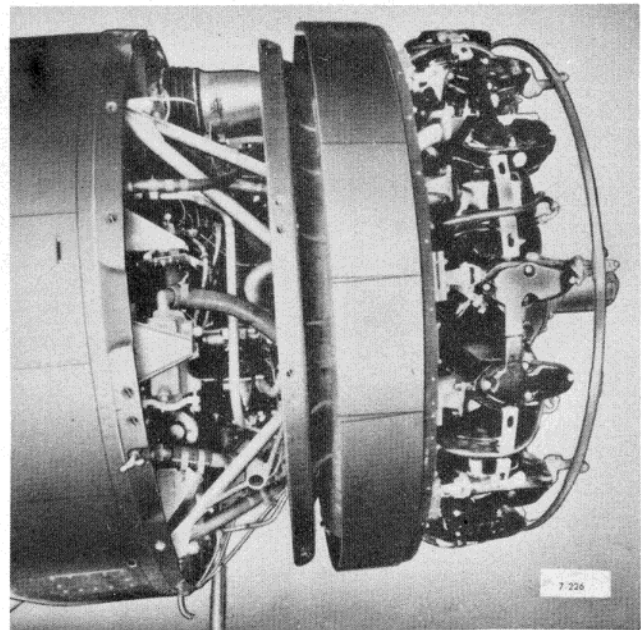
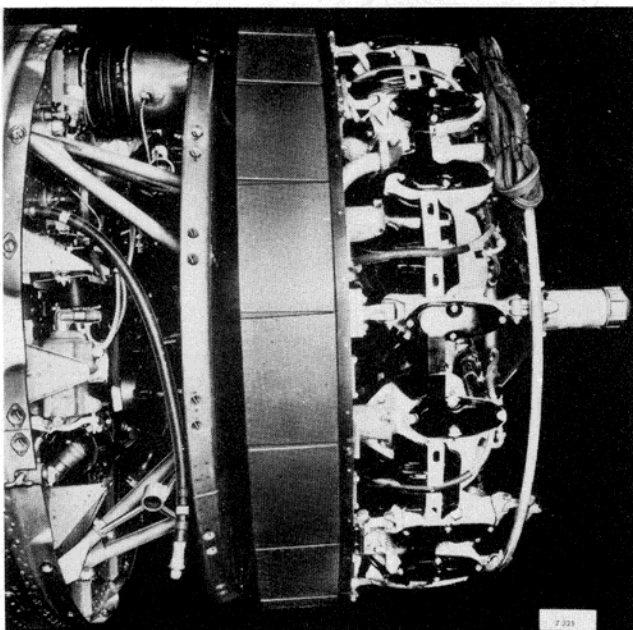


Figure 108—No. 1 Power Plant Details

(b) The reduction driving gear, meshing with the planetary pinion gears, causes them to travel around the rim of the stationary reduction gear, carrying the propeller shaft, to which they are attached, in the same direction of rotation as the crankshaft, but at 9/16 of its speed.

(c) The reduction driving gear is machined from a nitroalloy steel forging, with internal spur gear teeth cut inside the rim to drive the pinion gears. Splines are cut on the inside diameter of the hub for crankshaft attachment. Teeth cut on the outside diameter of the hub, form the cam drive gear. *The outside rim is provided with a timing scale, ranging from 0 degree to 35 degrees, for magneto and valve timing checks.* Three tapped puller holes are located near the hub for disassembly purposes.

(d) The stationary reduction gear is machined from an alloy-steel forging. It is tapped with 12 holes to accommodate the ten 3/8-inch and two 5/16-inch crankcase front section retaining bolts. The gear is mounted with a loose fit on the pilot of a support machined from an aluminum alloy casting. This support has an alloy-steel sleeve shrunk in its inside diameter on which the hydro oil seal assembly rides. The sleeve and support are drilled for oil passages to and from the governor pump. A steel guard ring is supported between the stationary reduction gear and the support, to eliminate damage to the reduction gear system in the event of a pinion's accidentally becoming unattached.

(e) The oil seal spacer assembly consists of a carbon steel sleeve which supports six cast-iron rings in grooves cut in its outside diameter. The oil seal rings are arranged in groups of two on each side of the two

drilled sections of the sleeve, where oil is transferred to and from the propeller governor pump.

(f) Propeller shaft thrust is absorbed by a ball bearing having a wide split or solid inner race, which eliminates the use of a slinger ring customarily employed with this type of bearing. The front end of the inner race is grooved around its outside diameter to accommodate a puller for disassembly purposes. The 11 balls are retained by two plates riveted together.

(g) The stationary reduction gear support attaching cap screws also retain the crankcase front section flange and spacer. The flange is machined from a chrome nickel forging and is cadmium plated on all surfaces except the bore, in which the thrust nut oil seal rings revolve. The spacer is finish machined from an aluminum forging.

(h) The thrust nut, which limits the end movement of the propeller shaft in the thrust bearing inner race, is machined from carburized chrome nickel steel and has three oil seal ring grooves on the rear outside diameter. The front end is shouldered with eight slots cut into the rim for use of a spanner wrench. The three cast-iron rings provide an effective seal against oil leakage, and prevent the thrust nut from rubbing directly on the flange.

(6) CRANKCASE AND SUMP CONSTRUCTION.

(a) The crankcase is built up of six principal sections located from front to rear as follows: crankcase front section, front main section, rear main section, supercharger front housing, rear housing, and rear cover.

Note

The supercharger section is an integral part of the engine and is not to be confused with

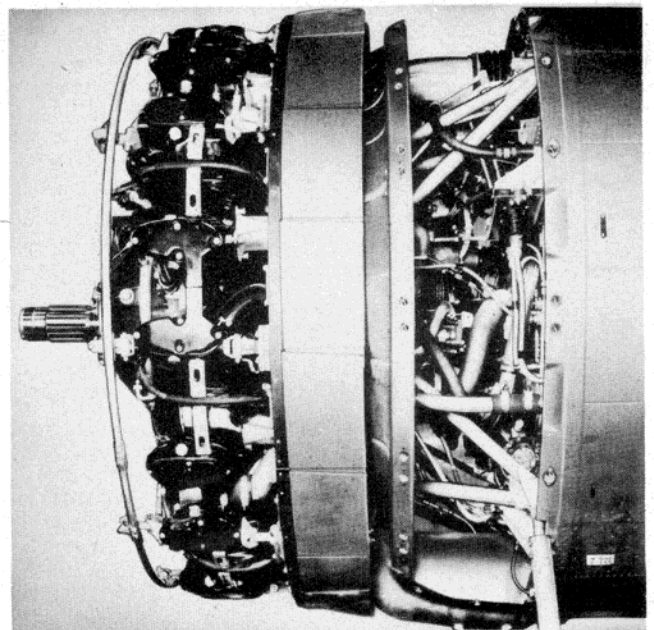
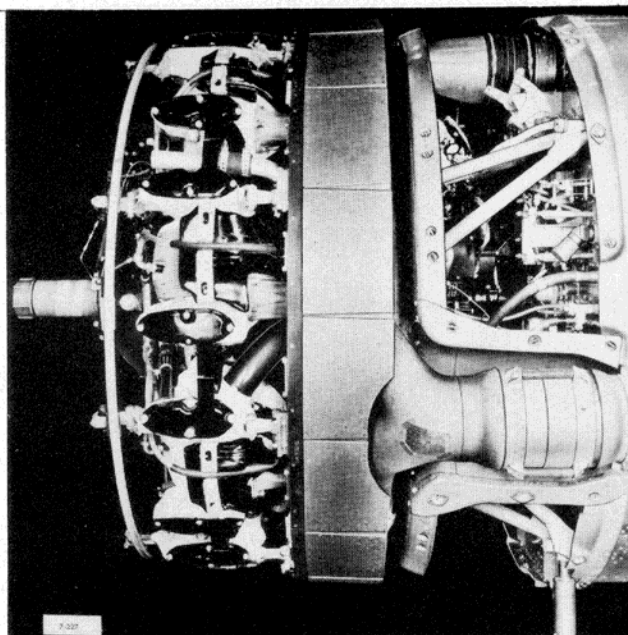


Figure 109—No. 2 Power Plant Details

the "turbo superchargers" installed on the airplane.

(b) The crankcase front section is machined from a magnesium alloy casting. It supports the thrust bearing in a steel retainer, which is shrunk into the forward portion of the section. The propeller governor drive shaft is supported in a bronze bushing on the top center line of the section. The reduction gear assembly is also housed in this portion of the crankcase. The crankcase front section is attached to the front main case by cap screws.

(c) The main section of the crankcase consists of two alloy-steel forgings which are parted at the cylinder center line, and attached by short steel bolts through internal lugs cast integrally with the cases. A wide rubber oil seal ring is used between the front main case and the crankcase front section to form an oil-tight joint. A narrow seal ring is used between the rear main case and the supercharger section front housing.

(d) The supercharger section front housing, machine-finished from a magnesium alloy casting, has nine mounting lugs for supporting the engine and nine tapped bosses for intake pipe connections. As the fuel mixture is distributed to the intake pipes from this section, bosses with tapped holes are provided for a priming line and manifold pressure connection. The front housing is attached to the crankcase rear main section by means of 18 cap screws.

(e) The magnesium alloy supercharger section rear housing forms the induction passages to the impeller entrance and forms the housing for all the accessory drive gears. The vaned-type diffuser plate is attached to the forward end of the induction passage where it shrouds the impeller. The rear housing, which is attached to the supercharger section front housing by studs, forms the rear wall of the diffuser chamber. A removable filter is attached to the left side of the blower rear housing. Two gun synchronizers and a fuel pump are also mounted on the sides of this section.

(f) The supercharger section rear housing cover, machined from a magnesium alloy casting, is secured to the rear housing by cap screws. The rear cover provides mounting pads for the two magnetos, generator, starter, oil pump, and dual spare drive housing. Bushings in bosses of the front face of the cover form support for the accessory drive gears and the rear journal of the accessory drive and starter shaft. The cover is provided with the necessary pressure oil passages to lubricate all the accessory drives. Provision is made for an oil tank vent connection at the upper center of the cover.

(g) The oil sump is a magnesium alloy casting of irregular shape, fitting between No. 5 and No. 6 cylinders. The drainage capacity of the sump is approximately one gallon when the engine is stopped; however, the sump is kept nearly dry in normal operation by the scavenge oil pump. The forward part of the sump is attached to the crankcase front section and to the super-

charger section by studs. A screened plug is screwed into the lower forward end of the sump, with the screen fitting into a pilot to keep any coarse, foreign material from entering the oil circulation. A drain plug equipped with a permanent magnet is screwed into the bottom of the sump to trap any magnetic material. The oil from the rear crankcase sections drains into the sump through holes in the left arm of the sump, while the holes in the right arm communicate with holes in the supercharger section front housing for breathing purposes.

(7) CONNECTING ROD CONSTRUCTION.—
A one-piece banjo-type master rod, equipped with eight articulated rods, is installed on the crankpin. The master rod is located in No. 1 cylinder.

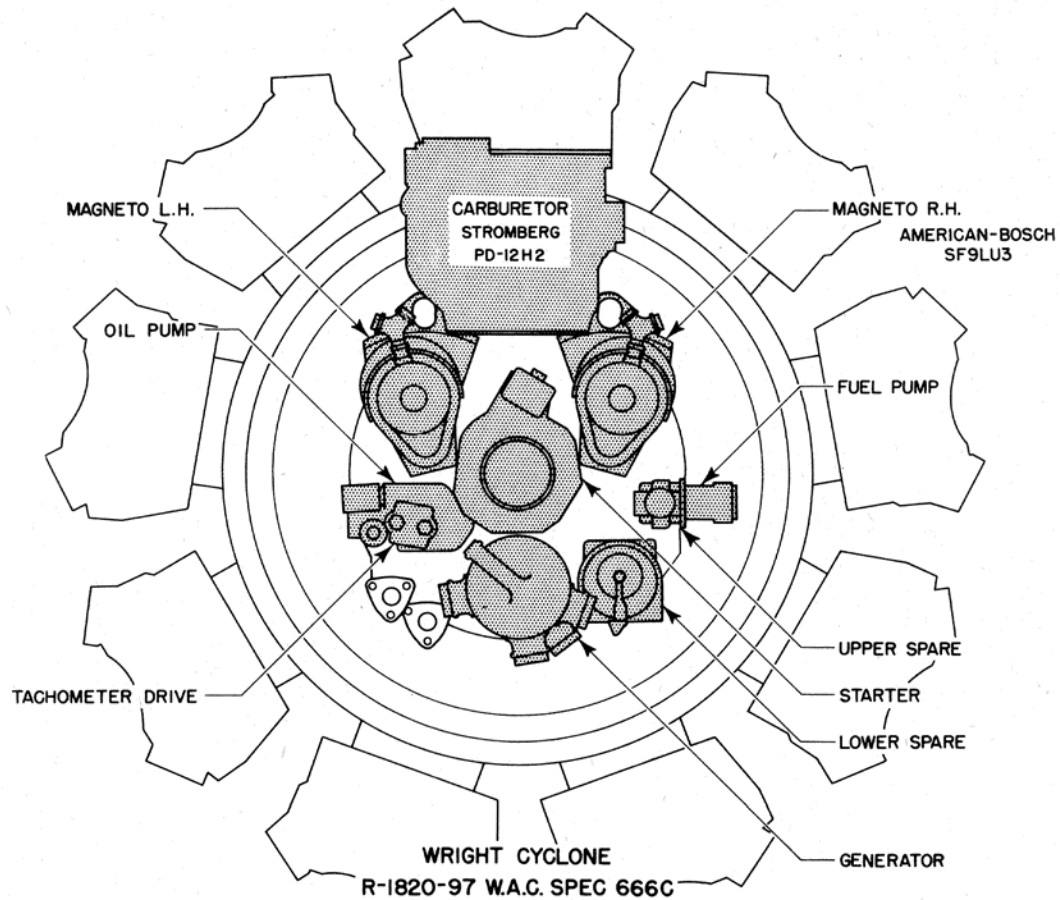
(8) PISTON AND PISTON PIN CONSTRUCTION.

