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June, 1942

AIR PUBLICATION 2014A  
Volume I  
(Second edition)

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(PART 1 OF 2)

## THE KITTYHAWK I AEROPLANE

(Curtiss Model H-87A-2 and H-87A-3)

AND

## THE KITTYHAWK IA AEROPLANE

(U. S. Army Air Forces Model P-40E-1)

PROPERTY OF THE  
NATIONAL AIR & SPACE MUSEUM  
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JAN 23 1984

500 pages

NOTE: The main body of this handbook covers the Kittyhawk I aeroplane only. Appendix I at the end of this handbook indicates the differences between the Kittyhawk I and IA and also gives information peculiar to the Kittyhawk IA.

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Volume I

The amendments promulgated in the undermentioned amendment lists have been made in this publication.

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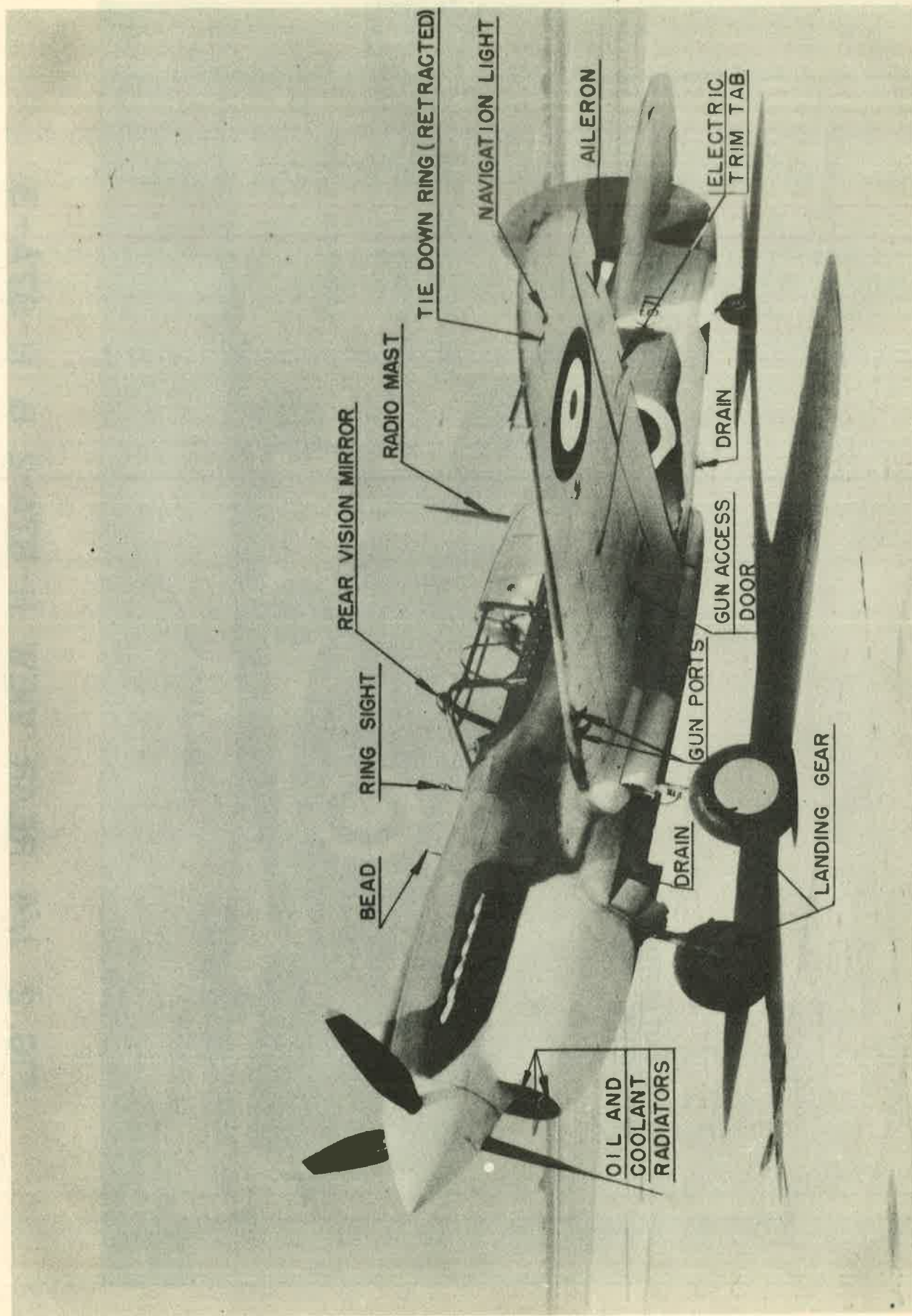


FIG.1 AIRPLANE- 1/4 FRONT VIEW- H-87A-2



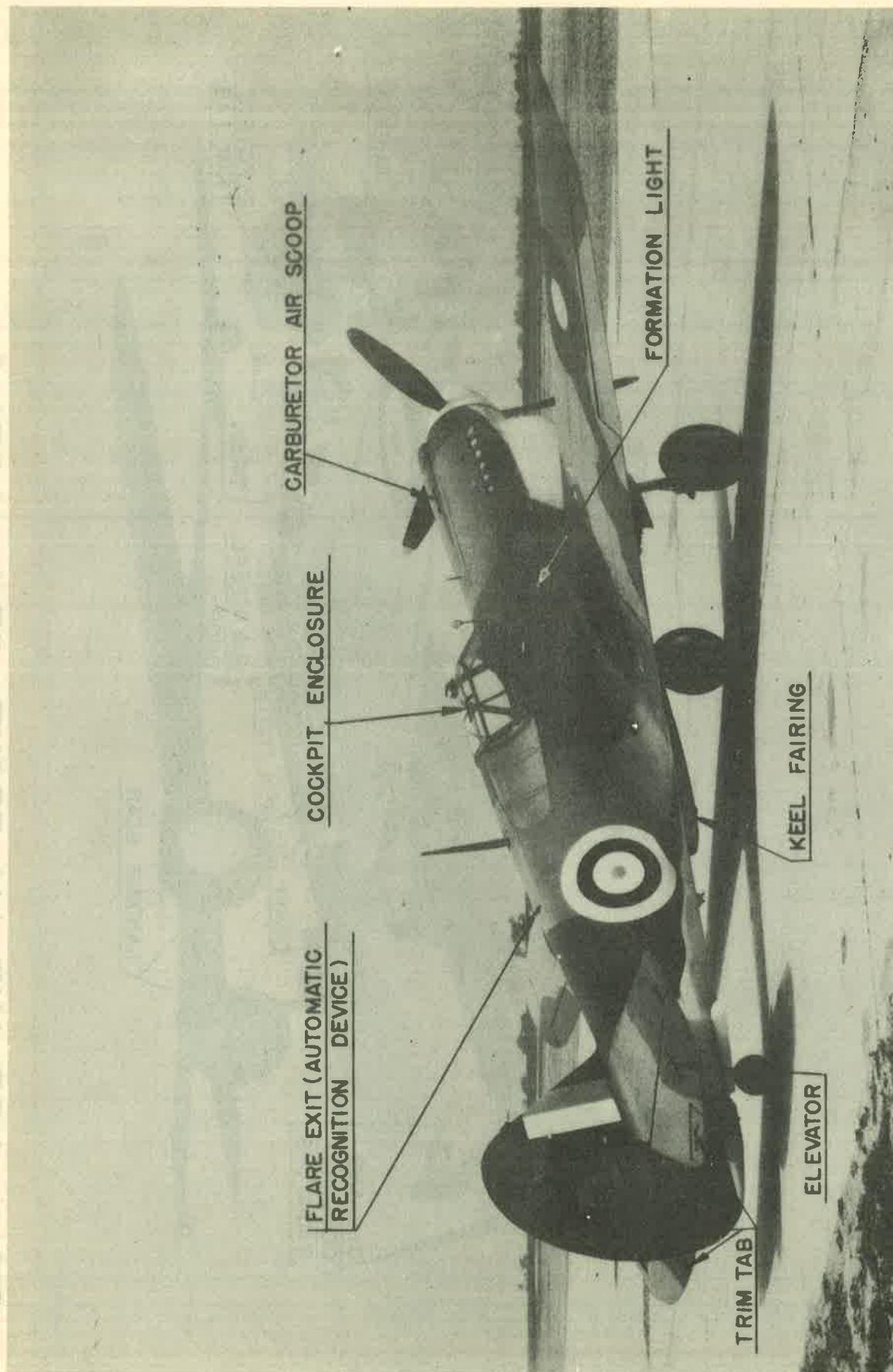


FIG. 2 1/4 REAR VIEW H-87A-2 & H-87A-3

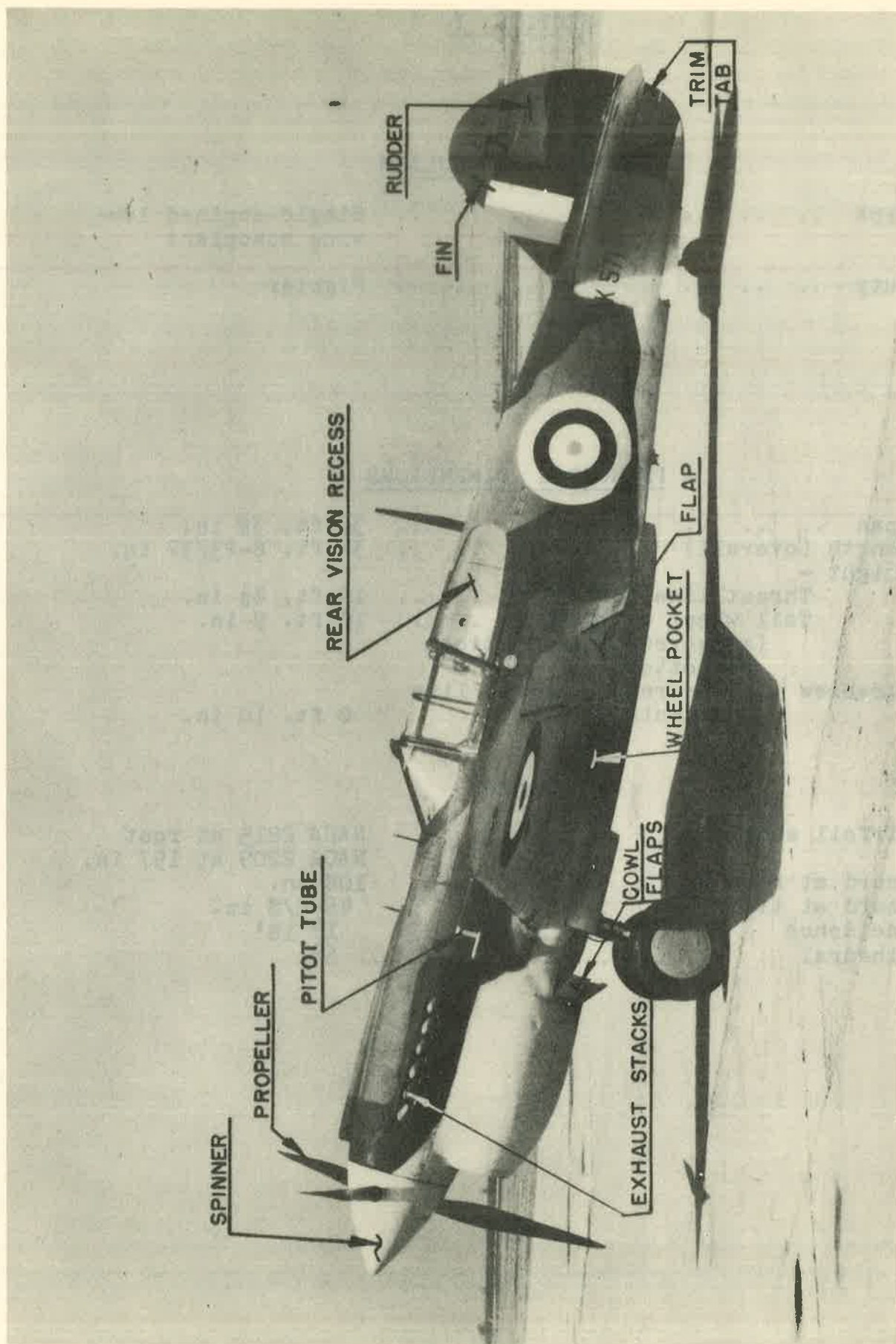


FIG. 3 SIDE VIEW - L. H. SIDE H-87A-2 & H-87A-3

## SECTION I

### LEADING PARTICULARS

|      |    |    |    |    |    |    |    |                                   |
|------|----|----|----|----|----|----|----|-----------------------------------|
| Type | .. | .. | .. | .. | .. | .. | .. | Single-engined low-wing monoplane |
| Duty | .. | .. | .. | .. | .. | .. | .. | Fighter                           |

### PRINCIPAL DIMENSIONS

|                                                 |    |    |    |    |    |    |    |                            |
|-------------------------------------------------|----|----|----|----|----|----|----|----------------------------|
| Span                                            | .. | .. | .. | .. | .. | .. | .. | 37 ft. 3 $\frac{1}{2}$ in. |
| Length (overall)                                | .. | .. | .. | .. | .. | .. | .. | 31 ft. 8-23/32 in.         |
| Height -                                        |    |    |    |    |    |    |    |                            |
| Thrust line horizontal                          | .. | .. |    |    |    |    |    | 12 ft. 4 $\frac{1}{2}$ in. |
| Tail wheel on ground                            | .. | .. |    |    |    |    |    | 10 ft. 9 in.               |
| (airscrew blade vertical at bottom)             |    |    |    |    |    |    |    |                            |
| Airscrew tip clearance (thrust line horizontal) |    |    |    |    |    |    |    | 0 ft. 10 in.               |

### Wings

|                 |    |    |    |    |    |                      |
|-----------------|----|----|----|----|----|----------------------|
| Airfoil section | .. | .. | .. | .. | .. | NACA 2215 at root    |
|                 |    |    |    |    |    | NACA 2209 at 197 in. |
| Chord at root   | .. | .. | .. | .. | .. | 108 in.              |
| Chord at tip    | .. | .. | .. | .. | .. | 46-5/8 in.           |
| Incidence       | .. | .. | .. | .. | .. | 10° 18'              |
| Dihedral        | .. | .. | .. | .. | .. | 6°                   |

## Tail Plane

|                   |         |                  |
|-------------------|---------|------------------|
| Span (overall)    | .. .. . | 12 ft. 9-5/8 in. |
| Incidence (fixed) | .. .. . | +2°              |

AREAS

|                                  |         |              |
|----------------------------------|---------|--------------|
| Wings (including ailerons)       | .. .. . | 236 sq. ft.  |
| Ailerons (total, including tabs) | .. .. . | 18.41 sq.ft. |
| Flaps (total)                    | .. .. . | 34.80 sq.ft. |
| Tail plane, with elevators       | .. .. . | 48.30 sq.ft. |
| Elevators (two)                  | .. .. . | 17.44 sq.ft. |
| Fin                              | .. .. . | 7.0 sq.ft.   |
| Rudder                           | .. .. . | 13.74 sq.ft. |

SETTINGS AND RANGES OF MOVEMENT OFCONTROL SURFACES

|                        |         |              |
|------------------------|---------|--------------|
| Tail plane             | .. .. . | Fixed        |
| Fin offset             | .. .. . | 1½° to port  |
| Aileron                | .. .. . | 18-3/4° up   |
|                        |         | 10-3/4° down |
| Flaps                  | .. .. . | 45° down     |
| Elevators              | .. .. . | 30° up       |
|                        |         | 20° down     |
| Elevator trimming tabs | .. .. . | 3° up        |
|                        |         | 26° down     |
| Rudder                 | .. .. . | 28° each way |
| Rudder trimming tab    | .. .. . | 20° each way |

(Note. Tolerances are given in relevant parts of text)



ALIGHTING GEARUndercarriage

|                       |    |    |    |    |    |    |    |    |                                                |
|-----------------------|----|----|----|----|----|----|----|----|------------------------------------------------|
| Type                  | .. | .. | .. | .. | .. | .. | .. | .. | Retractable                                    |
| Track                 | .. | .. | .. | .. | .. | .. | .. | .. | 8 ft. 2-1/8 in.                                |
| Shock absorber struts | .. | .. | .. | .. | .. | .. | .. | .. | Oleo-pneumatic                                 |
| Air pressure          | .. | .. | .. | .. | .. | .. | .. | .. | 204 lb./sq. in.                                |
| Fluid                 | .. | .. | .. | .. | .. | .. | .. | .. | Lockheed No.5 or equivalent (not mineral oil). |

|                                  |    |    |    |    |    |    |    |    |                                           |
|----------------------------------|----|----|----|----|----|----|----|----|-------------------------------------------|
| Wheels -                         |    |    |    |    |    |    |    |    |                                           |
| Type                             | .. | .. | .. | .. | .. | .. | .. | .. | 30 in. Type II                            |
| Tyre                             | .. | .. | .. | .. | .. | .. | .. | .. | 30 in. dia. Smooth contour (Goodrich)     |
| Tyre pressure - wheels on ground |    |    |    |    |    |    |    |    | 40 lb./sq.in. (at 8300 lb. all up weight) |

|        |    |    |    |    |    |    |    |    |                                           |
|--------|----|----|----|----|----|----|----|----|-------------------------------------------|
| Brakes | .. | .. | .. | .. | .. | .. | .. | .. | Hayes reversible hydraulic (12x3 1/4 in.) |
|--------|----|----|----|----|----|----|----|----|-------------------------------------------|

Tail wheel unit

|                      |    |    |    |    |    |    |    |                                                |
|----------------------|----|----|----|----|----|----|----|------------------------------------------------|
| Shock absorber strut | .. | .. | .. | .. | .. | .. | .. | Oleo pneumatic                                 |
| Air pressure         | .. | .. | .. | .. | .. | .. | .. | 34 1/2 lb./sq.in.                              |
| Fluid                | .. | .. | .. | .. | .. | .. | .. | Lockheed No.5 or equivalent (not mineral oil). |

|                                 |    |    |    |    |    |    |    |    |                                                     |
|---------------------------------|----|----|----|----|----|----|----|----|-----------------------------------------------------|
| Wheel -                         |    |    |    |    |    |    |    |    |                                                     |
| Type                            | .. | .. | .. | .. | .. | .. | .. | .. | 12 1/2 in. smooth contour                           |
| Tyre                            | .. | .. | .. | .. | .. | .. | .. | .. | 12 1/2 in. smooth contour, self-earthing (Goodrich) |
| Tyre pressure - wheel on ground | .. |    |    |    |    |    |    |    | 60 lb./sq.in.                                       |

ENGINE

|      |    |    |    |    |    |    |    |    |                                                                                                            |
|------|----|----|----|----|----|----|----|----|------------------------------------------------------------------------------------------------------------|
| Type | .. | .. | .. | .. | .. | .. | .. | .. | Allison V-1710 F-3 R. Liquid - cooled.                                                                     |
| Fuel | .. | .. | .. | .. | .. | .. | .. | .. | British 100 octane (Spec. R.D.E./f/100) or 95 octane C.F.R. Method fuel conforming to A.E.C. Spec. No. 123 |
| Oil  | .. | .. | .. | .. | .. | .. | .. | .. | Summer D.T.D. 472, Grade C. Winter D.T.D. 472, Grade B.                                                    |

AIRSCREW

|                        |                                                                                                                                                                 |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type .. .. .           | Curtiss electric<br>Model C5315S-D1 on<br>Airplanes AK571-AK610<br>Model C532D-F-24 on<br>Airplanes AK611 and<br>subsequent (See Curtiss<br>propeller handbook) |
| Control .. .. .        | Constant speed or<br>manual.                                                                                                                                    |
| Pitch settings .. .. . | Coarse - - - 54.5°<br>Fine - - - 24.5°                                                                                                                          |

TANK CAPACITIES (Imp. Gallons)

|                              |               |
|------------------------------|---------------|
| Fuel tanks -                 |               |
| Fuselage .. .. .             | 51.5 gallons  |
| Front wing .. .. .           | 29.2 gallons  |
| Rear wing .. .. .            | 42.1 gallons  |
| Total capacity .. .. .       | 122.8 gallons |
| Oil tank -                   |               |
| Normal .. .. .               | 10.75 gallons |
| Overload .. .. .             | 13.3 gallons  |
| Air space (overload) .. .. . | 1.2 gallons   |

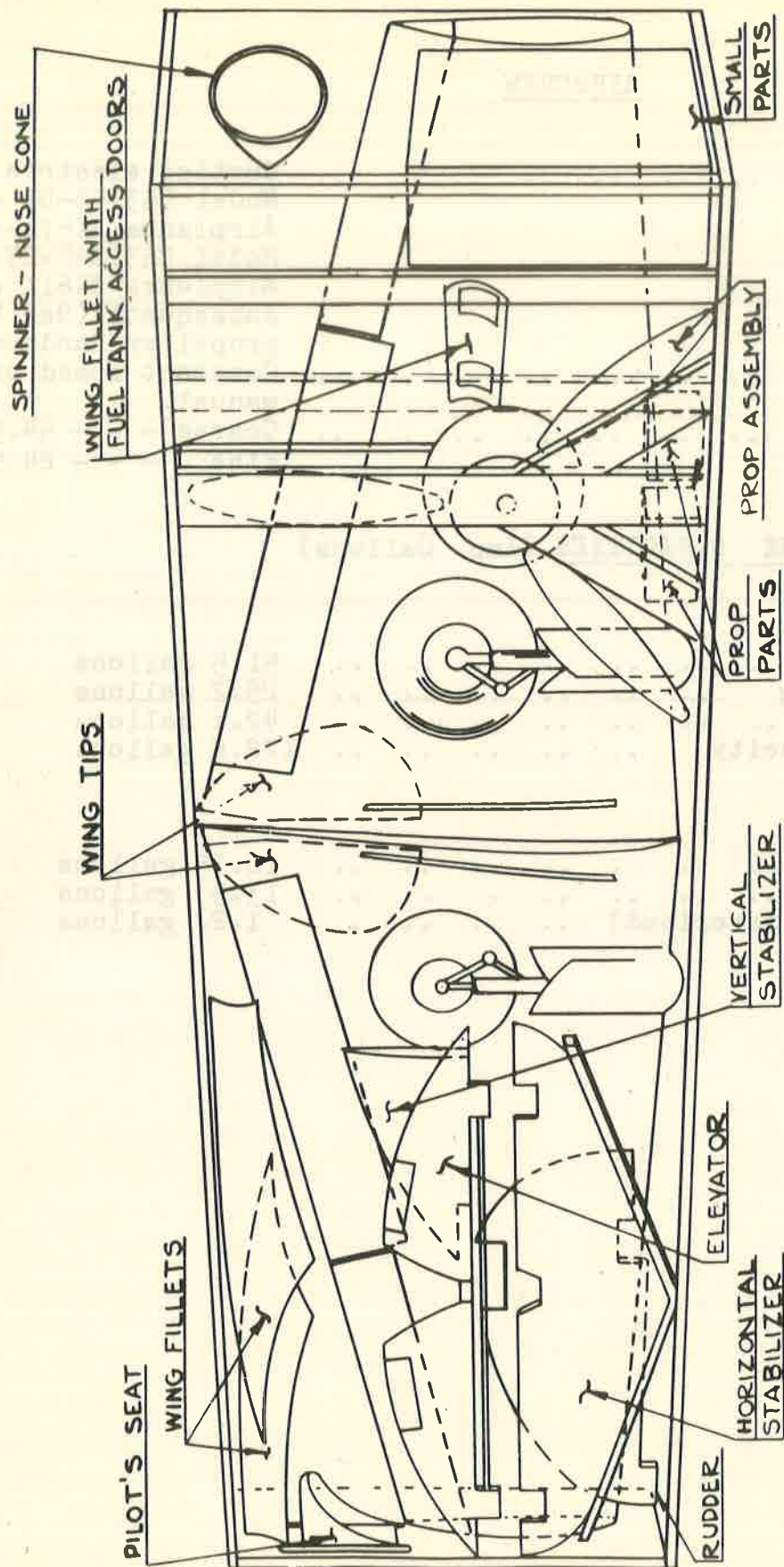
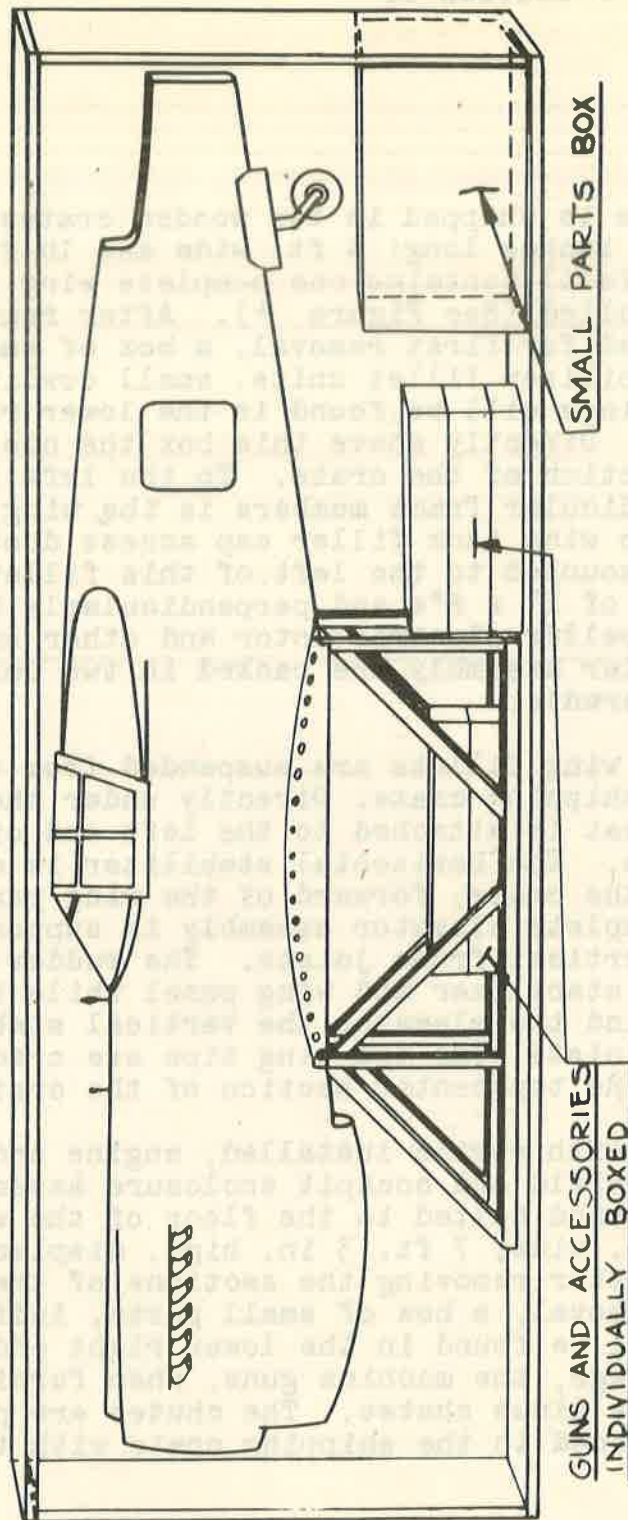


FIG. 4 PANEL BOX H-87A-2 & H-87A-3





**FIG. 5 FUSELAGE BOX H-87A-2 & H-87A-3**



## SECTION II

### A. UNCRATING

#### 1. General

Each airplane is shipped in two wooden crates. The larger crate (35 ft. 6 inches long; 4 ft. wide and 10 ft. high, displacing 1420 cubic feet) contains one complete wing panel with landing gear installed (See Figure 4). After removing the side sections marked for first removal, a box of small parts including wing and stabilizer fillet units, small cowlings sections and miscellaneous fittings will be found in the lower right end of the shipping crate. Directly above this box the nose cone is fastened to the end section of the crate. To the left of this box, strapped to two perpendicular frame members is the wing fillet section containing the two wing tank filler cap access doors. The propeller assembly is mounted to the left of this fillet in an inverted V shaped cradle of 2" x 8"s and perpendicularly braced by two 2" x 8"s. The propeller electric motor and other small parts to complete the propeller assembly are packed in two boxes at the base of the propeller cradle.

The two rear wing fillets are suspended from the top left hand side of the shipping crate. Directly under the wing fillets, the pilot's seat is attached to the left end of the crate in an inverted position. The horizontal stabilizer is cradled in the lower left end of the crate, forward of the wing panel. Above this stabilizer the complete elevator assembly is supported by a cross member between vertical frame joists. The rudder is mounted between the horizontal stabilizer and wing panel while to the right and directly behind the elevator the vertical stabilizer is attached to the frame joists. The two wing tips are cradled aft of the wing panel, at the top center section of the crate.

The fuselage with engine installed, engine and radiator cowlings attached, windshield and cockpit enclosure assembled, is mounted on a fuselage stand bolted to the floor of the smaller crate (29 ft. long 5 ft. wide, 7 ft. 3 in. high, displacing 1086.2 cu. ft. See Fig. 5) After removing the sections of the box which are marked for first removal, a box of small parts, individually wrapped and packed, will be found in the lower right end of the crate. Under the fuselage, the machine guns, when furnished, are packed in separate boxes minus chutes. The chutes are packed in other containers and placed in the shipping crate with the gun equipment.

## 2. Uncrating Panel Box

The first crate to be dismantled is the wing panel crate. The ends, top and bottom are each a section but each side is built in two sections. The side section to be removed first is clearly marked. Remove the top section. The hoisting sling (Drawing No. 87-88-509) and horizontal cradle wing truck furnished with the first airplane will be packed separately. Immediately after removing the top section of the panel box attach the hoisting sling to the panel. Support the panel with the hoist while removing the other units.

To attach the sling secure the two sliding plates marked "Rear" to the rear ends of the tee sections on the panel. There are two studs in each of these plates. Match the stud marked "2<sup>4</sup>th Hole" with the 2<sup>4</sup>th hole from the front of the tee section as indicated in Fig. 6. Do not attach the other two plates marked "Front". Dismantle the remaining side sections and ends of the crate and remove the propeller, tail surfaces and other units, including all small parts boxes.

Remove the bolts securing the wing to the bottom of the crate and hoist it clear of the crate. With about ten men holding the leading edge, the wing may be lowered to a horizontal position and the two plates marked "Front" of the hoisting sling attached to the respective positions. The stud marked "4th Hole" should be inserted in the 4th hole from the front of the tee section. The wing assembly weight is approximately 1722 lbs.

With the wing resting in the horizontal position raise it to clear the horizontal wing cradle truck. Move the truck to its proper position beneath the wing and lower the wing upon the supporting points. See Fig. 7.

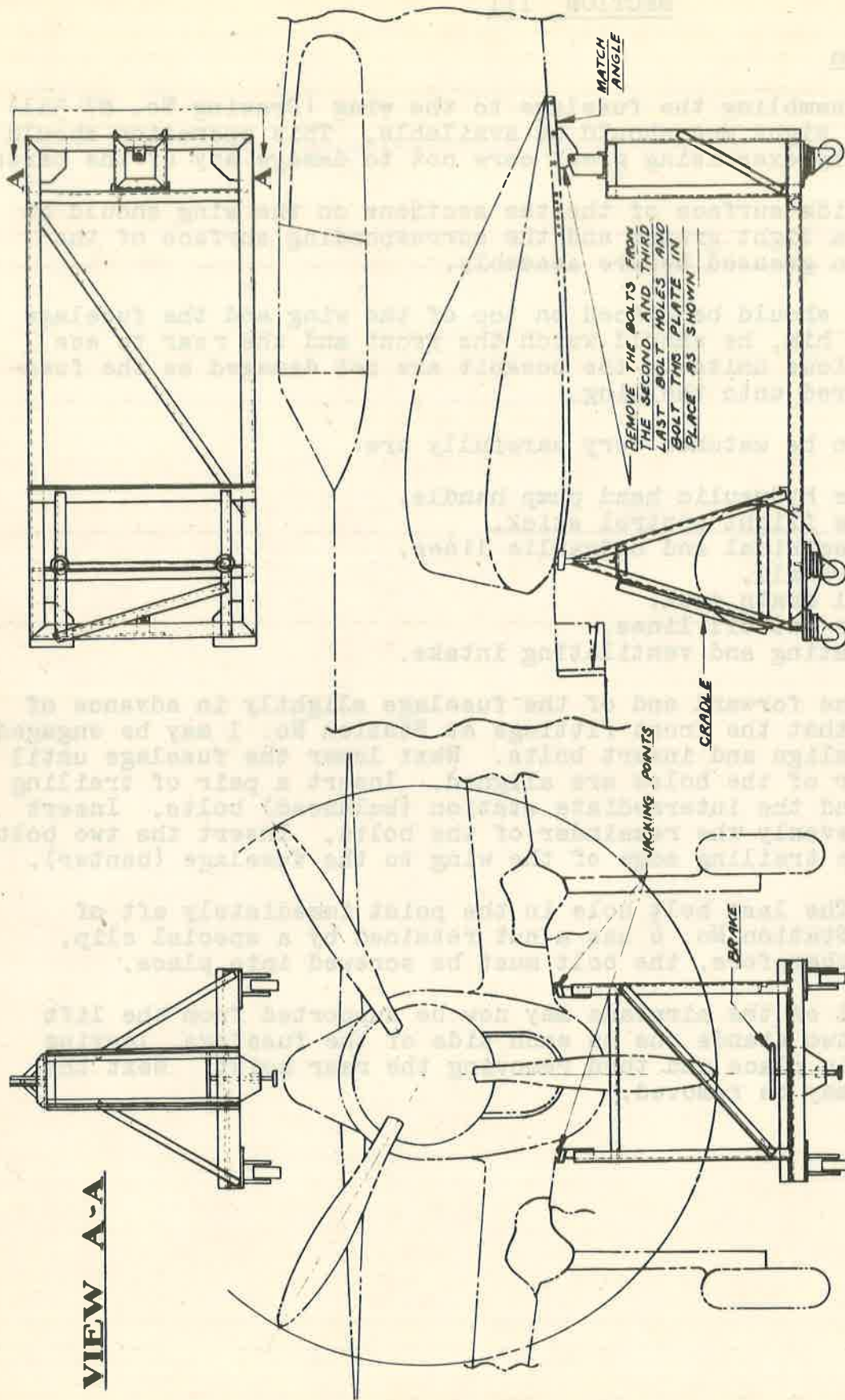
## 3 Uncrating Fuselage Box:

The ends, top and bottom are made in separate sections. The first section to be removed is clearly marked. Dismantle crate and remove small parts box and gunnery equipment units. Remove the top engine cowl and attach front hoisting sling to hoisting lugs on engine mount. Insert a bar about 3 1/2 ft. long thru the lift tube at the rear of the fuselage, hang a 100 lb. weight on each end of the bar and attach hoisting sling. Attach front and rear hoisting slings to their respective traveling hoists and take up slack in both sling assemblies. Remove the bolts attaching the fuselage to the metal fuselage stand and hoist fuselage clear of the packing crate.

Two traveling hoists at least 18 ft. high should be available. The hoist at the front end of the fuselage should have a capacity of 2 tons if only the fuselage is to be hoisted and 4 tons if the complete airplane is later to be hoisted by it. The hoist at the rear end should have a capacity of one ton.







NOTE  
SUSPEND TWO 100 LB. WEIGHTS FROM  
THE LIFT TUBE JUST FORWARD OF  
THE LEADING EDGE OF THE STABILIZER

FIG. 7 AIRPLANE CRADLE



### SECTION III

#### A. Erection

When assembling the fuselage to the wing (Drawing No. 87-511) about six or eight men should be available. This operation should proceed slowly exercising great care not to damage any of the parts.

The inside surface of the tee sections on the wing should be coated with a light grease and the corresponding surface of the fuselage also greased before assembly.

One man should be placed on top of the wing and the fuselage lowered over him, he should watch the front and the rear to see that the various units in the cockpit are not damaged as the fuselage is lowered onto the wing.

Units to be watched very carefully are:

1. The hydraulic hand pump handle.
2. The flight control stick.
3. Electrical and hydraulic lines.
4. Firewall.
5. Oil drain cock.
6. Gas and oil lines.
7. Heating and ventilating intake.

Lower the forward end of the fuselage slightly in advance of the rear so that the front fittings at Station No. 1 may be engaged first, then align and insert bolts. Next lower the fuselage until the remainder of the holes are aligned. Insert a pair of trailing edge bolts and the intermediate station (bulkhead) bolts. Insert and tighten evenly the remainder of the bolts. Insert the two bolts attaching the trailing edge of the wing to the fuselage (center).

NOTE: The last bolt hole in the point immediately aft of Station No. 6 has a nut retained by a special clip, therefore, the bolt must be screwed into place.

The tail of the airplane may now be supported from the lift tube bar by two stands one on each side of the fuselage, leaving the weights in place and then removing the rear hoist. Next the front hoist may be removed.