(a) The pistons are full trunk type, heat-treated aluminum die forgings. A domed head is used to secure the desired compression ratio. Cooling is effected by fins machined on the inside diameter of the skirt at the thrust and anti-thrust sides. The piston employs six ring grooves, five above the piston pin bore, and one below. The top three grooves taper in slightly towards the center to accommodate the wedge type rings; the fourth and fifth grooves are of rectangular shape to take conventional compression rings which act as oil control rings. Ten holes are drilled in the fourth groove, five in the thrust and five in the anti-thrust sides. Twelve holes are drilled in the fifth groove, six in the thrust and six in the anti-thrust sides. These holes permit efficient control of the oil. The single groove below the piston pin bore is square cut to accommodate the same type of ring as used in the fourth and fifth grooves. However, this ring is inverted to give a pumping action and to permit a film of oil to be spread over the cylinder bore and piston.

(b) The piston pins, machined from alloy steel, have a case-hardened bearing surface. The pins are of tubular cross section and have ground bevels at each end. The piston pins float in the connecting rod bushings and in the pistons. The piston pins are retained in the piston by coiled spring-type retainers which are sprung into grooves located at each end of the piston pin bore.

(9) ACCESSORY DRIVE MECHANISM. (See figure 110.)

(a) The impeller and all the accessories are driven by a forged steel extension shaft from the rear end of the crankshaft, through an accessory drive gear. The accessory drive gear is machined and case-hardened from an alloy-steel forging. The starter and accessory drive shaft is splined at its front end to mesh with a coupling which is splined to the rear crank cheek. The shaft is supported at its rear end by a bronze bushing-lined boss on the rear cover. The journal at the rear end of the shaft has involute splines, cut into the side diameter, which mate with a detachable starter dog.



DRIVE	SPEED RATIO	STYLE DRIVE	FLANGE	ROTATION (DRIVE END)	ACCESSORY AND LOCATION			
					ENGINE 1	ENGINE 2	ENGINE 3	ENGINE 4
STARTER	1 TO 1	3 JAW CLUTCH	6 STUDS	CLOCKWISE	STARTER TYPE G6 OR F2	STARTER	STARTER	STARTER
GENERATOR	1.5 TO 1	16 TOOTH SPLINE (INVOLUTE)	6 STUDS	CLOCKWISE	GENERATOR TYPE P-1 OR O-1	GENERATOR	GENERATOR	GENERATOR
	1.5 TO 1	12 TOOTH SPLINE	4 STUDS	COUNTER CLOCKWISE		VACUUM PUMP TYPE B-8	VACUUM PUMP	
	1.5 TO 1	12 TOOTH SPLINE (INVOLUTE)	4 STUDS	COUNTER CLOCKWISE		GLYCOL PUMP ROMECH RD-4550		
FUEL PUMP	1 TO 1	11 TOOTH SPLINE (INVOLUTE)	4 STUDS	COUNTER CLOCKWISE	FUEL PUMP TYPE G-9	FUEL PUMP	FUEL PUMP	FUEL PUMP
TACHOMETER	.5 TO 1	STD.		CLOCKWISE		TACHOMETER	TACHOMETER	TACHOMETER
	1 TO 1	12 TOOTH SPLINE	4 STUDS	CLOCKWISE		PROP. GOV.	PROP. GOV.	PROP. GOV.
	9 TO 16	16 TOOTH SPLINE		COUNTER CLOCKWISE	PROPELLER HUB 23E50-473 BLADE 6477A-0	PROPELLER	PROPELLER	PROPELLER

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Figure 110—Engine Accessory Chart

Holes are drilled in the journal wall section for the main oil feed into the center-drilled shaft. Two journals on the starter shaft support the supercharger impeller shaft. The three-jawed starter dog is made of alloy-steel with splines on its front end which mate with splines at the accessory drive and the starter shaft rear end. A hollow aluminum alloy spacer is installed between the starter dog and the accessory drive and starter shaft at assembly and is machined to give proper end clearance at the spherical oil seal ring.

(b) All principal drives are effected through spur gearing and are located in the supercharger section rear housing, with journals rotating in bushings pressed in bosses on the supercharger section rear cover. The gun synchronizer gears are spiral and mesh with gear teeth cut into the center of the magneto drive shafts. A fuel pump gear meshes with a gear cut in the center of the spare drive shaft.

(c) Each gun synchronizer is mounted in two bronze bushings which are pressed into an aluminum alloy support. The supports are attached to the sides of the supercharger section rear housing. On engines upon which gun synchronizers are not to be used, as in the B-17G, covers replace the gun synchronizer impulse generator supports.

(d) Additional accessory drives are provided for by the use of a spur gear box attached to the supercharger section rear housing cover at the spare drive mounting pad.

(e) TACHOMETER DRIVES.—Provisions are made at the rear end of the oil pump for two tachometer drives. The tachometer drives are affected by a small drive shaft which is splined at one end to mate with similar splines in the oil pressure pump drive shaft. Oil leakage is prevented by use of spring-loaded plunger, neoprene ring oil seals. One tachometer drive is the standard threaded type connection and the other a flange type mount. Both tachometer drives have the same speed ratio and rotate in the same direction.

(10) SUPERCHARGER SECTION.—The centrifugal type blower consists of an impeller, a diffuser, a distribution chamber, and an impeller drive mechanism.

(a) IMPELLER.—The impeller operates with the inlet side facing the rear of the engine, and is mounted on a splined, hollow shaft which is supported by journals on the crankshaft extension. Steel oil seal sleeves, each grooved to accommodate four bronze oil sealed rings, are installed on the impeller shaft, at the front and rear ends of the impeller, and the whole assembly is retained by a nut and nut lock at the threaded front end of the shaft. The front and rear impeller oil seals are supported by steel sleeves in the front and rear supercharger section housings and the induction passage to the impeller is cast into the upper part of the supercharger section front housing. A steel tube, extending from the top of the supercharger section rear housings, to an annulus around the midpoint of the impeller

rear oil seal assembly, vents the impeller front and rear oil seal assemblies to the atmosphere. Venting at this point prevents oil from leaking into the diffuser section by rendering ineffective any suction or pressure that might arise at either impeller oil seal.

(b) DISTRIBUTION PASSAGE.—The distribution chamber is an annular passage in the supercharger front housing around the diffuser chamber. The nine intake pipes are attached to the circumference of this section.

(c) DRAIN VALVE.

1. A drain passage leads from the lower rear portion of the supercharger inlet chamber to the bottom of the supercharger section rear housing to prevent the accumulation of excess fuel. A check valve drops by gravity when the engine is not running, to allow drainage of the excess fuel to the atmosphere. When the engine is running, the check valve is pulled into its seat by the suction in the passage and prevents air from entering the chamber. A restricted air bleed is provided, however, through a small diameter "gurgle" tube that leads up through the drain passage to the mouth of the impeller. During engine operation, any fuel that runs down the walls of the induction passage is prevented from draining to the atmosphere by the closed check valve and is drawn into four holes drilled at the base of the "gurgle" tube above the air bleed, where it is atomized and delivered to the impeller.

2. With the turbo supercharger in operation, the pressure in the induction passage at the mouth of the impeller is above atmospheric pressure. Under these conditions, there is little or no suction retaining the disc valve in its seat, and the disc tends to drop, thus opening the drain valve to the atmosphere. At this point, manifold pressure acts on a piston fixed to the top of the disc valve to break the remaining suction on the disc and to press it firmly against the outlet flange in the drain valve body, thereby sealing the drain valve against atmospheric pressure. For this purpose, the manifold pressure is conducted from the distribution chamber, through a drilled passage in the supercharger rear housing wall and through the drain valve body, to the top of the piston. The mixture at manifold pressure also proceeds through a ball check valve opposite the piston and passes through the jet into the "gurgle" tube, drawing with it atomized fuel. This mixture issues at the mouth of the impeller, where at all times the pressure is less than manifold pressure.

(11) IGNITION.

(a) Ignition is supplied by two American Bosch SF-9LU3 magnetos, attached to the supercharger section rear cover. The magnetos are nine cylinder, fixed ignition, four-pole, flange mounted, polar inductor type. Breaker point cams turn at 1/2 crankshaft speed. Both magnetos are timed to No. 1 cylinder, after which they operate with fixed timing. The lobe for firing the No. 1 cylinder is identified by a red dot. The right magneto

fires the front spark plugs and the left magneto fires the rear spark plugs.

(b) The ignition wire is rubber insulated and covered to prevent wear and deterioration. A manifold extending around the outside of the crankcase front section at the parting surface, conducts the ignition leads to the front and rear spark plugs of each cylinder. All parts of the ignition wire assembly are shielded to eliminate radio interference.

(c) R-1820-97 engines may be equipped with either Aero LS38C or Champion C34S spark plugs.

(12) CARBURETION.

(a) R-1820-97 engines are equipped with Bendix Stromberg PD-12H2 injection carburetors. This carburetor differs from other types of carburetors in that it does not have a vented float chamber, but instead has a closed fuel system from fuel pump to discharge nozzle. The fuel is delivered by the engine driven fuel pump at about 14 pounds pressure, into the regulator and control units. There it is metered according to the mass air flow rate, as registered by the venturi tube, and automatic mixture control unit. The fuel is then forced into nozzles which spray the charge evenly across the supercharger section entrance. Fuel is prevented from leaking into the engine by the spring controlled discharge nozzle which is closed when the nozzle fuel pressure is less than four pounds per square inch.

(b) Some of the advantages of this carburetor over other types of carburetors are that there is no ice formation from fuel vaporization, as the fuel is discharged between the engine and the throttle valves; the carburetor meters accurately at all engine speeds and loads, independent of changes in altitude or attitude; and the pressure atomization of the fuel results in increased economy, flexibility, and smoothness.

(13) CRANKCASE BREATHER.

(a) The engine breathes entirely through the cored passage in the blower section front housing. Crankcase vapors enter the sump through the crankcase oil drain holes, where they pass around a ribbed section and out of a port in the right arm of the sump. Leaving the sump, the vapors pass through a cored passage around the rim of supercharger section front housing. Arriving at the top of the passage, the vapors pass to the atmosphere through an outlet which is secured to the top of the supercharger front housing.

(b) A spring-loaded relief valve, located in the upper section of the cored passage, opens to give the crankcase vapors a short direct route to the atmosphere. This is a flat steel disc valve which seats in a bronze insert screwed into the passage front wall section.

(14) LUBRICATION.—The lubrication system is of the full pressure, dry sump type, in which all moving parts are under oil pressure except the cylinder walls, piston pins, crankshaft roller, and ball bearings, which are lubricated by splash.

(a) OIL PUMP.

1. The oil is drawn from and returned to an external oil supply tank, by an oil pump assembly mounted on the lower left side of the blower section rear cover. This pump consists of a cast aluminum alloy body with the cored passages for two sections accommodating separate pressure and scavenge pumps, located at the rear and front of the pump body respectively. Each pump consists of two spur gears with large teeth, the scavenge gear teeth being longer than those of the pressure pump. The front end plate is drilled with two large diameter holes which line up with similar holes in the rear housing cover, to form the inlet and outlet passages for the pump. Provision is made for flanged inlet and outlet connections, with the outlet slightly below the inlet for accessibility. Two oil inlet and one oil outlet temperature connections are also provided.

2. Oil enters the left pump connection, passes up through the cored inlet passage, and enters the pressure pump gears at the bottom where it is carried around in the spaces between the gear teeth, and discharged into a pocket-shaped chamber at the top of the gears. From this pocket the oil has two possible outlets, both of which are controlled by spring-loaded, piston-type, relief valves.

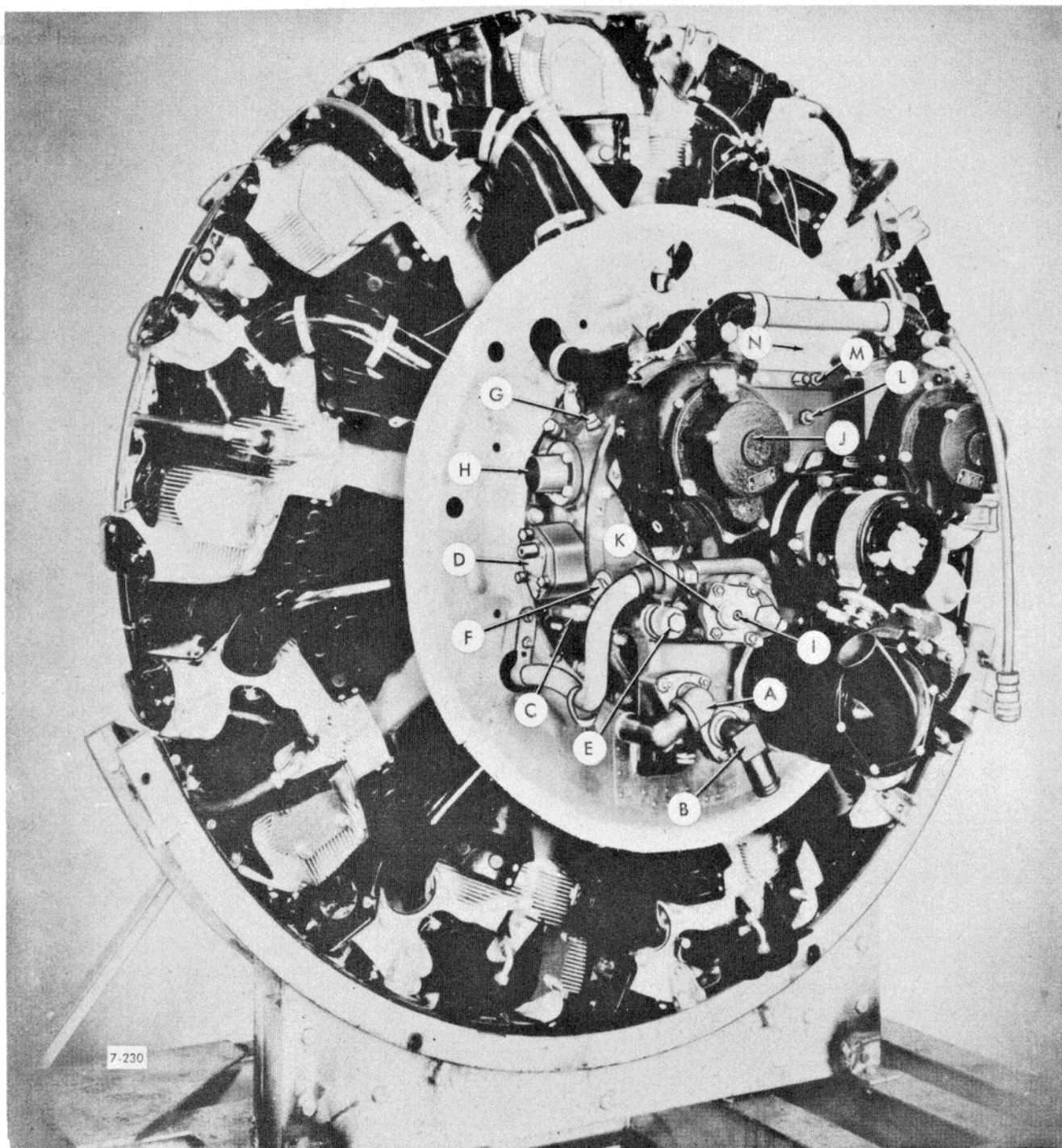
3. All oil entering the engine must pass through the oil inlet check valve. The spring tension, which is not adjustable, is designed to keep the valve closed against the gravity head of oil in the supply tank when the engine is stopped, and to open with very little restriction when the engine is running. The valve assembly is retained in a bronze sleeve which is screwed into the oil pump body, and over which a steel cap is screwed. The alloy-steel piston is spring loaded and accommodates one bronze piston ring. When the engine is running, end movement of the piston uncovers ports in the sleeves through which the oil passes to the engine. Displaced air and oil leakage are vented through a drilled passage into the blower rear housing cover and housing.