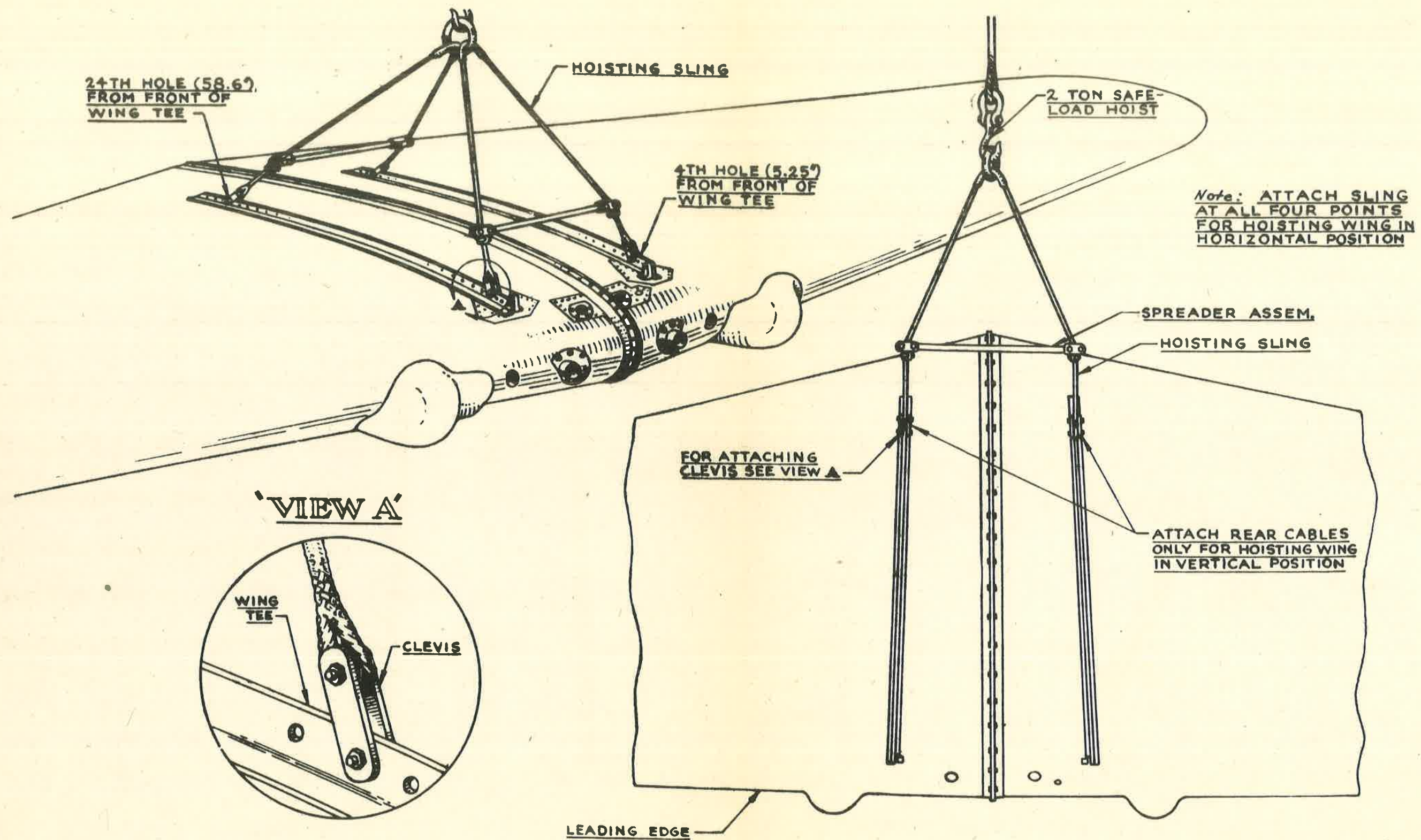


FIG. 6 WING HOISTING SLING





The following is a list of installations and connections to be made after the wing and fuselage are assembled:

1. Install the horizontal and vertical stabilizers.
2. Assemble the rudder and elevators.
3. Connect the elevator and rudder cables.
4. Connect the trim tab controls.
  - a. For details of the above installations see Section V, Empennage Assembly
5. Connect the vertical stabilizer navigation light wires.
6. Check all cable tensions after rigging the tail.
7. Connect hydraulic lines to the hand pumps.
8. Connect hydraulic lines to the hydraulic system selector valve.
9. Connect the hydraulic lines from the brake pedal to brakes.
10. Connect the hydraulic lines from the selector valve to the wheels and flap control.
11. Fill the hydraulic system with Lockheed No. 5 fluid or equivalent. Substitutes may be a mixture of 50% castor oil and 50% butyle monohydroxy-ethyl ether or if not available use 50% castor oil and 50% diacetone alcohol.
12. Install the battery.
13. Check the landing gear and tail wheel retracting units.
14. Make electrical connections for the wing navigation lights one each side of the cockpit.
15. Install the propeller - following the instructions of the propeller instruction book issued by the manufacturer.
16. Connect the airspeed indicator.
17. Install the pitot tube and make the necessary electrical connections.
18. Install the fuel valve control rod through the nose of the wing panel
19. Connect the fuel selector valve connections in front of the firewall at the lower left-hand corner.
20. Connect the aileron cables and check the cable tension and aileron travel. See Section V, Wing Assembly.
21. Install the radio.
22. Install the oxygen equipment.
23. Install the wing tips.
24. Install the tail fillets.
25. Install the wing fillets.
26. Install the guns. See Section V, Machine Gun Installation.
27. Connect the gun charging controls to the hydraulic charging cylinders.
28. Remove the protective oil coating from the power plant and remove the anti-corrosion compound from the exterior of plane with a spray of Varnoline or Kerosene - wipe off excess.



29. Drain the interior of the engine at the two drain plugs in the aft outboard ends of the valve cover boxes. Turn the engine 2 or 3 times manually using a propeller shaft wrench. This will remove the excess compound in the cylinders.
30. Drain the carburetor at the lower plug. Whatever is left in the engine will dilute with the engine oil when the engine is running.
31. Attach all the engine cowl.
32. Attach the cowling beneath the wing.
33. Give the airplane a complete "Pre-flight", "25-Hour" and "50-Hour" inspection. See Section VI.

REF. DWG5. 87-06-601 ; 87-06-803

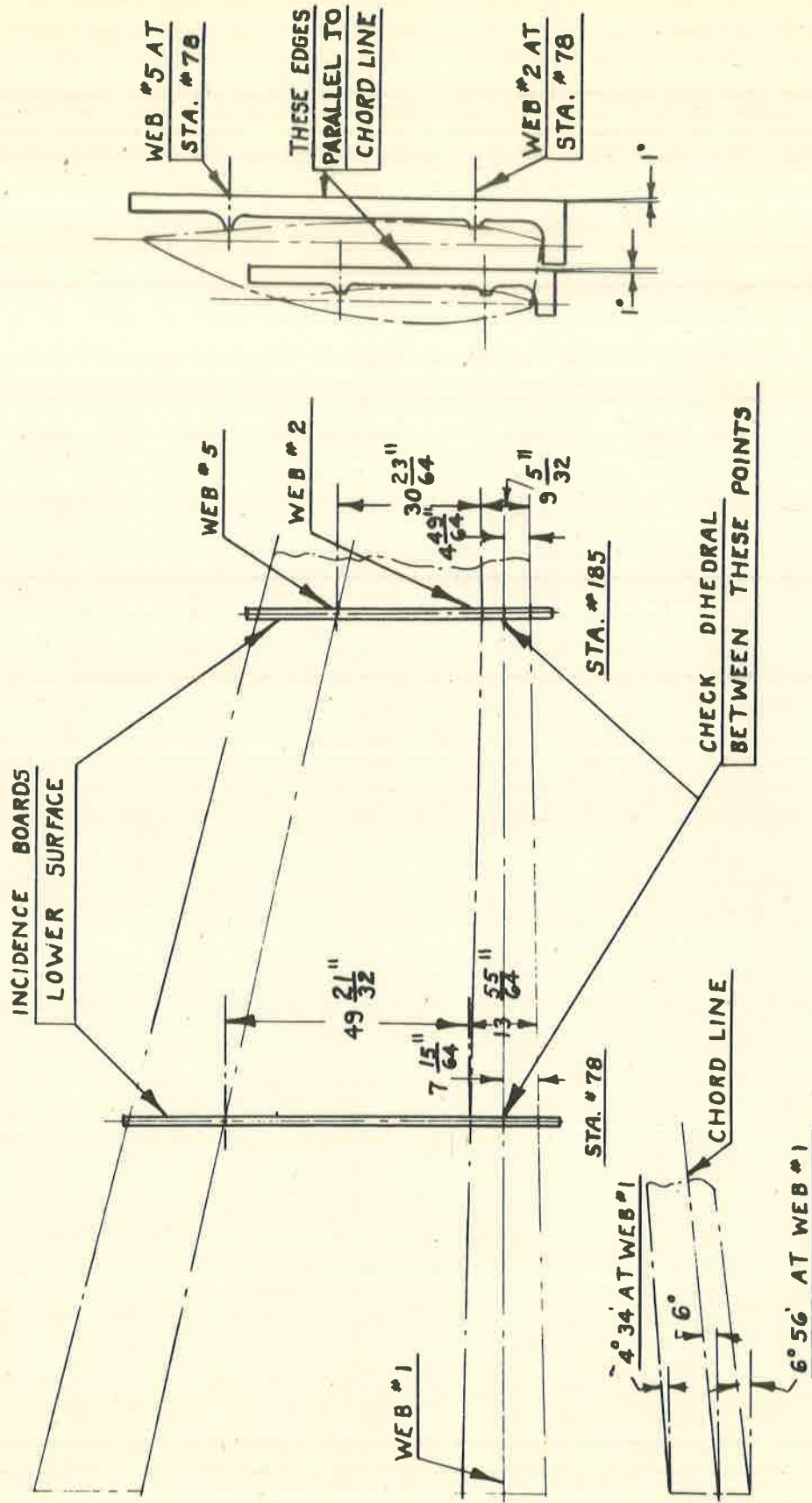


FIG. 8 WING RIGGING DIAGRAM

H-87A-2 & H-87A-3



Rigging:

Wing heaviness is corrected by bending the tab on the trailing edge, inboard end, of the right-hand aileron. Bend tab up, slightly.

The following items need not be checked as they have to do with characteristics that are rigidly built into the structure and cannot be altered.

1. Wing Rigging
  - a. Dihedral
  - b. Incidence
  - c. Sweepback
2. Landing Gear Alignment

Compensate Compass:

With the engine running, the lights "ON", the propeller in "AUTO" and the airplane in a "LEVEL" position, the following procedure may be followed in compensating the compass. Remove the top front cover, of the compass exposing the compensating screws. Head the airplane to magnetic north, using a compass rose or pelorus. Note the reading of the compass and eliminate the error by turning the screw marked N.S. Now head the plane East and remove error by turning screw marked E.W. Head plane South and note the error. Only half of this error should be removed by turning N.S. screw. Now head the plane West and remove half the error turning E.W. screw. The compass is now compensated and the plane should be swung at 30° intervals and the readings recorded on the correction card.



REF. DWGS 87-88-019  
87-88-020

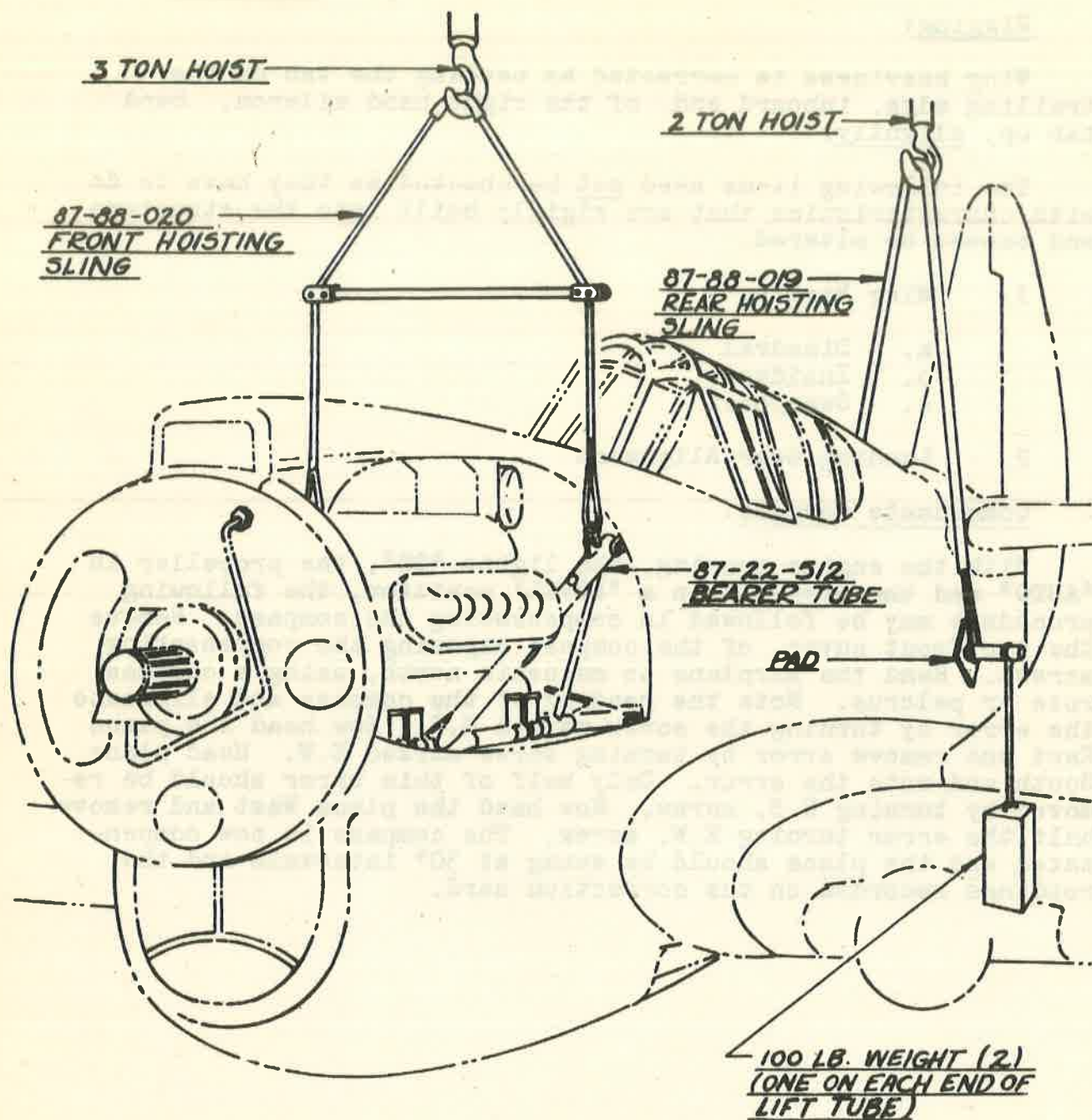


FIG. 9 HOISTING SLINGS — FRONT & REAR

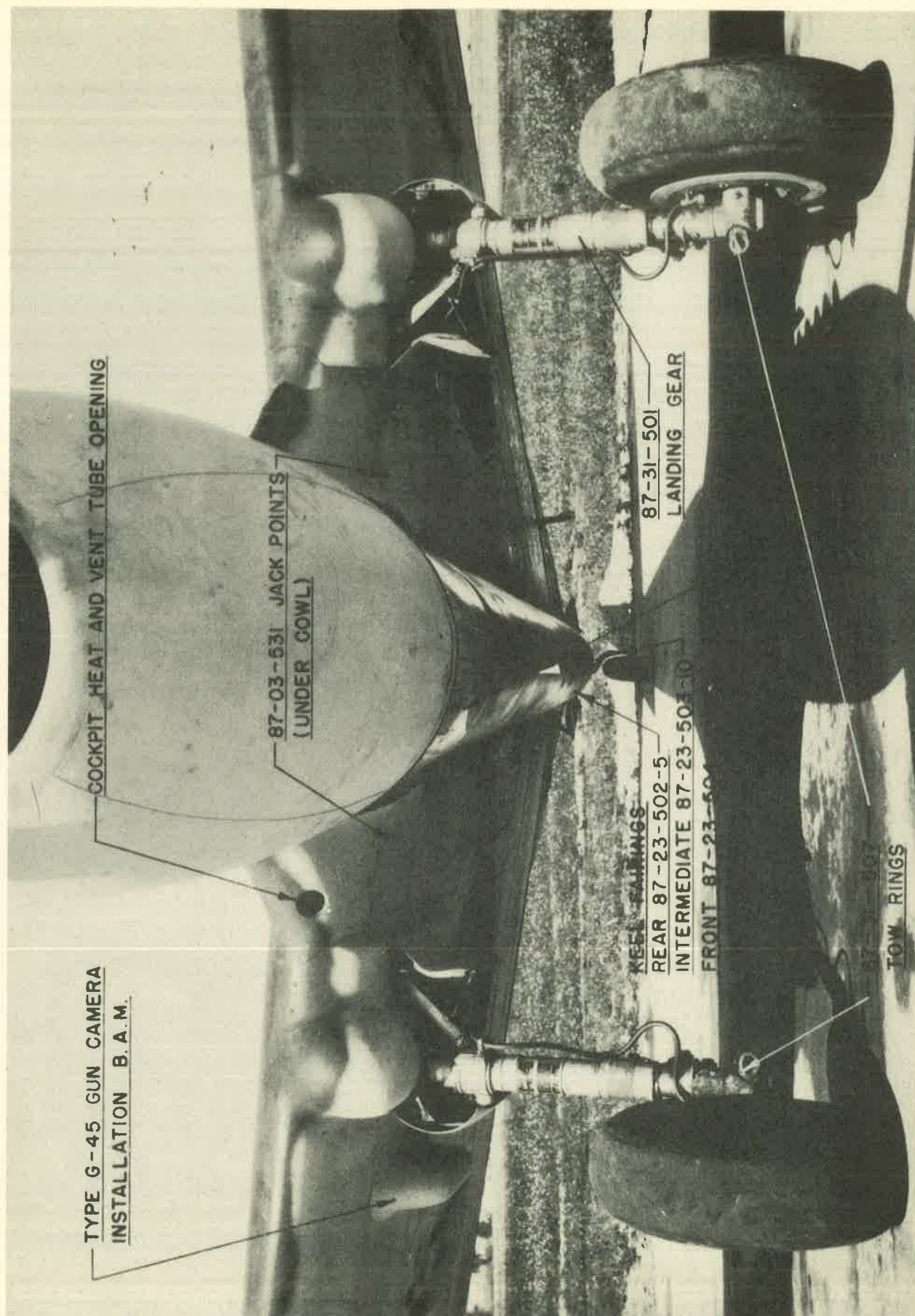


FIG.10 JACK POINTS & TOW RINGS H-87A-2 & H-87A-3





| Item | No. | Aircraft at Tare Weight                                   | Day & Night Fighter              |          |           | Alternative Radio                 |         |          | Desert Fighter                   |        |          |
|------|-----|-----------------------------------------------------------|----------------------------------|----------|-----------|-----------------------------------|---------|----------|----------------------------------|--------|----------|
|      |     |                                                           | Weight                           | Arm      | Moment    | Weight                            | Arm     | Moment   | Weight                           | Arm    | Moment   |
|      | 1   | G .45 Camera                                              | 10                               | + 23     | + 273     | 10                                | + 23    | + 273    | 10                               | + 23   | + 273    |
|      | 2   | N2A Gunsight                                              | 4                                | + 36     | + 148     | 4                                 | + 36    | + 148    | 4                                | + 36   | + 148    |
|      | 3   | Belly fuel tank and supports                              | -                                | -        | -         | -                                 | -       | -        | -                                | -      | -        |
|      | 4   | .50 cal. ammunition 2460 rounds                           | 738                              | + 41.5   | + 30258   | 738                               | + 41.5  | + 30258  | 738                              | + 41.5 | + 30258  |
|      | 5   | 4 .50 cal. guns, & blast tubes, adapters                  | 309                              | + 42     | + 12978   | 309                               | + 42    | + 12978  | 309                              | + 42   | + 12978  |
|      | 6   | Ammunition boxes and chutes                               | 84                               | + 41.5   | + 3486    | 84                                | + 41.5  | + 3486   | 84                               | + 41.5 | + 3486   |
|      | 7   | Pilot and parachute                                       | 180                              | + 60     | + 10800   | 180                               | + 60    | + 10800  | 180                              | + 60   | + 10800  |
|      | 8   | P. 3003 wireless                                          | 29                               | +121     | + 3473    | 29                                | +121    | + 3473   | 29                               | +121   | + 3473   |
|      |     | R. 3003 controls and accessories                          | 5                                | + 35     | + 171     | 5                                 | + 35    | + 171    | 5                                | + 35   | + 171    |
|      | 9   | Oxygen cylinders, filled                                  | 29                               | +122     | + 3550    | 29                                | +122    | + 3550   | 29                               | +122   | + 3550   |
|      | 10  | First Aid Outfit                                          | 3                                | +142     | + 426     | 3                                 | +142    | + 426    | 3                                | +142   | + 426    |
|      | 11  | Duffle bag                                                | -                                | -        | -         | -                                 | -       | -        | 4                                | +140   | + 560    |
|      |     | Desert equipment                                          | -                                | -        | -         | -                                 | -       | -        | 23                               | +140   | + 3220   |
|      | 12  | TR9D wireless                                             | 37                               | +160     | + 5888    | -                                 | -       | -        | 37                               | +160   | + 5888   |
|      |     | TR9D controls and accessories                             | 16                               | +147     | + 2359    | -                                 | -       | -        | 16                               | +147   | + 2359   |
|      | 13  | TR1133A wireless                                          | -                                | -        | -         | 43                                | +160    | + 6880   | -                                | -      | -        |
|      |     | TR1133A controls and accessories                          | -                                | -        | -         | 32                                | +162    | + 5239   | -                                | -      | -        |
|      | 14  | Cartridge signals                                         | 3                                | +147     | + 441     | 3                                 | +147    | + 441    | 3                                | +147   | + 441    |
|      | 15  | Ballast weights, (17.5) lbs. each                         | -                                | -        | -         | 35                                | + 54    | + 1890   | 35                               | + 54   | + 1890   |
|      |     | Total All Up Weights & Moments Of Removable Military Load | (1447)                           | -        | (+ 74215) | (1504)                            | -       | (-76188) | (1509)                           | -      | (-76105) |
|      | 16  | Fuel at 7.2#/gal: Front wing tank (29.0)                  | 210                              | + 27     | + 5690    | 210                               | + 27    | + 5690   | 210                              | + 27   | + 5690   |
|      | 17  | " " " " Rear wing tank (42.0)                             | 303                              | + 52     | + 15745   | 303                               | + 52    | + 15745  | 303                              | + 52   | + 15745  |
|      | 18  | " " " " Fuselage tank (52.0)                              | 375                              | + 95     | + 35535   | 375                               | + 95    | + 35535  | 375                              | + 95   | + 35535  |
|      | 19  | " " " " Belly tank (43.0)                                 | -                                | -        | -         | -                                 | -       | -        | -                                | -      | -        |
|      | 20  | Oil at 9.0#/gal: (17.5)                                   | 158                              | -        | + 316     | 158                               | -       | + 316    | 158                              | -      | + 316    |
|      |     | Total All Up Weights & Moments (wheels down)              | 8470                             | -        | +225241   | 8492                              | -       | +227214  | 8532                             | -      | +227231  |
|      |     | Moment due to retracting wheels                           | -                                | -        | + 11708   | -                                 | -       | + 11708  | -                                | -      | + 11708  |
|      |     | Total All Up Weights & Moments (wheels up)                | 8470                             | + 27.972 | +236949   | 8492                              | + 28.02 | +238922  | 8532                             | + 28.0 | +238939  |
|      |     | C. G. Wheels up                                           | 27.97" aft datum pt. (31.5% MAC) |          |           | 28.02" aft datum pt. (31.64% MAC) |         |          | 28.0" aft datum pt. (31.61% MAC) |        |          |

Tare Weight, 5977 lbs., Includes Following:

Ring and bead sight  
Gun firing mechanism  
Battery and all electrical services  
All instruments  
Oxygen instruments  
Recognition device.  
Sutton harness and seat pad  
Fixed parts of W/T equipment  
Starter crank and extension  
Fuel tank protection and bullet proof glass  
Armour plate  
Steel propeller

4 - Gun Aeroplane  
Steel Propeller  
AK-571-AK-590

Loading and C.G. Diagram  
Kittyhawk Aeroplane  
(Allison V-1710-F3R)

Issue No: 1  
Date: April 10, 1942

1. Maximum all-up weight at which the aircraft has been designed and flight tested = 7740 lbs.
2. Limits of permissible C.G. travel = 19.4" to 28.05" aft of axis of reference, measured parallel to thrust line (this corresponds to 21.0% M.A.C. to 31.7% M.A.C.)
3. Length of mean chord = 81.6 inches
4. 1% of mean chord = .816 inches
5. Use fuel from fuselage tank first

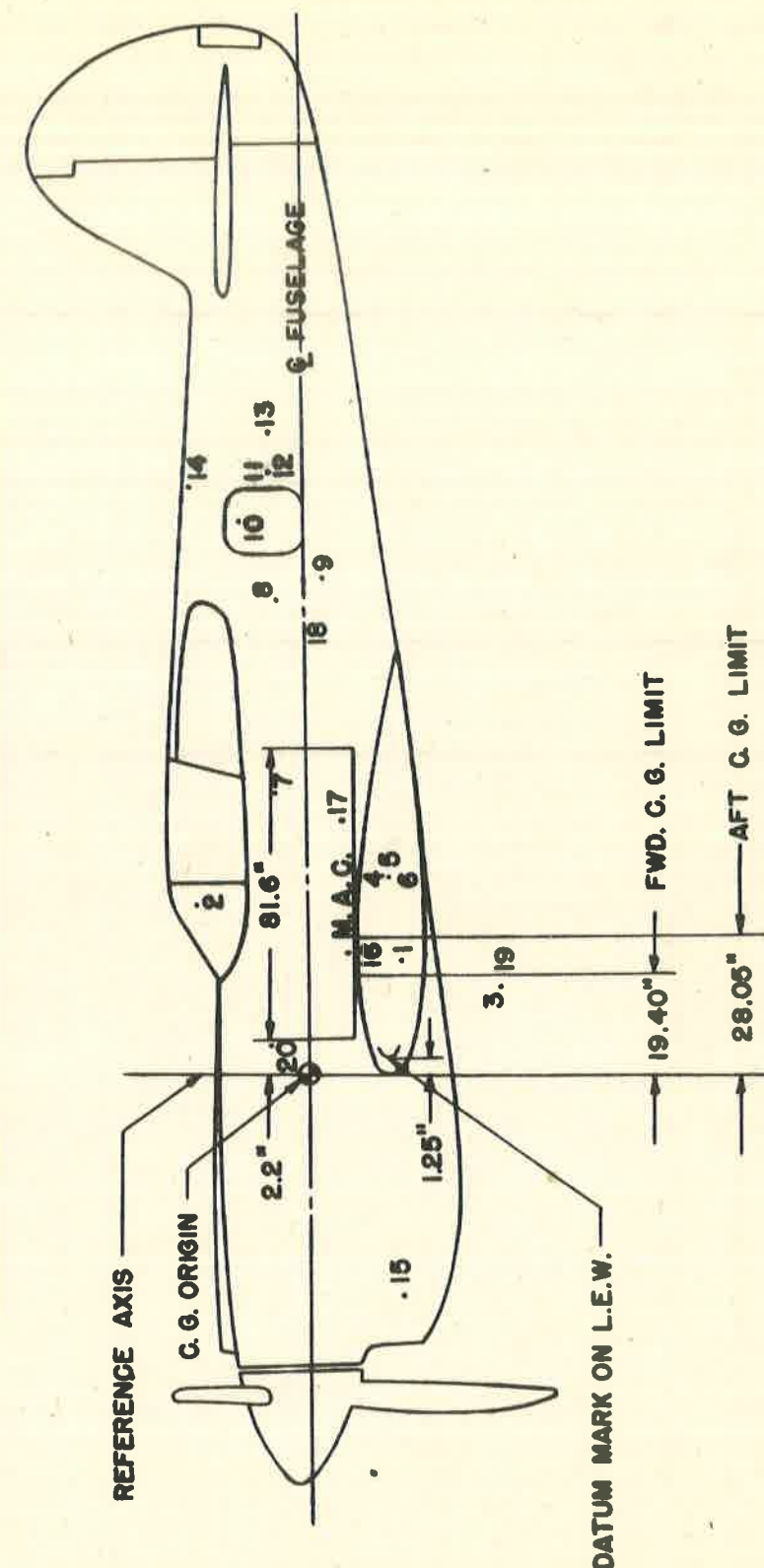


FIG. 11 LOADING & C.G. DIAGRAM

AIRPLANES AK571 THROUGH AK590







| Item No.                                                  | Aircraft at Tare Weight                    | Day & Night Fighter               |        |         | Alternative Radio                |        |         | Desert Fighter                  |        |         |
|-----------------------------------------------------------|--------------------------------------------|-----------------------------------|--------|---------|----------------------------------|--------|---------|---------------------------------|--------|---------|
|                                                           |                                            | Weight                            | Arm    | Moment  | Weight                           | Arm    | Moment  | Weight                          | Arm    | Moment  |
| 1                                                         | G .45 Camera                               | 10                                | + 23   | + 237   | 10                               | + 23   | + 237   | 10                              | + 23   | + 237   |
| 2                                                         | N2A Gunsight                               | 4                                 | + 36   | + 148   | 4                                | + 36   | + 148   | 4                               | + 36   | + 148   |
| 3                                                         | Belly fuel tank and supports               | -                                 | -      | -       | -                                | -      | -       | -                               | -      | -       |
| 4                                                         | .50 cal. ammunition 1686 rounds            | 506                               | + 41.5 | +20999  | 506                              | + 41.5 | +20999  | 506                             | + 41.5 | +20999  |
| 5                                                         | 6 - .50 cal. guns, & blast tubes, adapters | 463                               | + 41   | +18933  | 463                              | + 41   | +18933  | 463                             | + 41   | +18933  |
| 6                                                         | Ammunition Boxes                           | 80                                | + 41.5 | + 3320  | 80                               | + 41.5 | + 3320  | 80                              | + 41.5 | + 3320  |
| 7                                                         | Pilot and parachute                        | 180                               | + 60   | +10800  | 180                              | + 60   | +10800  | 180                             | + 60   | +10800  |
| 8                                                         | R. 3003 wireless                           | 29                                | +121   | + 3473  | 29                               | +121   | + 3473  | 29                              | +121   | + 3473  |
|                                                           | R. 3003 controls and accessories           | 5                                 | + 35   | + 171   | 5                                | + 35   | + 171   | 5                               | + 35   | + 171   |
| 9                                                         | Oxygen cylinders, filled                   | 29                                | +122   | + 3550  | 29                               | +122   | + 3550  | 29                              | +122   | + 3550  |
| 10                                                        | First Aid Outfit                           | 3                                 | +142   | + 426   | 3                                | +142   | + 426   | 3                               | +142   | + 426   |
| 11                                                        | Duffle bag                                 | -                                 | -      | -       | -                                | -      | -       | 4                               | +140   | + 560   |
|                                                           | Desert equipment                           | -                                 | -      | -       | -                                | -      | -       | 23                              | +140   | + 3220  |
| 12                                                        | TR9D wireless                              | 37                                | +160   | + 5888  | -                                | -      | -       | 37                              | +160   | + 5888  |
|                                                           | TR9D controls and accessories              | 16                                | +147   | + 2359  | -                                | -      | -       | 16                              | +147   | + 2359  |
| 13                                                        | TRII33A wireless                           | -                                 | -      | -       | 43                               | +160   | + 6880  | -                               | -      | -       |
|                                                           | TRII33A controls and accessories           | -                                 | -      | -       | 32                               | +162   | + 5239  | -                               | -      | -       |
| 14                                                        | Cartridge signals                          | 3                                 | +147   | + 441   | 3                                | +147   | + 441   | 3                               | +147   | + 441   |
| 15                                                        | Ballast weights, (17.5) lbs. each          | -                                 | - 54   | -       | 35                               | - 54   | - 1890  | 35                              | - 54   | - 1890  |
| Total All Up Weights & Moments Of Removable Military Load |                                            | 1365                              |        | +70745  | 1422                             |        | +72727  | 1427                            |        | +72635  |
| 16                                                        | Fuel at 7.2#/gal: Front wing tank (29.0)   | 210                               | + 27   | + 5690  | 210                              | + 27   | + 5690  | 210                             | + 27   | + 5690  |
| 17                                                        | " " " " Rear wing tank (42.0)              | 303                               | + 52   | +15745  | 303                              | + 52   | +15745  | 303                             | + 52   | +15745  |
| 18                                                        | " " " " Fuselage tank (52.0)               | 375                               | + 95   | +35535  | 375                              | + 95   | +35535  | 395                             | + 95   | +35535  |
| 19                                                        | " " " " Belly tank (43.0)                  | -                                 | -      | -       | -                                | -      | -       | -                               | -      | -       |
| 20                                                        | Oil at 9.0#/gal: (17.5)                    | 158                               |        | + 316   | 158                              |        | + 316   | 158                             |        | + 316   |
| Total All Up Weights and Moments (wheels down)            |                                            | 8428                              |        | +223924 | 8484                             |        | +225996 | 8490                            |        | +225904 |
| Moments due to retracting wheels                          |                                            |                                   |        | + 11708 |                                  |        | + 11708 |                                 |        | + 11708 |
| Total All Up Weights & Moments (wheels up)                |                                            | 8428                              | +27.96 | +235632 | 8484                             | +28.02 | +237704 | 8490                            | + 28.0 | +237612 |
| C.G. wheels up                                            |                                            | 27.96" aft datum pt. (31.57% MAC) |        |         | 28.02" aft datum pt. (31.6% MAC) |        |         | 28.0" aft datum pt. (31.6% MAC) |        |         |

Tare Weight, 6081 lbs., Includes Following:  
 Ring and bead sight  
 Gun firing mechanism  
 Battery and all electrical services  
 All instruments  
 Oxygen regulator and piping  
 Recognition device  
 Sutton harness and seat pad  
 Fixed parts of W/T equipment  
 Starter crank and extension  
 Coolant and hydraulic fluid  
 Fuel tank protection and bullet proof glass  
 Armour plate  
 Steel propeller

6 - Gun Aeroplane  
 Steel Propeller  
 AK-591-610  
  
 Loading and C.G. Diagram  
 Kittyhawk I Aeroplane  
 (Allison V-1710-F3R)

Issue No: 2  
 Date: April 10, 1942

1. Maximum all-up weight at which the aircraft has been designed and flight tested = 7740 lbs.
2. Limits of permissible C.G. travel = 19.4" to 28.05" aft of axis of reference, measured parallel to thrust line. (this corresponds to 21.0% M.A.C. to 31.7% M.A.C.)
3. Length of mean chord = 81.6 inches
4. 1% of mean chord = .816 inches
5. Use fuel from fuselage tank first

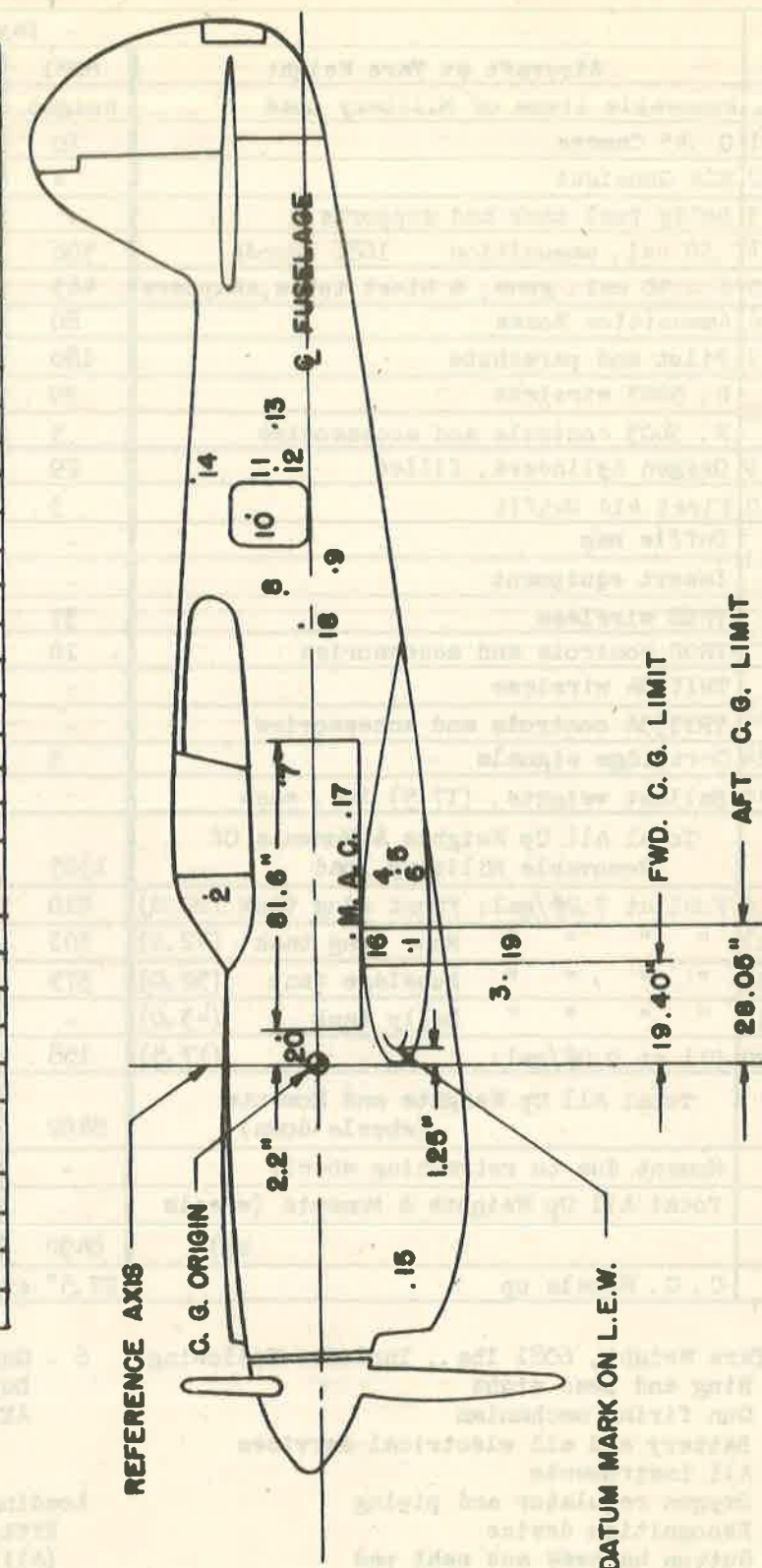


FIG. 11 LOADING & C.G. DIAGRAM  
 AIRPLANES AK591 THROUGH AK610



| Item No. | Aircraft at Tare Weight                                   | Day & Night Fighter             |        |         | Alternative Radio               |        |         | Desert Fighter                  |        |         |
|----------|-----------------------------------------------------------|---------------------------------|--------|---------|---------------------------------|--------|---------|---------------------------------|--------|---------|
|          |                                                           | 6081                            | -15.4  | -93924  | 6081                            | -15.4  | -93924  | 6081                            | -15.4  | -93924  |
|          | Removable Items of Military Load                          | Weight                          | Arm    | Moment  | Weight                          | Arm    | Moment  | Weight                          | Arm    | Moment  |
| 1        | G .45 Camera                                              | 10                              | +23    | + 237   | 10                              | +23    | + 237   | 10                              | +23    | + 237   |
| 2        | N2A Gunsight                                              | 4                               | +36    | + 148   | 4                               | +36    | + 148   | 4                               | +36    | + 148   |
| 3        | Belly fuel tank and supports                              | -                               | -      | -       | -                               | -      | -       | -                               | -      | -       |
| 4        | .50 cal. ammunition 1686 rounds                           | 506                             | +41.5  | +20999  | 506                             | +41.5  | +20999  | 506                             | +41.5  | +20999  |
| 5        | 6 - .50 cal. guns, & blast tubes, adapters                | 463                             | +41    | +18933  | 463                             | +41    | +18933  | 463                             | +41    | +18933  |
| 6        | Ammunition Boxes                                          | 80                              | +41.5  | + 3320  | 80                              | +41.5  | + 3320  | 80                              | +41.5  | + 3320  |
| 7        | Pilot and parachute                                       | 180                             | +60    | +10800  | 180                             | +60    | +10800  | 180                             | +60    | +10800  |
| 8        | R. 3003 wireless                                          | 29                              | +121   | + 3473  | 29                              | +121   | + 3473  | 29                              | +121   | + 3473  |
|          | R. 3003 controls and accessories                          | 5                               | + 35   | + 171   | 5                               | + 35   | + 171   | 5                               | + 35   | + 171   |
| 9        | Oxygen cylinders, filled                                  | 29                              | +122   | + 3550  | 29                              | +122   | + 3550  | 29                              | +122   | + 3550  |
| 10       | First Aid Outfit                                          | 3                               | +142   | + 426   | 3                               | +142   | + 426   | 3                               | +142   | + 426   |
| 11       | Duffle bag                                                | -                               | -      | -       | -                               | -      | -       | 4                               | +140   | + 560   |
|          | Desert equipment                                          | -                               | -      | -       | -                               | -      | -       | 23                              | +140   | + 3220  |
| 12       | TR9D wireless                                             | 37                              | +160   | + 5888  | -                               | -      | -       | 37                              | +160   | + 5888  |
|          | TR9D controls and accessories                             | 16                              | +147   | + 2359  | -                               | -      | -       | 16                              | +147   | + 2359  |
| 13       | TRII33A wireless                                          | -                               | -      | -       | 43                              | +160   | + 6880  | -                               | -      | -       |
|          | TRII33A controls and accessories                          | -                               | -      | -       | 32                              | +162   | + 5239  | -                               | -      | -       |
| 14       | Cartridge signals                                         | 3                               | +147   | + 441   | 3                               | +147   | + 441   | 3                               | +147   | + 441   |
| 15       | Ballast weights. (17.5) lbs. each                         | -                               | - 54   | -       | -                               | - 54   | -       | -                               | - 54   | -       |
|          | Total All Up Weights & Moments Of Removable Military Load | 1365                            | -      | +70745  | 1387                            | -      | +74617  | 1392                            | -      | +74525  |
| 16       | Fuel at 7.2#/gal: Front wing tank (29.0)                  | 210                             | + 27   | + 5690  | 210                             | + 27   | + 5690  | 210                             | + 27   | + 5690  |
| 17       | " " " " Rear wing tank (42.0)                             | 303                             | + 52   | +15745  | 303                             | + 52   | +15745  | 303                             | + 52   | +15745  |
| 18       | " " " " Fuselage tank (52.0)                              | 375                             | + 95   | +35535  | 375                             | + 95   | +35535  | 375                             | + 95   | +35535  |
| 19       | " " " " Belly tank (43.0)                                 | -                               | -      | -       | -                               | -      | -       | -                               | -      | -       |
| 20       | Oil at 9.0#/gal: (17.5)                                   | 158                             | -      | + 316   | 158                             | -      | + 316   | 158                             | -      | + 316   |
|          | Total All Up Weights and Moments (wheels down)            | 8492                            | + 25.7 | +221955 | 8514                            | + 26.4 | +225827 | 8519                            | + 26.4 | +225961 |
|          | Moment due to retracting wheels                           | -                               | -      | +11708  | -                               | -      | +11708  | -                               | -      | + 11708 |
|          | Total All Up Weights & Moments (wheels up)                | 8492                            | + 27.5 | +233663 | 8514                            | + 27.9 | +237535 | 8519                            | + 27.9 | +237443 |
|          | C. G. Wheels up                                           | 27.5" aft datum pt. (31.0% MAC) |        |         | 27.9" aft datum pt. (31.5% MAC) |        |         | 27.9" aft datum pt. (31.5% MAC) |        |         |