4. The oil pressure relief valve in the oil inlet regulates oil pressure. It consists of a bronze alloy body containing a nickel steel piston with a flat seat. The spring tension may be varied by turning an adjusting screw on the rear of the body. A steel lock nut and a steel cap, screwed on the outside diameter of the adjusting screw, keeps the screw from loosening, and prevents oil leakage.

(b) CUNO AUTOMATIC FILTER.

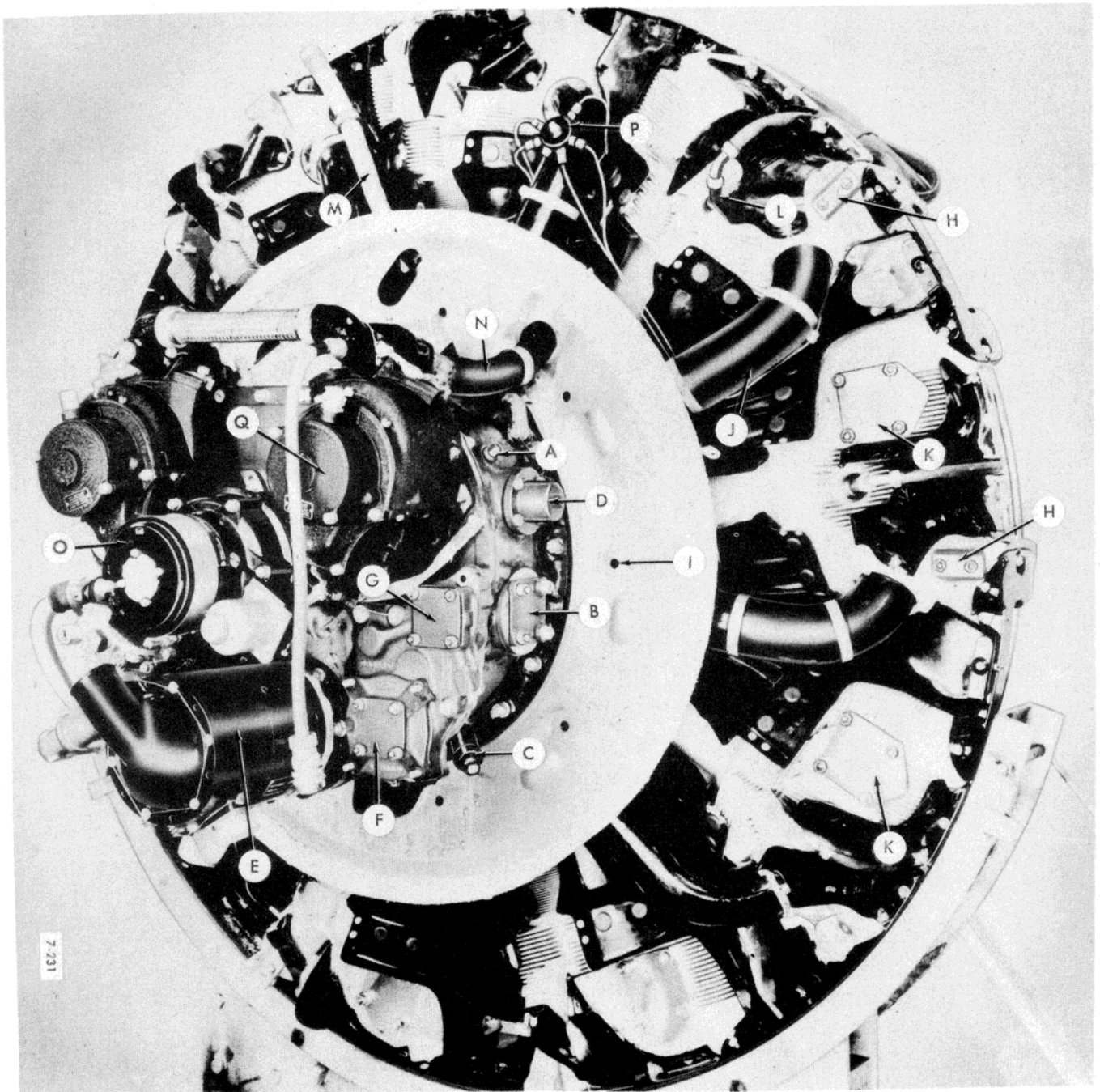
1. After leaving the oil pump the oil flows through a hole drilled in the supercharger section rear cover, to an annular chamber surrounding the Cuno automatic filter.

2. The Cuno filter consists of a cartridge filter unit, made up of closely spaced discs separated by cleaner blades, and a small hydraulic motor to provide



- | | | | |
|----|-------------------------------------|----|---|
| A. | Oil inlet | I. | Mechanical tachometer drive |
| B. | Oil to cooler | J. | Left hand magneto (for rear plugs) |
| C. | Oil to supercharger regulator | K. | Electric tachometer drive (remove mechanical drive pad) |
| D. | Cuno oil filter | L. | Oil pressure gage connection |
| E. | Oil pressure relief valve | M. | Manifold pressure gage connector |
| F. | Oil pump check valve | N. | Carburetor pad |
| G. | Oil tank vent connection | | |
| H. | Gun synchronizer (not used on B-17) | | |

Figure 111—Engine Accessory Pads (Left Rear View)



- | | | | |
|----|-----------------------------------|----|-------------------------------------|
| A. | Oil tank vent connection | I. | Engine mount bolt holes |
| B. | Fuel pump pad | J. | Intake pipe |
| C. | Blower drain | K. | Exhaust pad |
| D. | Gun synchronizer (not used) | L. | Spark plug |
| E. | Generator pad | M. | Breather vent |
| F. | Vacuum pump pads—Engs. 2 & 3 only | N. | Ignition wire shield |
| G. | Hydraulic pump pad—Engine 1 only | O. | Starter pad |
| H. | Glycol pump pad—Engine 2 only | P. | Primer line distributor |
| I. | Cowl Ring Support | Q. | Right hand magneto (for front plug) |

Figure 112—Engine Accessory Pads (Right Rear View)

RESTRICTED

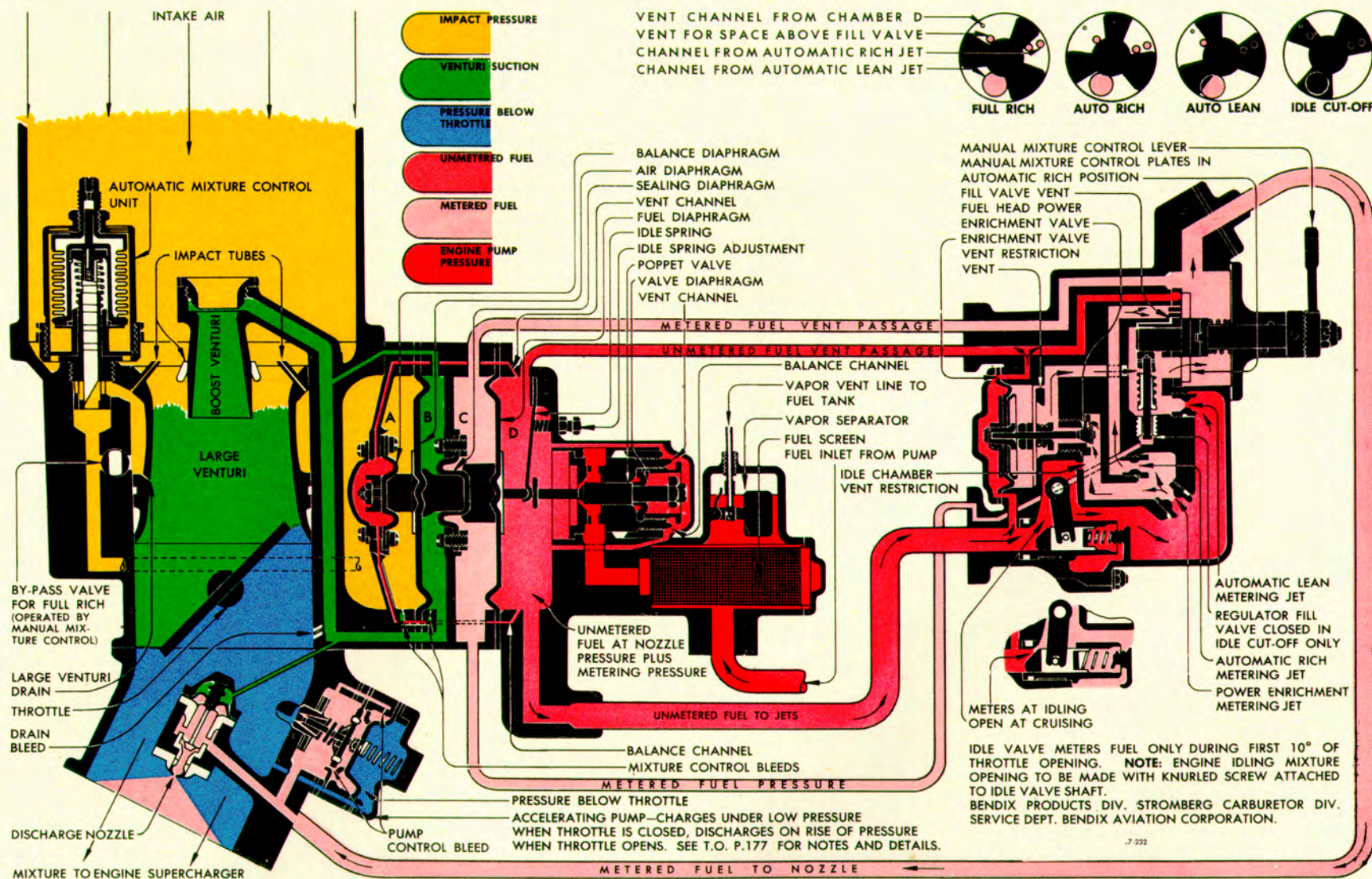
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Figure 113—Bendix Stromberg Injection Carburetor Flow Diagram

continuous rotation of the cartridge. The cleaner blades remain stationary and impart a combing action to the discs which turn at approximately one to two rpm under normal conditions. The motor operates on a very little amount of the filtered oil, is self starting, and remains in operation as long as the oil system is under pressure. The oil used by the motor returns to the engine lubricating system. A pinion shaft is provided to turn the cartridge manually for inspection or test purposes. A spring-loaded ball pressure relief valve is incorporated in the filter to allow the oil to bypass the filter when the oil is cold and viscous or when the filter unit becomes clogged.

3. The inner end of the filter cartridge is a light press fit in the accessory drive and starter shaft supporting boss. The oil is forced through the closely spaced discs, or through the pressure relief valves to the hollow center of the filter where it is conducted to the inner end of the filter, and through an annulus surrounding the bronze accessory drive and starter shaft supporting bushing. At this point the oil is divided, with the major quantity continuing through the engine, and the remainder lubricating the accessory drives in the blower section rear housing cover.

(c) SUPERCHARGER SECTION REAR HOUSING COVER.

1. The front face of the cover is cast with four drilled ribbed sections extending radially from the accessory drive and starter shaft supporting boss through which oil is conducted from the annulus around the accessory drive and starter shaft to the accessory drive bushings. A tube, extending from the top of the accessory drive and starter shaft supporting boss, conducts oil to a pressure gage connection at the upper right section of the cover.

2. The two upper drilled ribbed sections supply oil to a groove around the outside diameter of each magneto shaft bushing. The upper portion of each magneto shaft bushing is milled away for the installation of gun synchronizer supports. These milled away portions uncover the oil grooves of the magneto shaft bushing in two locations, through which oil issues to lubricate the inside diameter of the magneto shaft bushings. The inner gun synchronizer supporting bushing is provided with grooves in its inside diameter, through which oil enters to lubricate the outer bushing and the synchronizer mechanism, (not installed on this airplane). An external line from the left synchronizer mounting pad carries oil to the low pressure governor oil supply passage in the crank case front section. Holes, drilled in the outer flanged section of the gun synchronizer support, drain the surplus oil into the supercharger section rear housing.