Tare Weight, 6081 lbs., Includes Following:

Ring and bead sight  
Gun firing mechanism  
Battery and all electrical services  
All instruments  
Oxygen regulator and piping  
Recognition device  
Sutton harness and seat pad  
Fixed parts of W/T equipment  
Starter crank and extension  
Coolant and hydraulic fluid  
Fuel tank protection and bullet proof glass  
Armour plate  
Dural propeller

6 - Gun Aeroplane  
Dural Propeller  
AK-611-950

Loading and C.G. Diagram  
Kittyhawk I Aeroplane  
(Allison V-1719-F3R)

Issue No: 3

Date: April 10, 1942

1. Maximum all-up weight at which the aircraft has been designed and flight tested = 7740
2. Limits of permissible C.G. travel = 19.4" to 28.05" aft of axis of reference, measured parallel to thrust line (this corresponds to 21.0% M.A.C. to 31.7% M.A.C.)
3. Length of mean chord = 81.6 inches
4. 1% of mean chord = .816 inches
5. Use fuel from fuselage tank first

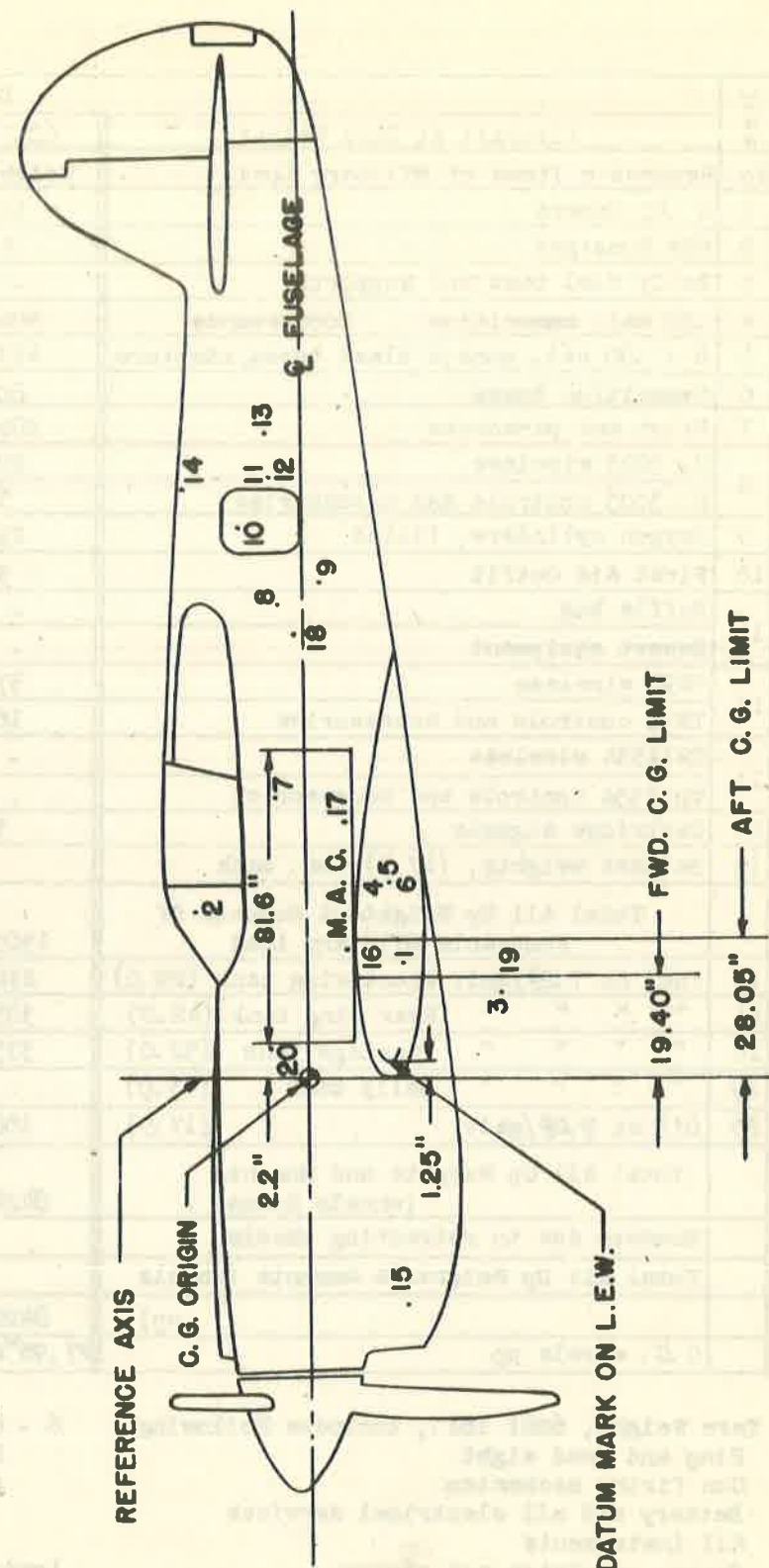


FIG. 11 LOADING & C.G. DIAGRAM

AIRPLANES AK611 AND SUBSEQUENT



## SECTION IV

### GENERAL INSTRUCTIONS

#### A. Hoisting

One forward hoisting sling (Drawing No. 87-88-020), one tail hoisting sling (Drawing No. 87-88-019), and one wing hoisting sling (Drawing No. 87-88-509) are provided with every nine airplanes delivered.

By removing the top engine cowl and attaching the front sling to the lugs provided on the engine mount, the forward end of the airplane may be raised. (See Figure 9 )

A lift tube is provided in the aft end of the fuselage for inserting a bar to lift the tail. Attach the tail sling to the lifting bar and raise the aft end of the airplane.

WARNING: The tail lifting bar must be passed completely through the fuselage and the tail raised by lifting on both ends of this bar, otherwise serious damage to the fuselage may result. DO NOT use horizontal stabilizer for lifting aft end of the airplane. If the tail is raised to FLIGHT POSITION, a hundred pound weight must be hung on the lifting bar on each side of the fuselage.

An Engine Hoisting Sling is furnished by the engine manufacturer and by attaching the sling to studs (which hold the cylinder heads to the crankcase) the engine may be raised.

DO NOT UNDER ANY CIRCUMSTANCES attempt to hoist the airplane by means of the engine hoisting sling attached to engine. This sling is for the installation and removal of engine only.

#### B. Jacking

Five jacking points are provided on the airplane. Two are located on the under surface of the wing panel inboard of the landing gear assemblies and one on the bottom of the fuselage aft of the tail wheel doors. (Figure 10 ) These three jacking points are used to support the airplane while checking the landing gear and tail wheel retracting mechanism. The two jack points on the under surface of the wing must be removed before the aft bottom extension of the wing fillet can be installed. Provision has been made for carrying these jack points in the tool kit. The decalcomania "JACK HERE" is located so that it is completely visible when all cowlings are installed with an arrow pointing towards the hidden location inside the wing fillet extension fairing. A jacking point is located on the bottom of each towing ring on the landing gear axle for supporting the forward end of the airplane while servicing the wheels and the brakes.

REF DWG. 87-21-530

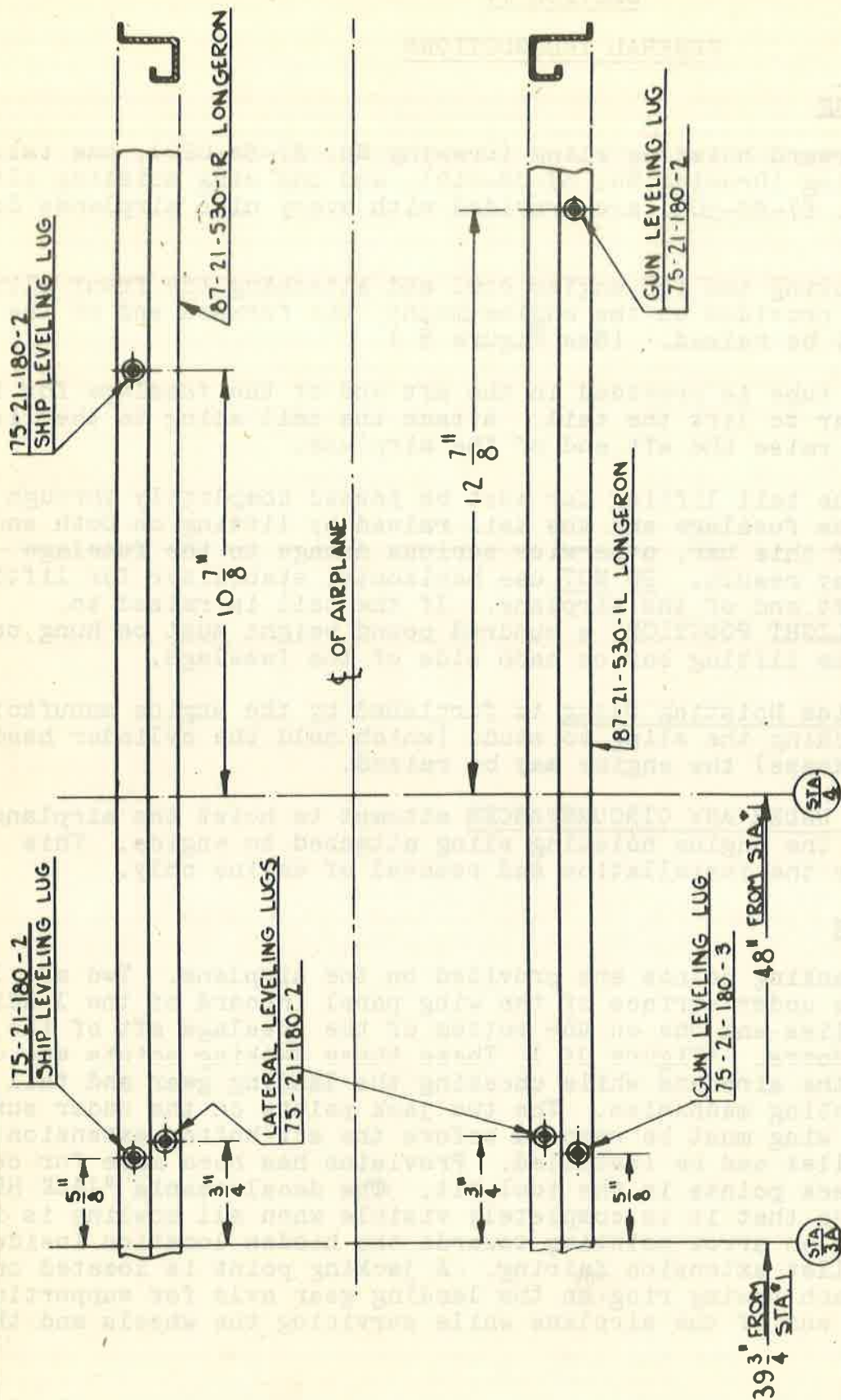


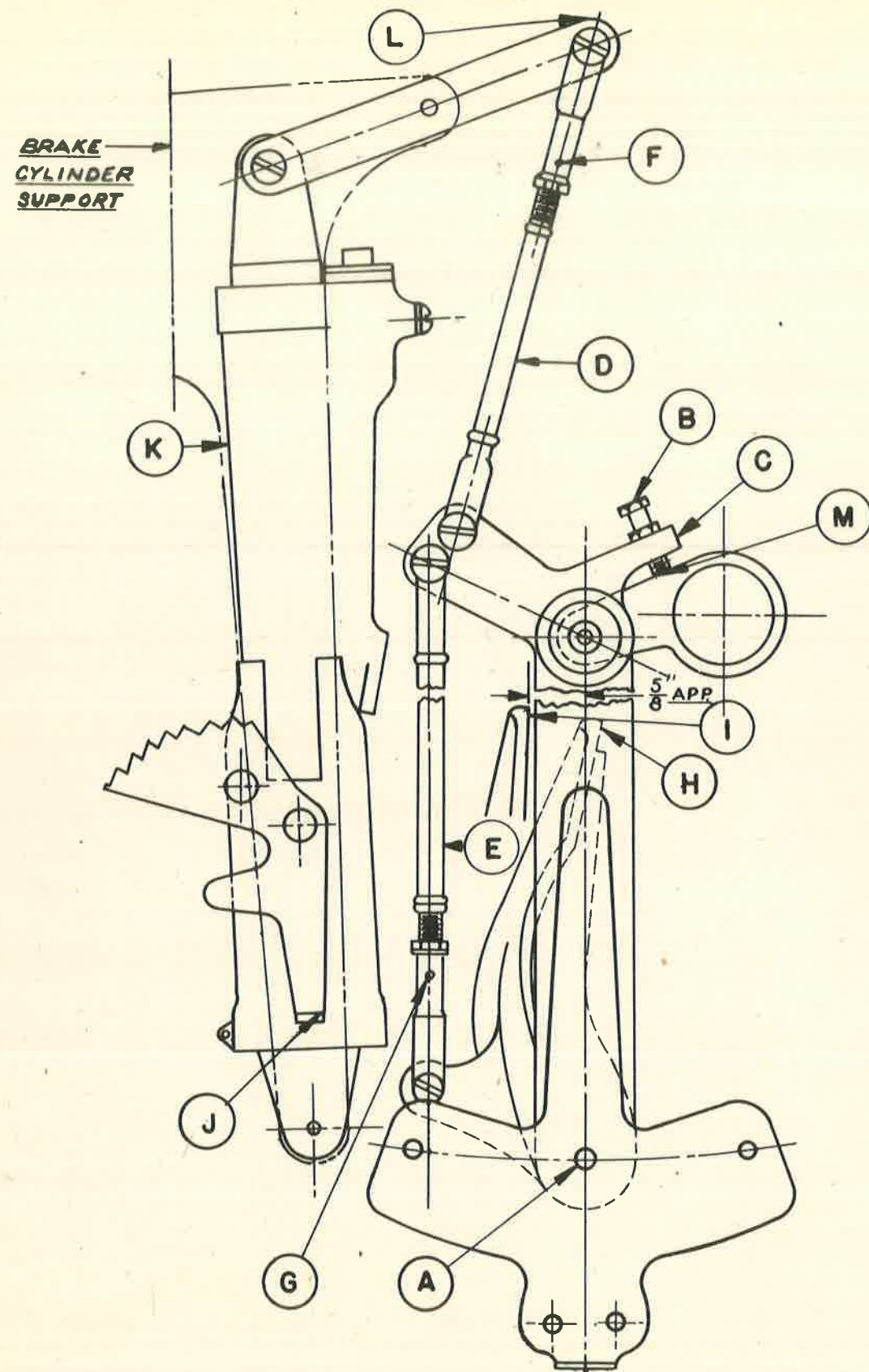
FIG. 12 PLAN VIEW LEVELING LUGS H-87A-2 & 3











#### ADJUSTMENT OF BRAKE TREADLE ANGLE

(1) PLACE THE RUDDER PEDALS IN NEUTRAL POSITION, SET THE PEDAL LENGTH ADJUSTMENT IN NEUTRAL (PEDAL ADJUSTMENT LOCKING PIN IN CENTER HOLE (A)), AND PLACE THE BRAKES IN THE OFF POSITION.

(2) LOOSEN LOCK NUT AND ROTATE (B) COUNTER-CLOCKWISE UNTIL IT IS FLUSH WITH THE BOTTOM SURFACE OF LEVER (C).

(3) DISCONNECT AND ADJUST THE CLEVIS ENDS ON RODS (D) AND (E) UNTIL THEY EITHER COVER THEIR INSPECTION HOLES (F) AND (G) BY ONE COMPLETE TURN, OR UNTIL THE TOP OF THE BRAKE TREADLE (H) HAS MOVED FORWARD TO POINT (I), WHEN THE RODS ARE TEMPORARILY RECONNECTED.

(4) BE SURE THAT THE PARKING BRAKE RATCHET IS SEATED FULLY AT POINT (J) AND THAT THE BRAKE CYLINDER (K) IS FULLY COMPRESSED (OFF POSITION) BEFORE CONNECTING THE RODS

(5) CONNECT RODS AND SAFETY.

(6) ROTATE STOP BOLT (B) CLOCKWISE UNTIL IT TOUCHES POINT (M) AND TIGHTEN THE LOCK NUT.

NOTE: CHECK ADJUSTMENT BY OPERATING THE PARKING BRAKE SEVERAL TIMES. THE PARKING BRAKE RATCHET SHOULD RETURN TO POINT (J) WHEN THE PARKING BRAKE IS OFF. IF IT DOES NOT RETURN TO ITS PROPER POSITION, CHECK THE PARKING BRAKE CONTROL AND CABLE LENGTH.

**FIG. 13A BRAKE  
TREADLE ADJUSTMENT**





C. Towing

Towing rings are provided at the inboard end of each wheel axle on the landing gear.

D. Leveling

1. Six leveling lugs are located on the two longerons which form the cockpit sill. Two lugs for longitudinal leveling are located in the longeron on the right hand side, and two lugs for gun leveling are similarly located on the left-hand side. The two lugs for lateral leveling are located on the right and left-hand sills immediately aft of the windshield. A 26" level will serve for all levelings. A tapped block located on the wing match angle immediately aft of the leading edge provides for plumb bob attachment on airplanes #AK571 through #AK620. On airplanes #AK621 and subsequent there is an 1/8" hole drilled in the nose of the propeller spinner cone, concentric with the center line of the spinner, for plumbing when sighting guns.

E. Lashing Down

Tie-down rings are located in the under surface of each wing panel between the outboard bulkhead and the removable wing tip. These rings are held in the retracted position in the wing by springs and are pulled down through slots in the wing by small tabs which protrude through the bottom surface of the wing. A decalcomania "TIE-DOWN" indicates the location of these tabs.

F. Walkways

No walkways are provided. If it is necessary to walk on the wing beyond the "NO STEP" line painted on the wing, the heavy throw-over pad furnished with the airplane (Drawing No. 87-88-524) should be used to protect the wing skin on airplanes AK571 through AK590. On airplanes AK591 and subsequent partial walkways are provided to prevent slipping. These walkways are made of 1/16 inch green "Aero Floor" manufactured by the Armstrong Cork Company. The walkways are cemented to the wing skin and bound on all four sides by binding strips which are fastened to the wing surface with flush head screws.

G. Parking Brakes and Surface Control Locks

The parking brake is set by pulling on the lever on the left-hand side of the cockpit, below and to the left of the instrument panel marked "BRAKE PARKING PULL", while both brake pedals are depressed. Release parking brake by depressing brake pedals. To adjust the brake treadle angle see Figure 13a.



The control surfaces are locked by rigging the parking harness (87-64-570) around the control stick. Attach the cables as shown in Fig. 13. If the hooks are painted, attach the green hooks to the pilots seat and the red hooks to the rudder pedals. If the cables seem too short, adjust the rudder pedals to the full aft position, and the seat in the down position. Attach the cables and raise the seat to remove the slack. In some rare cases it may be necessary to wrap the harness around the stick below the electric conduit plug to gain enough slack to engage all the hooks.

H. Engine (For Ground Crew)

1. Before Starting Engine or Taxiing:
  - a. Make a pre-flight inspection of the airplane. See Section VI.
  - b. For starting and operating the engine. See the engine manufacturer's "Operator's Handbook" and propeller manufacturer's instruction book.

I. Accessories:

Separate instructions by the respective manufacturers covering the operation, service and maintenance of units not manufactured by the Curtiss Airplane Division, will be bound in one complete volume and forwarded as they are received from the accessory manufacturers who supply this instruction material. A list of the instruction books is as follows:

| <u>Instruments</u>                                                          | <u>Manufacturer</u>            |
|-----------------------------------------------------------------------------|--------------------------------|
| 1. Engine Gage Units                                                        | The Electric Auto-Lite Co.     |
| 2. Landing Light                                                            | Grimes Manufacturing Co.       |
| 3. Reversible Hydraulic Brakes                                              | Hayes Industries, Inc.         |
| 4. Engine Primer                                                            | The Parker Appliance Co.       |
| 5. Streamline and Smooth<br>Contour Wheels                                  | Hayes Industries, Inc.         |
| 6. Horizontal and Directional<br>Gyro                                       | Sperry Gyroscope Co., Inc.     |
| 7. Type DJ-4 D-C Selsyn<br>Position Indicator                               | General Electric               |
| 8. Storage Battery                                                          | Gould Storage Battery Corp.    |
| 9. Oil Temperature Regulators<br>Viscosity Valve                            | United Aircraft Products, Inc. |
| 10. Altimeter, Manifold<br>Pressure Gage, Airspeed<br>Indicator, Tachometer | Pioneer                        |
| 11. Aircraft Thermometer                                                    | U. S. Gage Co.                 |

J. Special Precautions:

1. Never leave the airplane without all guns "safetied" and the brakes applied.
2. Be sure ignition, gun, propeller, and battery switches are "OFF", when engine is not running.



3. Leave mixture on "IDLE CUT-OFF" while engine is not in operation.
4. Do not lift the airplane by the engine hoisting sling.
5. Keep engine and cockpit cover on, when airplane is parked in open overnight. When covers are removed be careful not to damage bead and ring sights.
6. Always tie down airplane securely if it is to be left in the open.
7. Lock controls with parking harness when airplane is parked in open overnight.

#### K. Loading and Center of Gravity Information

The Loading and Center of Gravity diagram (Figure 11) should be used instead of the old style weight sheet summaries.















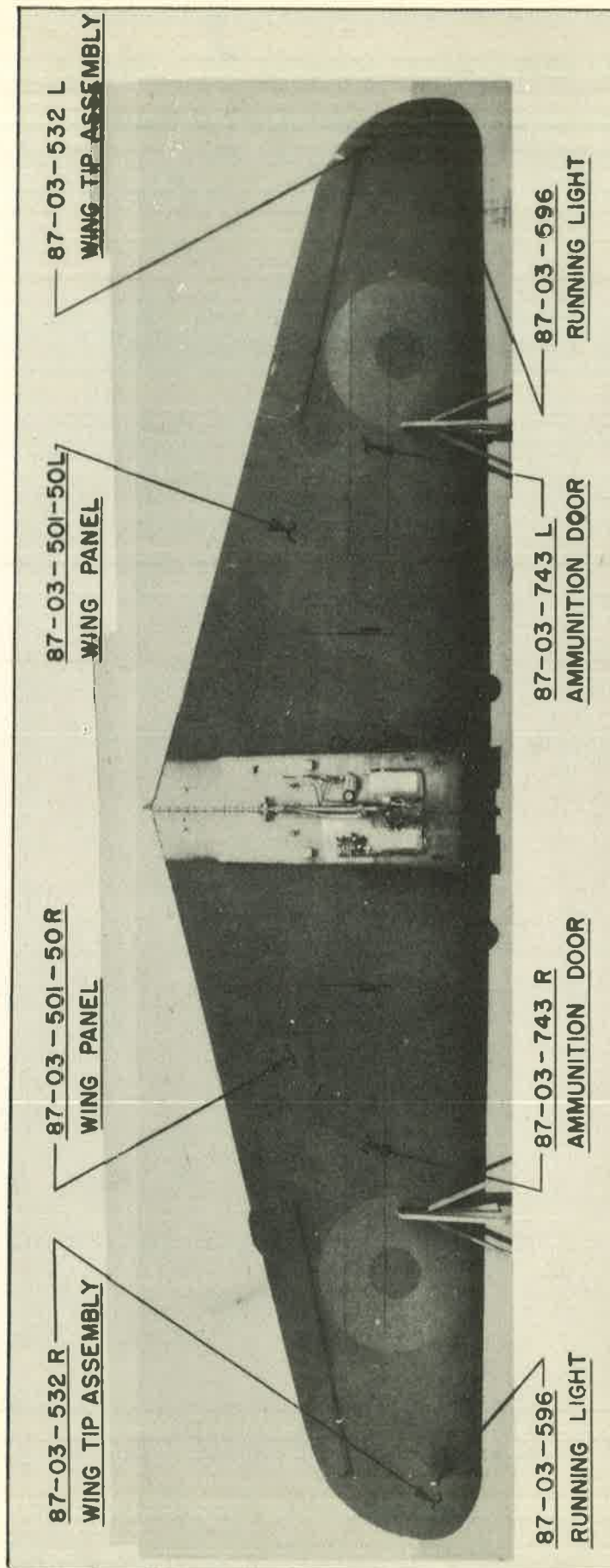
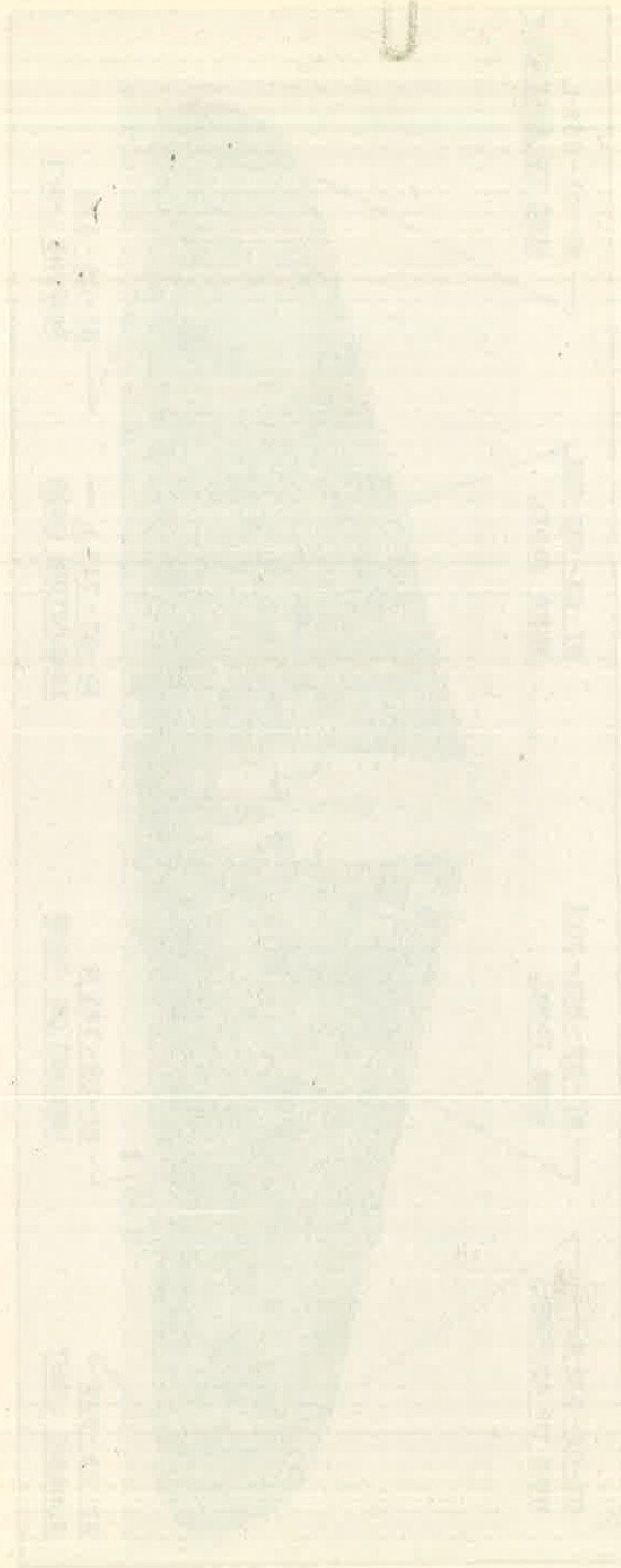


FIG.17 WING ASSEMBLY-TOP VIEW- H-87A-2



FIG 17. MINC ASSEMBLY FOR VIEW 90°-170°



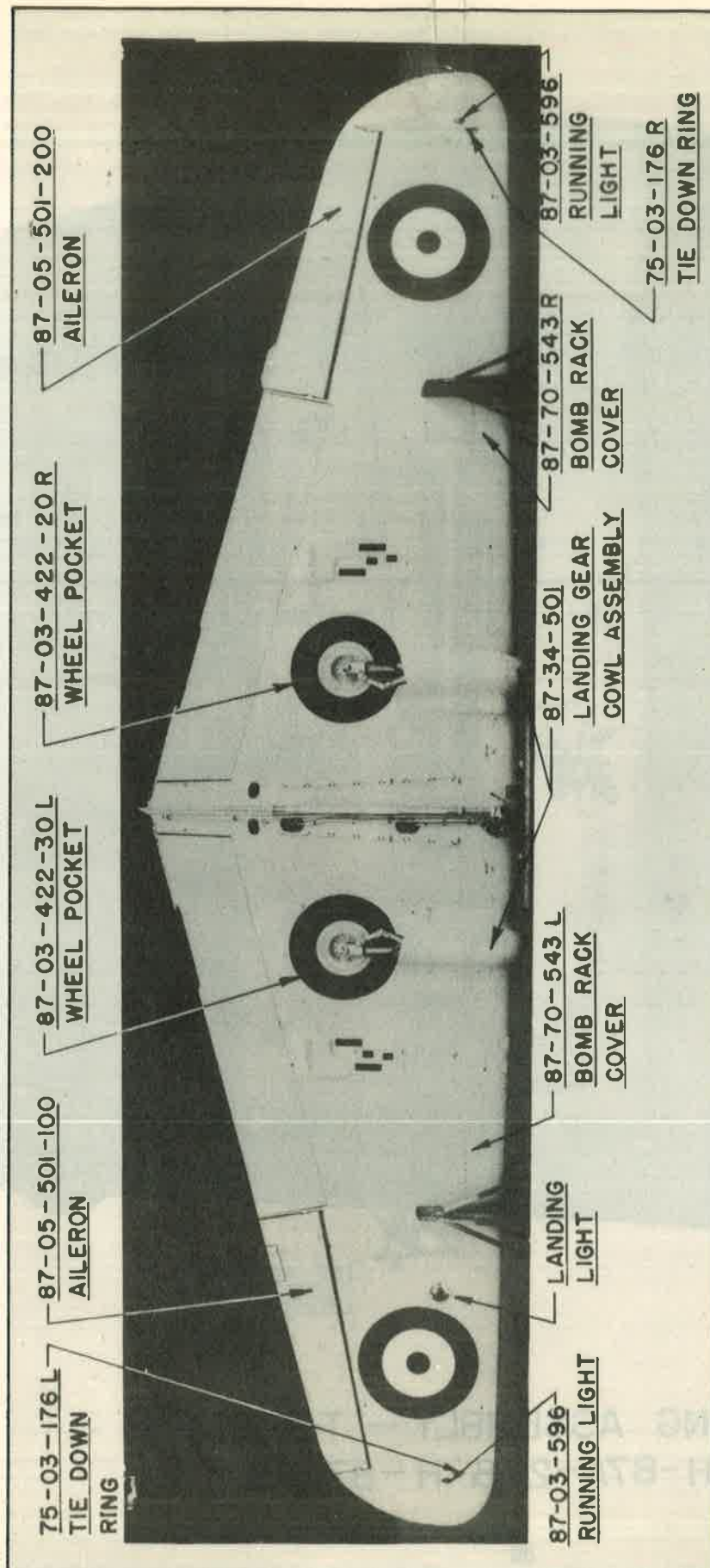


FIG 18 WING ASSEMBLY - BOTTOM VIEW H-87A-2

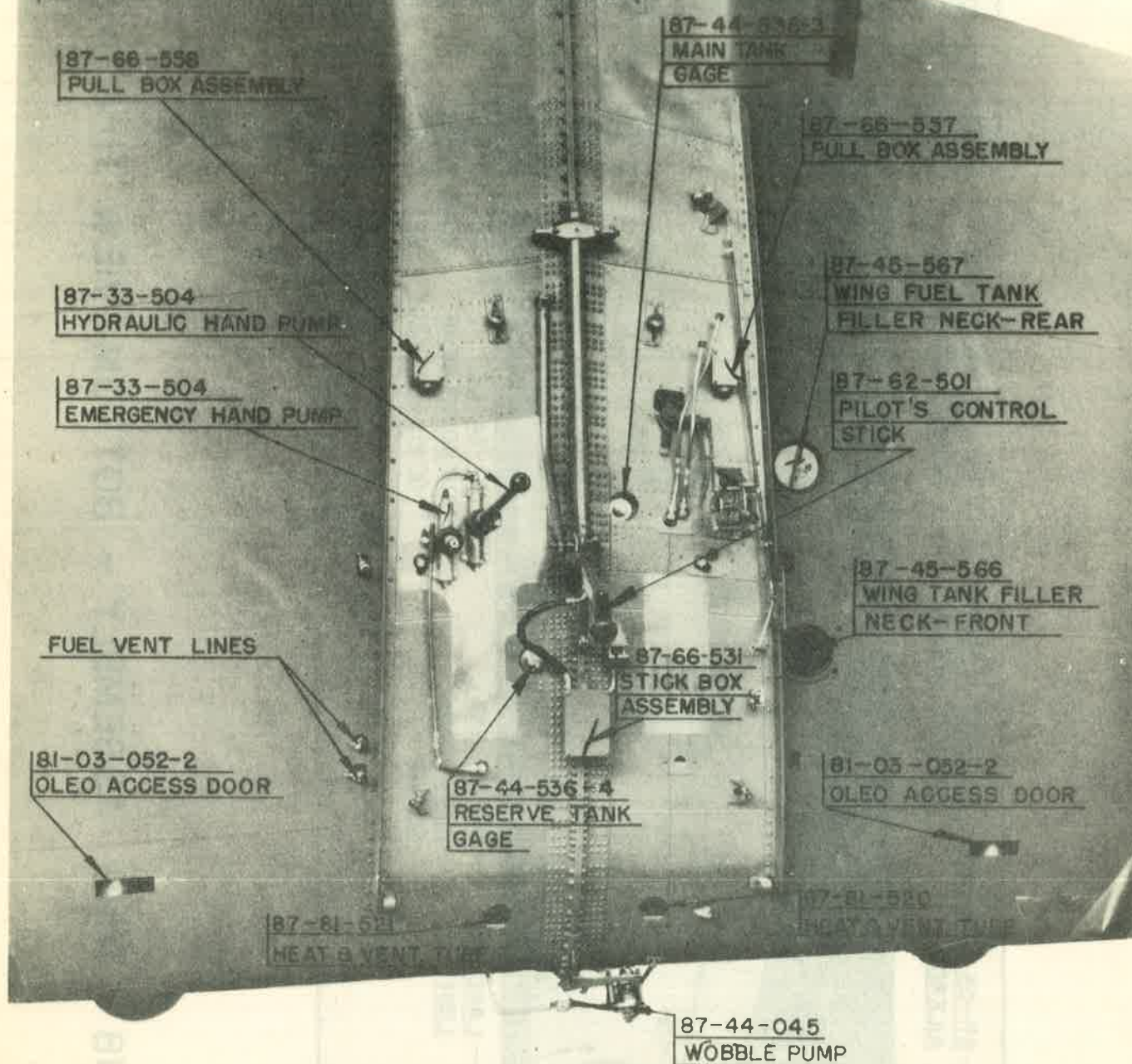


FIG.19 WING ASSEMBLY — TOP VIEW  
H-87A-2 & H-87A-3



## SECTION V

### A. Wing Assembly

- (Drawing No. 87-06-601, Wing Erection, H-87A-2)
- (Drawing No. 87-06-803, Wing Erection, H-87A-3)
- (Drawing No. 87-03-809-50, Wing Panel Assembly, H-87A-3)
- (Drawing No. 87-03-501-50, Wing Panel Assembly, H-87A-2)

1. General: The wing is of internally braced, full cantilever, multi-cellular, stressed-skin construction. The entire skin of the wing is riveted with flush rivets to form a smooth contour. The major portion is constructed of 24ST aluminum alloy, with the exception of the aileron, which is cloth covered. The two wing panels are connected in the center by a series of horizontal bolts through match angles riveted to the skin and through a bulkhead between the panels.

2. Removal and Disassembly: To remove the complete wing the manufacturer recommends that the cradle shown in Figure 7 be used for support of the airplane and subsequently for the support of the wing after separation from the fuselage. If a cradle of this type is not available, then a padded chordwise support at least five inches wide and curved to fit the underside of the wing, should be placed approximately eight feet, three inches outboard from the airplane center line under each panel.

a. Suspend the airplane by the forward and tail hoisting slings. Attach the former to the lugs on the engine mount and the latter to a bar passed through the lift hole in the rear of the fuselage.

b. Drain all fuel tanks.

(1) The drain cock for the fuselage tank is located on the bottom side of the fuselage aft of the trailing edge of the wing.

(2) Drain cocks for the wing tanks are located under the wing on the left panel approximately five inches from the center line of the airplane.

c. Remove the engine cowlings.

d. Remove the keel fairing.

e. Remove the wing fillets and fillet bulkheads attached to the wing or fuselage. The drain casting in the trailing edge of the left hand fillet should be supported by a wire up to a temporary screw in one of the fillet nut plates in the fuselage after the removal of the fillet.

f. Remove the cowl flaps by removing the cowl flap support channel and entire exit duct as one unit.

g. Drain the oil system at the "Y" drain and at the drain plug located on the inboard side of the "Y" drain cock. This plug is on the end of the 1/2" O.D. drain line from the bottom rear of the oil tank. (The "Y" drain cock is located on the right hand side 3" forward of the leading edge.)

h. Disconnect the oil line at the leading edge of the wing.

i. Remove the support assembly attached to the leading edge of the wing.

j. Disconnect the wing tank vent lines.

k. Remove the section of the heater and ventilator ducts forward of the firewall. Remove the clamps holding the heater and ventilator ducts to their supports on the leading edge immediately forward of the firewall.

l. Remove the cowl flap torque shaft support attached to the leading edge of the wing on the center line of the airplane.

m. Disconnect the fuel selector control at the joint below the gear box forward of the firewall.

n. Disconnect the two fuel lines leading from the top of the wobble pump (on airplanes AK571 - AK720) electric auxiliary pump on airplanes AK721 and subsequent.

o. Drain the hydraulic brake system at the wheels.

p. Disconnect the drain casting at the hose connection.

q. Remove the pilot's seat.

r. Disconnect the elevator push-pull tube at its junction to the elevator controls and tie to the control stick.

s. Remove the armor plate aft of the pilot's seat.

t. Drain the hydraulic system tank (forward of the fuselage access door.)

u. Disconnect the vertical brace to the rudder pedal cross bar at the match angle.

v. Disconnect the wing gun charger hydraulic lines at the connection to the hand control valves.

w. Disconnect the two hydraulic brake lines at the cockpit floor aft of the firewall.

- x. Disconnect the airspeed lines at the upper surfaces of the panel.
  - y. Disconnect the wing electrical system at the plugs on the cockpit floor aft of Sta. #4. One plug on each side of cockpit.
  - z. Disconnect the two 5/16" O.D. hydraulic flap control lines at the elbows on the cockpit floor directly below the hydraulic control valve.
  - aa. Disconnect the two 3/8" O.D. hydraulic landing gear lines at the auxiliary hand pump, at their connections on the trailing edge of the wing.
  - bb. Disconnect the 3/8" O.D. hydraulic landing gear lines at the elbows where they enter the wing.
  - cc. Disconnect the two 3/8" O.D. hydraulic landing gear lines at the inboard emergency hand pump.
  - dd. Disconnect the two 3/8" O.D. inboard hydraulic lines at the tee connection under the landing gear control box.
  - ee. Disconnect the 1/16" diameter cable from the recognition device damped rate control on the right hand side of the cockpit floor, between the hydraulic hand pumps, to the recognition device on Sta. #10 bulkhead in the fuselage.
  - ff. Raise the airplane slightly to relieve the load on the fuselage wing bolts.
  - gg. Remove the three bolts attaching the rear end of the wing angle to the fuselage.
  - hh. Remove wing to fuselage joint bolts.
  - ii. Raise the fuselage approximately one inch, for the firewall to clear angle, and push forward about three inches to clear the oil lines to the engine.
  - jj. Raise the fuselage slowly until all items attached to the top surface of the wing are cleared.
3. To Disassemble the Complete Wing: To separate the wing into individual panels.
- a. Remove the rear, intermediate inboard landing gear fairing. (This is necessary to remove wing tank doors).
  - b. Remove drain and vent lines from upper surface of the panel.
  - c. Remove the wobble pump (Airplanes AK721 and subsequent, have an electric auxiliary pump), strainer and fuel selector from their supports at the match angle.



- d. Remove the main fuel lines.
- e. Remove the oil lines.
- f. Remove the two fuel cell gages.
- g. Remove the fuel tank doors as a single unit by removing all screws and bolts which attach the door to the wing, including screws and six bolts through web #3.
- h. Remove bonding and tank straps.
- i. Remove pan assemblies and fuel cells.
- j. Remove screws in the plate across the center line of the wing at forward bottom edge of web #3.
- k. Disconnect the two 3/8" O.D. hydraulic control lines at tee fittings on the left panel, forward of the landing gear control handle.
  - l. Disconnect the 3/8" O.D. hydraulic control lines, from inboard emergency hand pump, at tee connections on the right hand panel forward of the instrument board.
- m. Remove the link from the flap actuating cylinder to the bellcrank in the left panel and disconnect the hydraulic lines to the actuating cylinder. (Cylinder is attached to the center line bulkhead.)
- n. Remove the two bolts which attach the control stick torque tube rear fitting to the match angles.
- o. Disconnect the links at the aileron control arm on the torque tube.
- p. Remove bonding from the control stick to the panel.
- q. Remove the bolt which attaches the lower end of the elevator stop to the match angle.
- r. Disconnect the gun trigger and landing gear electrical conduit at base of the control stick.
- s. Remove the two bolts which attach the control stick torque tube forward fittings to the match angles and remove the control stick assembly.
- t. Remove heating and ventilating control shaft.
- u. Remove all bolts through the match angles and separate the wing. (Center line bulkhead is attached to and will remain with the right hand panel.)

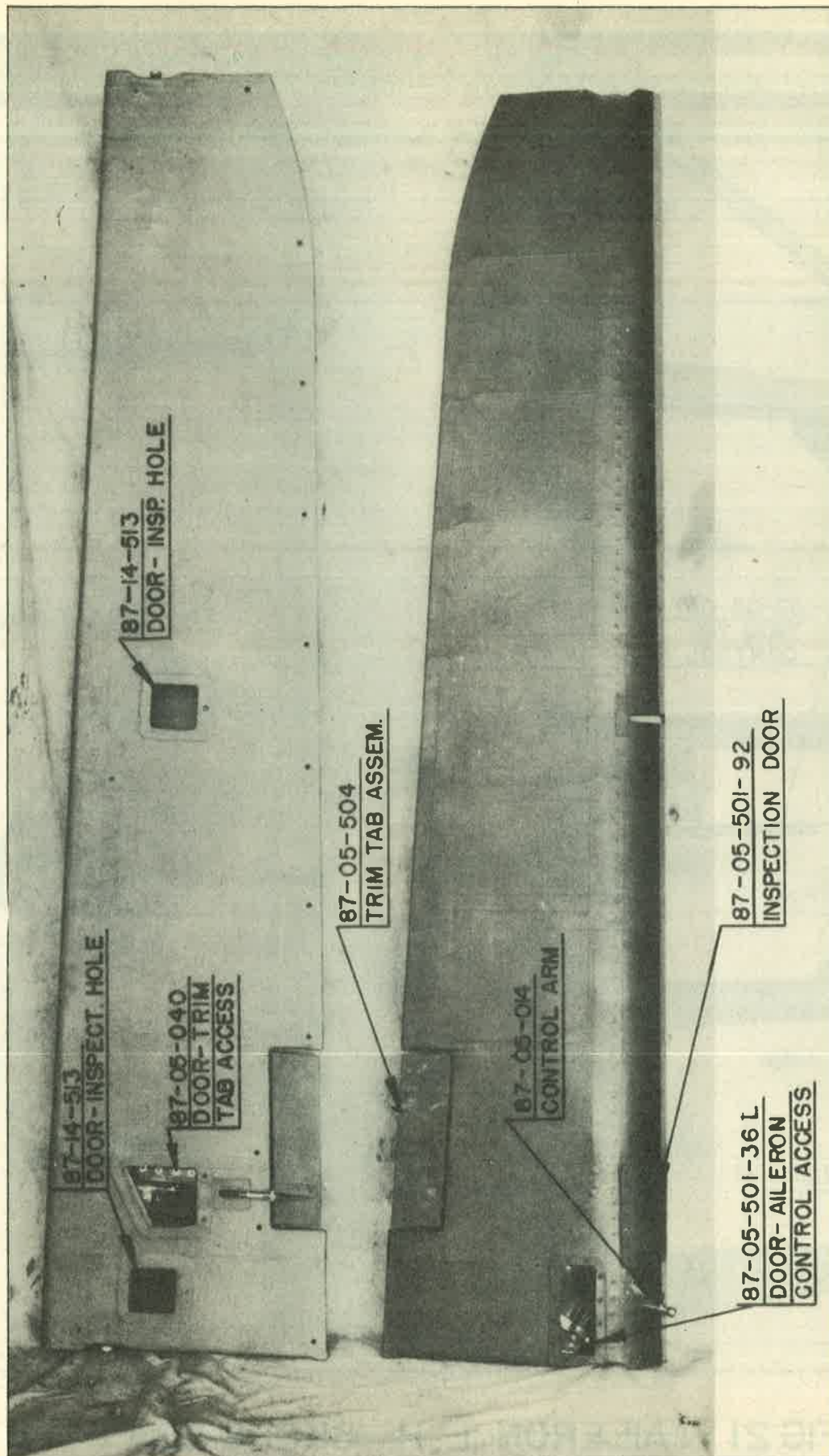


FIG. 20 AILERON - TOP & BOTTOM - COVERED - L.H.  
H-87A-2 & H-87A-3



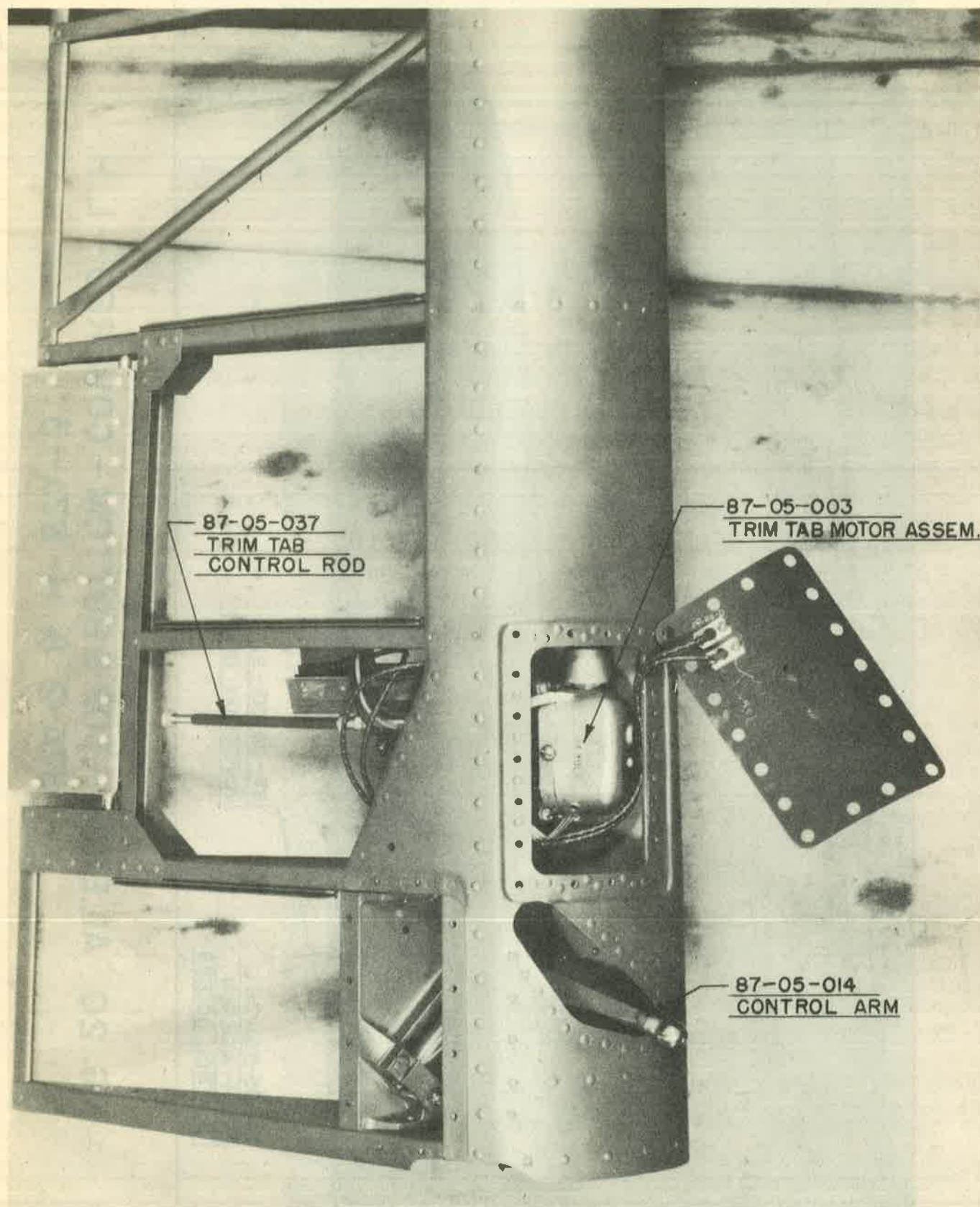


FIG 21 AILERON L.H. SKELETON  
WITH ELECTRIC TRIM TAB MECHANISM INSTALLED



4. To Install The Complete Wing: Assembly of the wing to the fuselage is a reversal of the procedure outlined in paragraph 2 of this section. (Additional information may be found in Part A Sec.III)

The wing tips are separate units attached to the main structure by a series of truss-head screws on the surface. When removing the wing tips disconnect the navigation light wires. These tips are replaceable in the event of damage.

Wells are built into the underside of the wing for fuel tanks and landing gear wheels. The match angle joint which connects the two wing sections will serve as a skid in case of an emergency landing with the landing gear retracted.

#### 5. Ailerons:

The skeleton frame work is metal (aluminum alloy) and covered with fabric. The normal aileron movement is  $18\frac{3}{4}$   $\pm 2^\circ$  up and  $10\frac{3}{4}$   $\pm 2^\circ$  down.

Installation: The aileron (Drawing No. 87-05-501-200 right-hand Aileron Assembly, No. 87-05-501-100 left-hand aileron assembly) is assembled to the panel by raising it until the ball bearings on the ends of the aileron are seated in the upper half of the split clamp fittings on the panel, and the center hinge on the panel drops into place through a slot in the aileron leading edge. At the same time it is necessary to guide the ball on the aileron control unit into the socket in the panel. This joint is located near the inboard end of the aileron. There are no loose parts in this connection. The end hinges are then clamped up and bolted and the center hinge bolted through an access door in the lower surface.

The ailerons are controlled by movement of the drum on which the socket for the aileron ball is mounted. Cables attached to this drum run inboard along the flap compartment, and are accessible for adjustment or replacement with the flap down.

Near the center of the wing the cables run around pulleys and forward to a bellcrank. Between the pulleys and the bellcrank, the cables are crossed. The bellcrank is connected to a lever on the torque shaft of the control stick by means of an adjustable link through the upper surface of the wing. Range of the movement of the aileron is controlled by adjustable stops on the lever. With the stick in neutral both ailerons should droop  $\frac{3}{16}$  to  $\frac{1}{4}$  from the wing contour. If the correct aileron movement is not attained within one degree, adjust the link and cables on one side at a time, always maintaining approximately 90 lbs. tension in the cables. To correct for an aileron up or down on one side, shorten one cable and lengthen the other by means of the turnbuckle. With one aileron up and the other down, correct as near as possible by adjusting the links, completing the adjustment with the turnbuckles.

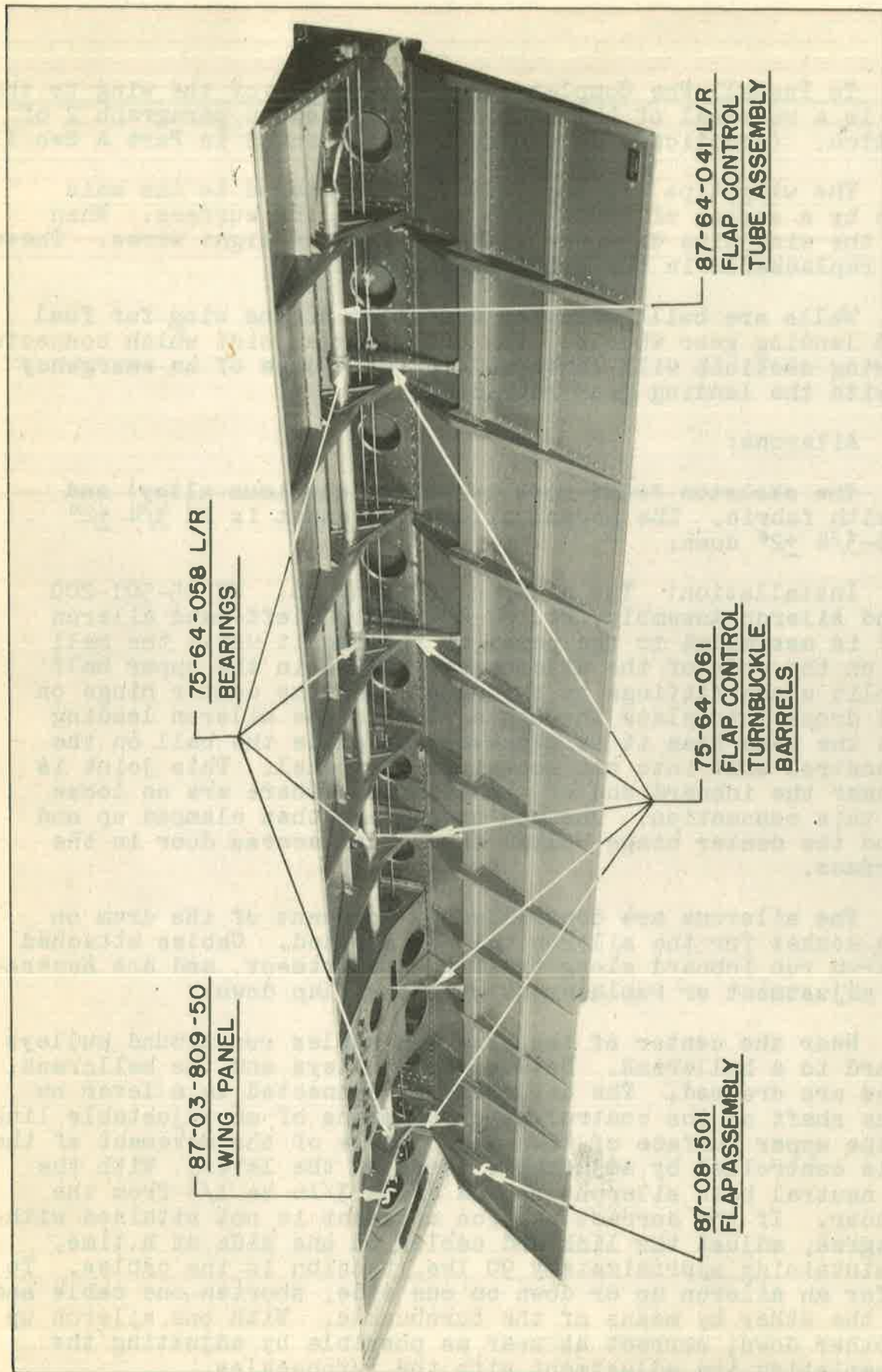


FIG. 22 WING FLAP - OPEN 45°



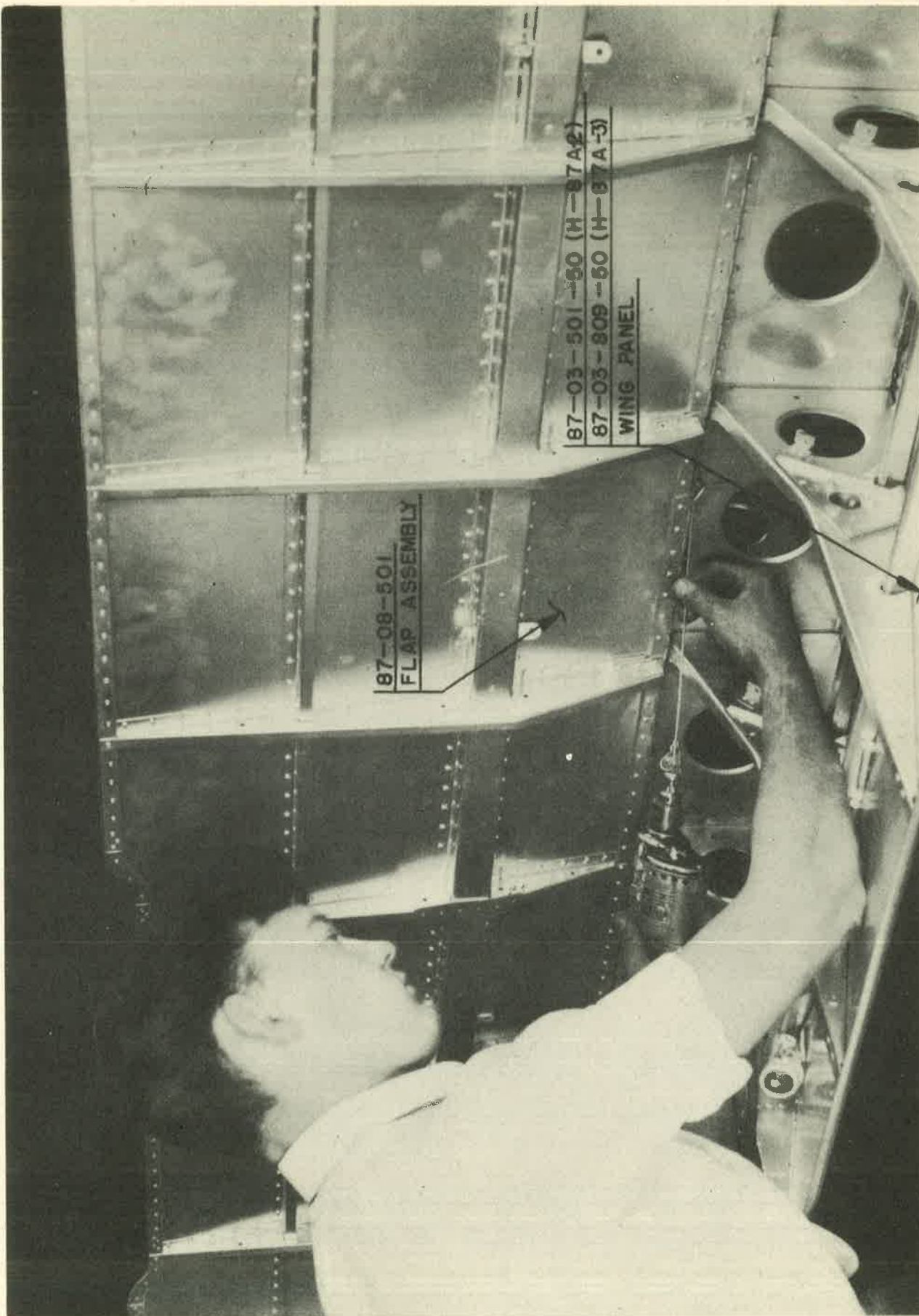
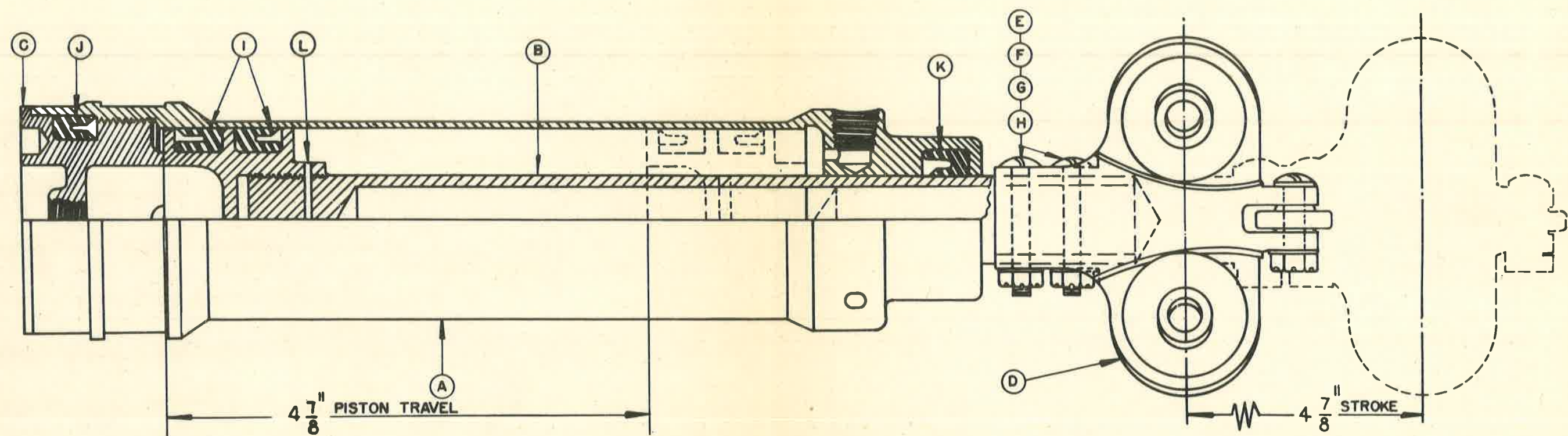


FIG 23 WING FLAP HINGE PIN INSTALLATION H-87A-2 & H-87A-3





| LETTER | PART NO.  | NAME            | NO. REQ'D. | LETTER | PART NO.   | NAME   | NO. REQ'D. | LETTER | PART NO.  | NAME | NO. REQ'D. |
|--------|-----------|-----------------|------------|--------|------------|--------|------------|--------|-----------|------|------------|
| A      | 75-64-071 | CYLINDER        | 1          | H      | AN380-C2-2 | COTTER | 2          | I      | 99179     | CUP  | 2          |
| B      | 75-64-072 | PISTON ASSEMBLY | 1          | G      | AN320-3    | NUT    | 2          | J      | 99178     | CUP  | 1          |
| C      | 75-64-073 | PLUG            | 1          | F      | AN960D10   | WASHER | 2          | K      | 99180     | CUP  | 1          |
| D      | 87-64-024 | END ASSEMBLY    | 1          | E      | AN 23-23   | BOLT   | 2          | L      | 106D-1-20 | PIN  | 1          |



PRESSURE TEST ASSEMBLY TO 2500 \* / SQ. IN.  
SEE FOLLOWING PAGE FOR ASSEMBLY & DISASSEMBLY INSTRUCTIONS

**FIG. 24**  
**WING FLAP ACTUATING**  
**CYLINDER**

REF. DWG. 87-64-004





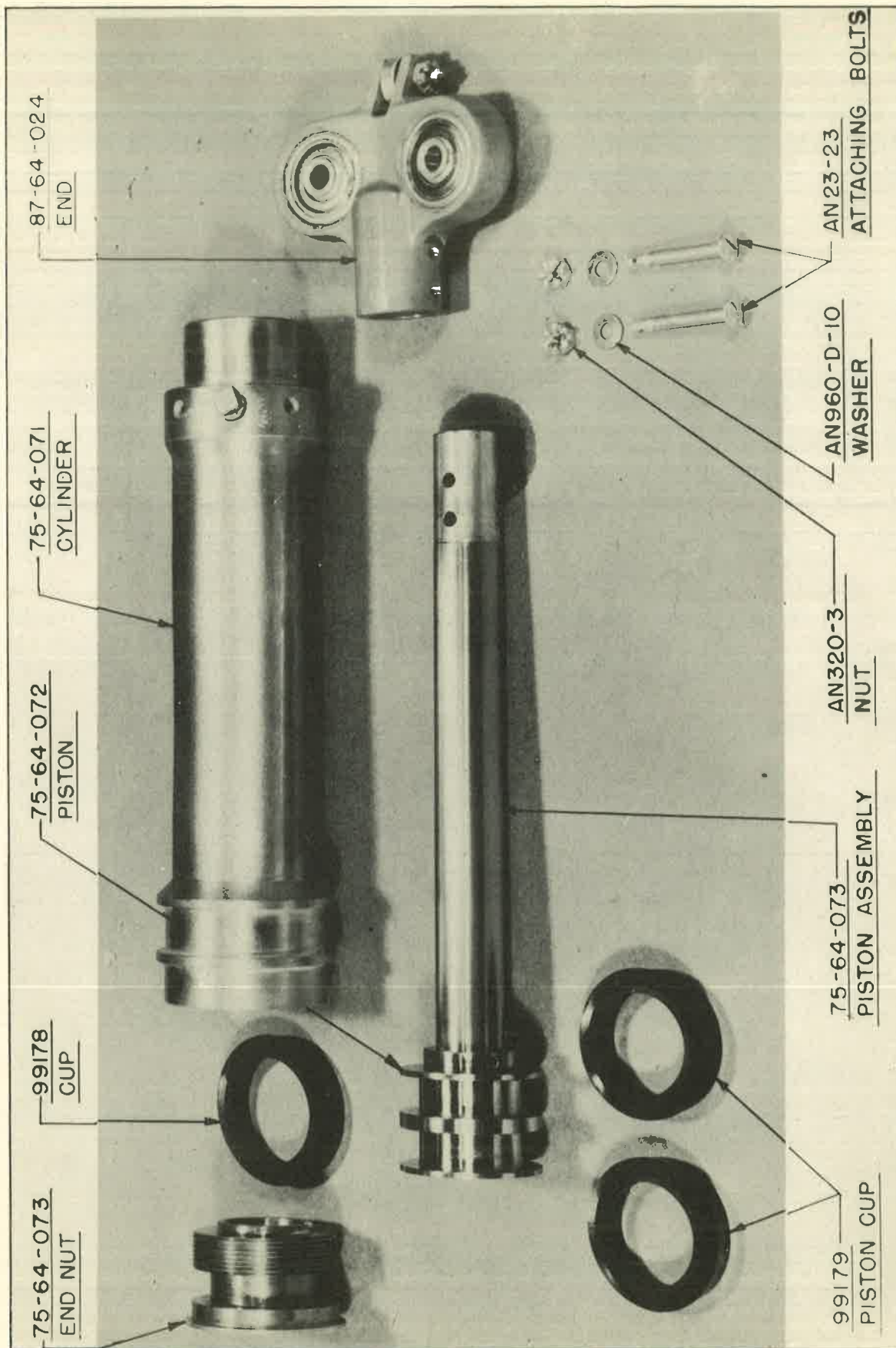


FIG.24A ACTUATING CYLINDER DISASSEMBLED



Wing heaviness is corrected by bending the right hand aileron trim tab slightly ( $\pm 15^\circ$  limit) up for right wing low, down for left wing low. If correction is necessary, while in flight, the electrically controlled trim tab on the opposite panel should be actuated.

The electrically controlled trim tab on the left hand aileron is operated by an electric motor assembly on the leading edge of the aileron directly forward of the trim tab. The electric motor is controlled by a switch in the cockpit. The switch is marked "LEFT WING UP", "LEFT WING DOWN" and "OFF". This trim tab moves through a range from  $20^\circ$  up to  $20^\circ$  down.

To remove the trim tab from the left aileron, disconnect the control arm from the horn, rotate as far as possible from the neutral position and remove the two cap screws from the blocks on each end of the front face of the tab.

6. Flaps: Hydraulically-operated, split-trailing edge flaps extend from within a few inches of the airplane center line to the inboard ends of the ailerons. They are attached to the wings by a continuous hinge running the full length of each flap.

The primary function of the split-trailing edge flaps is to decrease the stalling speed and the length of the glide, therefore making possible a slower landing speed. They will also aid in take-off. The flaps are made of aluminum alloy and are operated hydraulically by the electric pump or the outboard hand pump.

The actuating cylinder is mounted on the center bulkhead near the trailing edge and operates the bellcrank, which is connected to a spanwise push-pull tube running the length of the flap. At intervals along this tube are five rods with turnbuckles connected to the flap, which raise or lower the flap by movement of the tube. The lines for operating the cylinder are accessible through the lower surface door near the cylinder, or the hand hole immediately forward.

To Disassemble the Hydraulic Actuating Cylinder: When the wing panel is separated at the center bulkhead the flap actuating cylinder may be easily removed for inspection and disassembly. First disconnect the two hydraulic lines at the cylinder. See Figure 24. Next remove the two bolts attaching bellcrank arms to the piston shaft end "D". Remove the four bolts in the clamp assemblies which attaches the cylinder to the center bulkhead. Place cylinder "A" in wooden block clamps and insert in a vice. If block clamps are not available use a vice with aluminum or copper covered jaws. With cylinder "A" held firm, unscrew the end plug "C" using the spanner wrench (Drawing No. 87-88-030) which is carried in the tool compartment of the duffle bag. Pull the two cotter pins "H" and unscrew the nuts "G". Remove the washers "F" and pull bolts "E" which attach end "D" to the piston shaft "B". Remove piston assembly "B" from the cylinder through uncapped end. The rubber piston cups "I" may now be



inspected and replaced if necessary. Also inspect rubber cup on the end plug "C" and cup in forward end of cylinder "A". If worn replace with new cups.

**To Assemble Actuating Cylinder:** Before assembling cylinder be sure that no dirt or foreign matter of any kind is on the parts to be assembled. To assemble reverse the procedure outlined above for disassembly.

**Installation and Removal:** To assemble the flap to the wing interlock the part of the hinge attached to the wing to the part attached to the flap itself and insert the hinge pins. The loop end of the hinge pin may be clamped in the chuck of a low R.P.M. portable electric drill. Lubricate the hinge pin with a light engine oil and then use the rotating motion of the drill to feed the pin through the hinges. See photograph, Fig. 23 showing hinge pin installation. The flaps should at all times seat perfectly into the wing contour when in the up position. If the flap as a whole is not seated, the link connecting the bellcrank and the push rod should be shortened. If the flap is not seated locally, shorten the turnbuckles near these points. The flaps should be adjusted to have the same angular movement for both flaps and should move downward simultaneously to a maximum opening of  $45^{\circ}$ . Connect the flap position indicator linkage.