3. A passage drilled angularly through the supercharger section rear housing cover at the spare drive mounting pad, conducts oil under pressure to lubricate the dual spare drive gear box and accessories requiring engine oil for lubrication.

4. The accessory drive gears run in a bath of oil which is constantly being forced out of the ends of their shaft supporting bushings. To prevent the external leakage of oil, the following types of oil seals are employed:

<i>Accessory Drive</i>	<i>Type of Seal</i>
Starter and accessory drive shaft	Spherical oil seal ring of oilite material
Generator and magneto drives	Spring-loaded neoprene diaphragm
Fuel pump drive shaft	Leather seal reinforced with coiled spring
Tachometer drives	Plunger-loaded neoprene packing rings

5. A passage is drilled at the base of a recess behind each accessory drive shaft bushing to drain the surplus oil into the blower section rear housing. The magneto, oil pump, and spare drive shaft recesses have one drain hole each. The generator drive shaft has three drain holes, while the starter and accessory drive shaft has two internal drain holes and provision for one external drain at the lower right side of the mount pad.

(d) CRANKSHAFT AND CYLINDER LUBRICATION.

1. The major quantity of oil arriving at the accessory drive and starter shaft bushing annulus, passes through slots in the bushing and enters the hollow accessory drive and starter shaft through holes in its rear journal and holes in the hollow aluminum oil seal spacer. Some oil is forced into the inside diameter of the slotted accessory drive and starter shaft bushing and is distributed over the front face of the bushing shoulder by shallow grooves. In passing through the accessory drive and starter shaft, some of the oil is forced through a hole drilled in the shaft near its front end and fills the annulus formed between the accessory drive and starter shaft and the impeller drive shaft. Oil flats are provided on the accessory drive and starter shaft outer diameter to distribute oil over the entire length of each impeller shaft supporting bushing. From the accessory drive and starter shaft, the oil enters a recess in the rear counterweight crank cheek.

2. A hole drilled through the rear crank cheek conducts the oil into the center of the hollow crankpin. A tube extending into the crankpin conducts some of the oil to flats milled on the crankpin, and these flats distribute oil over the surface of the crankpin on which the master rod bearing rides. The oil enters an annulus in the knuckle pin lock plate and is conducted through holes drilled in the knuckle pin lock plate tabs to the knuckle pin locking screws. Oil entering holes drilled in the front of the knuckle pin locking screws fills the hollow centers of the knuckle pins. Two holes drilled 180 degrees apart in each knuckle pin conducts the oil to the outside diameter of the pin, where two flats distribute the oil over the knuckle pin bushings in the articulated rods.

3. An oil jet screwed into the front end of the crankpin also supplies lubrication for the cylinder walls, piston pins, and roller bearings. The motion of the crankshaft and connecting rods assures effective splash distribution.

4. The oil is led from the crankpin, through a passage in the front crank cheek, to the hollow drive shaft. Here it acts as a header for various indexing passages, through which the cam and valve operating mechanism and the reduction gear assembly are lubricated. This reservoir also supplies oil to the propeller governor.

(e) REDUCTION GEAR LUBRICATION.—Oil from the reservoir in the hollow crankshaft takes the following paths:

1. Through a hole drilled in the wall section of the crankshaft to a hole drilled through the wall section of the propeller shaft, supplying oil to the propeller governor pump and lubricating the reduction gear.

2. Around the front end of the crankshaft, lubricating the propeller shaft front bushing by means of a flat on the surface of the crankshaft.

3. Through an adapter into a distributor valve, supplying low pressure oil for operating the hydromatic propeller.

(f) VALVE GEAR LUBRICATION.

1. Oil from the reservoir in the crankshaft is supplied to the propeller governor pump, passing through a drilled passage in the stationary reduction gear and through indexing passages in the crankcase front section, to the governor propeller mounting pad.

2. A passage intersecting the low pressure governor pump oil supply passage conducts the oil to an annulus surrounding the governor drive bushing, lubricating the bushing.

3. A passage, intersecting the annulus around the governor drive shaft bushing, connects with a channel machined into the shoulder of the rear surface of the crankcase front section. This channel is sealed by a rubber channel oil seal ring between the crankcase front section and the front main section.

4. Passages leading from the channel section supply oil to the eight tappet assemblies above the horizontal engine center line. Lubrication of the eight upper valve tappet assemblies is accomplished as follows:

a. Oil is metered into the hollow valve tappet every time a drilled hole in the reciprocating tappet coincides with the valve tappet guide. Surplus oil lubricates the inside diameter of the guide, tappet roller, hub, pin, and cam lobes.

b. The oil is forced into the hollow push rods through indexing holes in the inner ball ends and the spring-loaded valve tappet socket.

c. The oil enters the valve clearance adjusting screw through indexing holes in the push rod outer ball ends and the socket end of the adjusting screw. The screw is drilled with three radial passages intersecting the index hole in the cup end of the adjusting screw, through which oil is delivered to a groove in the rocker arm threads.

d. From this groove, the oil is forced through a drilled passage in the rocker arm through an annulus formed by the outer race retaining clip in the tapered roller bearing. Oil lubricates the bearing and escapes out of its ends to supply lubrication to the rocker roller and valve stem.

e. Excess oil drains down the inside of the push rod housing and is returned to the engine crankcase through an angularly drilled passage in the valve tappet guide which aligns with a spot-faced corner of the tappet roller slot in the crankcase.

f. The following rocker assemblies are lubricated by pressure oil feed: cylinders No. 1, No. 2 and No. 9—both intake and exhaust; cylinder No. 3—exhaust; cylinder No. 8—intake. The rocker assemblies below the horizontal engine center line are lubricated by oil seeping through the clearance between each valve tappet and its guide, after which it runs down the inside of the push rod housing and fills the rocker box. The desired quantity of gravity-fed oil for this purpose is obtained by controlling the valve tappet diametrical clearance in their guides.

(g) DUAL ACCESSORY DRIVE LUBRICATION.—The supercharger section cover is drilled just above the spare drive shaft to supply pressure for lubricating the dual spare drive box, and accessories mounted thereon requiring engine oil for lubrication.

1. All the bushings in the spare drive assembly are pressure fed, with the surplus oil providing a bath for the gears, and then draining into the supercharger section rear housing. Pressure oil passages are drilled in the dual spare drive housing cover to supply accessories requiring engine oil for lubrication.

2. Engine oil under pressure enters the upper left side of the dual spare drive housing through a drilled passage which indexes with the supply passage in the rear supercharger housing cover. This passage extends through the housing to the parting flange, where an indexing hole in the dual spare drive housing cover conducts the oil into the cover passages so that both housing and cover receive oil from the same source of supply.

3. A cast magnesium adapter plate may be installed on the lower drive to accommodate an accessory with the same stud spacing as the upper drive. This plate is drilled with an oil passage, its front face indexing with the accessory supply passage on the lower drive mount pad, and the outlet on its rear face at a location corresponding to the upper drive accessory supply passage.

(15) SCAVENGE SYSTEM.

(a) All of the oil in the lubrication system drains into an oil sump located between No. 5 and No. 6 cylinders. The crankcase front section drains, through a large hole in the section, directly into the sump at its forward end. The crankcase main section drains into flange channels in the main case, leading to the sump through two short tubes in the front section, where it meets the front section drainage and passes into the sump. The rear channel in the crankcase main section drains into an escape outlet in the blower front section, which drains into the left hole of the two large holes drilled in the left arm of the sump. Oil drainage from the accessory gearing in the blower section rear housing drains into the same hole in the blower front housing.

(b) Oil removed from the sump by the engine scavenge pump first passes through a removable cylindrical screen (12 mesh per inch brass wire) and then through the large hole of the left arm of the sump. This hole mates with a cored passage in the blower section front and rear housings which communicate with a drilled passage in the blower rear housing cover. A hole drilled in the oil pump body and plate lines up with the hole in the cover and delivers the oil to the scavenge pump gears, which discharge into the external oil supply tank.

(c) Oil is also conducted to the pump through an external line extending from the oil sump strainer on R-1820-97 engines.

(16) PRIMING SYSTEM.

(a) Prior to and during the period of starting, it is necessary to provide a supply of fuel to the cylinders from some source other than the carburetor. This is accomplished by a priming system which consists of an auxiliary pump and feeder lines from the No. 3 engine fuel strainer to a distributor clamped on the No. 1 intake pipe of each engine. From the distributor the fuel is conducted through tubes and injected into the upper cylinders. See also section IV, paragraph 6. e.

(b) The priming system supply line enters the top of the distributor. Five brass nipples are screwed radially into the periphery or the distributor body, pro-

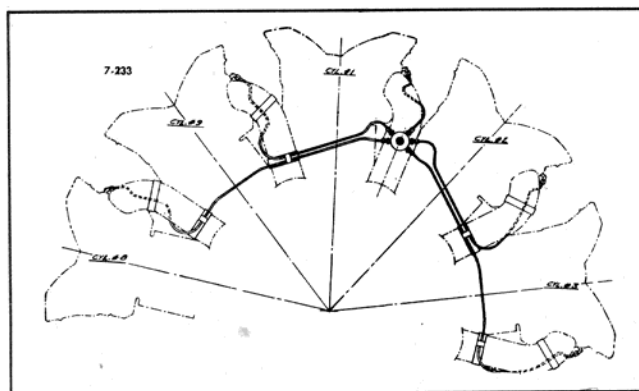


Figure 114—Priming System Distributor and Lines

viding spherical seal connections for the steel priming tubes. The tubes are secured to the intake pipes by clips and are encircled at the clip locations by heat-and-oil-resistant rubber bushings to protect the tubes and to absorb vibration. Ninety-degree brass attaching nipples are screwed into the intake ports and provide spherical seat connections for the priming tubes. Each nipple is provided with an outlet jet which discharges the priming fuel into the intake port in the form of a fine spray.

b. TROUBLE SHOOTING.—Determining the causes of engine troubles is complicated by the number of sources to which a given symptom may be attributed. The best method of "trouble shooting" is first to decide on the possible causes and then eliminate them one by one, starting with the most probable. The following table lists the most common engine troubles and their causes:

(1) FAILURE OF ENGINE TO START.—Follow starting instructions in Section II. If the engine fails to start, it may be due to any one of the following conditions:

- (a) Lack of fuel or insufficient fuel pressure.
- (b) Underpriming or overpriming.
- (c) Booster magneto defective.
- (d) Throttle opening incorrect.
- (e) Incorrect operation of the mixture control.
- (f) Defective ignition wiring. Examine wiring for wear, breaks, and incorrect connections.
- (g) Dirty spark plugs. Check the spark plugs for proper functioning. (Refer to paragraph c. (2) below.)
- (h) Incorrect valve tappet clearance. Check the valve tappet clearance. (Refer to paragraph d.)
- (i) Incorrect timing. Check the valve and ignition timing. (Refer to paragraph d.)
- (j) Air in carburetor regulator unit. Remove vent plug in the top of the unmetred fuel chamber of regulator unit. Pump fuel until it stands level with the plug opening.
- (k) Main fuel discharge nozzle sticking open. See that nozzles hold three pounds pressure without discharging fuel. Otherwise the fuel will boil under a high vacuum, giving erratic metering.
- (l) Cold oil. With the ignition switches "OFF" and mixture control in "ENGINE OFF" position, turn the engine over by hand. If it is very stiff, it will be necessary to drain and heat the oil before starting.
- (m) Magnet^o breaker points. See that the magneto breaker points are clean and properly adjusted. Test the spark delivered by the magneto. (See instructions in paragraph 8. c. (11) following.

Note

The oil sump drain plug is equipped with a permanent magnet on the threaded end to

catch foreign particles in the oil sump. If some internal trouble is suspected, this drain plug should be removed and trapped particles examined.

(2) **LOW OIL PRESSURE.**—Low oil pressure or none at all may result from one or more of the following:

(a) Lack of priming in oil pump. Disconnect the oil suction line and fill the pump with oil. Be sure that the oil suction line is full of oil in order to prevent an air lock. Turn the engine over by hand until the oil is sucked into the pump. Check the oil supply.

(b) Leak in suction lines. Examine the oil suction lines for air leaks.

(c) Dirt in oil filter. Inspect Cuno automatic filter for proper operation. Remove and clean if clogged.

(d) Air-lock or dirt on the seat of the relief valve. Removing and replacing relief valve will often free the oil for circulation.

(e) Improper setting of relief valve. Adjust the oil pressure relief valve to obtain 70 pounds per square inch (oil temperature 70 degrees C (158 degrees F)). If this pressure is not reached until the screw is all the way down, or nearly all the way down, the trouble lies somewhere else. Adjustment of the pressure may be made with the engine running, and should be made when the oil is hot.

(f) Excessive bearing clearance. A bearing may be worn enough to reduce the pressure, in which case an overhaul will be necessary.

(g) High oil temperature. Excessive temperatures reduce the viscosity of the oil which then passes the bearings more freely and tends to drop the oil pressure. Check the oil temperature regulator for proper operation and check the cooler core for clogging.

(h) Low outside temperature. In very cold weather the oil may become congealed in the suction line from the oil tank, preventing the oil from reaching the pump.

(i) Foaming in oil supply tank. Foaming is a frequent cause of fluctuating oil pressure and loss of pressure. The presence of air in the scavenge oil is normal. The return oil from the engine should be directed into the supply tank in such a manner as to produce a minimum of splashing, and to permit air which may be trapped in the return line to separate from the oil as readily as possible. If foaming is experienced, the oil should be removed from the system and the oil system cleaned. Refer to paragraph (9) of this section for other causes of oil foaming.

(j) It should be remembered that the pressure will vary with the varying engine speeds and oil temperature, and due allowance should be made for the pressure drop to be expected at increased temperatures.