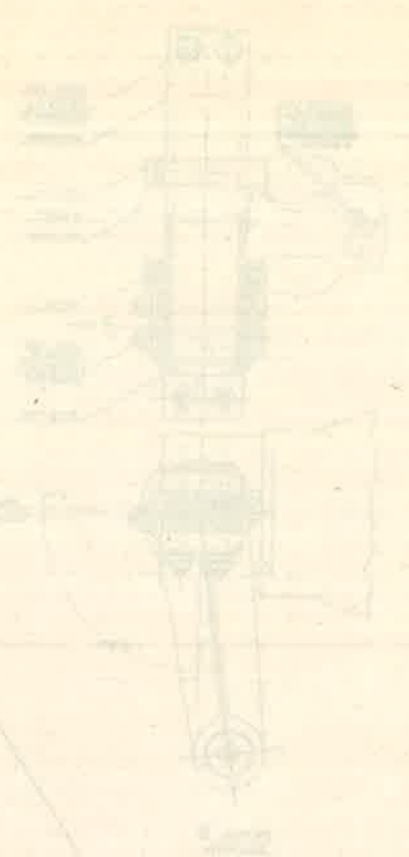
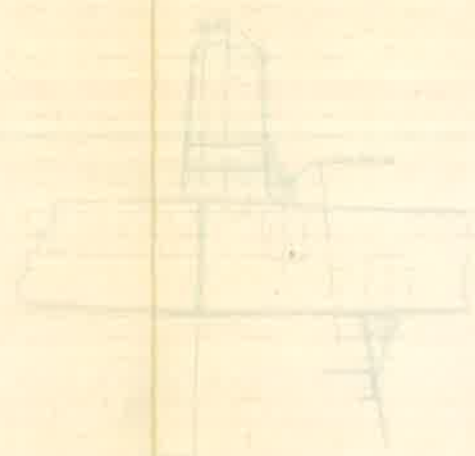
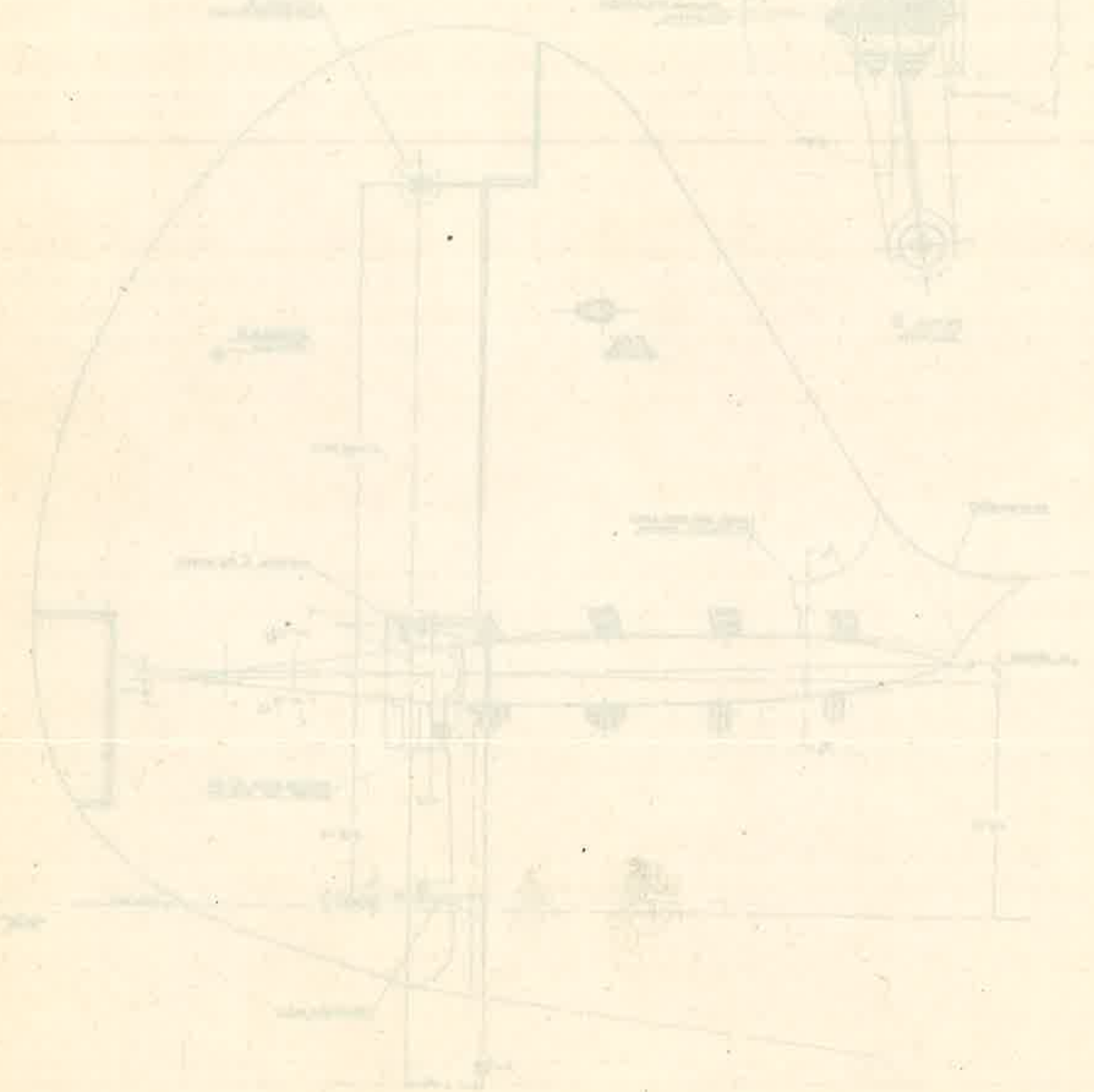
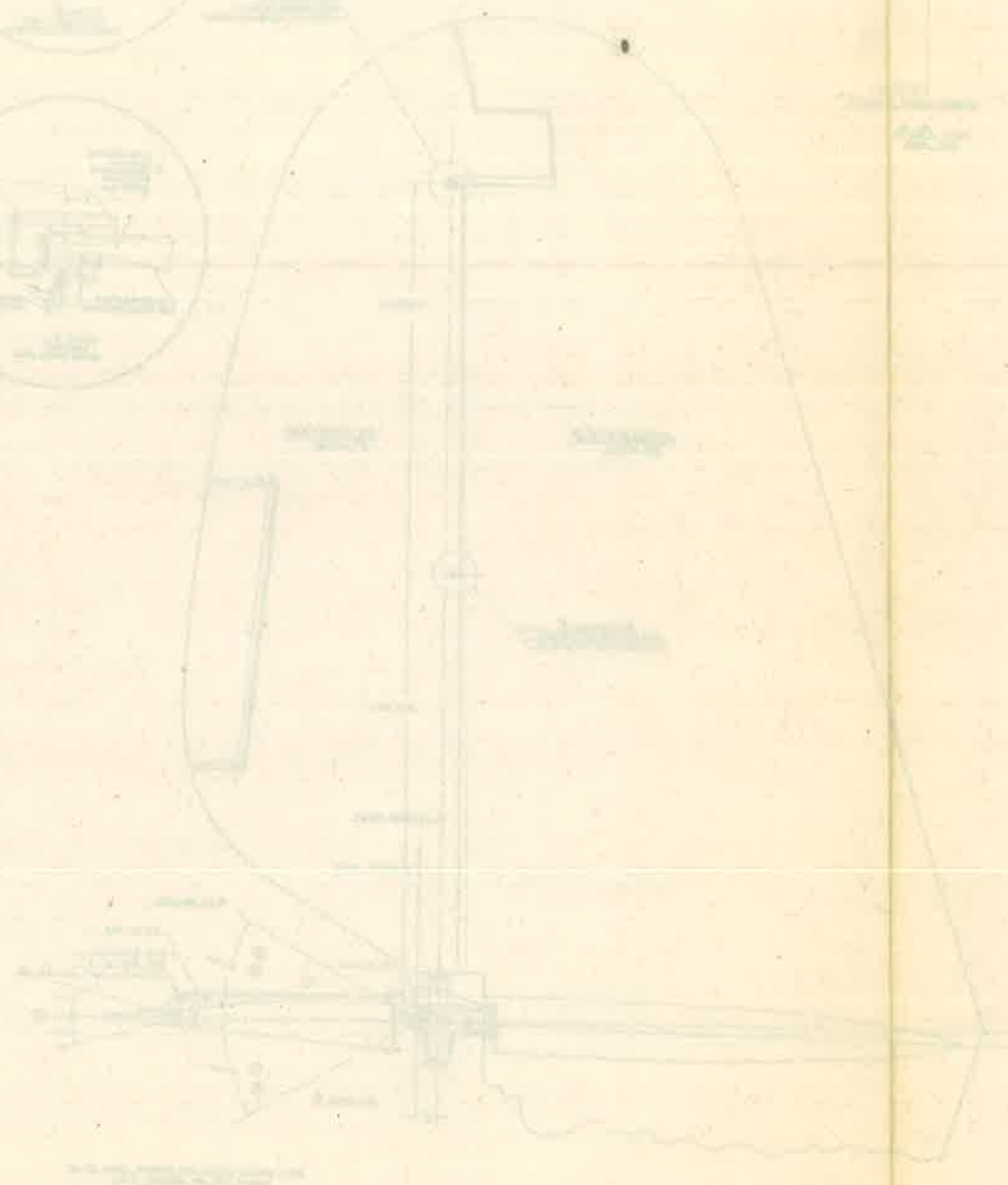
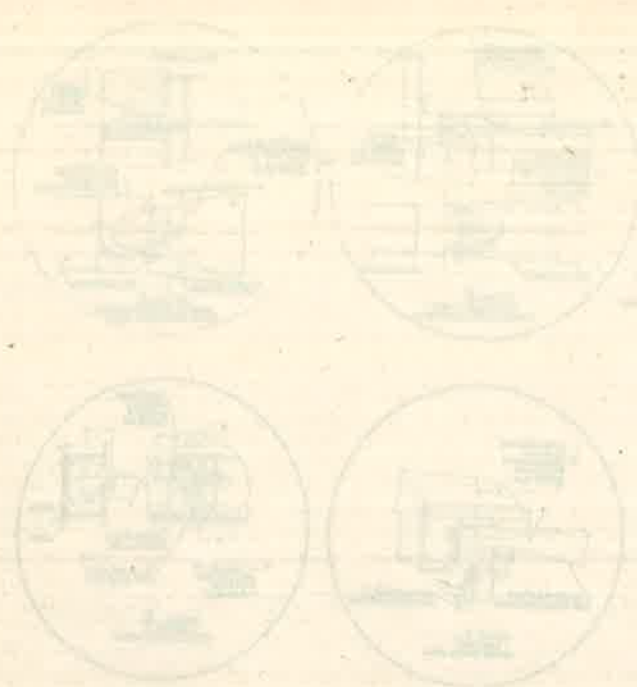
The flap may be removed by first disconnecting the flap position indicator linkage, the turnbuckles, and then pulling out the hinge pin which runs the length of the continuous hinge. The bellcrank and actuating cylinder are removable through a door in the lower trailing edge wing surface. Push rod removal requires that the panels be separated, the fittings for the turnbuckle ends loosened, and the rod slid inboard. This operation should seldom be necessary.







FIG. 23 ENLARGED  
ASSEMBLY 02-15-201





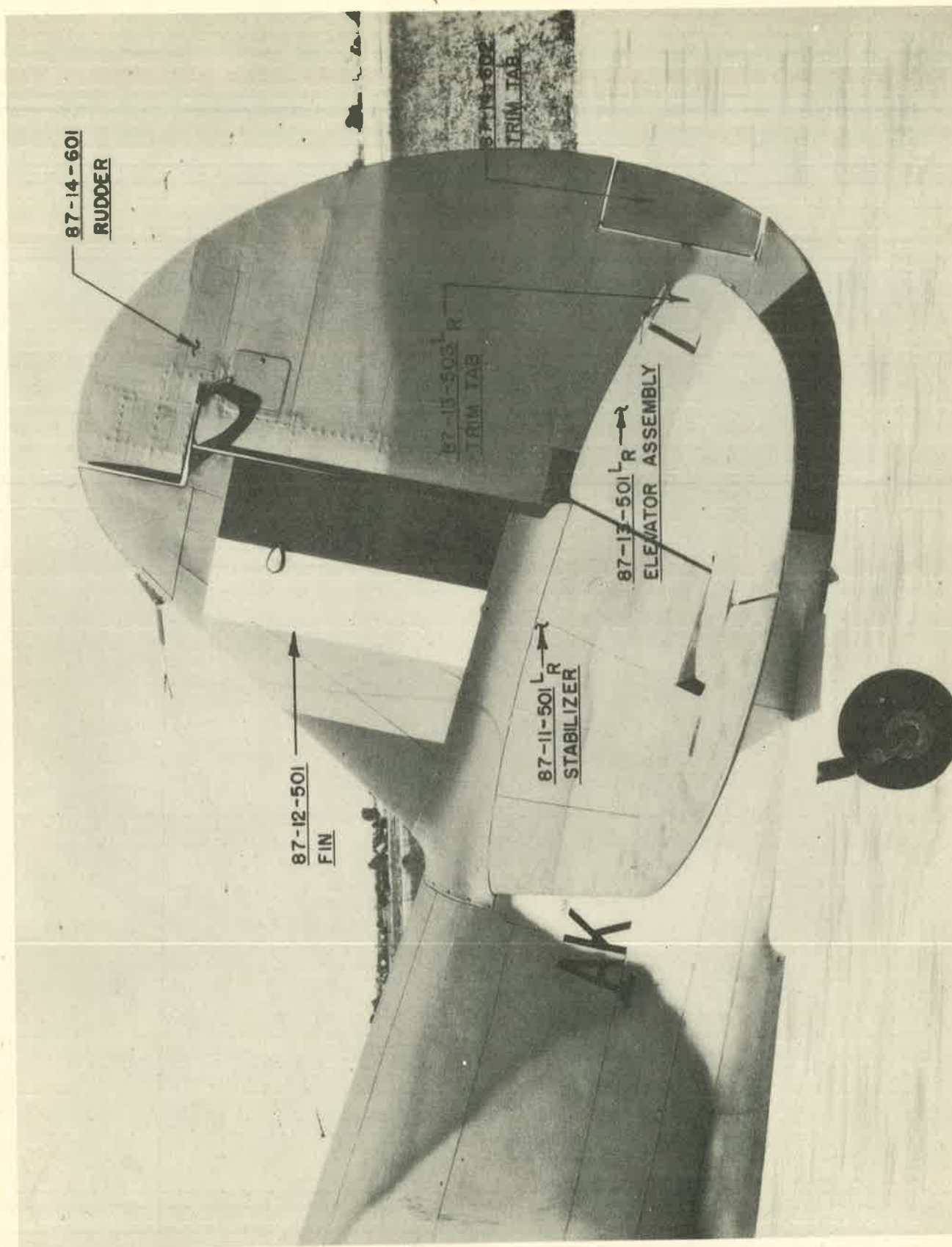


FIG.26 EMPENNAGE INSTALLED H-87A-2 & 3



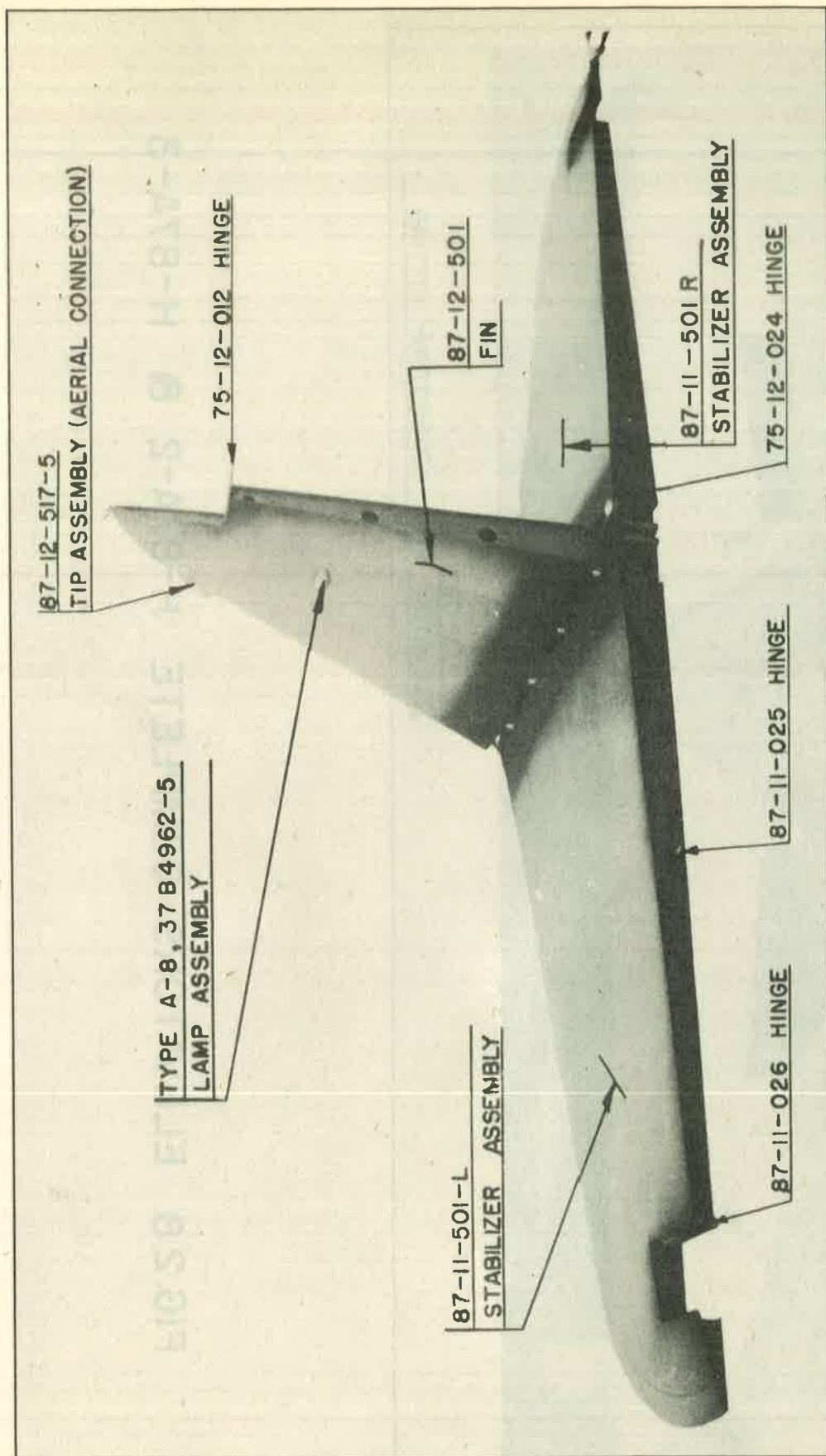


FIG. 27 STABILIZERS COMPLETE H-87A-2 & H-87A-3



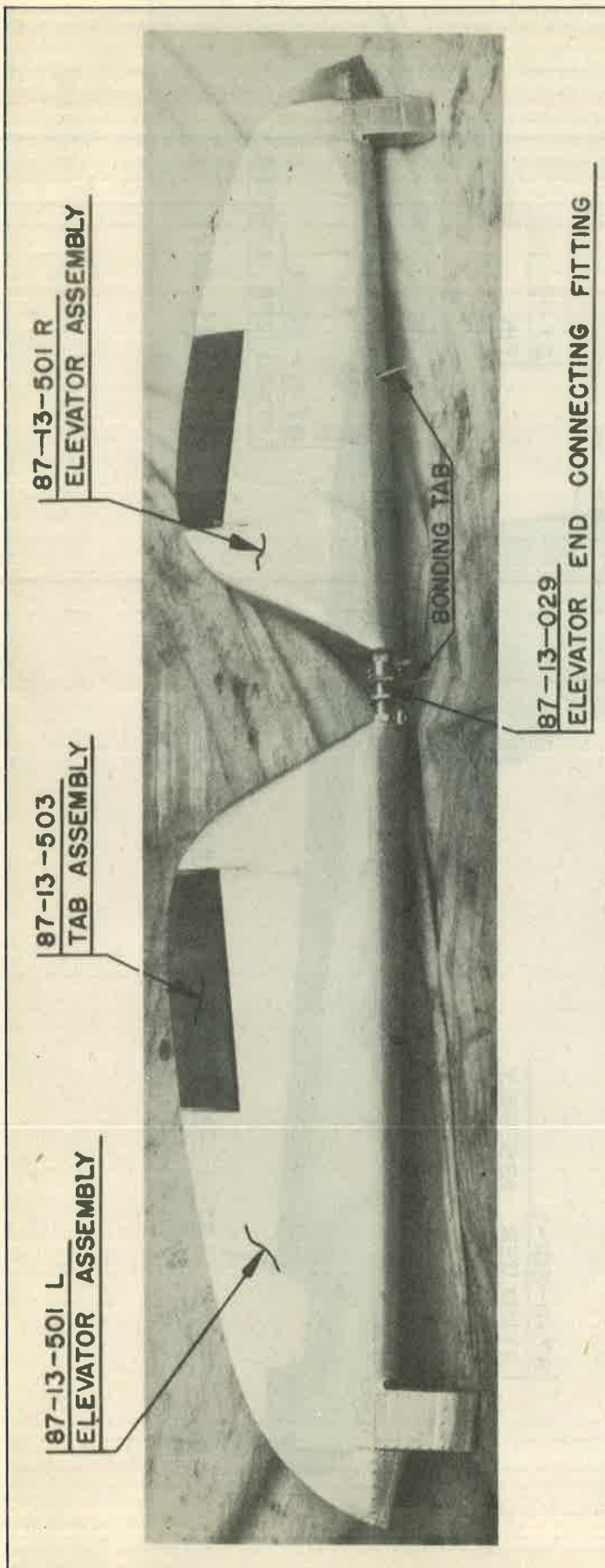
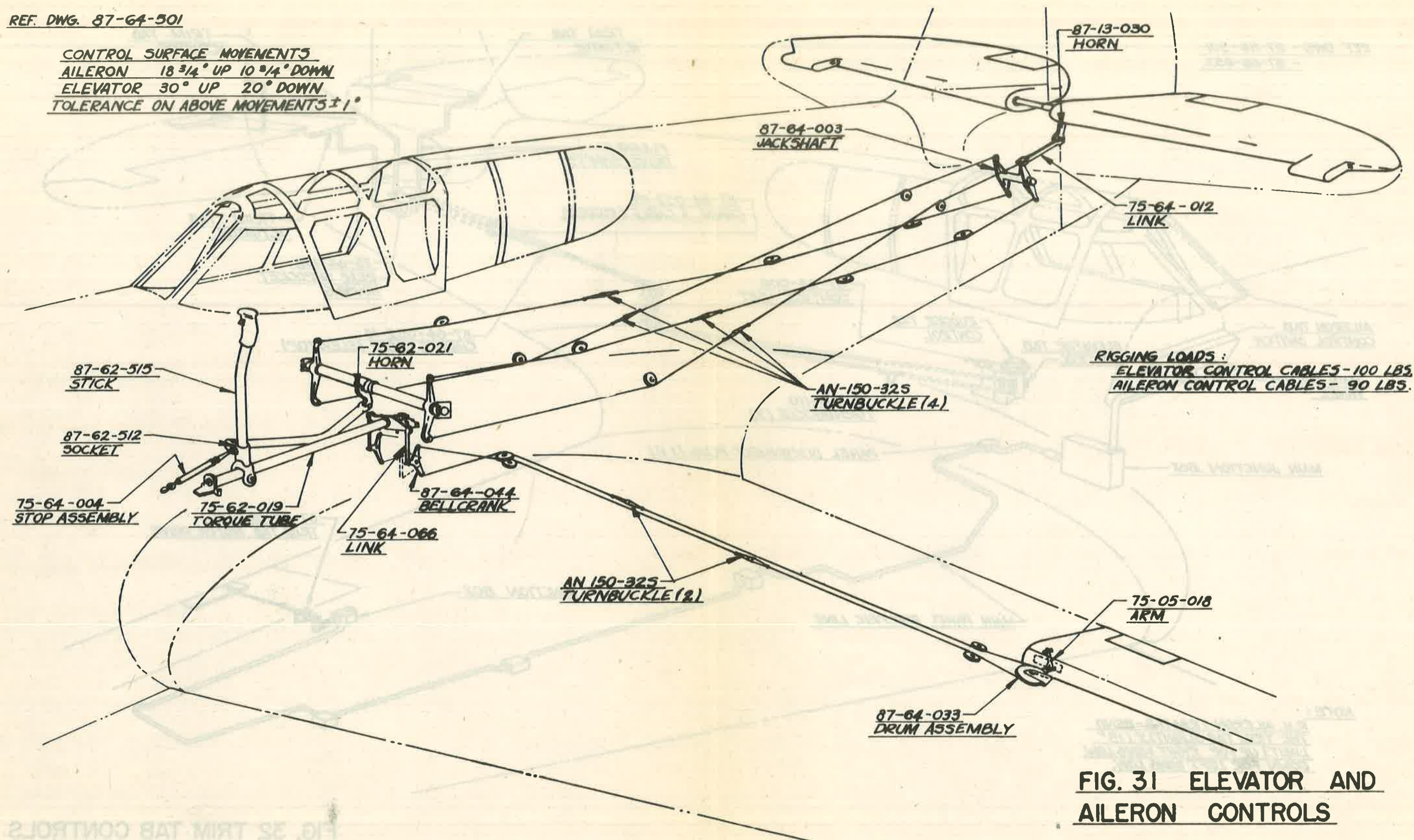


FIG.28 ELEVATORS COMPLETE H-87A-2 & H-87A-3

REF. DWG. 87-64-501

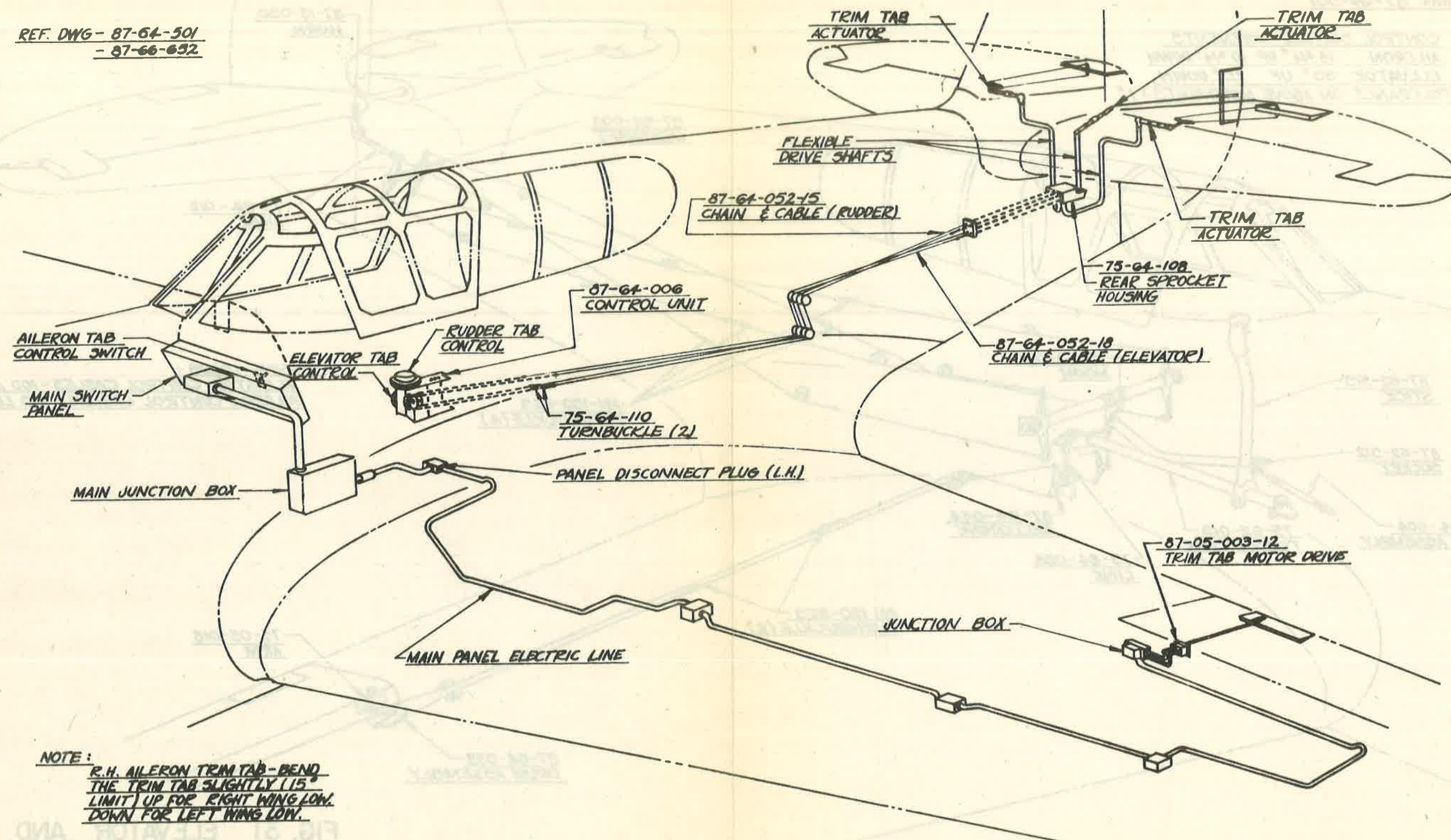
CONTROL SURFACE MOVEMENTS  
AILERON 18 3/4° UP 10 3/4° DOWN  
ELEVATOR 30° UP 20° DOWN  
TOLERANCE ON ABOVE MOVEMENTS ± 1°



**FIG. 31 ELEVATOR AND  
 AILERON CONTROLS**

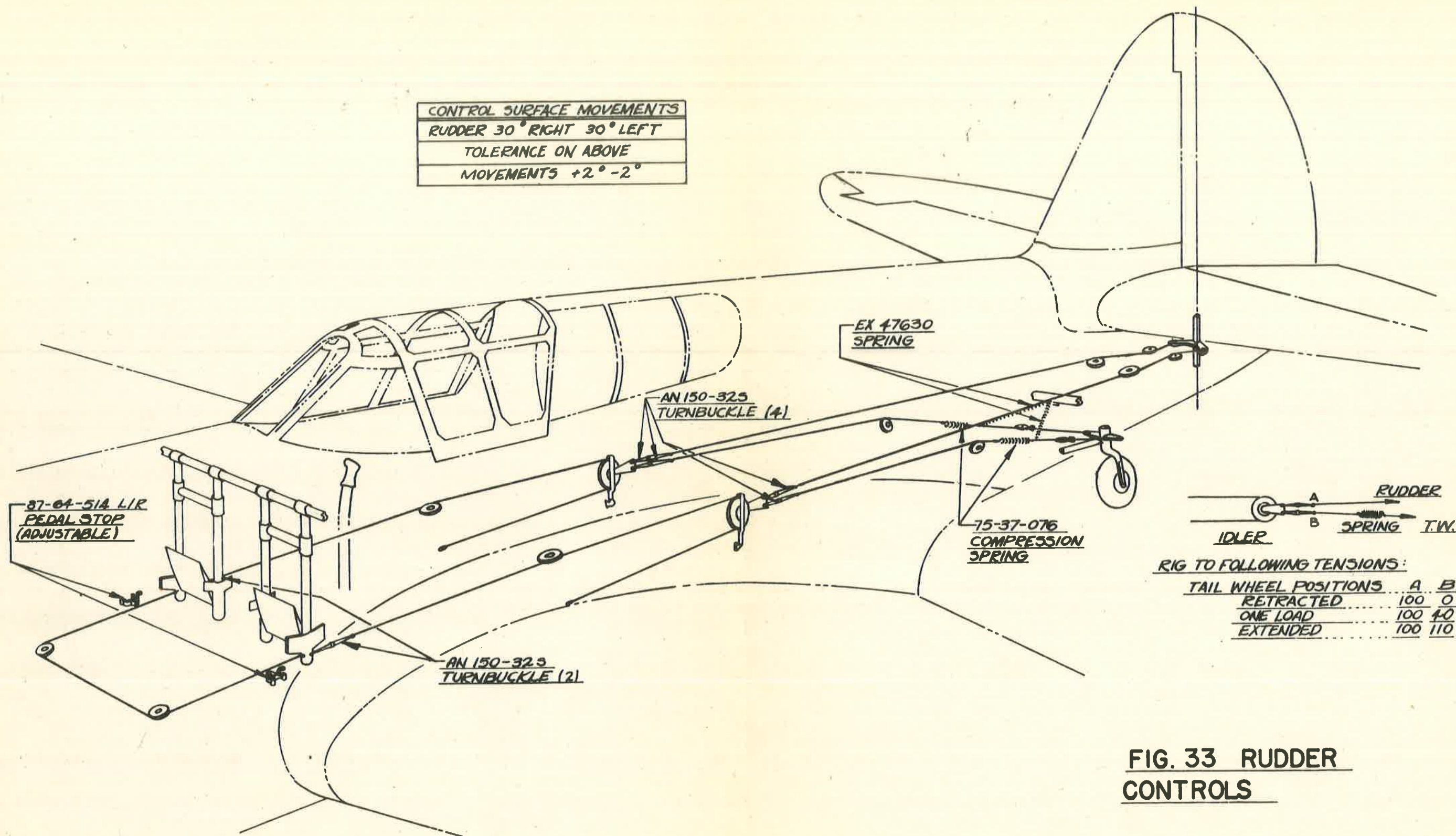


REF. DWG - 87-64-501  
- 87-66-652



### FIG. 32 TRIM TAB CONTROLS





IDLER      A      RUDDER  
             B      SPRING      T.W.

RIG TO FOLLOWING TENSIONS:

| TAIL WHEEL POSITIONS | A   | B   |
|----------------------|-----|-----|
| RETRACTED            | 100 | 0   |
| ONE LOAD             | 100 | 40  |
| EXTENDED             | 100 | 110 |

**FIG. 33 RUDDER  
CONTROLS**



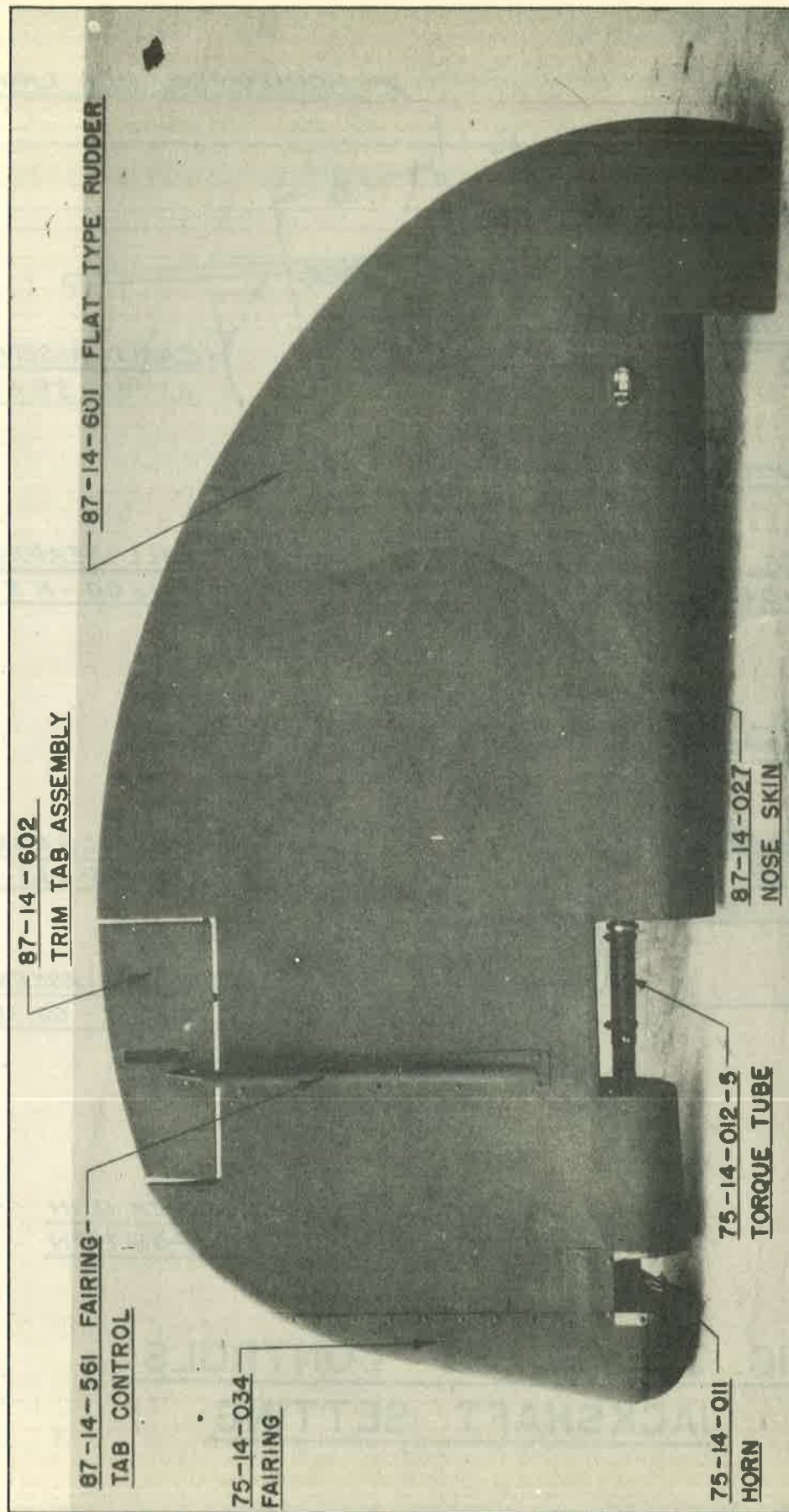
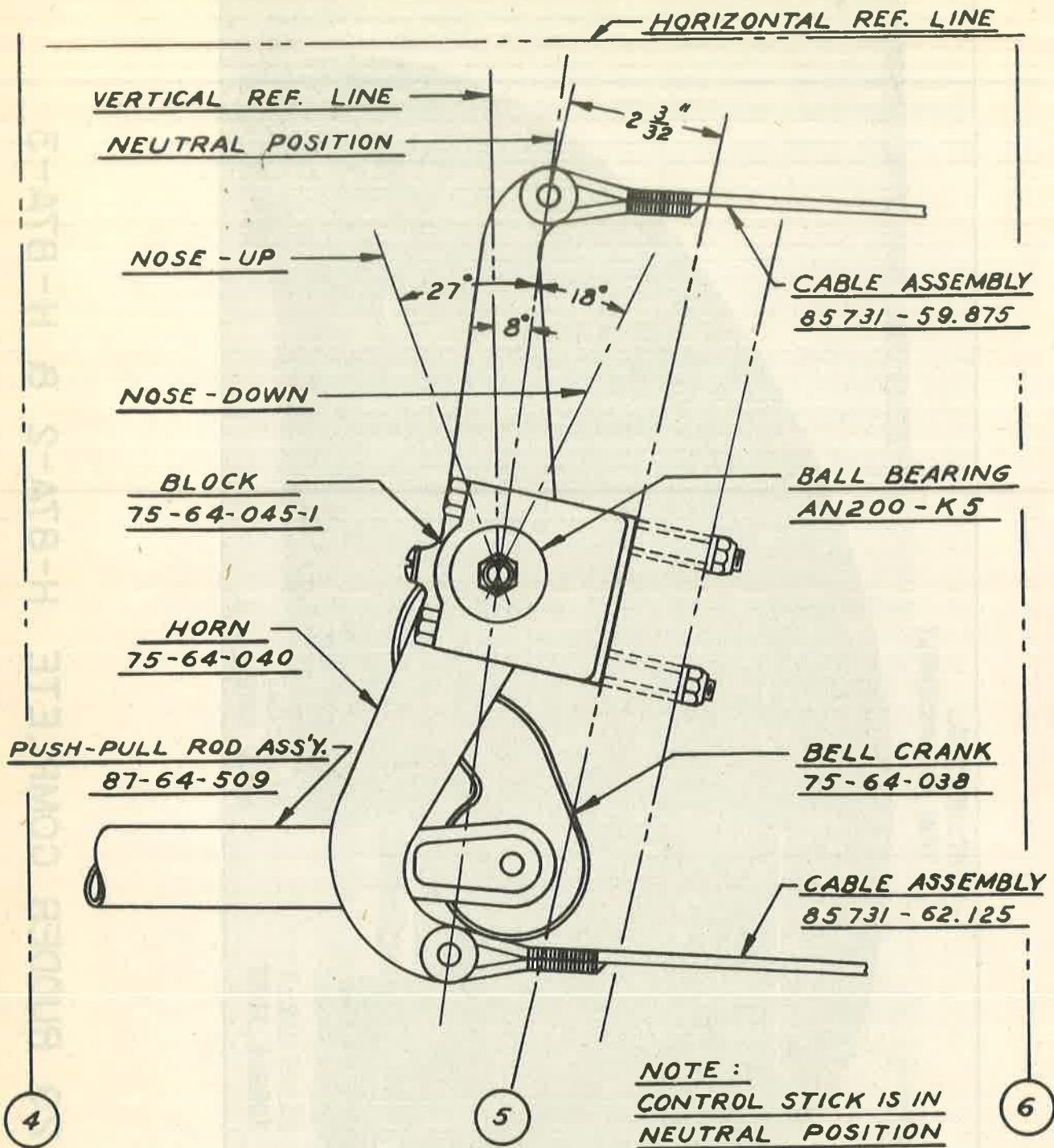


FIG.29 RUDDER COMPLETE H-87A-2 & H-87A-3





**FIG. 30 FLIGHT CONTROLS  
JACKSHAFT SETTING**

B. Empennage (Drawing 87-15-501)

The horizontal stabilizer and vertical stabilizer are of aluminum alloy, multi-cellular construction, metal covered. The horizontal stabilizer is made up as one piece and attached to the fuselage by a series of vertical bolt studs in the stabilizer. The vertical stabilizer is attached to the horizontal stabilizer by a series of vertical bolt studs in the horizontal stabilizer.

The elevator (Drawing No. 87-31-501 R/L) and flat type rudder (Drawing No. 87-14-601) are of aluminum alloy construction, cloth covered. The elevators are both equipped with trim tabs and the rudder with a servo tab controllable from the cockpit. These tabs are all dynamically balanced. The rudder servo tab is so designed that it always maintains the same angle to the center line of the airplane, at which it is set by the control in the cockpit, regardless of the angle of the rudder to the airplane's center line.

The elevator must be attached to the stabilizer and the cap on the center bearing bolted solid before the rudder is put in place. The rudder may then be assembled to the vertical stabilizer and fuselage. Connect the flexible drive shafts for the trim tabs to the tab control units in each elevator and the rudder. Care must be taken to connect the proper shafts to the right surfaces. Connect the push-pull tube to the elevator horn, and the rudder cables to the rudder horn.

To Remove the Stabilizers and Elevators as a Unit:

- (1) Remove the empennage fillets.
- (2) Disconnect the electrical conduit at the plug in the forward base of the vertical stabilizer.
- (3) Disconnect the bonding tabs.
- (4) Disconnect the two elevator tab control units at the control surfaces.
- (5) Disconnect the elevator control at the link attached to the horn.
- (6) Remove the eight bolts and nuts at the horizontal stabilizer to fuselage fittings and remove the unit.

To Remove the Elevators:

- (1) Disconnect the bonding tabs.
- (2) Disconnect the push-pull link from the elevator horn.
- (3) Remove the four outboard hinge bolts.





(4) Take off the center hinge caps by removing the four bolts, and remove the elevators.

(5) Either elevator may be removed without removing the rudder by the following steps:

(a) Disconnect the trim tab control at the hinge on the inboard end of the elevator.

(b) Disconnect the two outboard hinge bolts.

(c) Disconnect the two bolts on the inboard end of the elevator.

To remove the elevator trim tab disconnect the control rods from the tab horn. Rotate the tab as far as possible from the neutral position and remove the two cap screws from the block on the front face, at the outboard end of the tab. Pull the tab outward and downward until the hinge shaft on the inboard end of the tab is free.

To Remove the Rudder:

(1) Disconnect the rudder trim tab control unit at the rudder.

(2) Disconnect the rudder control cables at the horn.

(3) Disconnect the bonding tabs.

(4) Remove the top hinge bolt.

(5) Take off the upper and lower bearing caps by removing two nuts in each, and remove the rudder.

To remove the rudder servo tab, disconnect the control rod from the tab horn. Rotate the tab as far as possible from the neutral position and remove the two cap screws from the blocks on each end of the front face of the tab beam.

The settings for the control surfaces are as follows:

Elevator \_\_\_\_\_  $30^{\circ} \pm 2^{\circ}$  up \_\_\_\_\_  $20^{\circ} \pm 2^{\circ}$  down

Elevator Tab

(With elevator at  $0^{\circ}$ )  $3^{\circ} \pm 2^{\circ}$  up \_\_\_\_\_  $26^{\circ} \pm 2^{\circ}$  down

Rudder \_\_\_\_\_  $28^{\circ} + 2^{\circ}$   
-0 either way

Rudder Tab

(With rudder at  $0^{\circ}$ )  $15^{\circ} + 5^{\circ}$   
-  $2^{\circ}$  either way

To remove the vertical stabilizer, remove the eight nuts at the horizontal stabilizer fittings and remove the vertical stabilizer.

Assembly and Installation of the Complete Empennage

- (1) Assemble the elevators to the stabilizers and then assemble the stabilizers to the fuselage.
- (2) Assemble the vertical stabilizer to the horizontal stabilizer.
- (3) Attach the elevators to the horizontal stabilizer and bolt on the center bearing caps securely.
- (4) Connect the push-pull link to the elevator horn.
- (5) Connect the flexible drive-shaft for the elevator and rudder trim tabs to the correct tab control units.
- (6) Insert a plumb bob on a bar through the rudder fitting on the vertical stabilizer and fuselage, to check the alignment before installing the rudder. Incorrect tension of the vertical stabilizer-to-horizontal stabilizer and the horizontal stabilizer-to-fuselage bolts may cause misalignment. When installing the lower rudder bearing cap, be careful to seat the thrust washer and dust shields in their proper grooves.
- (7) Install the rudder and connect the rudder cables to the rudder horn.









|   |                           |   |                              |    |                            |
|---|---------------------------|---|------------------------------|----|----------------------------|
| A | RADIO CONTROLLER - L.H.S. | K | RECOGNITION DEVICE           | U  | CONTROL STICK              |
| B | RADIO RECEIVER CONTROL    | L | DESERT EQUIPMENT             | V  | HYDRAULIC HAND PUMPS       |
| C | OIL TANK                  | M | TAIL WHEEL                   | W  | RUDDER PEDALS              |
| D | COOLANT EXPANSION TANK    | N | FUSELAGE ACCESS DOOR         | X  | WING GUNS                  |
| E | MAP CASE                  | O | FIRST AID KIT                | Y  | OIL & COOLANT RADIATORS    |
| F | SEAT                      | P | RADIO RECEIVER & TRANSMITTER | Z  | HYDRAULIC TANK (EMERGENCY) |
| G | FUSELAGE FUEL TANK        | Q | BATTERY                      | AA | COWL FLAPS                 |
| H | RECEIVER                  | R | HYDRAULIC PUMP (ELECTRIC)    | BB | REAR VIEW MIRROR           |
| I | GLYCOL SPRAY TANK         | S | HYDRAULIC TANK               | CC | COWL FLAP CONTROL HANDLE   |
| J | STARTER CRANK             | T | OXYGEN BOTTLE                | DD | DAMPED RATE CONTROL HANDLE |

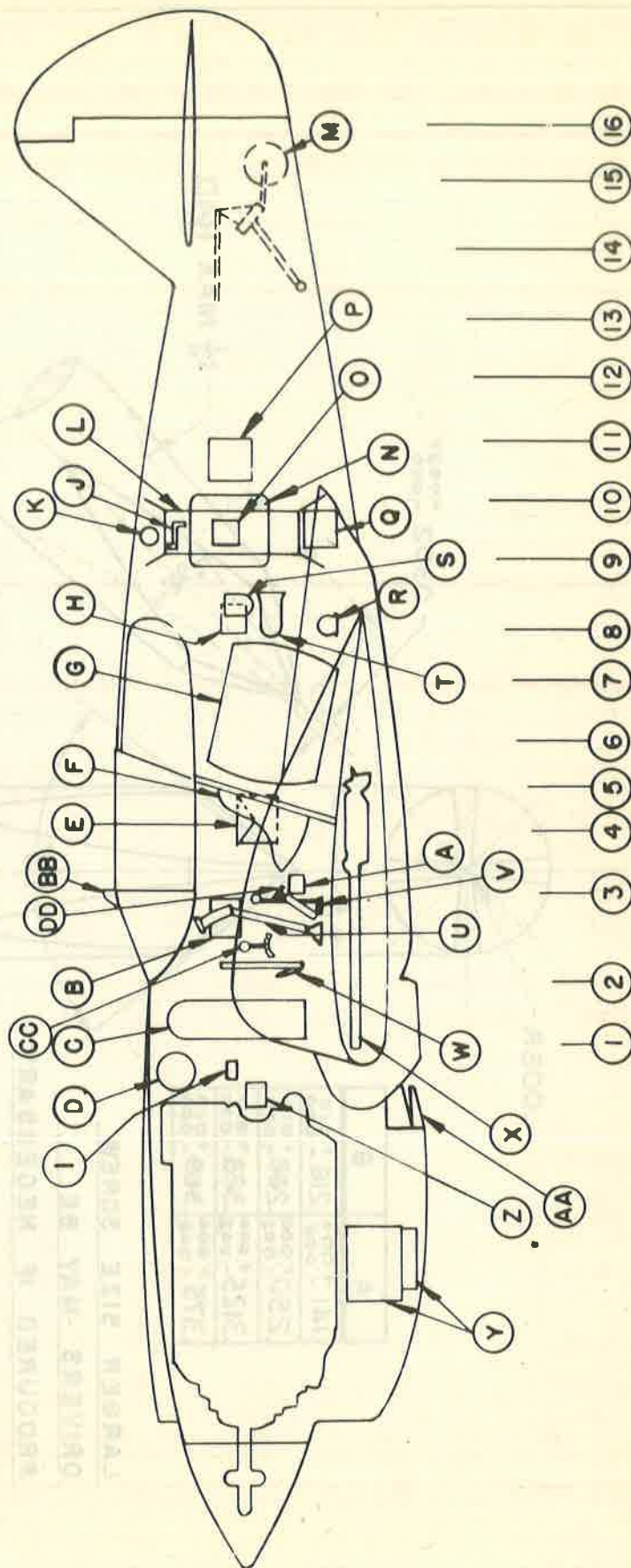
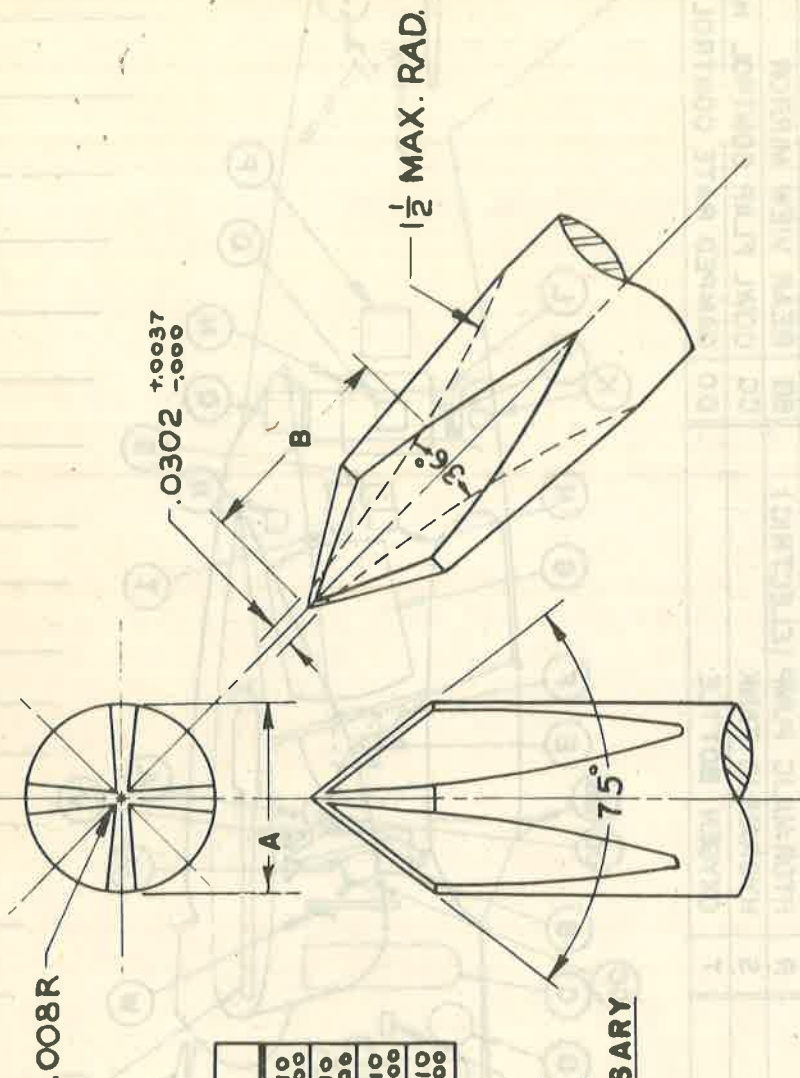


FIG. 35 FUSELAGE CONTENTS H-87A-2 & 3

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16



| A                | B               |
|------------------|-----------------|
| .141 $\pm .002$  | .216 $\pm .010$ |
| .250 $\pm .002$  | .288 $\pm .010$ |
| .3125 $\pm .002$ | .328 $\pm .010$ |
| .375 $\pm .002$  | .369 $\pm .010$ |

LARGER SIZE SCREW  
DRIVERS MAY BE  
PROCURED IF NECESSARY

FIG. 36 REED & PRINCE SCREW DRIVER HEAD DIM.



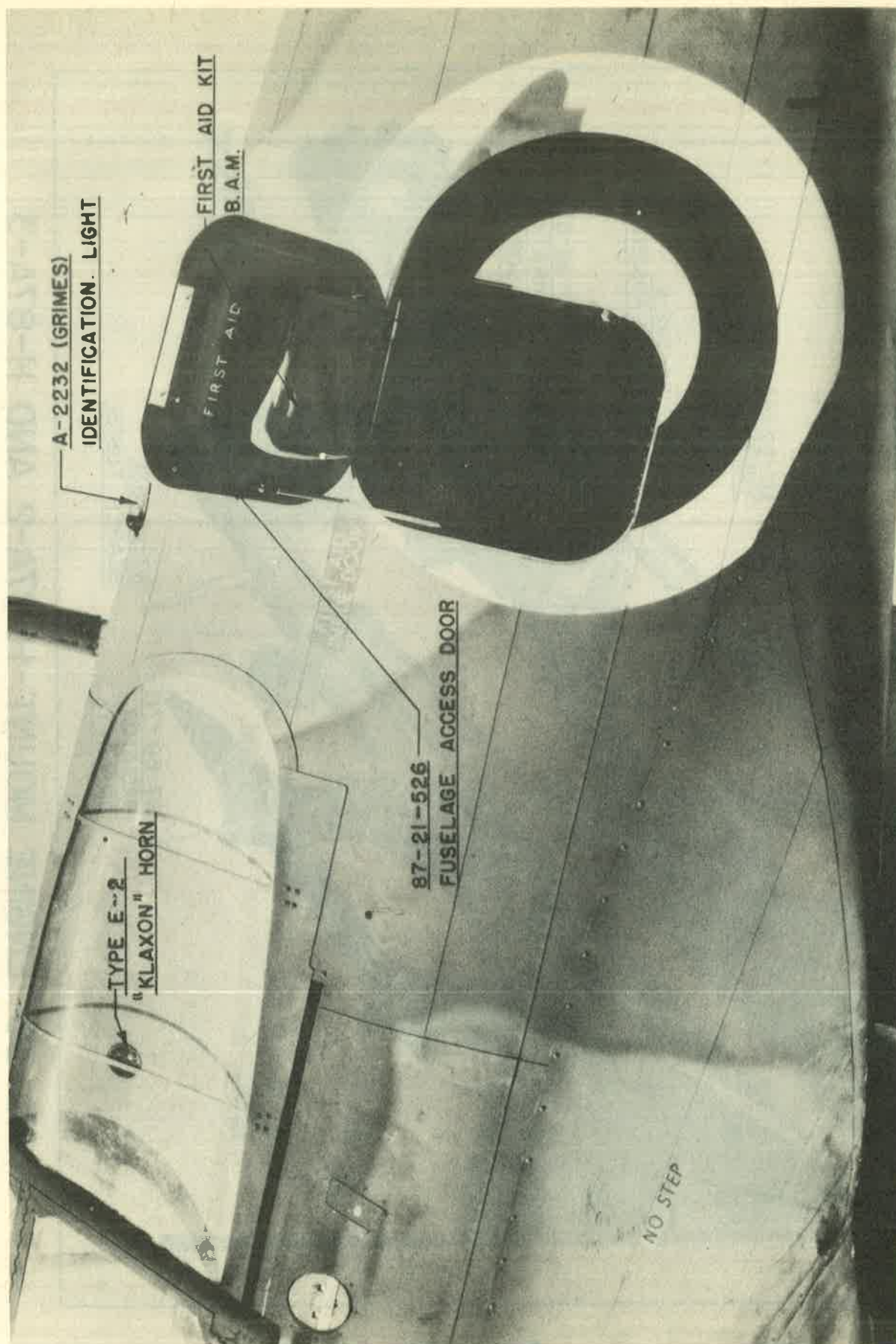


FIG. 37 FUSELAGE - SIDE VIEW ACCESS DOOR OPEN  
H-87A-2 & H-87A-3

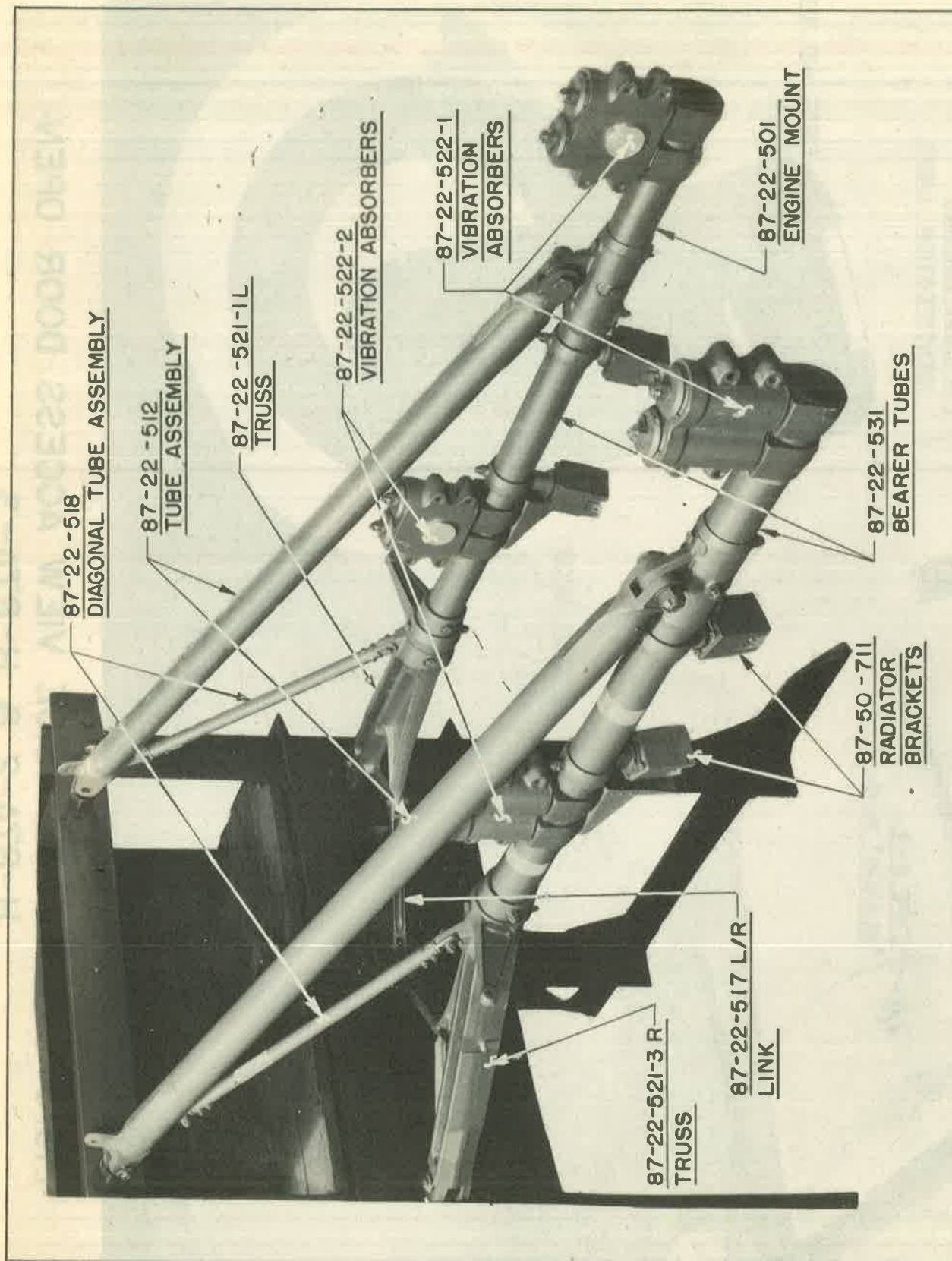


FIG. 38 ENGINE MOUNT-H-87A-2 AND H-87A-3

REF. DWG. 87-22-501

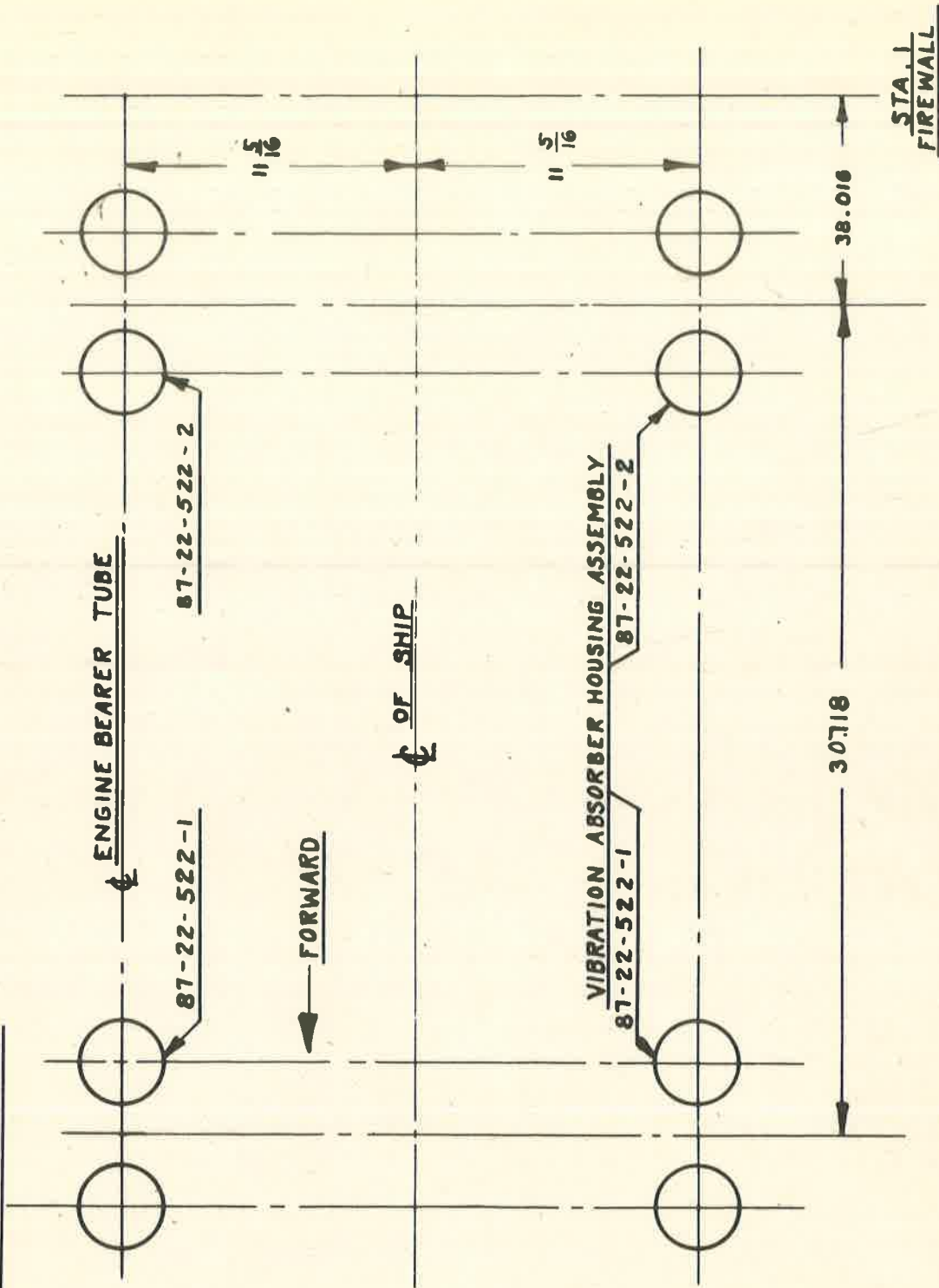


FIG. 39 PLAN VIEW - LOCATION OF VIBRATION  
ABSORBERS H-87A-2 & H-87A-3



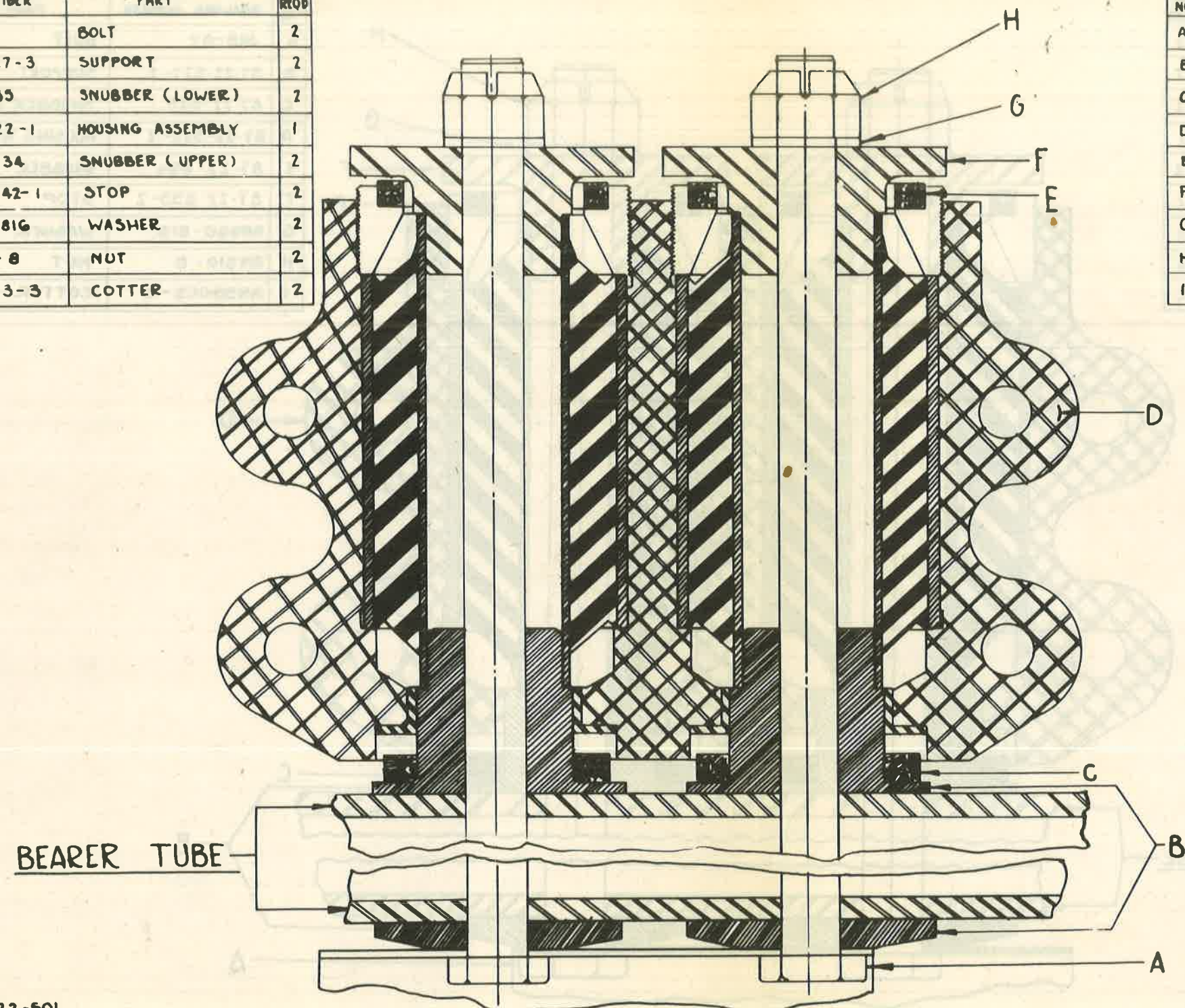


# L.H. FRONT VIBRATION ABSORBER

| REF. NO. | DRAWING NUMBER | PART             | NO. REQD |
|----------|----------------|------------------|----------|
| A        | AN8-86         | BOLT             | 2        |
| B        | 87-22-527-3    | SUPPORT          | 2        |
| C        | 87-22-535      | SNUBBER (LOWER)  | 2        |
| D        | 87-22-522-1    | HOUSING ASSEMBLY | 1        |
| E        | 87-22-534      | SNUBBER (UPPER)  | 2        |
| F        | 87-22-542-1    | STOP             | 2        |
| G        | AN-960-816     | WASHER           | 2        |
| H        | AN-310-8       | NUT              | 2        |
| I        | AN-380C3-3     | COTTER           | 2        |

# R.H. FRONT VIBRATION ABSORBER

| REF. NO. | DRAWING NUMBER | PART             | NO. REQD |
|----------|----------------|------------------|----------|
| A        | AN8-87         | BOLT             | 2        |
| B        | 87-22-527-4    | SUPPORT          | 2        |
| C        | 87-22-535      | SNUBBER (LOWER)  | 2        |
| D        | 87-22-522-1    | HOUSING ASSEMBLY | 1        |
| E        | 87-22-534      | SNUBBER (UPPER)  | 2        |
| F        | 87-22-542-2    | STOP             | 2        |
| G        | AN960-816      | WASHER           | 2        |
| H        | AN310-8        | NUT              | 2        |
| I        | AN380C3-3      | COTTER           | 2        |



REF. DWG. 87-22-501

FIG. 40 FRONT VIBRATION ABSORBER H-87A-2 & H-87A-3

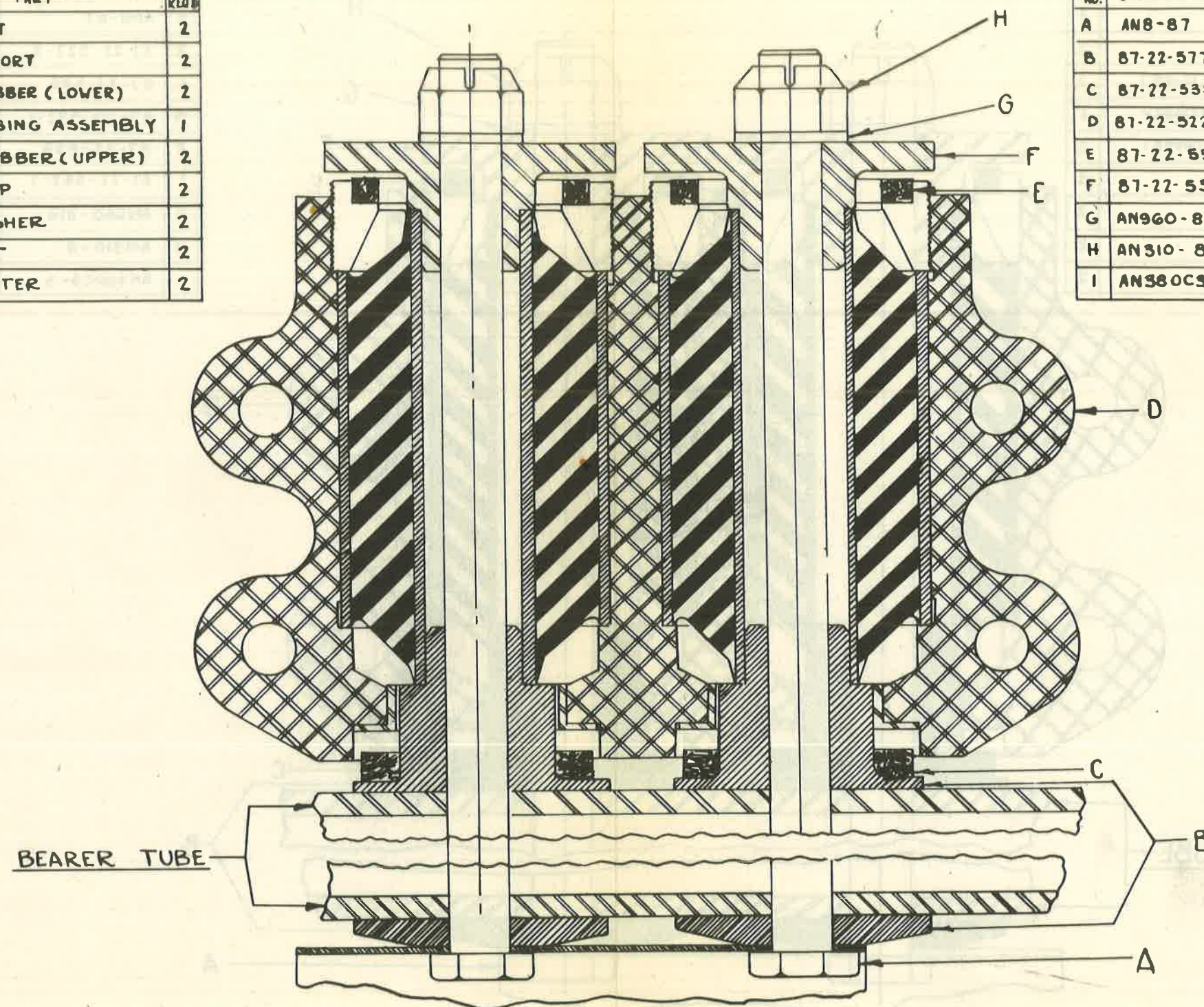


# L.H. REAR VIBRATION ABSORBER

| REF NO | DRAWING NUMBER | PART             | NO. REQ'D |
|--------|----------------|------------------|-----------|
| A      | AN8-87         | BOLT             | 2         |
| B      | 87-22-527-1    | SUPPORT          | 2         |
| C      | 87-22-535      | SNUBBER (LOWER)  | 2         |
| D      | 87-22-522-2    | HOUSING ASSEMBLY | 1         |
| E      | 87-22-534      | SNUBBER (UPPER)  | 2         |
| F      | 87-22-533-1    | STOP             | 2         |
| G      | AN960-816      | WASHER           | 2         |
| H      | AN310-8        | NUT              | 2         |
| I      | AN380C3-3      | COTTER           | 2         |

# R.H. REAR VIBRATION ABSORBER

| REF. NO. | DRAWING NUMBER | PART             | NO. REQ'D |
|----------|----------------|------------------|-----------|
| A        | AN8-87         | BOLT             | 2         |
| B        | 87-22-577-2    | SUPPORT          | 2         |
| C        | 87-22-535      | SNUBBER (LOWER)  | 2         |
| D        | 87-22-522-2    | HOUSING ASSEMBLY | 1         |
| E        | 87-22-534      | SNUBBER          | 2         |
| F        | 87-22-533-2    | STOP             | 2         |
| G        | AN960-816      | WASHER           | 2         |
| H        | AN310-8        | NUT              | 2         |
| I        | AN380C3-3      | COTTER           | 2         |



REF. DWG 87-22-501

FIG. 41 REAR VIBRATION ABSORBER H-87A-2 & H-87A-3



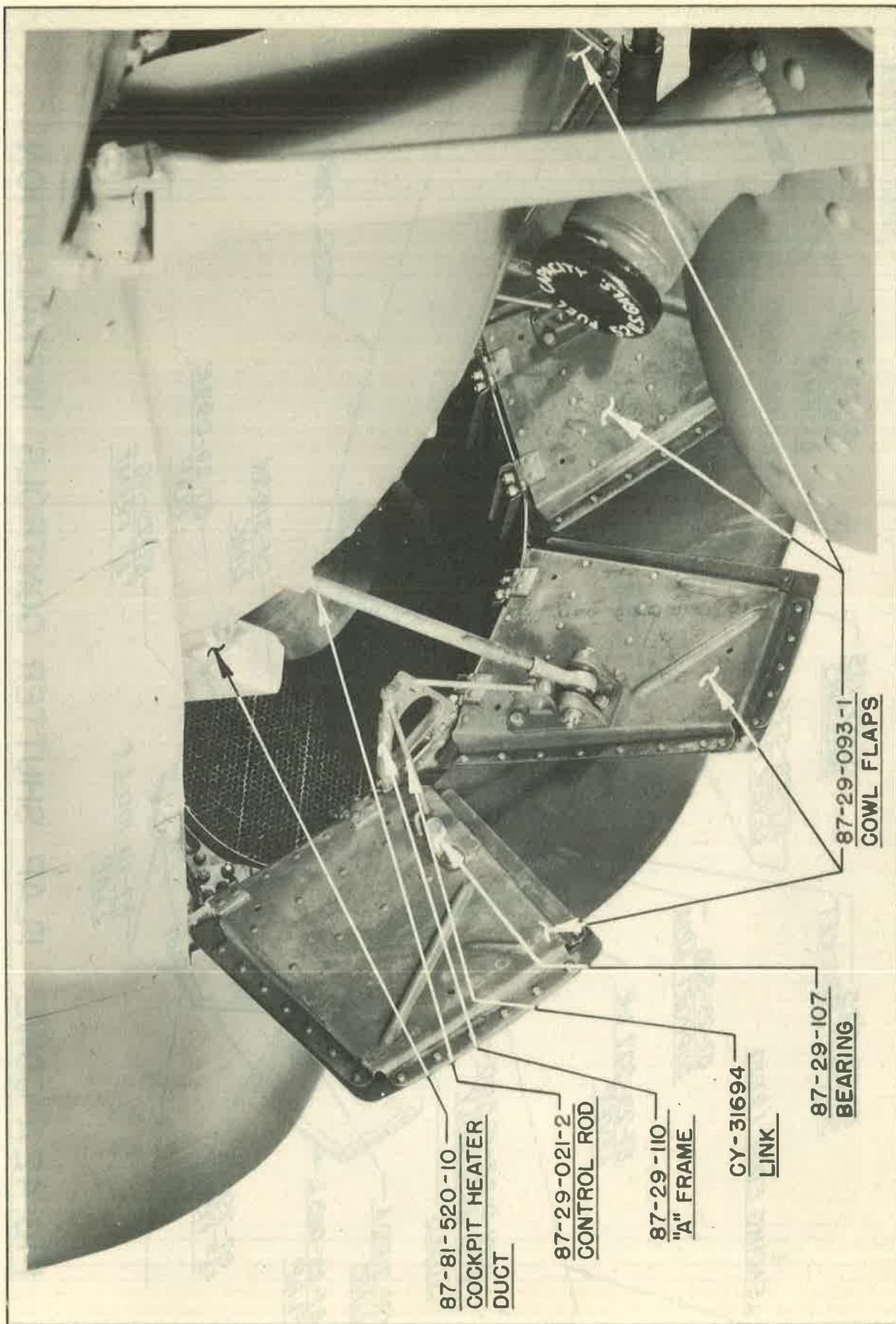


FIG. 42 COWL FLAPS AND FORMER - OPEN

REF. NO. 87-29-520

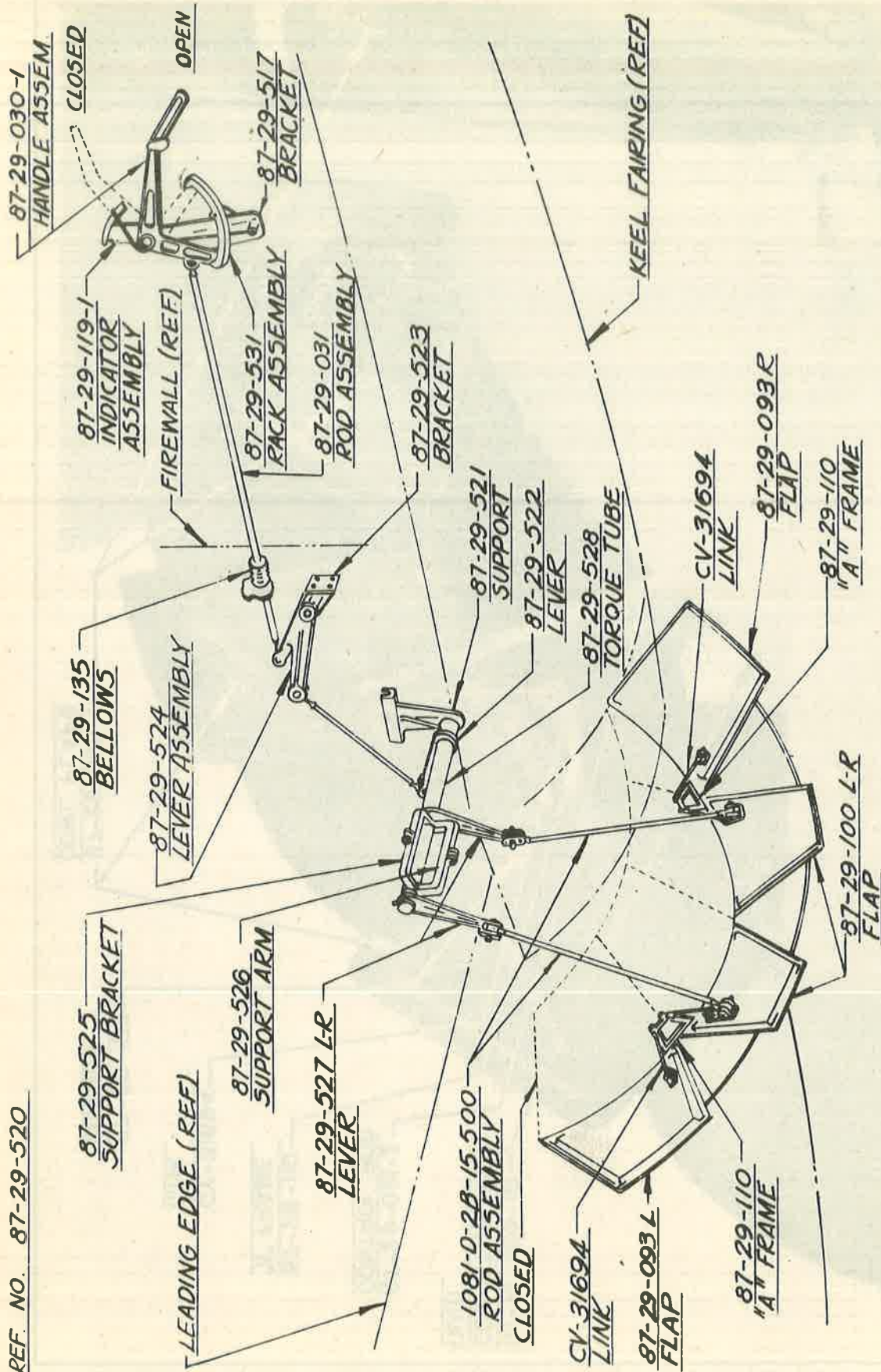


FIG. 42 A COWL FLAP SHUTTER CONTROLS INSTALLATION



## C. Fuselage Assembly

### 1. Fuselage (Drawing No. 87-21-701)

The fuselage proper is of semi-monocoque construction with smooth aluminum alloy, 24ST skin; bulb angle stringers and channel section bulkheads. In general the rivets are solid-modified countersunk head Al7ST aluminum alloy. The bulkhead behind the pilot's seat Sta. #5 is designed to protect the pilot in the event of a complete nose over. The jack point aft of the tail wheel is designed to protect the fuselage in case the tail wheel collapses on landing.