(3) **ENGINE RUNNING TOO RICH OR TOO LEAN AT CRUISING POWER.**

(a) Fuel pressure is too low. Check the fuel pump and the fuel pressure gage. Clean the fuel strainer if the pressure will not rise.

(b) Foreign matter in carburetor cruise jet.

(c) Carburetor economizer needle is leaking or stuck open. Remove the bushing above the needle to check the needle for free motion, or remove the fuel control unit cover body to check the needle and seat.

(d) Check the automatic mixture control unit setting and bellows, if the carburetor is running too rich or too lean in automatic position at altitude.

(4) **ENGINE RUNNING TOO LEAN AT TAKE-OFF OR RATED POWER BUT IS SATISFACTORY AT CRUISING POWER.**

(a) Carburetor economizer valve may be binding. Remove the fuel control unit cover body and check the mechanism for freedom of movement.

(b) Insufficient fuel pressure.

(5) **ENGINE RUNNING TOO LEAN OR TOO RICH AT ALTITUDE IN THE "AUTOMATIC" POSITION, BUT SATISFACTORY AT SEA LEVEL.**

(a) The carburetor vapor separator float needle may be stuck in the "CLOSED" position. Remove the strainer and inspect the float for free movement.

(b) The automatic mixture control unit may be incorrectly set or malfunctioning. Remove this unit from the carburetor and check the travel and set according to instructions.

(c) The manual mixture control valve may be set in wrong position. Check the linkage to the manual mixture control lever.

(d) The emergency "FULL RICH" valve plates in the carburetor may be open or leaking. Remove the valve cover on the throttle body and see that the slots in the plates are open only in "EMERGENCY FULL RICH" position and that the plates do not leak.

(6) **ENGINE NOT ACCELERATING PROPERLY, BUT RUNS SATISFACTORY WITH SLOW THROTTLE MOVEMENTS.**

(a) The accelerating pump may not be adjusted to give the required travel. Readjust.

(b) The fuel inlet to the acceleration pump may be clogged at the intake restriction. Remove the pump cover and diaphragms, and examine.

(c) There may be a leak into the air chamber in the regulator unit. Remove the air chamber drain plug.

(d) The suction hole to the air side of the accelerating pump diaphragm may be closed. Check to see whether or not the holes line up correctly.

(7) ENGINE DOES NOT SHUT OFF IN "ENGINE-OFF" POSITION.

(a) The idle cut-off valve washer on the mixture control needle may not be seating properly. Remove the plug on the side of the fuel control unit adjacent to the cruise jet to see if the washer seats in the "ENGINE-OFF" position. Check the control rods for full travel. Check for burr on the metering jet.

(b) The carburetor economizer needle may not be seating properly. Remove the fuel control unit cover body and check the mechanism for freedom of movement.

(c) Check the carburetor regulator unit for proper operation.

(8) OIL ACCUMULATION IN CRANKCASE.

(a) The filling of the crankcase with oil is usually caused by lack of priming in the scavenging pump. Disconnect the main discharge line from the engine and put on a short length of hose. While turning the engine backward, feed oil into the hose until a quart or so has been sucked in. Check the oil pump, strainers, and lines for failures or stoppages.

(b) Oil accumulation in the engine crankcase may also be due to high inlet temperature or pressure. Suggestions for determining the cause of excessive inlet temperatures are listed in paragraph (10). If high pressure appears to be the cause, the oil pressure relief valve should be checked and corrected.

(9) OIL FOAMING.—In addition to the cause of oil foaming given above, experience indicates that foaming and serious attendant difficulties may result from the cleaning of engine parts with aqueous cleaning solutions, most of which contain either soap compounds or caustic soda.

(10) EXCESSIVE OIL TEMPERATURE AND HIGH OIL CONSUMPTION.—This condition may result from:

- (a) Insufficient oil cooling.
- (b) Insufficient oil supply.
- (c) Low grade oil.
- (d) Suction pump failing to scavenge the oil properly from the crankcase.
- (e) An overheated bearing.
- (f) Dirty oil.
- (g) Worn piston rings.
- (h) Piston rings incorrectly installed.
- (i) Improper venting of oil system.
- (j) Clogged oil lines, strainers, or coolers.

(11) LOW POWER AND UNEVEN RUNNING.—Low power and uneven running may be traced to any of the following causes:

(a) RICH OR LEAN MIXTURE.—Too rich a mixture is evidenced by uneven running, "torching," and black smoke from the exhaust. Too lean a mixture is evidenced by uneven running, overheating, and back-firing. Adjust the mixture strength to the specified fuel air ratio.

(b) LEAKS IN INDUCTION SYSTEM.—Examine the intake pipes for cracks and for leaks at the cylinder and crankcase connections. Examine the carburetor and adapter flanges for tightness.

(c) SPARK PLUGS.—See that all the spark plugs are clean and that they have not burned. Test them for proper sparking. Be sure that the spark plugs are in good condition and of the recommended type.

(d) VALVE AND VALVE GEAR TROUBLE.—Check the valve tappet clearance, springs, washers, rocker arms, and push rods. Make sure the valves are not sticking.

(e) POOR FUEL.—Use only the recommended grade of gasoline and see that the carburetor has an ample supply at the specified pressure.

(f) MAGNETOS.—See that the magneto breaker points are clean and properly adjusted. See that primary cable connection is tight. Check the operation of the magnetos.

(g) IGNITION WIRING DETERIORATED OR BURNED.—Check condition of terminals and check each wire with buzzer or light to locate any broken or grounded wires.

(h) ENGINE OVERHEATING.—This condition may be caused by the conditions referred to in paragraphs (a), (b), (c), and (e) above. Continued running of an engine with cylinder temperatures beyond 218 degrees C (420 degrees F) is liable to cause considerable damage, so investigation of the cause should be started immediately. Other causes include improper cowling, high carburetor air temperature, thin oil, and insufficient oil cooling.

(12) SPARK PLUGS.—When a spark plug is removed from the engine, due to suspected trouble, the plug should be inspected thoroughly before disassembly. Fairly accurate indications of engine conditions may be diagnosed by examination of the spark plug.

(a) If the electrodes are heavily coated with carbon, the compression of the cylinder should be checked to determine whether the piston rings are stuck or worn and allow oil to pass. Check the logbook for evidence of high oil consumption.

(b) If the electrodes are clean but discolored, and appear to have been running hot, this may be due to the following:

1. Detonation from poor fuel.
2. Operating at excessive manifold pressure.
3. Loose core.

(c) If the electrodes are coated with a white powder after operating with leaded fuel, the plug may not have been firing but still subjected to excessive heat. Check ignition wires and spark plug terminals for failure. Check magneto breaker point functioning and spark plug gap.

(d) A coating of fresh oil indicates that the plug is not firing. Check ignition wires, terminals, magneto breaker points, and spark plug gap.

(e) After the spark plug is disassembled the core should be inspected for defects in the mica insulation. If the mica insulation is broken, flaked, or dented, or if any of the mica laminations project beyond adjacent laminations, the core should not be used.

(13) **MAGNETOS.**—Burned magneto breaker points may be traced in some instances to the application of excessive quantities of lubricant. If this is experienced, the magneto breaker assembly should be thoroughly cleaned and readjusted.

(14) **CARBURETOR LEAKAGE.**—Because of the fire hazard involved, the engine will not be run if the carburetor leaks fuel excessively. Leakage of the carburetor may be caused by:

(a) Mixture control in wrong position.

(b) Improper functioning of the discharge nozzle valve in the carburetor adapter.

CAUTION

In no case will the carburetor be disassembled to correct any leakage. Replace the carburetor instead.

(15) LEAKAGE OF SUPERCHARGER SECTION DRAIN VALVE.

(a) Leakage of the supercharger section drain valve is often caused by dirt or foreign matter which hinders the sliding action of the piston or which prevents seating of the disc or ball check valves.

(b) In some instances, valve faces may require lapping to effect the proper seal. The valve faces must not be lapped together.

(c) Improper fit of the piston in the valve body might also cause leakage.

(16) COLD WEATHER PRECAUTIONS.

(a) Use the oil dilution system for cold weather engine stopping as outlined in Section III.

(b) In cold weather it is advisable to have some sort of insulation on the external oil lines on the engine to and from the tank. This will result in higher oil temperature at cruising speed and will decrease the danger of stoppage due to congealed oil. A layer of asbestos cord, shellacked and then wrapped with friction tape,

provides very good insulation. If asbestos is not available, several layers of ordinary packing cord can be used.

(c) To obtain immediate indication of oil pressure variation in cold weather, drain the oil pressure gage lines and fill them with oil, Specification AN-0-6.

c. REPLACEMENT OF PARTS AND MINOR REPAIR.

(1) **GENERAL.**—The following instructions are limited to the "top overhaul" of the R-1820-97 engines, including the removal and replacement of defective parts. This work can be performed by the facilities usually available at Army Air Forces stations. For information on the starter and the various engine-driven accessories, refer to the paragraphs specifically covering their respective systems.

(2) SPARK PLUGS.

(a) All spark plugs will be removed at 100-hour intervals and replaced with new or reconditioned plugs (Aero LS38C or Champion C34S).

(b) Remove ignition cables, first loosening all elbow nuts with the proper wrenches (Wright No. 800630). Gently pull cable connectors straight out. **DO NOT JERK THEM.**

(c) Apply a socket wrench (Wright No. 84458) to the SHELL HEX only when removing or installing spark plugs.

CAUTION

Under no circumstances will chisels, punches, or oversize wrenches be used for this purpose. Do not apply too much pressure to the wrench when assembling or installing spark plugs, as the plug bodies may be stressed to a point that will result in distortion of the gasket seat between the core and the shell. Be careful when installing or removing spark plugs, to prevent the wrench from tilting to one side, or slipping and striking the head of the plug.

(d) If plugs become loose at the joint between shell and core, they will be removed for tightening. When tightened, the gap clearance will be checked, as rotation of the core will change the gap.

(e) Whenever the gap is found to exceed .020 inch, the electrodes will be reset at $.012 + .002$ inch $-.001$ inch. Under no circumstances will the side electrode be set while a thickness gage is between the outer electrode and the center electrode.

(f) When installing spark plugs, be sure that the solid copper gaskets or washer-type thermocouple gaskets conform to the following limits: Maximum—.095 inch; minimum—.068 inch.

(g) Lubricate the threads with anti-seize compound and start the plug by hand and make sure that it turns freely before using the wrench.

CAUTION

Use every precaution to avoid dropping a plug. If a plug is dropped do not install it in an engine.

(b) Tighten all spark plugs with the proper wrench (Wright No. 84458) and a handle not more than 10 inches long. Use not more than 480 pound inches torque.

(i) Replace ignition cables, inserting the cable connectors straight into the spark plug shields, not at an angle. When each connector is in place, start its elbow nut by hand, making sure that it turns freely before tightening.

(j) Whenever checking the installation of shielded plugs, always check the terminals and elbows to see that they are securely tightened. Excessive tightening of the elbows will be avoided since this may cause rotation of the core with respect to the shell, thus closing the electrode gap. Elbow wrenches (Wright No. 800630) will be used for tightening terminal elbows.

(3) CYLINDER AIR DEFLECTORS.

(a) To accomplish minor repair work on the cylinder assemblies it is frequently necessary to remove cylinder head or cylinder barrel air deflectors.

(b) REMOVAL OF CYLINDER HEAD AIR DEFLECTORS.—Remove the rear spark plug ignition lead from the channel in the deflector. Break the lock wire and remove the fillister head screw which secures the attaching flange at the cylinder intake port. Break the lock wire from the two fillister head screws at the top of the deflector and remove the screws. The cross member is slotted to permit easy access with a screw driver.

(c) INSTALLATION OF CYLINDER HEAD AIR DEFLECTORS.

1. Place the air deflector in its approximate position on the cylinder head. Loosely install the three fillister head screws. Insure that lock washers are installed under each of the screws and tighten down each screw evenly. Lock wire each of the screws securely. If the cross members were disassembled, new elastic stop nuts should be used during assembly.

2. Place the rubber-covered ignition lead to the rear spark plug into its channel section in the deflector. Press the lead down into the channel so that it is below the contour of the cross members of the deflector.

(d) REMOVAL OF CYLINDER BARREL AIR DEFLECTORS.

1. To remove the cylinder barrel air deflectors of any of the upper five cylinders, it will first be necessary to remove the priming system tubes in accordance with the instructions outlined in paragraph (4).

2. Remove the intake pipes, using the procedure described in paragraph (5) below.

3. Remove the elastic stop nut and washer from the through bolt securing the cylinder barrel deflector and the barrel clamp. Remove the elastic stop nut and washer from the stud holding the deflector at the rocker box cover extension location. The rubber grommet and plate should be temporarily bolted to the deflector stud to prevent loss. Remove the cylinder barrel air deflector from the rear. It will not be necessary to remove the rubber packing unless replacement is required.

4. To remove the cylinder barrel air deflector from the sump section, remove the nut, retaining plate, and grommet securing the deflector to the rocker box cover extensions. Break the lock wire and remove the two cap screws securing the deflector to each leg of the sump. Withdraw the deflector to the rear.

(e) INSTALLATION OF CYLINDER BARREL AIR DEFLECTORS.

1. Place the air deflector in its approximate position between the cylinders.

2. Place the air deflector clamp so that the edges of the channel-shaped clamp fit into the fifth and eleventh fin space, counting the space between the first and second fin at the crankcase end of the cylinder as number one. Loosely install the through bolt through the deflector, spacer, and clamp. Install a new elastic stop nut but do not tighten at this time. Line up the deflector so that the stud protrudes through the space between the two rocker box cover extensions. Install the grommet and retaining plate; secure with a new elastic stop nut. Tighten the air deflector clamp at the base of the air deflector.

3. To install the air deflector at the sump location, place the deflector in its approximate position. Loosely install the two cap screws and washers securing the deflectors to the two legs of the sump. Line up the stud with the space between the two rocker box cover extensions; install the rudder grommet and retaining plate; and secure the assembly with a new elastic stop nut. Tighten the cap screw in the sump legs and lock wire securely.

(4) PRIMING SYSTEM.

(a) REMOVAL.—Detach the supply line from the distributor. Unscrew the priming tube union nuts from the fittings on the intake ports of the five upper cylinders and at the distributor nipples. If the same tubes are to be installed, tag, or otherwise mark, each priming tube to indicate to which cylinder it is attached. Remove the nut, washer, and bolts securing the priming tube clamps to the intake pipes. Spread open the clamps and remove the priming system tubes. It will be unnecessary to remove the distributor from the No. 1 cylinder intake pipe if this unit does not require replacement.

CAUTION

Exercise extreme care in removing the priming tubes to prevent their bending. A bent tube

will present great difficulty in installation and may restrict the flow of the priming charge in the tube.

(b) **INSTALLATION.**—Attach the distributor, if removed, to the clamp and place the clamp on the No. 1 cylinder intake pipe, facing the rear, at its approximate position. Do not tighten the clamp at this time. Place each priming tube in its approximate location and slip the clamps over the intake pipes. Install the nuts and bolts but do not tighten. Screw on the union nuts at the intake ports and the distributor. Tighten each union nut at the intake port and distributor locations. Tighten all the clamp nuts.

(5) **INTAKE PIPES.**

(a) **REMOVAL.**

1. The intake pipes of the upper five cylinders support the priming system. Before removing any of these intake pipes, remove the priming system tubes as described in paragraph (4).

2. Loosen the packing nut at the crankcase end of the intake pipe. This may be done with the special crowfoot-type wrench (Wright No. 84258), which fits the castellations on the nut.

3. Remove the three cap screws at the flanged end of the intake pipe. Remove the washers and pull the flange back from the intake port. Discard the gasket.

4. Withdraw the intake pipe from the supercharger section front housing. Remove the packing nut and packing. Discard the packing.

(b) **INSTALLATION.**

1. Install a new packing ring in the supercharger section front housing port and loosely install the packing nut.

2. Coat the crankcase end of the intake pipe with clean engine lubricating oil and insert into the supercharger section front housing.

3. Install a new gasket at the intake pipe attaching flange and the intake port parting surface, and install the three cap screws making sure that a shakeproof washer is installed under the head of each cap screw. Tighten each cap screw evenly, and lock wire securely. Tighten the packing nut at the crankcase end of the intake pipe, using the crowfoot-type wrench and handle.

(6) **OIL SUMP.**

(a) **REMOVAL.**

1. If not already removed, remove the No. 5 cylinder intake pipe as outlined in paragraph (5) and the cylinder air deflectors as described in paragraph (3).

2. Break the lock wire, and remove the screened and magnetic drain plug, and disconnect the external scavenge oil line from the bottom of the sump. Drain the oil into a clean receptacle, strain, and examine carefully for foreign material. Reinstall the plugs loosely in their proper locations to prevent their loss.

3. Remove the three palnuts, nuts, and washers securing the front attaching flange to the crankcase front section.

4. Support the sump and remove from each arm of the sump the two palnuts, nuts, and washers which secure it to the supercharger section front housing. Withdraw the sump.

(b) **INSTALLATION.**

1. Remove the screened plug (Wright wrench No. 02058) and the magnetic plug from the bottom of the sump.

2. Install new gaskets at the mounting flange locations. Make sure that the oil holes line up perfectly with the holes in the sump.

3. Place the sump in its proper position and install the washers and nuts. Tighten all nuts evenly with a torque of 225 to 250 pound-inches. Install palnuts on each of the studs with their smooth faces against the plain nuts. Tighten with the fingers, and then turn 1/6 turn with a wrench.

4. Reinstall the screened and magnetic drain plugs and the external oil line leading to the oil pump, using new gaskets under each. Lock wire the plugs securely together.

5. Reinstall the air deflectors and intake pipes as directed in paragraphs (3) and (5) respectively.

(7) **PUSH RODS AND VALVE TAPPETS.**

(a) **REMOVAL AND DISASSEMBLY.**

1. The following procedure is given for cases in which it is desired to remove a push rod without removing the rocker arm hub bolt, or disturbing the torque setting which has previously been applied to the rocker bolt nut.

a. Remove the clips securing the ignition leads of the manifold to the push rod housings. It will be unnecessary to remove the clips from the leads.

b. Loosen the two hose connection clamps using a socket wrench (Wright No. 801122) at the crankcase end of the push rod housing, and the single hose clamp at the cylinder end of the housing. Slide the crankcase end hose connection along the push rod housing until the bead on the end of the housing is visible.

c. Remove the nuts, lock washers, and plain washers from the four rocker box cover attaching studs of the rocker box, and remove the cover. Loosen all adjusting screw lock screws in the rocker arm and screw the adjusting screw all the way out to its stop. Screw the push rod removing tool onto the extended threads of the valve clearance adjusting screw and insert the handle to serve as a lever and compress the valve spring. The push rod, housing, and hose connection may be removed as a unit through the slot in the tappet guide.

2. If the special push rod removing tool is not available, it will be necessary to remove the rocker arm

before the push rod can be withdrawn. Remove the rocker box cover as previously described. Remove the cotter pin from the rocker bolt nut and remove the nut. Turn the crankshaft so that the valve is seated and a clearance exists between the rocker roller and the valve stem. Push or drive out rocker bolt, being careful not to damage the bolt threads, and remove the spherical seat washer from each end. Lift out the push rod and remove the housing by loosening the clamps and sliding the crankcase end connections along the housing.

Note

Push rods will be marked with an electric pencil or tagged to indicate their location. Replace in same location. If new ones are installed, mark their location prior to installation.

3. Remove the loose fitting valve tappet ball socket and mating spring, turning the crankshaft, if necessary, to push the tappet in reach. Remove the pal-nuts, nuts, and washers from the two tappet guide attaching studs, and withdraw the tappet and guide assembly from the crankcase front section. If the guide cannot be removed by hand, use a tappet guide puller. This consists of a rod which clamps to the bead on the tappet guide and weight which slides along the rod to provide the necessary inertia for removing the guide. Remove the gasket under the guide flange.

4. The tappet and guide assembly may be separated by inserting the hooked end of the valve tappet circlet removing tool, under the retaining circlet to effect its removal. *Do not attempt to make the circlet jump out of its groove by striking the hollow end of the tappet with a drift.* Care should be taken to avoid loss of any of the parts during this operation, as the floating tappet roller, bushing, and pin are exposed when the retaining circlet is removed. The tappet may be separated from its guide, and complete disassembly of the roller and bushing effected by pushing the floating pin out of the slotted end of the tappet.

(b) ASSEMBLY AND INSTALLATION.

1. Place the tappet roller, equipped with its floating bronze supporting bushing, in the slotted end of the tappet and insert the floating pin. Slide the tappet and roller into the tappet guide and install the retaining circlet with the installing tool. See figures 115 and 235. Install a new gasket under the tappet guide flange and insert in the crankcase front section. Install a plain washer, nut, and palnut on each of the two attaching studs. Insert the coiled spring and valve tappet ball socket into the hollow tappet. Be sure that all parts are thoroughly coated with engine oil before assembly.

2. Install a new short hose connection and one clamp on the rocker box end of the push rod housing. This end of the push rod housing may be identified by the location of the beading which is approximately 3/8 inch from the end. Install new hose connection and two clamps on the crankcase end of the housing. The

installation of the hose connections will be facilitated if a thin coat of engine oil is placed on the housing.

3. When assembling a push rod assembly which was withdrawn without removing the rocker arm, proceed as follows:

a. Oil the push rod ball end and insert the push rod in its housing having the hose connection at the crankcase end flush with the bead on the housing.

b. Compress the valve spring and rocker arm, using the tool described in the removal instructions. With the valve spring compressed, slide the push rod housing hose connection into the position at the rocker box and push the crankcase end of the push rod through the slot in the tappet guide.

c. Remove the valve spring compressing tool from the rocker box arm. Push the push rod housing all the way into its rocker box hose connection, and tighten the hose clamp. Slide the crankcase hose connections over the tappet guide and tighten both hose clamps.

d. Set the valve clearance in accordance with the instructions in paragraph d., below.

4. If the rocker arm was removed when the push rod was removed, the following additional instructions are applicable:

a. With the hose connections and clamps assembled on the push rod housing, install the housing on the engine, pushing it all the way into its rocker arm hose connection while tightening the clamp. Slide the crankcase end hose connection over the tappet guide and tighten both clamps.

b. Oil the push rod ball ends with clean engine lubricating oil and insert in the push rod housing through the rocker box. Install the rocker arm and insert the rocker bolt through its hub. Insure that the spherical seat washers are installed at each end of the through bolt. The bolt should be installed with the head facing the cylinder head center line.

c. Before tightening the castellated nut on the rocker bolt, check the end clearance between the bearing inner race and the rocker box. If it is over .015 inch, remove the bolt and install a shim to take up the excess.

d. Tighten the rocker bolt nut with a torque of 300 to 325 pound-inches, using the torque indicating handle. If the hole in the bolt cannot be lined up when using the correct torque value, remove the nut and install a new washer. Repeat the above procedure. Install a new cotter pin of the correct size.

e. Set the valve tappet clearance in accordance with the instructions outlined in paragraph d.

f. Fill the rocker boxes with clean engine lubricating oil and install a new gasket over the rocker box cover attaching studs. Install the cover and secure with plain washers, shakeproof washers, and nuts.

g. Reinstall the ignition harness retaining clips on the push rod housing, if removed.

(8) CYLINDERS, VALVES, AND PISTONS.

(a) CYLINDER REMOVAL.

1. Remove the four exhaust stack attaching nuts and lock washers. It may be necessary to remove all or part of the exhaust manifold in order to facilitate the removal of the cylinders.

2. Disconnect the ignition leads to the front and rear spark plug terminals and remove the air deflectors in accordance with the instructions given in paragraph (3).

3. Remove the intake pipe, following the instructions in paragraph (5). It may be necessary to remove the intake pipe of the adjacent cylinder for accessibility.

4. Remove the rocker box covers, rocker arms, push rods, and housing according to paragraph (7).

5. To remove cylinders adjacent to the two main front-to-rear ignition shielding conduits, it will be necessary to remove the attaching clamps and the

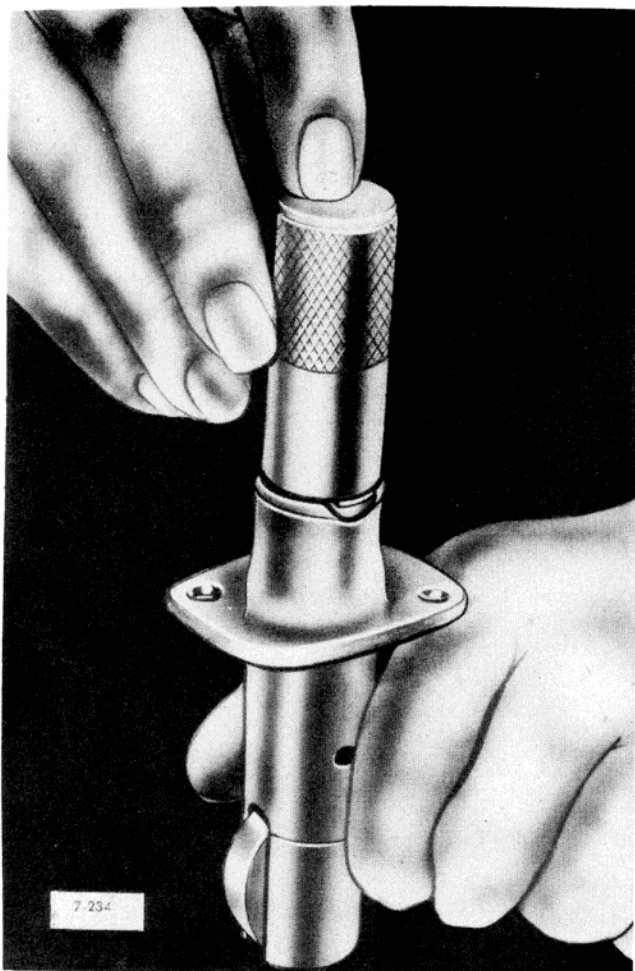


Figure 115—Installing Valve Tappet in Guide

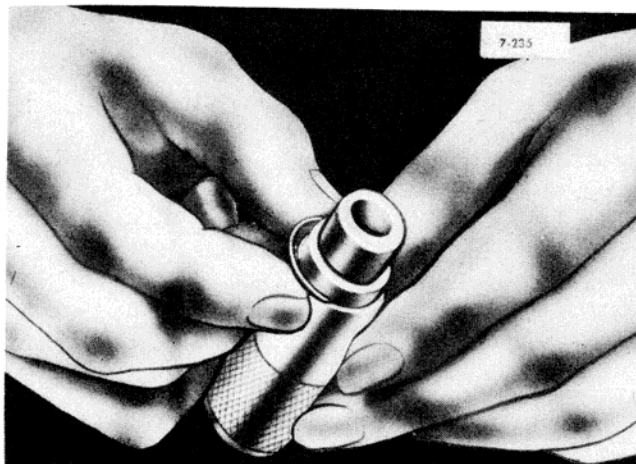


Figure 116—Installing Valve Tappet Retaining Circlip

knurled nuts on the shield assembly. Otherwise the cylinder hold-down cap screws will not be accessible.

6. To remove the cylinders adjacent to the oil sump, the oil sump must first be removed following the instructions outlined in paragraph (6).

7. Remove the spark plugs. See paragraph (2).

8. Turn the crankshaft until the piston of the cylinder being removed is at the top of its stroke. Break the safety wire from the cylinder hold-down cap screws and remove the cap screws, using a box wrench (Wright No. 82860). Remove the spherical seat washers from the cylinder flange, and pull the cylinder out straight, clear of the piston.

9. As the cylinder is being removed from the engine, but before the cylinder skirt clears the bottom piston ring, a cloth should be drawn around the connecting rod and spread over the cylinder hole to prevent pieces of broken piston ring from falling into the crankcase.