For maintenance and repair of aluminum alloy structures see Section VIII.

### 2. Engine Mount (Drawing No. 87-22-501)

The engine mount is comprised of steel tube construction with steel forged links employing both bolted and rigid joints. Major portions of it are heat-treated to 150,000 p.s.i. tensile strength. The engine mount is assembled to the fuselage by six attaching bolts which take the load in shear. There are four vibration absorbers attached to the mount; see Fig. 39. For detail of their assembly see Fig. 40 and 41.

### 3. Cowling (Drawing No. 87-23-505)

All cowl sections are of spot-welded and riveted aluminum alloy construction, with the exception of the cowl immediately adjacent to the exhaust stacks which is stainless steel. The cowling is supported by formers. The formers are supported by numerous fittings attached to the engine mount. The forward ends of the cowling are supported by a bulkhead which is attached to bosses, on the engine reduction gear housing with 4 "Lord" mount bushings. Cowling which must be frequently removed for servicing is attached with Dzus fasteners. The semi-permanent cowl is attached with Reed-Prince screws. The engine cowl has access doors for the expansion tank and for insertion of the starter hand crank.

### 4. Propeller Spinner Assembly (Drawing No. 87-42-503)

The propeller spinner assembly consists of two parts; a nose cone and base. The nose cone is fastened to the base by means of three studs and two locating dowel pins. The spinner base is comprised of three parts; a detachable aluminum alloy (S.H. 24SO) rear bulkhead, a cast aluminum alloy front bulkhead (14ST), and an aluminum alloy (S.H. 3SO) shell. The nose cone is made up of a rear bulkhead of aluminum alloy, (14ST) and a cone shaped shell of aluminum alloy, (S.H. 3SO). The nose cone and the spinner base as well as the complete assembly are individually statically



balanced. The rear bulkhead must never be interchanged with any other bulkhead or spinner unless the entire assembly is rebalanced. The dowel pins on the nose cone must be greased with a medium grease each time the cone is assembled to the base.

#### Removal of the Spinner Assembly.

1. Remove the sections of the engine cowl just below the exhaust stacks.
2. Working through hand holes in the bulkhead supporting the front end of the engine cowl, remove the three elastic stop nuts holding the nose section to the base section.
3. Remove the nose by pulling forward. (Access to the propeller electric motor for adjustment.)
4. Remove the outer row of screws from the rear bulkhead. (DO NOT TOUCH the inner row of balance screws.)
5. Remove the propeller nose assembly.
6. Remove the base by pulling forward.

To install the spinner assembly reverse the above procedure. When assembling the spinner be sure that the indicator arrow on the rear bulkhead coincides with the arrow on the aft part of the spinner to insure the proper balance of the assembly.

#### 5. Cowl Flaps

The cowl flaps extend from a former which is located aft from the coolant radiator and oil regulator at the aft end of the radiator air intake cowl. The flaps are operated by a control lever located on the right hand side of the cockpit. The flaps, which consist of four doors with feathers, open and close the air-flow in the exit duct to provide regulation of the coolant and oil temperatures. They are controlled by the following system:

1. A control lever in the cockpit which is provided with a ratchet for intermediate positions and a stop at each end for maximum travel.
2. A rod from the control lever to a bellcrank supported from the firewall.
3. An intermediate control rod from the above bellcrank to a bellcrank on the torque shaft, which operates two rods from the torque shaft to the flaps. All rods are adjustable at the ends. The flaps should open to 45° and close to 25° from the neutral flap position which is flush with the bottom engine cowl.

#### Removal of Cowl Flaps

The flaps may be detached as a complete unit as follows;

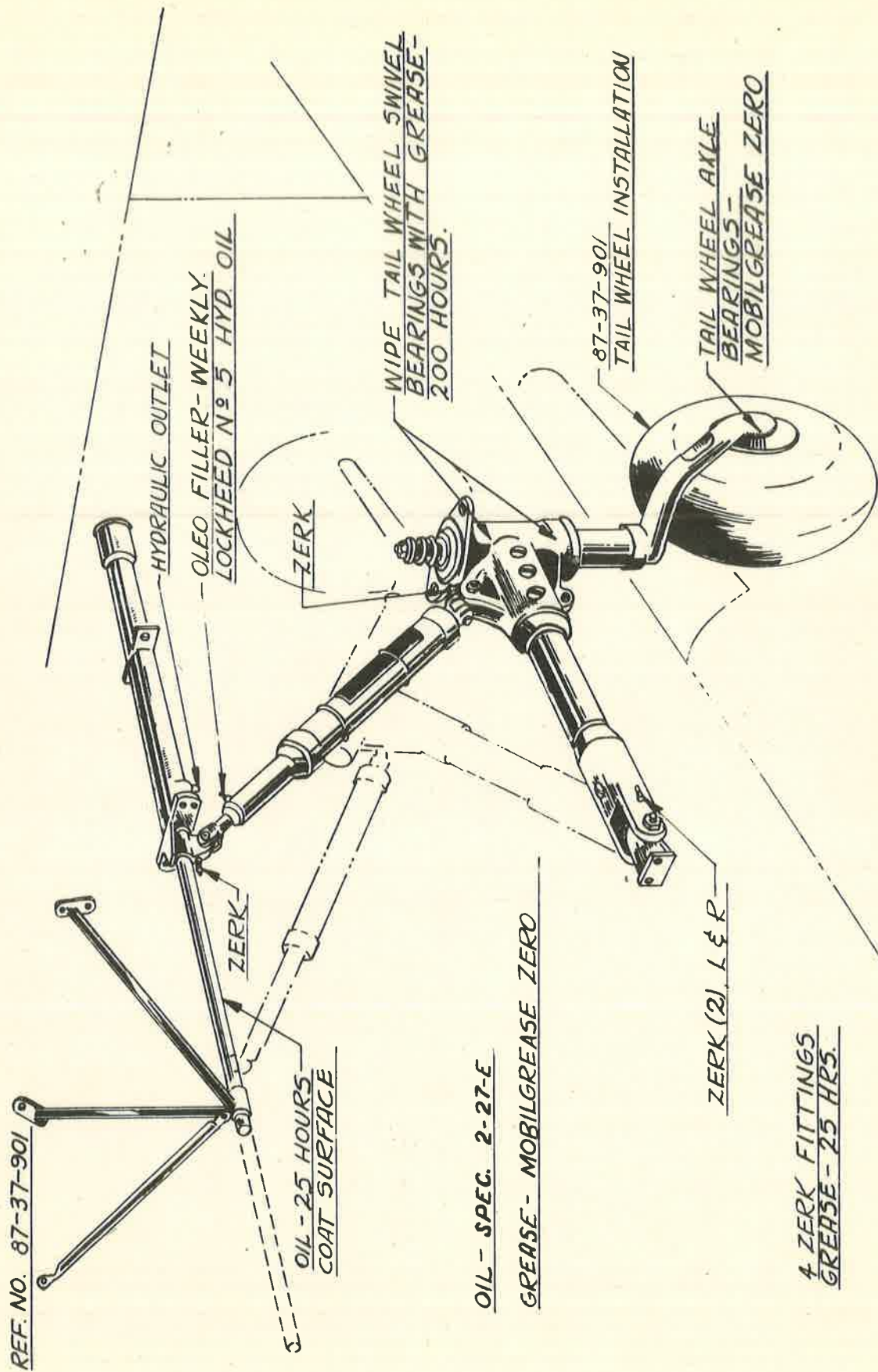
1. Remove each side of the engine cowl.
2. Remove the bottom cowl.
3. Disconnect the rod ends at the flaps.
4. Remove the twelve screws (six each side) at the former ends.
5. Pull the complete unit downward until the former ends are free of the engine mount attachment.











**FIG. 43A TAIL WHEEL ASSEMBLY LUBRICATION**





FIG. 44 TAIL WHEEL OLEO STRUT  
ASSEMBLY 87-37-510





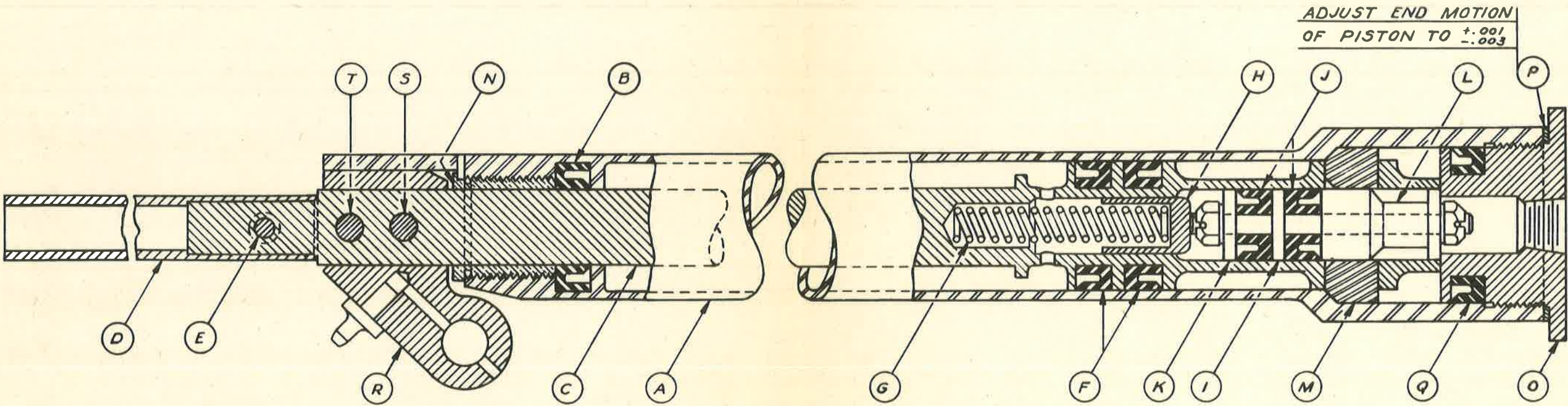


FIG. 44A TAIL WHEEL OLEO STRUT DISASSEMBLED





| LET. | PART NO.    | NAME        | QUAN. | LET. | PART NO.  | NAME        | QUAN. |
|------|-------------|-------------|-------|------|-----------|-------------|-------|
| A    | 87-37-920   | CYLINDER    | 1     | K    | 75-37-026 | WASHER      | 1     |
| B    | 75-37-032   | CUP PACKING | 1     | L    | 75-37-024 | ACTUATOR    | 1     |
| C    | 87-37-919   | PISTON      | 1     | M    | 75-37-023 | LOCK        | 2     |
| D    | 87-37-016   | GUIDE       | 1     | N    | 75-37-020 | BUSHING     | 1     |
| E    | 87-37-905-5 | RIVET       | 1     | O    | 75-37-019 | CAP         | 1     |
| F    | 75-37-030   | CUP PACKING | 2     | P    | 75-37-028 | SHIM        | 2     |
| G    | 75-37-079   | SPRING      | 1     | Q    | 75-37-029 | CUP PACKING | 1     |
| H    | 75-37-080   | FOLLOWER    | 1     | R    | 81-37-013 | LUG         | 1     |
| I    | 75-37-025   | STUD        | 1     | S    | AN 24-20  | BOLT        | 1     |
| J    | 75-37-031   | CUP PACKING | 2     | T    | AN 24-25  | BOLT        | 1     |



STRUT MUST BE FREE OF CHIPS.  
STRUT MUST NOT LEAK AT 2500 LBS./SQ. IN. PRESSURE.  
USE ONLY LOCKHEED #5 HYDRAULIC FLUID.  
LEAK TEST MUST BE MADE WITH PISTON IN  
MID-STROKE POSITION.

**FIG. 45 TAIL WHEEL  
RETRACTING STRUT**





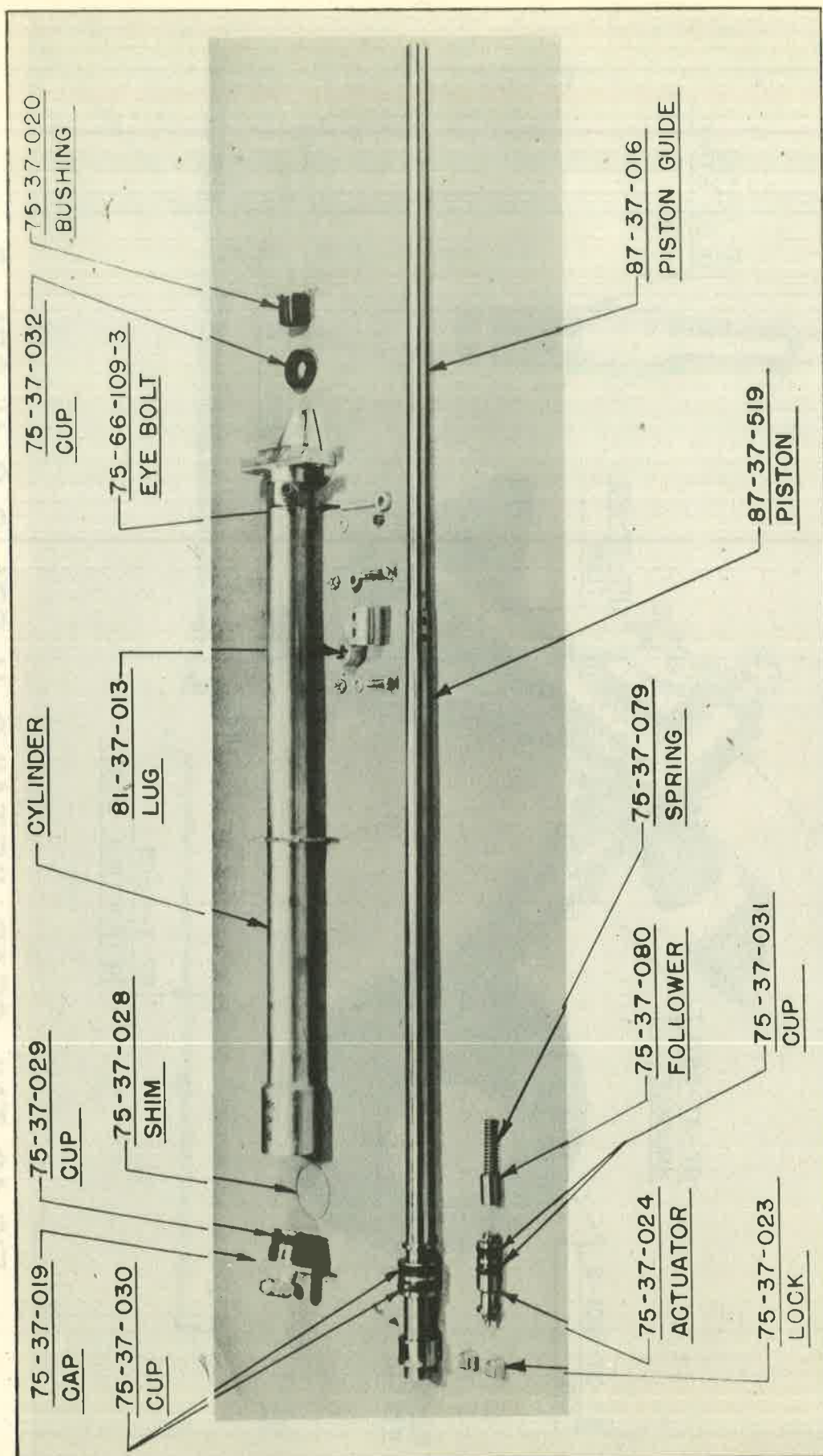


FIG.45A TAIL WHEEL RETRACTING STRUT DISASSEMBLED



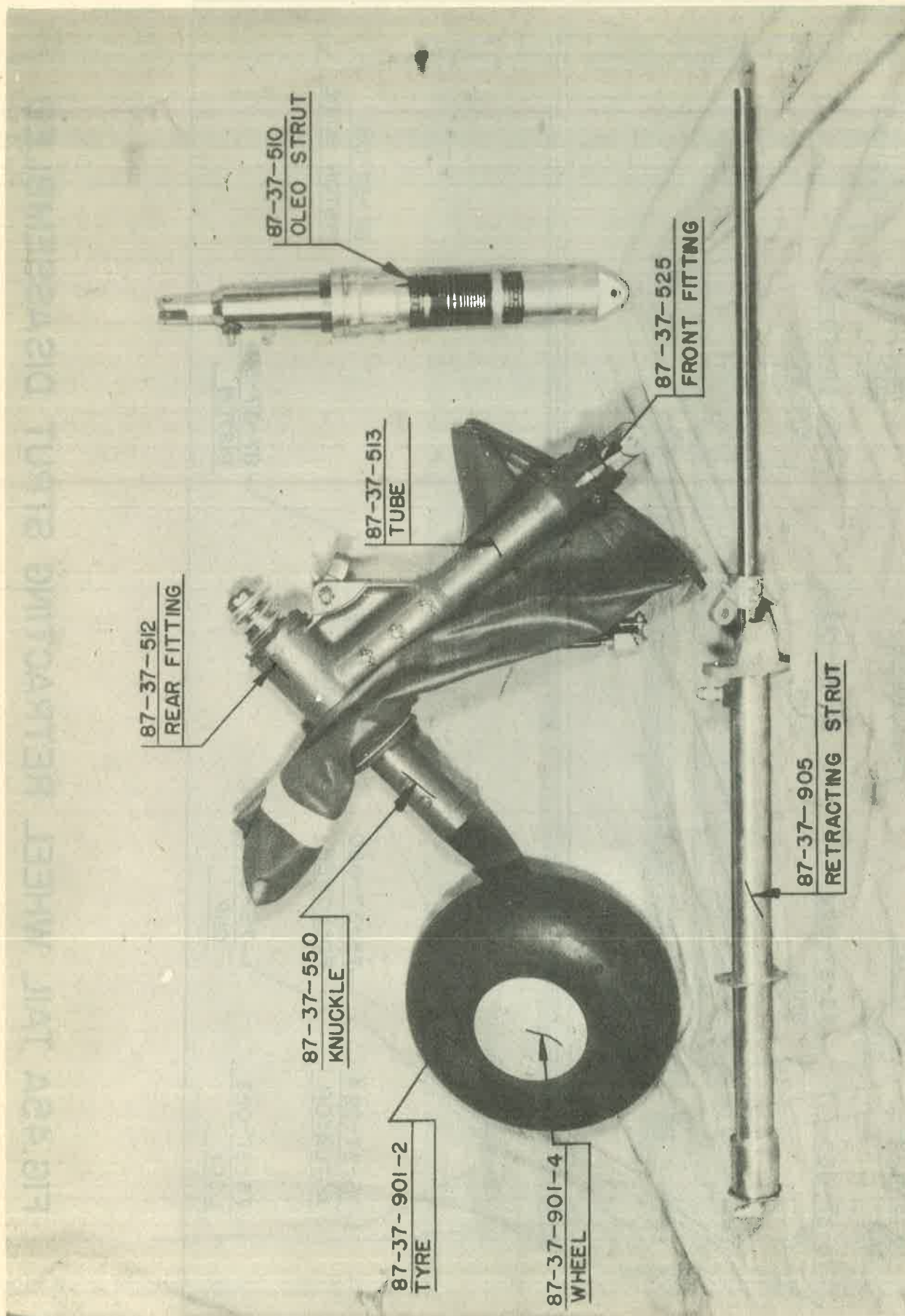


FIG 46 TAIL GEAR DETAILS H-87A-2 & H-87A-3

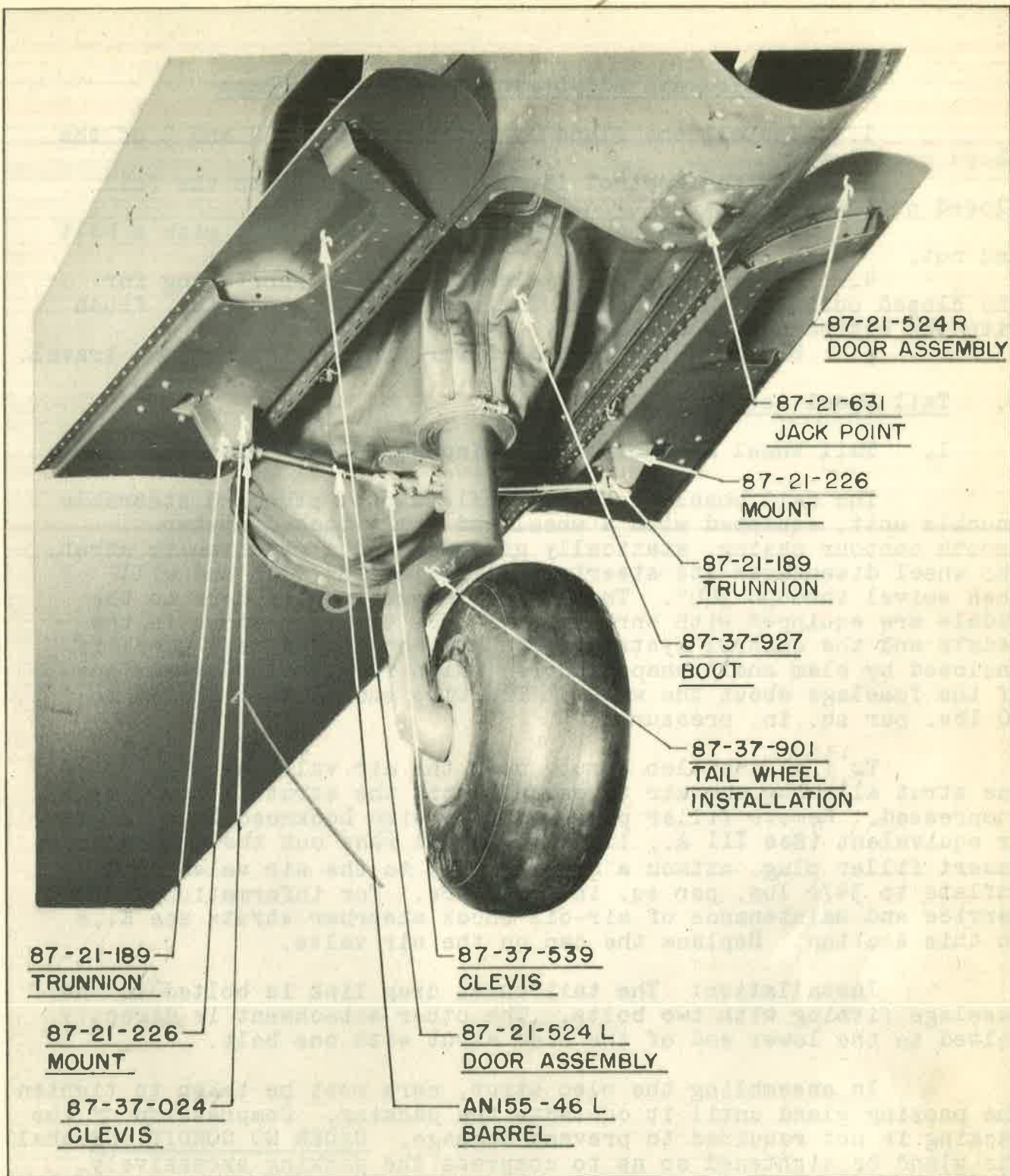


FIG. 47 TAIL WHEEL ASSEMBLY



Installation and Adjustment of the Cowl Flaps

1. Install the flaps by reversing steps 4 and 5 of the above procedure.
2. Set the control lever in the cockpit to the full closed position.
3. Connect the control rod end to the flap with a bolt and nut.
4. Adjust rod ends by lengthening or shortening for the closed position. (25° above the neutral flap position, flush with the bottom engine cowl.)
5. Stops on the control lever provide the maximum travel.

D. Tail Wheel Assembly

1. Tail Wheel Assembly: (Drawing No. 87-37-901-100)

The tail wheel assembly consists of a standard steerable knuckle unit, equipped with a wheel and a 12½ inch diameter smooth contour casing, statically grounded and a pneudraulic strut. The wheel disengages its steering splines at 28° ± 2° and will then swivel through 360°. The cables connecting the horn to the pedals are equipped with springs to reduce taxiing shocks in the pedals and the control system. When retracted, the tail wheel is enclosed by clam shell shaped doors, which form the under surface of the fuselage about the wheel. The tire should be inflated to 60 lbs. per sq. in. pressure.

To fill the oleo strut, open the air valve at the top of the strut allowing the air to escape until the strut is completely compressed. Remove filler plug and fill with Lockheed No. 5 fluid or equivalent (See III A., 11.) until oil runs out the filler hole. Insert filler plug, attach a Booster pump to the air valve, and inflate to 347½ lbs. per sq. in. pressure. For information on the service and maintenance of air-oil shock absorber struts see E., 8 in this section. Replace the cap on the air valve.

Installation: The tail wheel drag link is bolted to the fuselage fitting with two bolts. The other attachment is directly bolted to the lower end of the oleo strut with one bolt.

In assembling the oleo strut, care must be taken to tighten the packing gland until it contacts the packing. Compression of the packing is not required to prevent leakage. UNDER NO CONDITIONS shall the gland be tightened so as to compress the packing excessively.

Adjustment of the Tail Wheel Doors Upon Installation: After the tail wheel shock absorber strut is installed in the air-plane the adjustable links to the tail wheel doors must be installed and adjusted. With the tail wheel in the retracted position, install



a turnbuckle on one side only; attach to door and adjust the turnbuckle and disconnect it at the upper end. Repeat for the opposite side. Lower the tail wheel and attach the turnbuckles.

Removal: To remove the Tail Wheel Assembly.

- a. Disconnect the door turnbuckles at the doors.
- b. Remove the boot attaching screws.
- c. Remove the two bolts at the steering post cables.
- d. Disconnect the oleo strut at the lower end.
- e. Disconnect the drag link from the fuselage by removing the two hinge bolts at their forward end.
- f. Remove the unit through the bottom fuselage opening.
- g. Remove the bolt at the upper end of the oleo strut and remove the strut through the opening.
- h. Disconnect the hydraulic lines to the retracting strut, and disconnect the position indicator linkage at the lug on the retracting strut piston.
- i. Remove the two bolts at the front and two bolts at the center of the strut with the piston held in the full aft position, lower the rear end of the strut, at the same time moving it aft, until the piston rod is free of the guide.

2. Retracting Mechanism: (Drawing No. 87-37-905)

a. The retracting strut is located on the center line of the airplane and is operated hydraulically in conjunction with the landing gear. During retraction the piston and rod are forced forward carrying the upper oleo support with it. The oleo strut (Dwg. No. 87-37-510) is attached by a  $\frac{3}{8}$ " diameter bolt directly to the lug on the retracting strut piston. The retracting strut has a travel of  $17 \frac{1}{32}$ ". The position of the tail wheel at any time may be determined by means of the flap and wheel indicator on the instrument board when the battery switch is on "BAT".

b. To Disassemble the Retracting Strut:

- (1) Place the cylinder "A" in a wooden block clamp and insert the clamp in a vise. (See Figure 45).
- (2) Remove the cotters, nuts, washers and bolts "G" attaching the lug to the piston. Slide the lug off the piston and piston guide.
- (3) Remove the cylinder bushing "N" with a spanner wrench.

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(4) Move to the opposite end of the cylinder and remove the cap assembly "E" and shims.

(5) Grasp the piston guide and push the piston out of the cylinder far enough to free the two locks from the square broached holes. Remove the locks and pull the piston and guide completely out of the cylinder.

(6) Tip the piston with the guide end up until the actuator, follower and spring drops out of the piston end.

(7) Remove the cup from the forward end of the cylinder and the cylinder and piston are disassembled as illustrated in Fig.

c. To Assemble the Retracting Strut:

(1) Clean all parts thoroughly with alcohol and blow out with compressed air if available.

(2) Replace all worn packing cups and other parts where necessary.

(3) Insert the spring and follower into the end of the piston.

(4) Coat the cups on the actuator with hydraulic oil, Lockheed #5 or equivalent, (never use mineral oil) and slide the actuator into the piston. Be very careful not to tear or injure the edges of the packing cups as they enter the cylinder and are pushed past the square broached holes in the lock assembly.

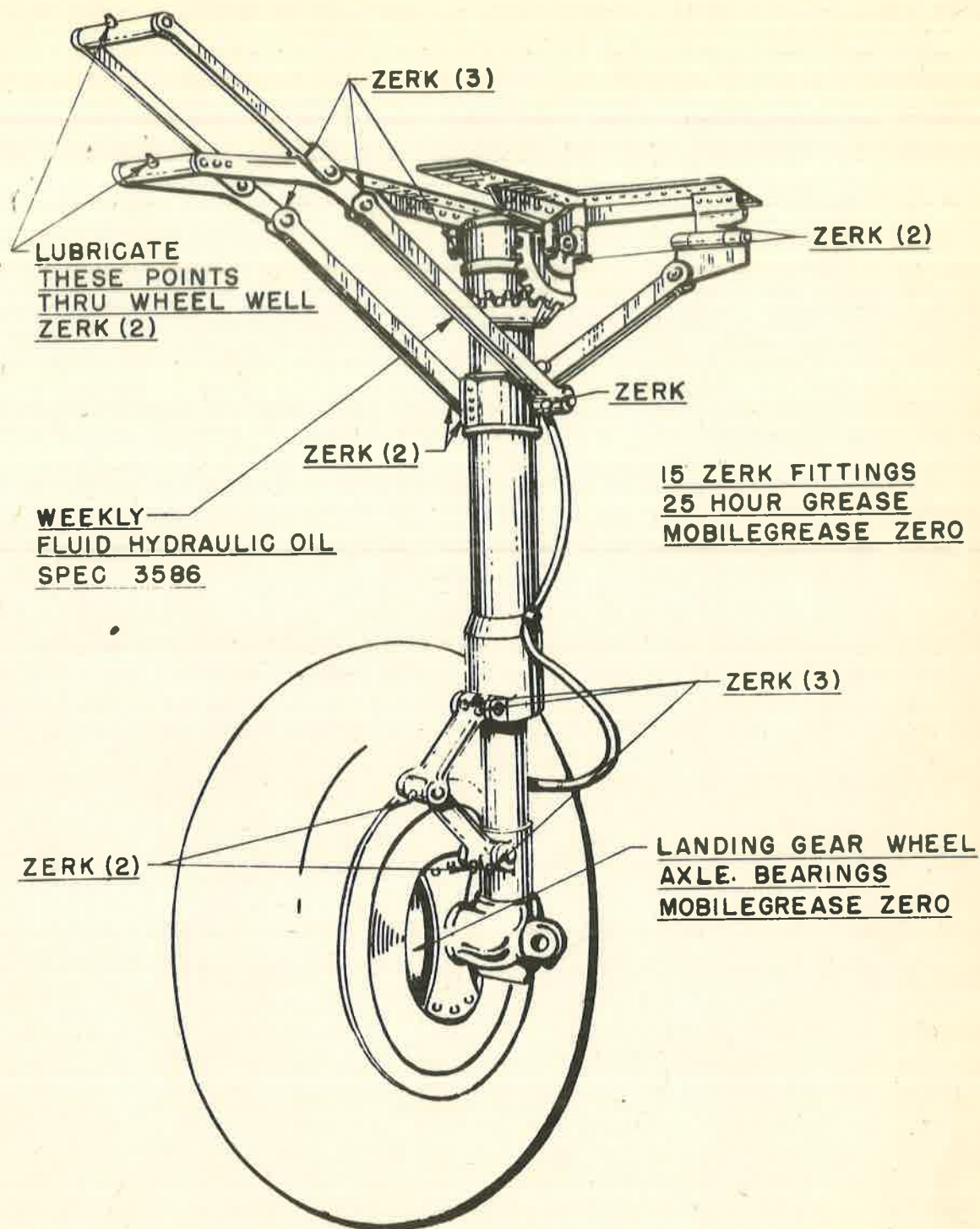
(5) Wet the cup that fits into the forward end of the cylinder with hydraulic fluid and replace the cup in the cylinder. Be extremely careful not to damage the cup surface on the threads in the end of the cylinder.

(6) Replace the two locks in the square broached holes and insert the piston and guide into the cylinder, guide end first.

(7) Screw the bushing into the cylinder until it is tight. Do not tighten the bushing excessively.

(8) Wet the packing cup on the cap, replace the shim and screw the cap into the aft end of the cylinder.

(9) Check the piston for back lash. The motion of the piston must be adjusted to a .002 or .005. Adjustment can be made by adding or removing a shim between the cap and cylinder.