10. Install a connecting rod guide on the cylinder pad and secure it temporarily with two cap screws. If the cylinder is to be used again, install a fin protector around the cylinder.

(b) PISTON REMOVAL.

1. See figure 117, which shows the application of the retainer removing tool (Wright No. 84377). Remove both piston pin retainers by inserting the spade-shaped end of the tool between two of the coils of the spring and turning the handle 90 degrees. Pry out the spring, resting the leg of the tool against the wall of the piston. Place one hand over the piston pin bore to catch the retainer as it is pried out.

2. Push the piston pin out of the piston with fingers. If the pin is tight or stuck, it may be removed as shown in figure 118. Encircle the piston with the felt-lined stirrup of the tool and turn down the splindle which forces out the piston pin. Cover the cylinder pad on the crankcase to prevent the entrance of any foreign material.

(c) PISTON INSTALLATION.

1. Install a new piston pin retainer in the rear piston pin retainer groove of each piston in the following manner: Place the retainer in the installation tool (Wright No. 800197) with the spring joint approximately 90 degrees either side of the cut-out in the tool. Install the piston pin in the piston with the large diameter of the chamber flush with the inner edge of the retainer groove. Insert the end of the installing tool in the piston pin from the side of the piston in which the retainer is to be installed, with the cut-out portion of the tool at the top of the piston pin hole. While performing this operation, locate the top section of the retainer spring in the top section of the groove. Install the adapter in the opposite end of the piston pin and, while holding the pin in position with one hand, apply pressure on the installing tool with the other, and force the spring into its seat in the retainer groove. Remove the installing tool and piston pin.

2. Turn the crankshaft so that the connecting rod is at the top of its stroke. Oil the piston pin, connecting rod, piston pin bushing, and piston pin bore with clean engine lubricating oil. Install the piston so that the part numbers stamped on the dome of the piston, face the rear. Insert the piston pin so that it bottoms against the retainer spring previously installed. Install the remaining retainer in the same manner as the first, using the installing tool.

(d) CYLINDER INSTALLATION.

1. Coat the cylinder barrel bore with clean engine oil and install a new oil seal ring below the hold-down flange. Thoroughly coat the piston and rings with clean engine oil; however, do not use excessive oil as drainage into the combustion chamber may cause fouling of the spark plugs. Set the piston rings so that the gaps are equally spaced (staggered) around the piston. Remove the connecting rod guide from the cylinder pad. Make sure that the cylinder pad is clean and dry.



Figure 117—Removing Piston Pin Retainer

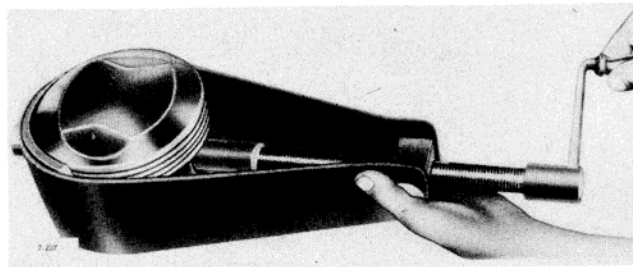


Figure 118—Removing Piston Pin

2. Compress the upper piston rings with the flexible piston ring clamp and slide the cylinder over the piston. As soon as the top five rings have entered the cylinder, remove the clamp and inspect the piston pin retainers to insure that they are in their proper position. Install the clamp over the single lower ring, compress the ring, and slide the cylinder into its proper location on the crankcase.

3. Install two cylinder hold-down locating cap screws on opposite sides of the cylinder, and tighten with a torque wrench to approximately 300 pound-inches. This prevents incorrect seating of spherical washers. Lubricate the regular hold-down cap screws with Glyptal and install finger tight with spherical seat washers under the heads. Do not install any clips, washers, or brackets except those supplied with the engine under the cylinder hold-down cap screws.

4. Using a torque of approximately 300 pound-inches (Wright wrench No. 82860), tighten two cap screws on opposite sides of the cylinder and approximately 90 degrees from each of the locating cap screws. Using the same torque, tighten two more cap screws on opposite sides of the cylinder and approximately 45 degrees from the last. Proceed in this manner until all cap screws are tightened. Remove the locating cap screws and replace with standard bolts and washers, using approximately 300 pound-inches torque. Finally, tighten all of the cap screws consecutively around the cylinder, using 375 to 400 pound-inches torque.

5. The following precautions will be observed when using a torque wrench:

a. Be sure the wrench does not bind on any part of the engine.

b. Install the wrench in such a position that the cap screw may be pulled up to the required tightness without interruption.

c. The torque load should be applied until the bolt has ceased to turn. This requires several seconds from the time that the indicator reaches the desired torque value.

6. Install the spark plugs loosely in the cylinder head to prevent the entrance of foreign material.

7. Safety wire the cylinder hold-down cap screws using a length of wire for each group of five cap screws. Twist the wire one turn between cap screws and twist together securely at the ends.

8. Install the cylinder barrel air deflectors in accordance with the procedure outlined in paragraph (3).

9. For cylinders No. 5 and No. 6, it will now be necessary to install the sump according to the instructions set forth in paragraph (6).

10. Install the intake pipe on the cylinder being installed, as well as the adjacent intake pipe which was removed for accessibility. Instructions for this procedure are found in paragraph (5).

11. Install the push rod housings, push rods, and rocker arms according to the procedure outlined in paragraph (7). If interference exists between the rocker arm and standard valve spring washer, it will be necessary to replace the valve spring upper washer with one having an undersize bore. This requires removal of the cylinder to a valve assembly block as previously described in this section.

12. After installation of any cylinder above the horizontal center line, fill the rocker boxes with engine oil to assure ample lubrication when engine is started the first time. Install the rocker box covers with gaskets, using a plain washer, a shakeproof washer, and a nut on each of the attaching studs. Install the ignition wire attaching clips on the proper push rod housings and rocker boxes.

13. Tighten the spark plugs in the cylinder head. Refer to paragraph (2).

14. On cylinders which were installed adjacent to the two main radio shielded ignition conduits, it will be necessary to attach the retaining yokes and tighten the couplings of the radio shielding.

15. Install the cylinder head air deflector unit according to the instructions given in paragraph (3), and connect the spark plug ignition terminals.

(9) BENDIX-STROMBERG INJECTION CARBURETORS.

(a) REMOVAL.

1. Disconnect the throttle and mixture controls and remove all lines to connections in the carburetor and adapter.

2. Remove the palnuts, nuts, and plain washers securing the turbo supercharger pressure duct to the carburetor. Disconnect the duct at the flexible connection at the fire wall, and remove the duct section and gasket.

3. Remove the cotter pins, nuts, and spherical seat washers securing the carburetor to the rear engine housing. Remove the carburetor and gasket.

4. Cover the opening into the induction chamber with a suitable cover or plate to prevent the entrance of foreign material into the induction chamber.

(b) INSTALLATION.

1. Before installing a replacement carburetor, remove all drain plugs and drain off any oil not re-

moved at the time of preparation for shipment or storage. Replace the plugs and safety wire.

2. Remove the cover plate from the mounting pad on the supercharger section rear housing. Install a new gasket over the mounting studs. Place the carburetor in position over the mounting studs and install the spherical seat washers. Install the nuts, drawing them up snugly against the washers. Tighten all the nuts evenly, lining up the cotter pin holes and cotter pinning securely.

3. Place a new gasket over the pressure duct mounting studs and install the duct, securing it with plain washers, nuts, and palnuts. Connect the pressure duct at the fire wall.

4. Connect the throttle, mixture, and heater controls and all other connections to the carburetor and adapter.

5. Check all controls for ease of operation through their full range of travel.

(10) IGNITION WIRE HARNESS.

(a) REMOVAL.

1. Disconnect the spark plug terminals from the front and rear spark plugs. Remove the clips securing the harness leads to the push rod housings and withdraw the ignition leads from the channel sections in the cylinder head air deflector.

2. Remove the rocker box covers from the rocker boxes of cylinders No. 1 exhaust, No. 1 intake, No. 2 exhaust, and No. 9 intake.

3. Remove the priming system tubes as directed in paragraph (4).

4. Remove the cylinder barrel air deflectors from between cylinders No. 1 and No. 2, and No. 1 and No. 9. See instructions in paragraph (3).

5. Remove the intake pipes of cylinders No. 1 and No. 9 as directed in paragraph (5).

6. Remove the four clips securing the harness to the supports, which are bolted to the crankcase front section at the housing parting surface location.

7. Disconnect the ignition harness at the coupling flange on each magneto and disconnect the coupling from the radio shield. Remove the two screws holding together the two halves of the shield assembly.

8. Remove the two fastening screws holding the radio shield to the magneto gear housing and the two fastening screws holding the shield to the dust cover. Withdraw the two halves of the shield assembly.

9. Loosen the dust cover, including the booster conductor assembly, by removing the two fastening screws. Raise cover slightly and push toward engine.

10. Remove the two distributor block fastening nuts. Lift the distributor blocks vertically from each magneto and remove the complete ignition harness.

(b) DISASSEMBLY AND ASSEMBLY.

1. If any part of the ignition harness is damaged, the part may be removed from the harness assembly by loosening one or more of its adjacent knurled couplings.

2. When replacing an ignition wire, solder or securely attach the new wire to the end of the wire being replaced. Dust the wire with talc and pull it carefully into the ignition harness.

Note

Lead or silver solder (U. S. Army Specification No. 57-99-1, 1/8-inch diameter rod) will be used in resoldering any part of the ignition manifold assembly. Extreme care will be taken to avoid burning any adjacent cables.

3. If a spark plug terminal is replaced or re-installed, the following procedure should be used:

a. Straighten out the ignition cable strands, which are fanned out at the base of the coiled contact spring, and pull the spring and sleeve assembly from the end of the cable. Loosen the knurled coupling securing the terminal elbow to the spark plug conduit and withdraw the elbow and rubber packing gland.

b. Install the replacement spark plug terminal elbow, using a new rubber packing.

c. Make sure the contact spring and washer assembly is not loose in the terminal sleeve of the replacement terminal. This may be checked by inserting a 1/4-inch diameter rod in the sleeve bottoming on the contact washer. Place the other end of the rod on a scale and hold the sleeve with the fingers. Press down on the sleeve with a 12- to 13-pound load and observe the washer and sleeve for movement. Repeat the procedure with the sleeve inverted on the rod. If the contact washer moves in either direction, the sleeve assembly should be replaced.

d. Twist the ends of the ignition cable slightly and insert the cable into the contact sleeve. The stripped end of the cable should protrude through the hole in the washer at the base of the contact spring about 1/8 inch. Fan the strands of cable around the washer and press the strands securely into position over the end of the contact washer nipple by means of a short copper tube (1/8-inch inside diameter).

e. Be sure that the terminal sleeve fits snugly into the recess in the terminal elbow and tighten the knurled coupling nut, securing the terminal assembly to the radio shielding.

4. To separate the magneto distributor block from the ignition cables, remove the insulation plate by hand and disconnect the spark plug cable by loosening the piercing screws. Disconnect the booster cable from the booster conductor by loosening the cable piercing screw.

5. To assemble the magneto distributor block to the ignition cables, proceed as follows:

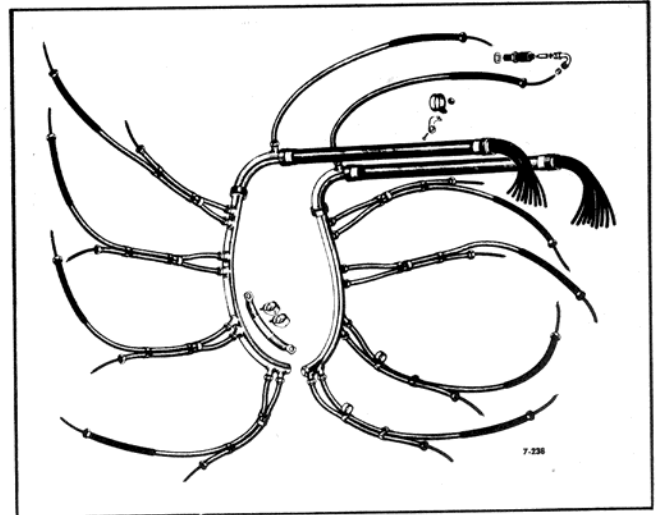


Figure 119—Ignition Wiring Diagram

a. Insert the cables through the ignition harness attaching flange.

b. Separate insulating plate from distributor block by hand and remove cable piercing screws and lock washers from the block. Insert the spark plug cables in the proper distributor block holes according to the following table, making sure that each cable seats properly in the bottom of the cable hole, and securing it with the lock washer and piercing screw.

Magneto Distributor Block Number Cylinder Number

1	1
2	3
3	5
4	7
5	9
6	2
7	4
8	6
9	8

c. Connect the booster magneto cable conductor to the booster and secure it with the cable piercing screw.

6. Before installing the ignition shielding assembly, check the ignition wiring for charts or open circuits and to ascertain whether the ignition cables lead to the proper cylinder from the magnetos.

a. To test for a short circuit due to faulty insulation of the cable, a booster magneto should be used. Connect the high tension terminal of the booster magneto to a distributor block electrode and hold the spark plug end of the corresponding ignition cable about 3/8 inch from a suitable ground. If a good spark does not jump the gap, examine the cable for faulty insulation.

b. To test for an open circuit in a cable and to check the firing order of the cylinders, a buzzer or light system should be used. Touch the distributor block electrode with one contact, and the spark plug end of

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the cable with the other contact. The circuit is complete if the buzzer signals or the lamp lights. If the circuit is not complete, check for a possible open circuit or wrong connection of the cables.

c. Tighten all the knurled shielding coupling nuts and cap screws.

7. INSTALLATION.

a. Place the ignition harness in its approximate position on the engine and insert the magneto distributor block in its recess in the magneto housing, using extreme care not to damage the contact buttons.

b. Secure the dust cover, including the booster assembly to magneto housing; assemble the radio shield and install with the fastening screws.

CAUTION

When installing the radio shielding, make certain that the screws holding the shield to the gear housing are tightened before the screws holding the shield to the duct cover are inserted.

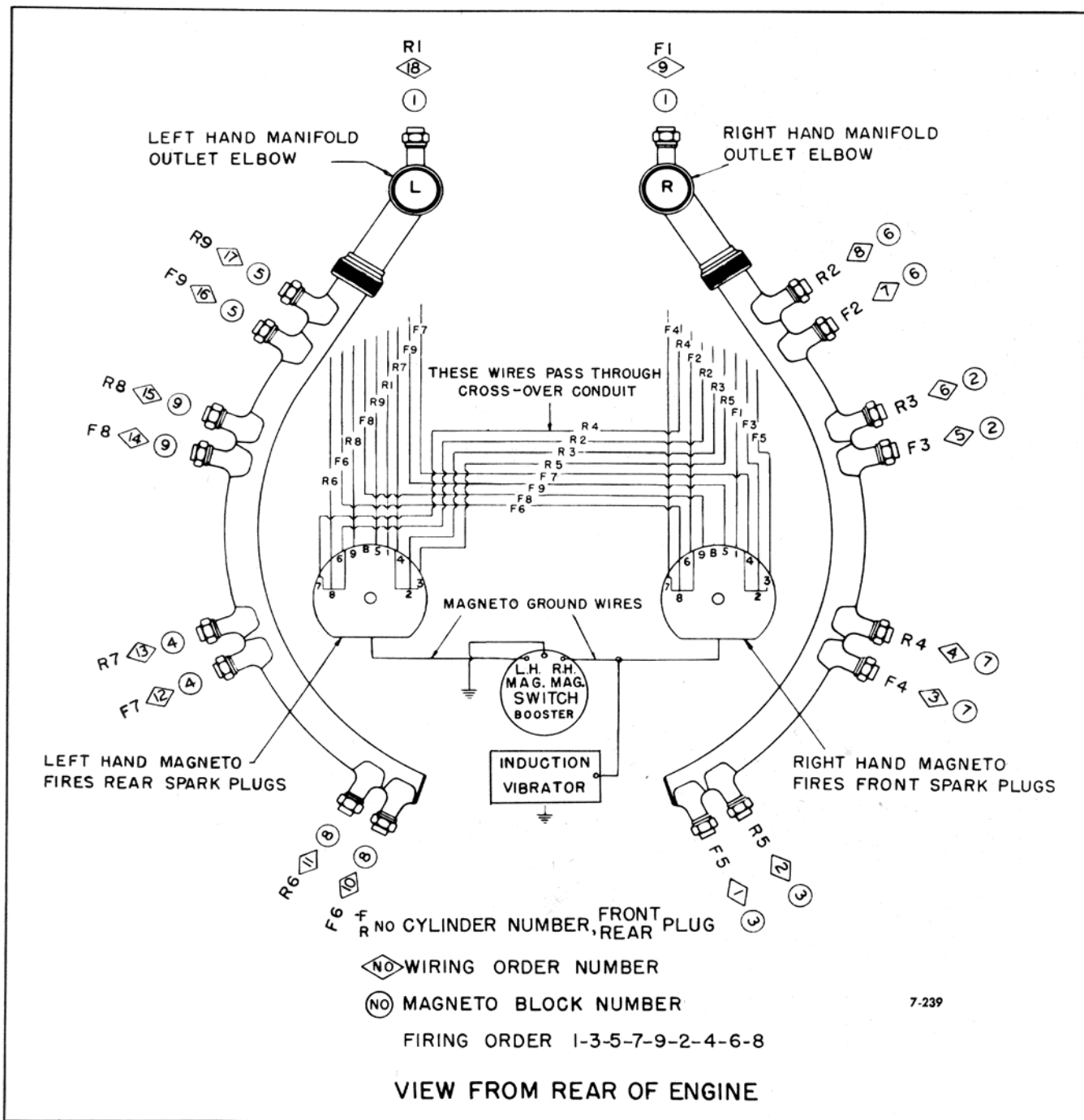


Figure 120—Engine Manifold Diagram

c. Install the four clamps, securing the two halves of the ignition harness to the four supports which are bolted to the crankcase front section.

d. Attach the flexible radio shielded ignition leads to the push rod housings by means of the clamps, and secure the ignition leads for the front and rear of each cylinder together by means of clamps, to prevent vibration of the leads.

e. Install the cylinder barrel air deflectors as outlined in paragraph (3).

f. Install the priming system tubes and intake pipes as directed in paragraphs (4) and (5) respectively.

g. Place the rear ignition leads in their respective locations in the channel sections of the cylinder head air deflectors, and attach the terminals to the spark plugs. Attach the front spark plug terminals to their respective spark plugs.

(c) MAGNETO GROUND TERMINAL.

1. REMOVAL.

a. Loosen the knurled coupling joining the radio shielded ground wire to the "Y" junction.

b. Loosen the knurled coupling joining the radio shielded ground wire which interconnects the two magneto ground junctions.

c. Remove the bail wire from the castella-tions on the ground terminal retaining nut, and with-draw the magneto ground terminal assembly complete.

d. Pull the brass contact away from the rub-ber washer and insulating sleeve, and melt the solder at the ends of the contact. Withdraw the wire from the contact and sleeve assembly.

2. INSTALLATION.

a. Strip back the insulation from the ground wire for about 3/16 inch and twist the wire tightly. Install the insulating sleeve with the flange toward the

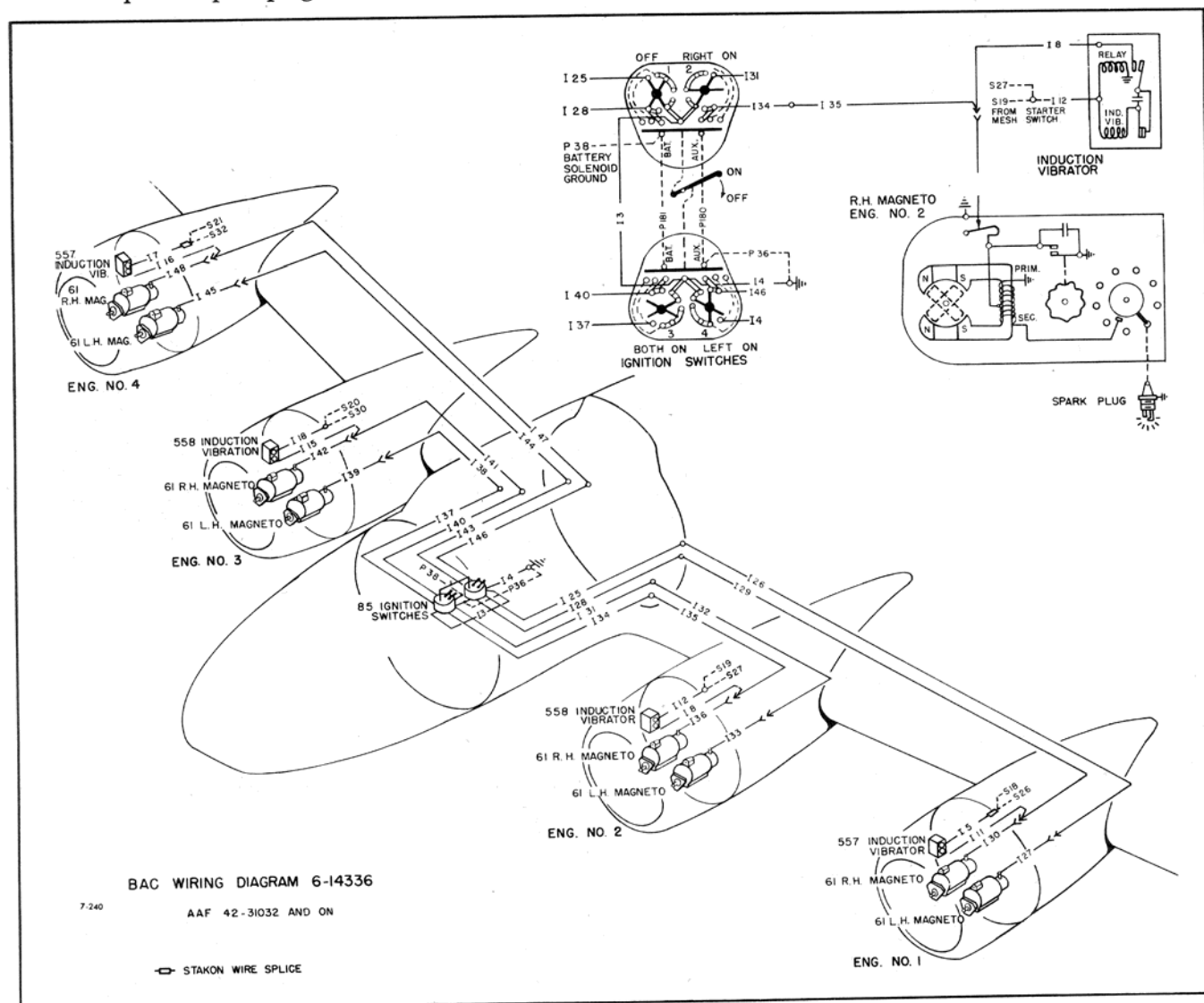


Figure 121—Ignition Control Circuit (1)

end of the wire. Install the rubber washer and insert the wire through the brass contact button. Pull the insulating sleeve and rubber washer away from the contact, and fan the wire out slightly. Solder the wire to the contact button, and file the solder flush with the end of the contact.

b. Insert the ground terminal into the sleeve in the magneto breaker housing and secure the assembly with the knurled nut. Lock the knurled nut with the spring wire lock ring. With the terminal inserted and held firmly in place by the slotted nut, clearance between the automatic grounding spring in the breaker assembly and the gear housing rim must be at least $\frac{3}{32}$ inch.

Note

American Bosch aviation magnetos are furnished with a short-circuiting spring which will automatically contact the inner rim of the gear housing when the terminal assembly is removed, thereby short circuiting the primary circuit. This prevents the possibility of a high tension secondary voltage being built up, which might otherwise result in unexpected ignition. Whenever the switch cable is connected to the magneto, however, the ignition switch must be kept in the "OFF" position and the ignition plug must be installed at the fire wall to prevent accidental starting of the engine.

c. Tighten the knurled coupling nuts securing the radio shielding at both ends of the "Y" terminal or install the cap if the terminal is not used.

(11) MAGNETOS.

(a) REMOVAL.

CAUTION

In removing magnetos disconnect the high tension loads from the magnetos *before* removing the ground lead, to assure control at the ignition switch at any time the magneto is in operating condition.

1. Remove the magneto air blast tube. Remove the coil cover and distributor block in accordance with instructions in paragraph (10).

2. Remove the magneto ground terminal as directed in paragraph (10).

3. Right and left magnetos are not interchangeable. However, in view of the fact that all the high tension ignition wires are secured to the distributor block, the block of a magneto may be used in a replacement magneto of the same type, unless the block requires repair.

4. Remove the breaker housing cover which exposes the cam and contact breakers.

5. With the ignition switch "OFF" and the mixture control set in "ENGINE OFF," turn the engine crankshaft in the direction of normal rotation, until the

step cut in the breaker cam lines up with the timing mark "T" cut in the rim of the breaker cup, as indicated by a straight edge. (See figure 122.) At this point the rotor is in a position to distribute a spark to No. 1 cylinder.

6. Remove the cotter pins, castellated nuts, and washers from each of the three magneto attaching studs, holding the magneto to keep it from dropping.

CAUTION

Do not disturb the engine crankshaft setting thus obtained, until the replacement magneto has been installed.

(b) INSTALLATION.

1. It is assumed in the following instructions that the replacement magneto is correctly timed internally.

2. Break the safety wire on the timing plug, located on the left side of the crankcase front section, and remove the plug with its copper-asbestos gaskets. If the crankcase has not been turned since the magneto was removed, the piston in No. 1 cylinder should be on 20 degrees before top center of its compression stroke. A crank angle degree scale, (0 to 35 degrees before top center on No. 1 piston) can be seen at the rear of the timing inspection hole on the reduction driving gear. Move the propeller until the line scribed on the rear of the timing inspection hole indexes with the 20 degrees before top center line on the reduction driving gear.

3. Remove the radio shield, dust cover, distributor block and breaker cover from the magneto.

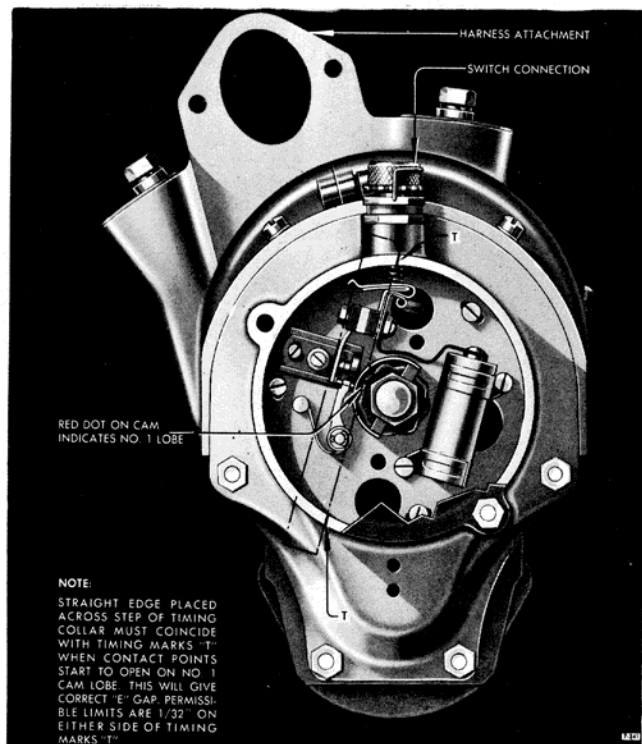


Figure 122—Magneto