**FIG. 48A LANDING GEAR LUBRICATION**





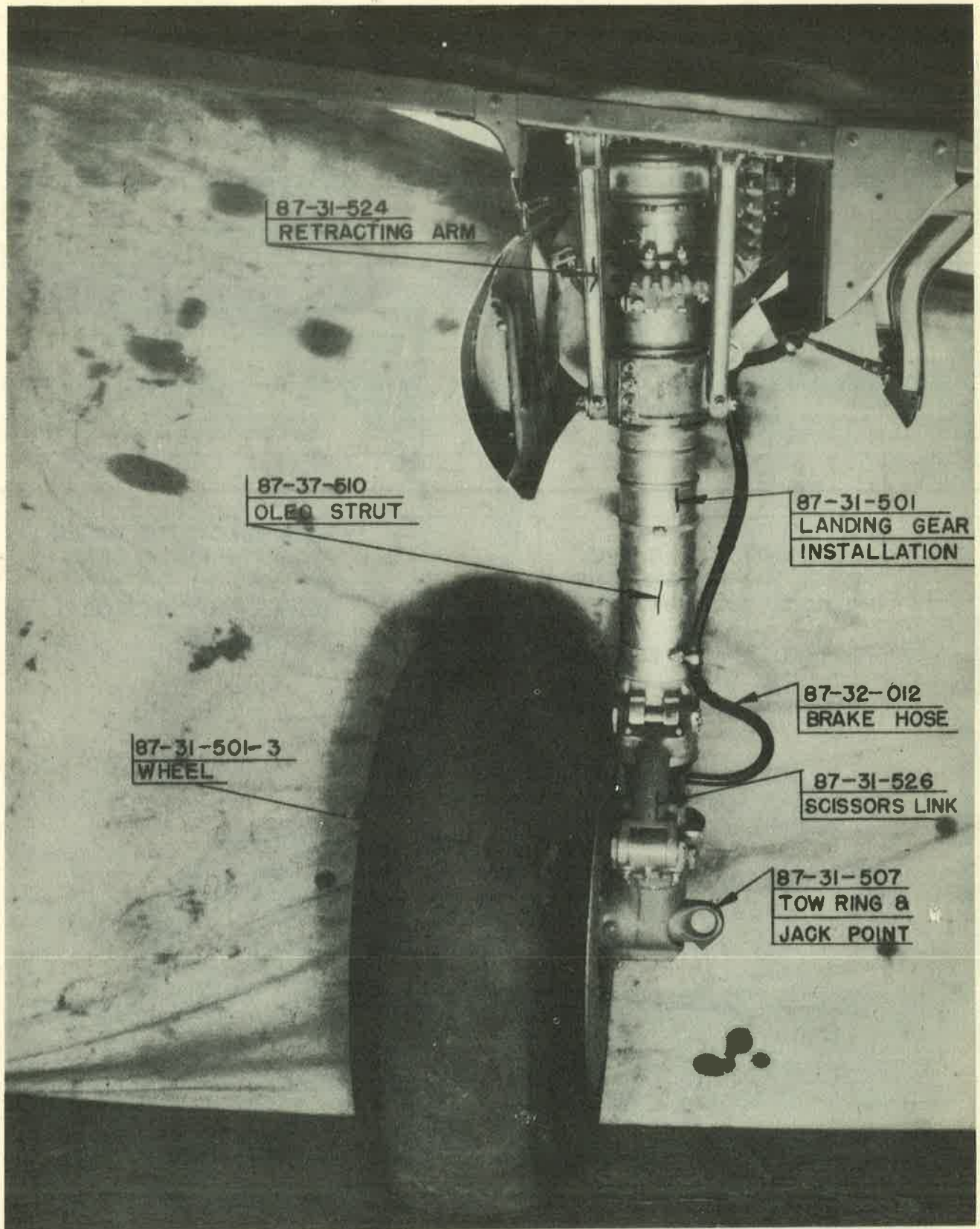


FIG.49 LANDING GEAR INSTALLATION -  
LOOKING FORWARD H-87A-2 & H-87A-3

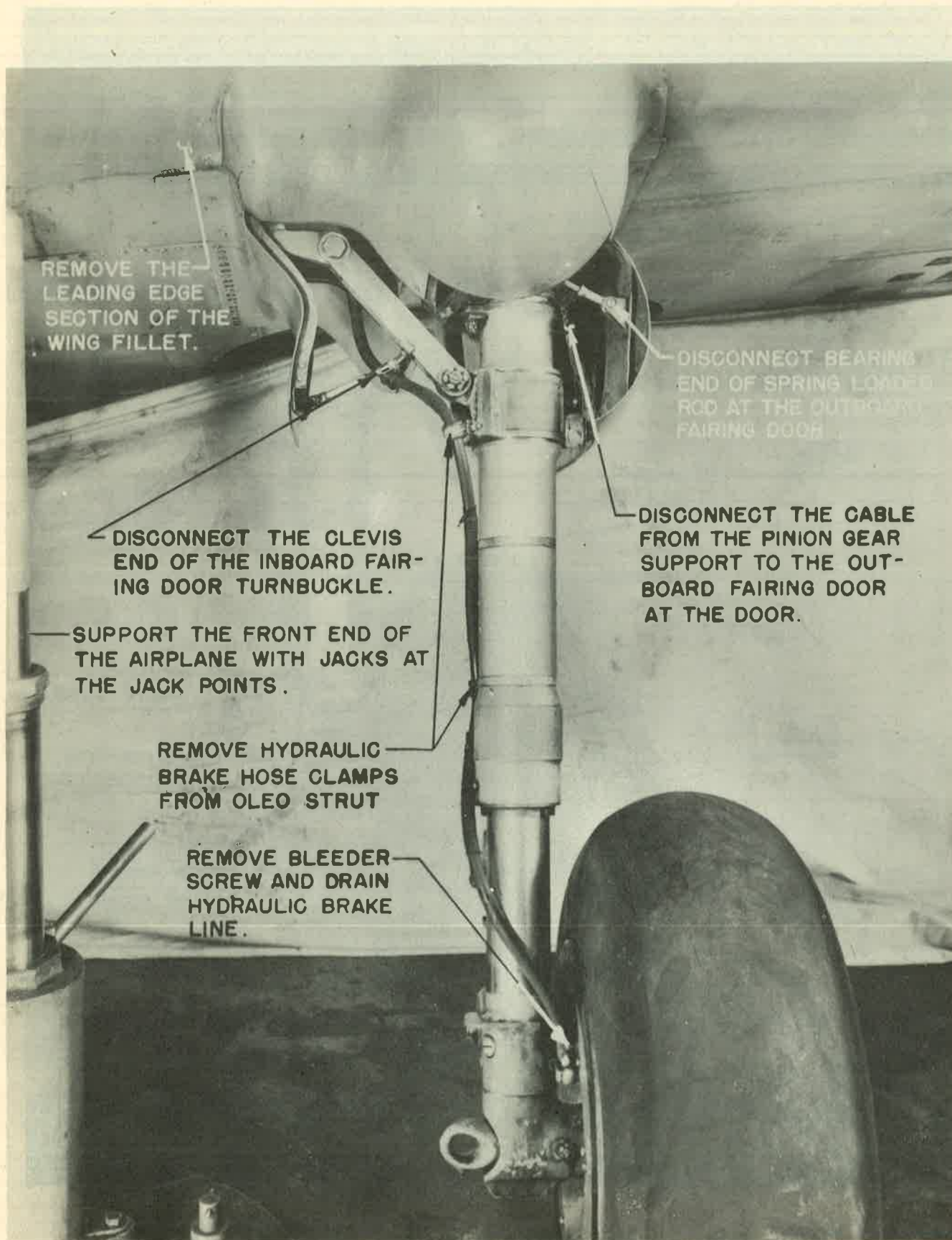


FIG.49A LANDING GEAR PRIOR TO REMOVAL



FREE THE UPPER FORWARD CIRCUMFERENCE OF THE CANVAS IN THE WHEEL POCKET AND TURN THE CANVAS DOWN AS SHOWN. PARTIALLY RETRACT THE LANDING GEAR SO THAT THE UPPER RETRACTING LINKS AND RETRACTING STRUT PISTON END THROUGH BOLT IS ACCESSIBLE FROM THE WHEEL POCKET AS ILLUSTRATED. PULL THE COTTER, TURN OFF THE NUT AND PULL THE THROUGH BOLT FREEING THE UPPER RETRACTING LINKS.

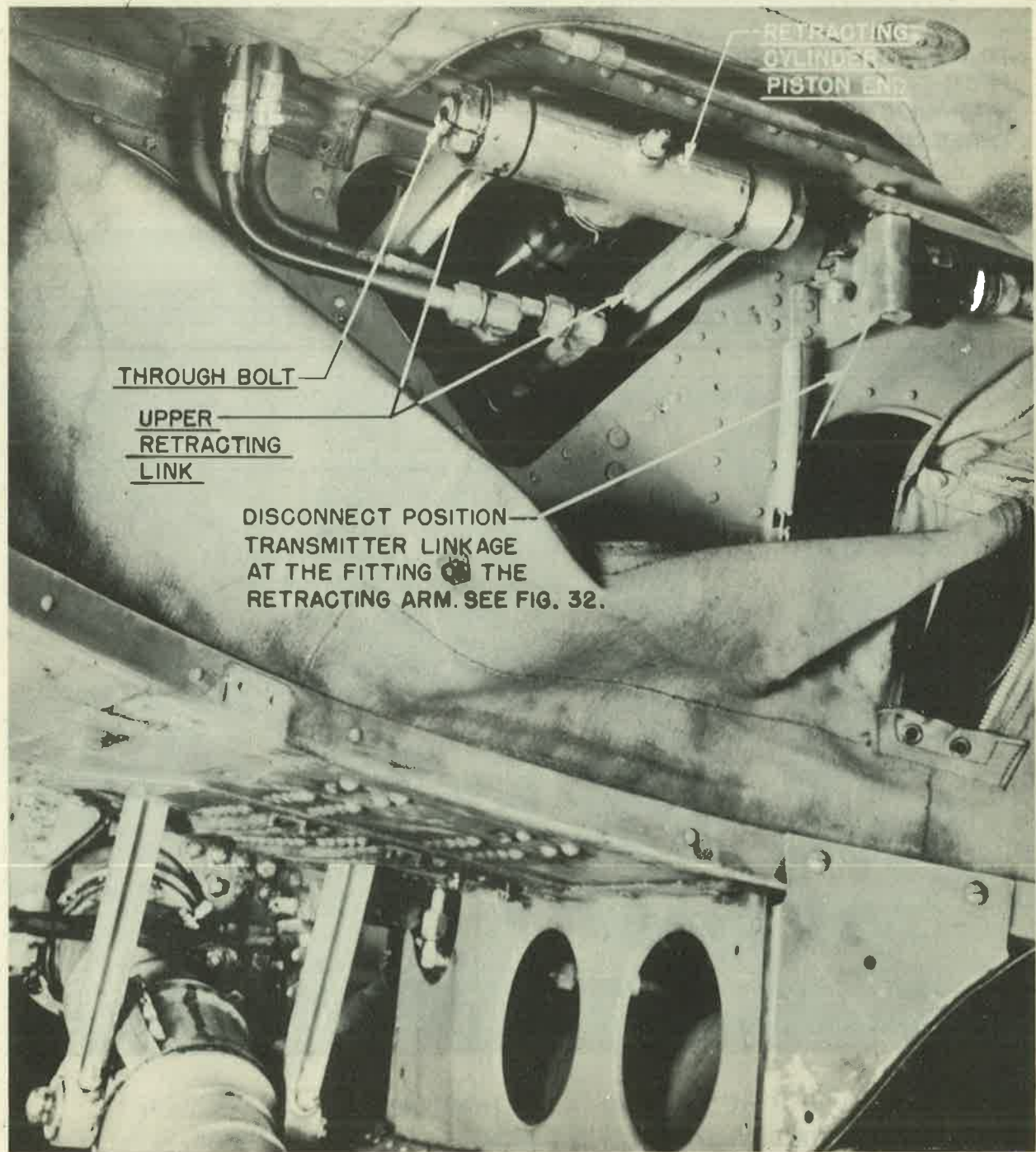
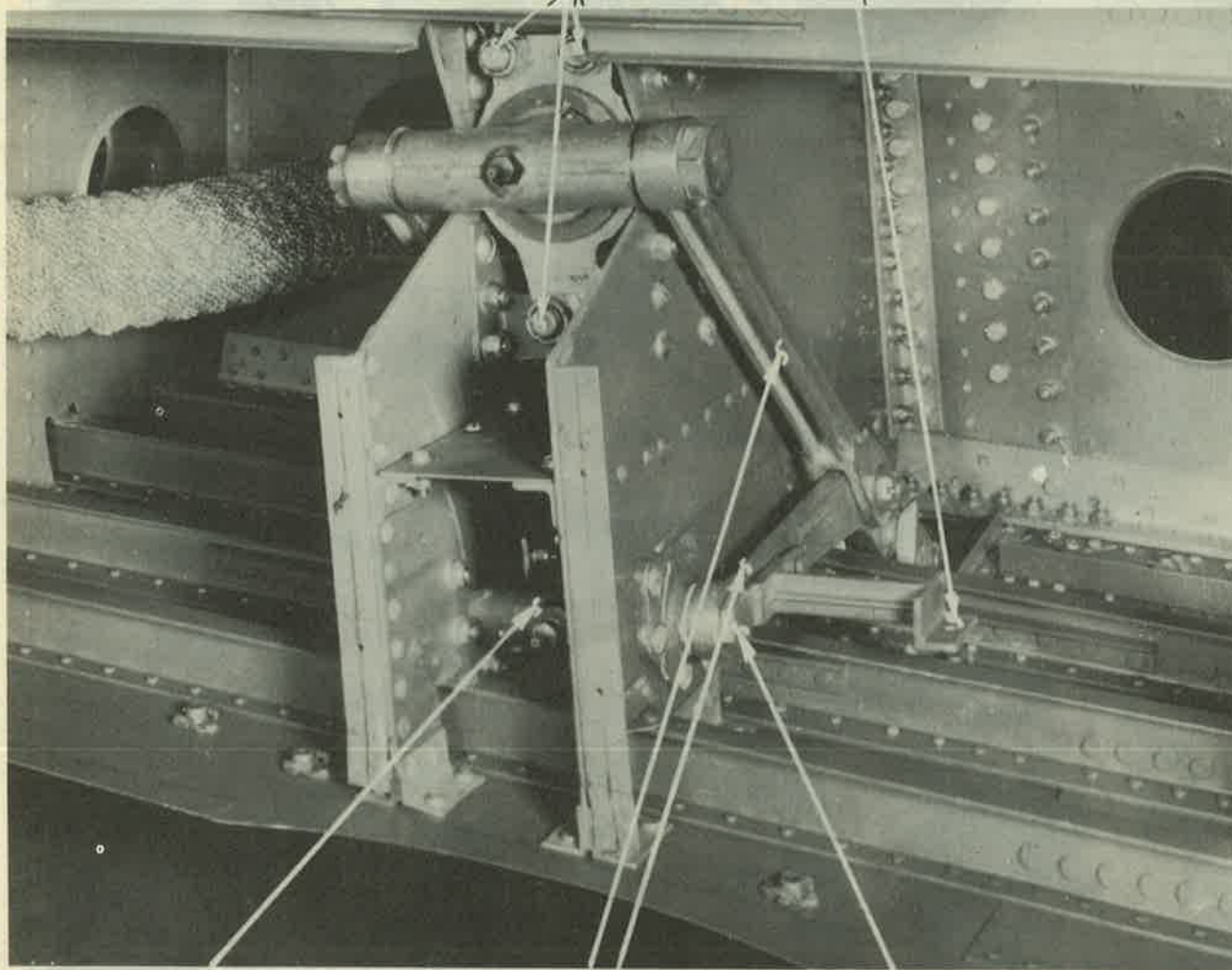


FIG.49B PISTON HALF EXTENDED FOR REMOVAL OF PISTON END THROUGH BOLT

AFTER THE UPPER RETRACTING LINKS ARE DISCONNECTED FROM THE PISTON END WORK THROUGH THE TWO LIGHTENING HOLES IN WEB 3 AT EITHER SIDE OF THE RETRACTING STRUT AND REMOVE THE COTTER AND NUT WORKING THROUGH THE LEFT HOLE. MOVE OVER TO THE RIGHT HOLE AND PULL THE THROUGH BOLT OUT FREEING THE SPACER BETWEEN THE BUSHINGS AND THE RETRACTING ARMS.

TO REMOVE THE RETRACTING CYLINDER FROM THE WING DISCONNECT THE TWO HYDRAULIC LINES AND REMOVE THE THREE NUTS AT THE AFT END.

DISCONNECT LANDING GEAR POSITION TRANSMITTER LINKAGE HERE



SPACER  
BUSHING

UPPER RETRACTING  
LINK

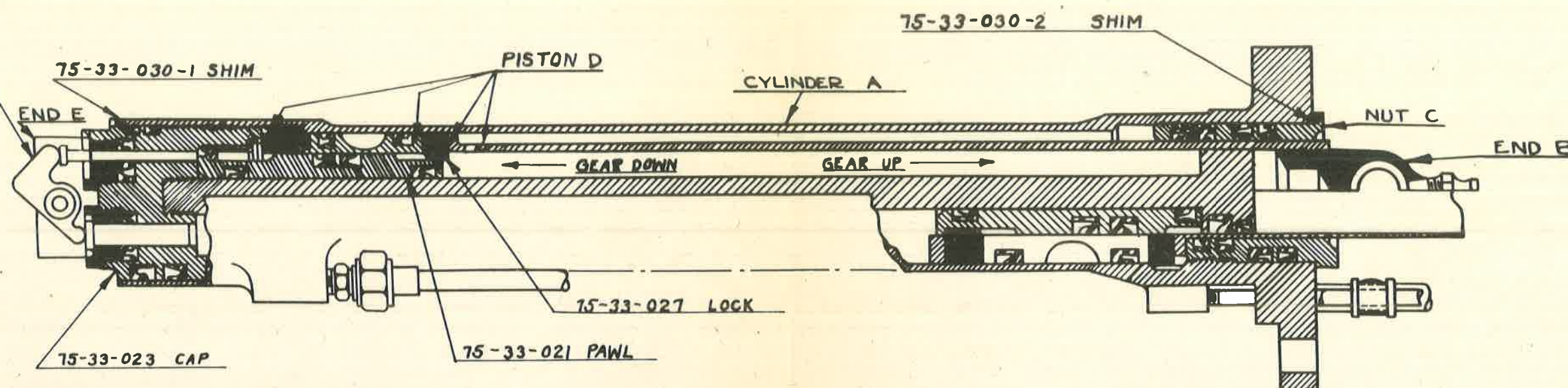
RETRACTING  
ARM

THROUGH  
BOLT

FIG.49C RETRACTING ARMS AND UPPER  
RETRACTING LINKS



CAUTION-THIS LEVER MUST BE  
INSTALLED AS SHOWN. DO NOT  
REVERSE



- 1 FOR TEST AND ASSEMBLY USE HYDRAULIC BRAKE FLUID #5. UNDER NO CONDITIONS SHOULD MINERAL OIL BE USED.
- 2 TO MANIPULATE PAWL 75-33-021 USE 5/32" DIA. DRILL ROD 16" OR LONGER - END THREADED #8-36 AND INSERT THRU 1/4 HOLE (75-33-023)
- 3 ELIMINATE OR ADD SHIMS AS REQUIRED TO 75-33-030-1 & -2 SO THAT LOCKS 75-33-027 HAVE CLEARANCE IN LOCKED POSITION .002 TO .003
- 4 TEST AFTER COMPLETE ASSEMBLY TO 2,500 <sup>PSI</sup>/SQ. IN.

FIG. 52      LANDING GEAR  
RETRACTING STRUT   H-87A-2  
     & H-87A-3





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AFTER THE CAP HAS BEEN REMOVED FROM THE SHAFT, THE SHAFT AND PAWL MAY BE PULLED FROM THE PISTON. AS THE PAWL AND SHAFT CUPS ARE REMOVED FROM THE PISTON THEY WILL FOUL THE SQUARE BROACHED HOLES IN THE PISTON. EXTREME CARE SHOULD BE EXERCISED TO PREVENT DAMAGE TO THE EDGES OF THE CUPS AND A SUITABLE TOOL SHOULD BE USED TO DEPRESS THE EDGES OF THE CUPS WHEN THEY ARE MOVED PAST THE SQUARE BROACHED HOLES AS ILLUSTRATED.

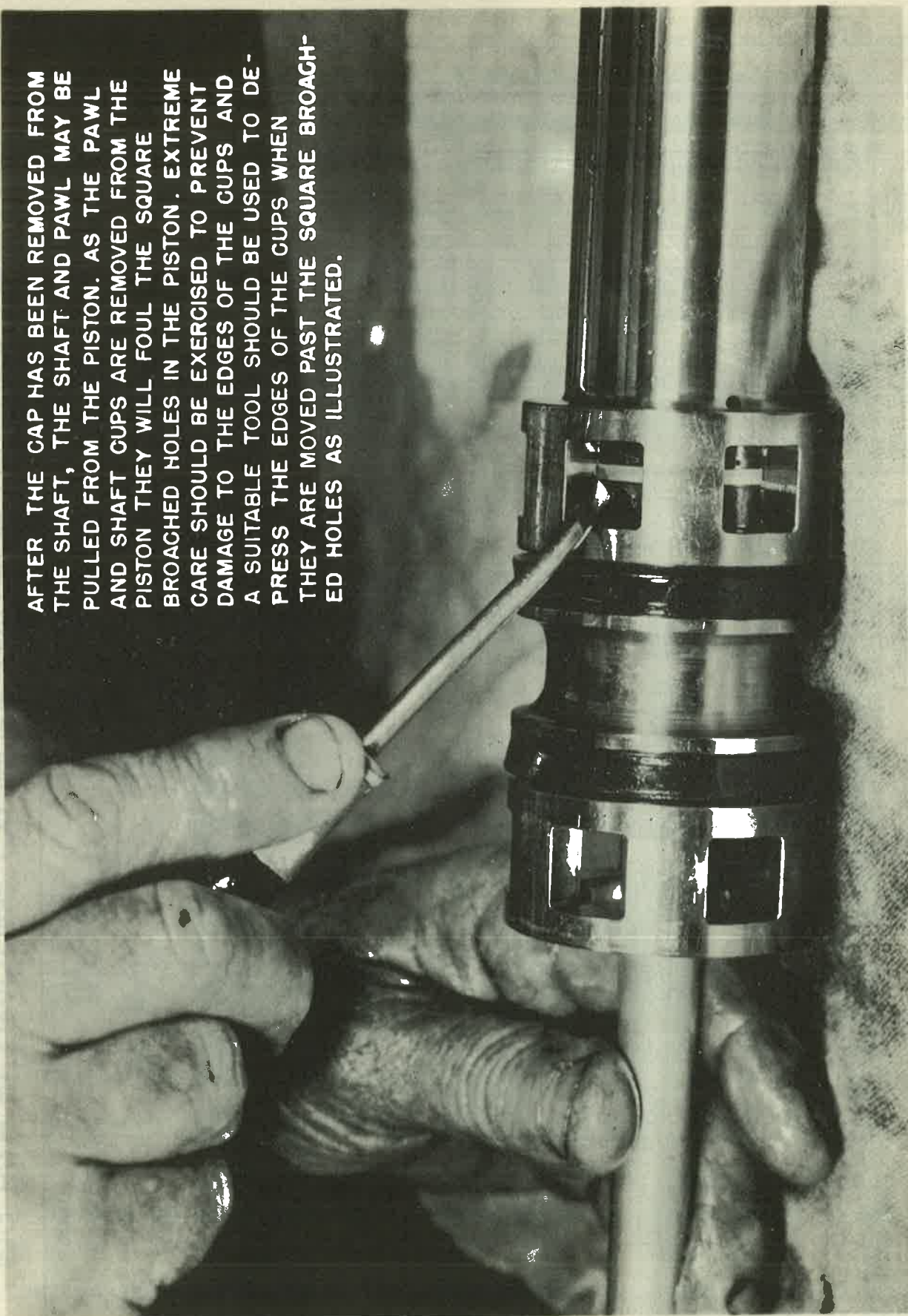


FIG.52A REMOVING SHAFT AND PAWL FROM PISTON

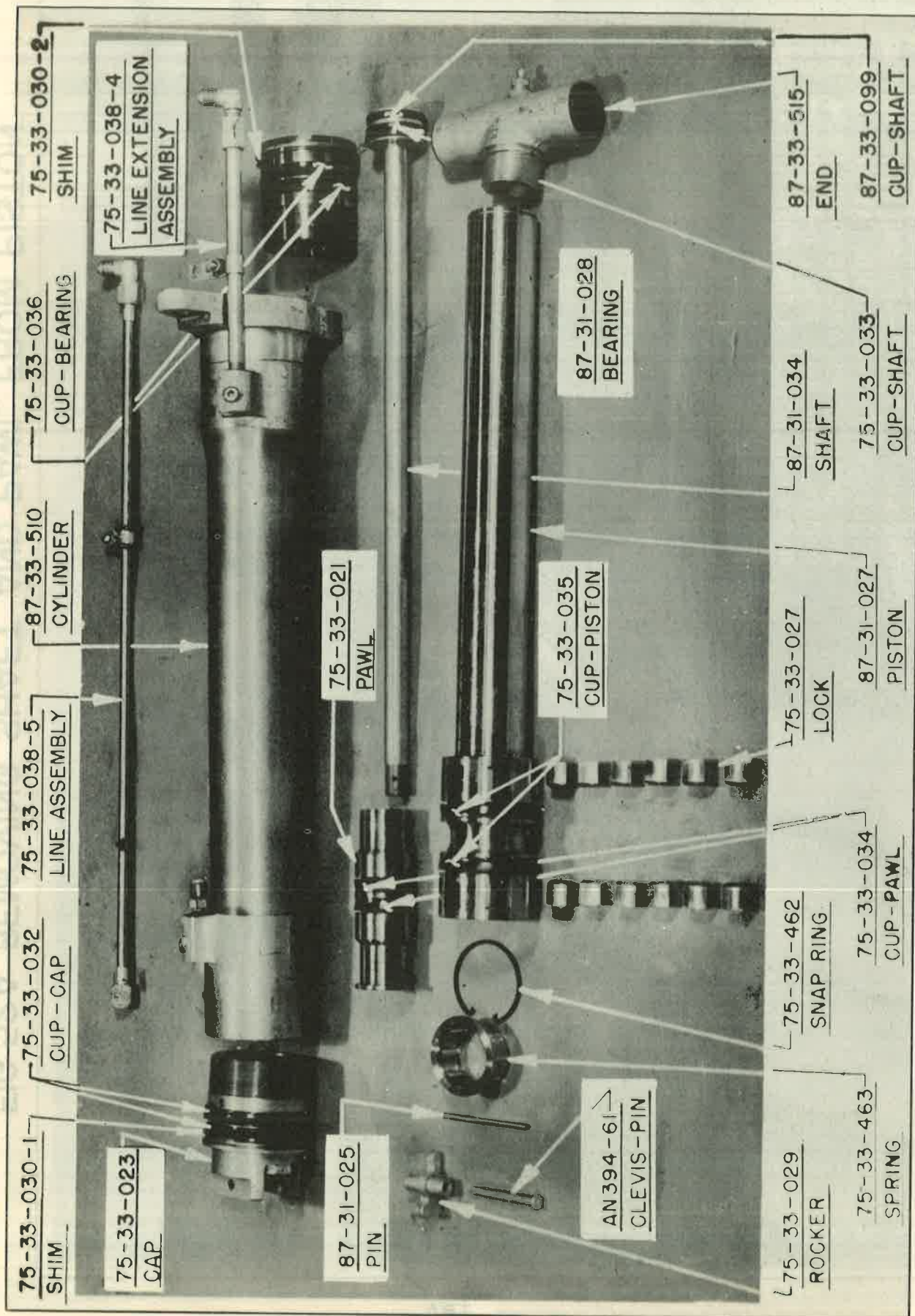


FIG. 52B RETRACTING CYLINDER UNITS WITH CUPS INSTALLED  
PRIOR TO ASSEMBLY



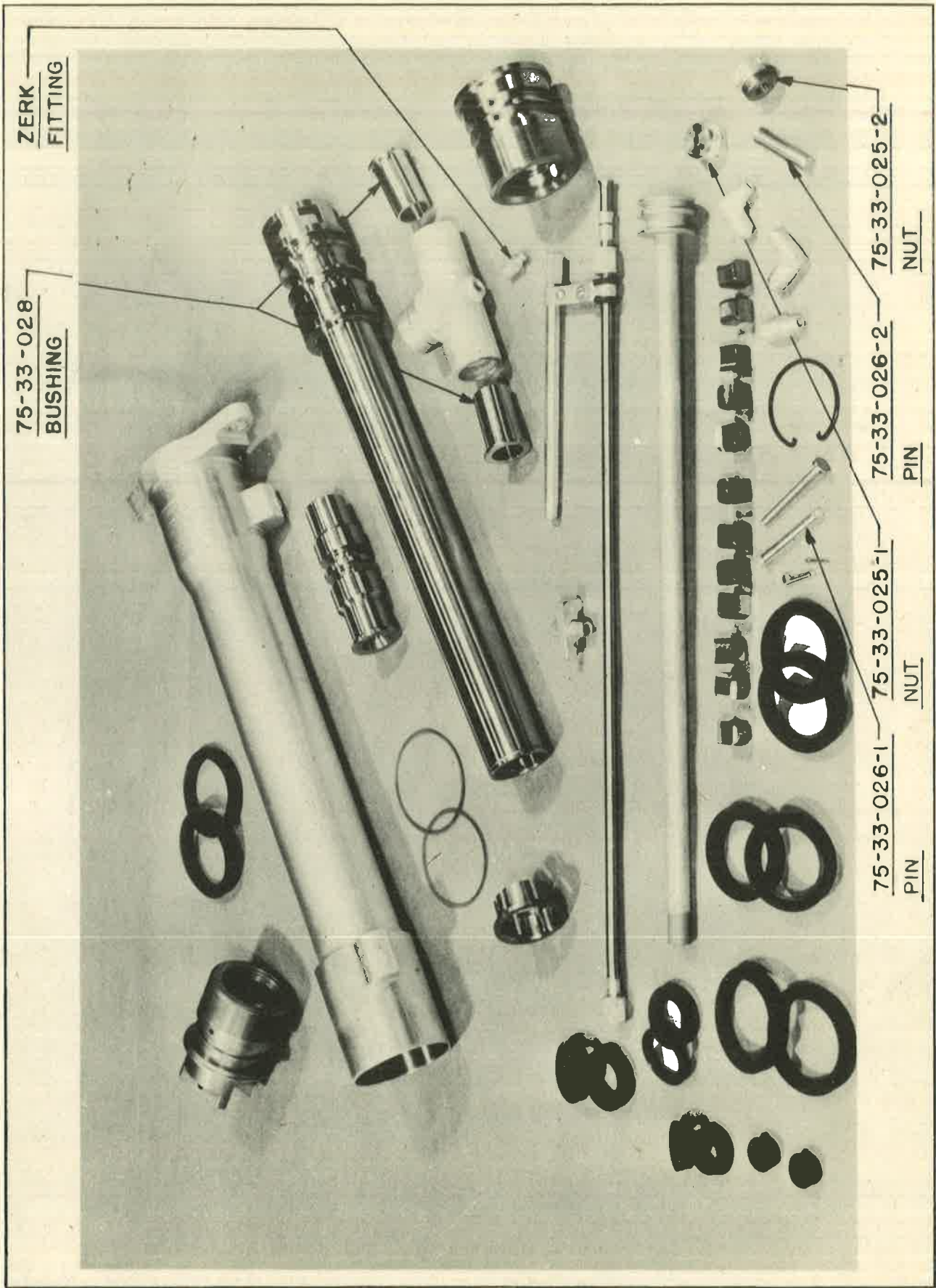
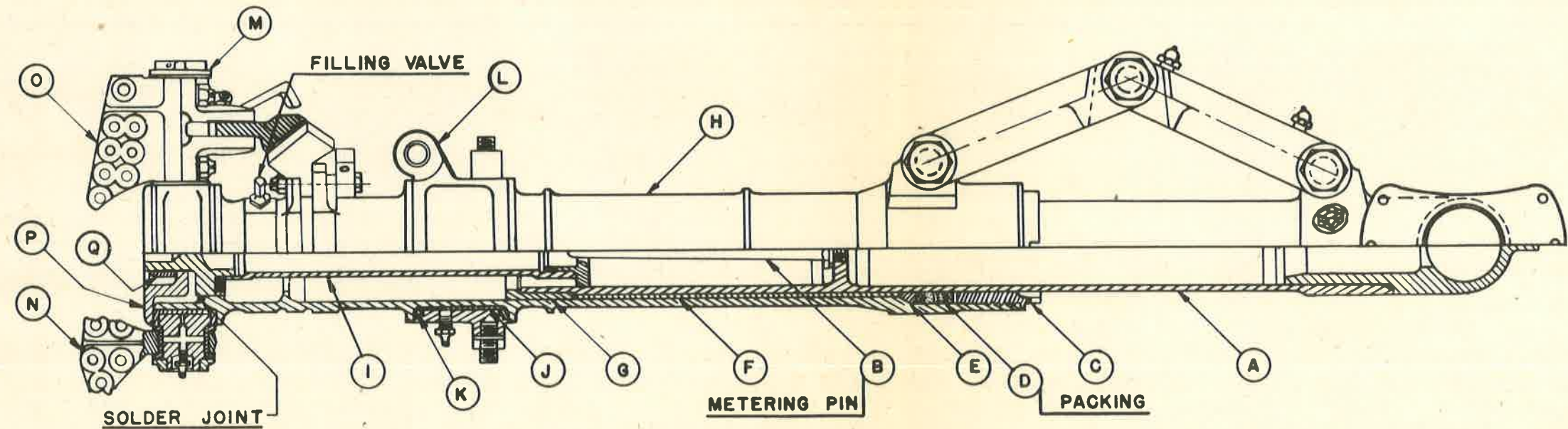


FIG. 52C RETRACTING STRUT COMPLETELY DISASSEMBLED



| PISTON ASSEMBLY |           |                      |       |
|-----------------|-----------|----------------------|-------|
| LET.            | PART NO.  | NAME                 | QUAN. |
| A               | 87-31-513 | PISTON               | 1 L   |
| B               | 75-31-050 | METERING PIN         | 1     |
| C               | 75-31-046 | CYLINDER BEARING NUT | 1     |
| D               | 75-31-049 | PACKING              | 1     |
| E               | 75-31-048 | RING                 | 1     |
| F               | 75-31-045 | SLEEVE               | 1     |
| G               | 75-31-044 | PISTON BEARING       | 1     |

| CYLINDER ASSEMBLY |             |                         |       |
|-------------------|-------------|-------------------------|-------|
| LET.              | PART NO.    | NAME                    | QUAN. |
| H                 | 87-31-543   | CYLINDER                | 1 L   |
| I                 | 87-31-512   | PLUNGER                 | 1     |
| J                 | 87-31-552   | BEARING PLATE           | 1     |
| K                 | 87-31-551   | BEARING                 | 2     |
| L                 | 87-31-525   | LOWER TRUNNION ASSEMBLY | 1 L   |
| M                 | 87-31-041   | UPPER TRUNNION ASSEMBLY | 1 L   |
| N                 | 87-31-506-5 | FITTING                 | 1 L   |
| O                 | 87-31-506-6 | FITTING                 | 1 L   |
| P                 | 87-31-547   | CAP                     | 1     |
| Q                 | AN 310-16   | NUT                     | 1     |

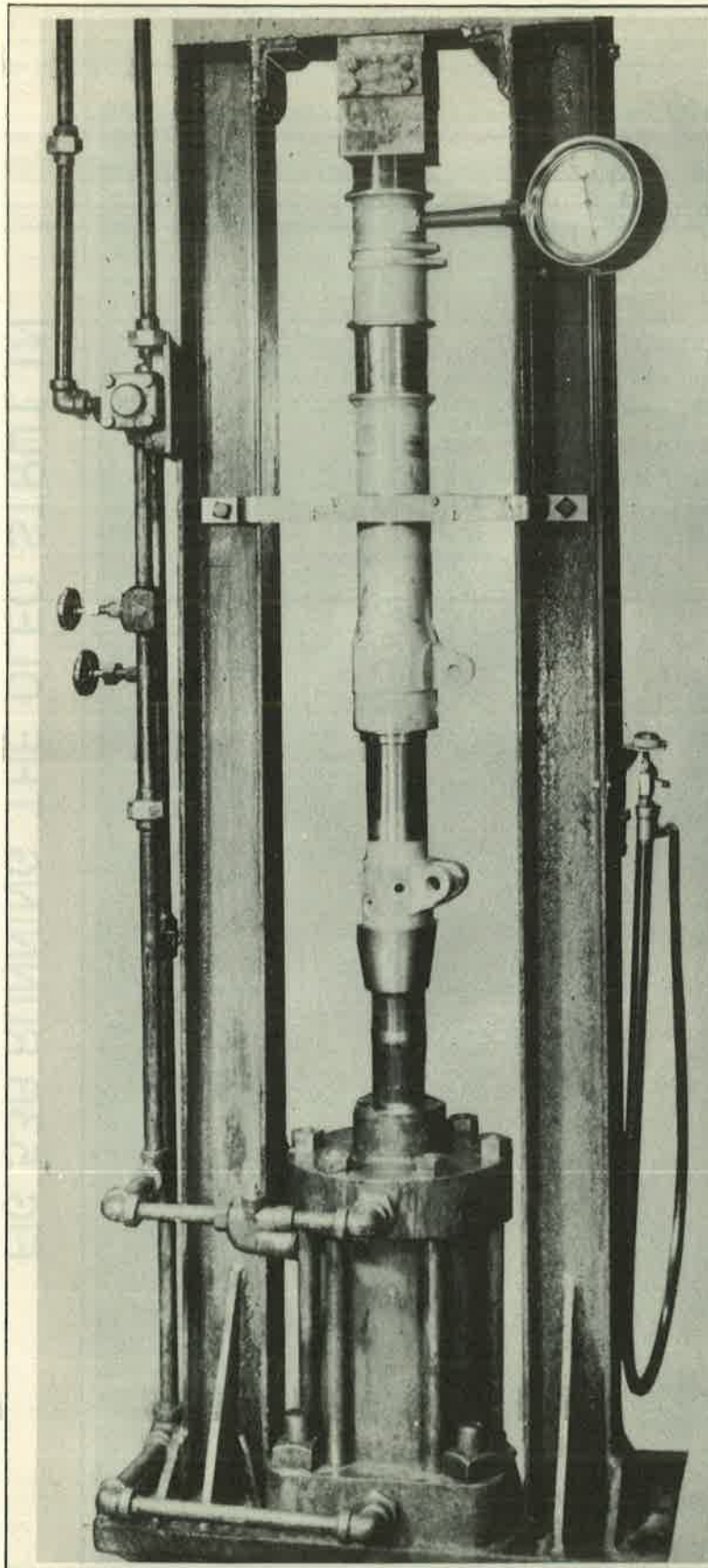


OLEO STRUT ASSEMBLY TO BE TESTED TO A PRESSURE  
OF 2800 LBS./SQ. IN. USING 50/50 ALCOHOL & CASTOR OIL.  
CHECK SPECIFICALLY - SOLDER JOINT, PACKING,  
& METERING PIN ON CYLINDER ASSEMBLY.

FIG. 53  
LANDING GEAR  
OLEO STRUT







WHEN THE OLEO CYLINDER AND PISTON ARE ASSEMBLED LAY THE OLEO STRUT ON A BENCH WITH THE SCHRADER PLUG UP. REMOVE THE SCHRADER PLUG AND EXTEND THE PISTON. FILL THE OLEO THROUGH THE SCHRADER PLUG HOLE WITH FLUID (50% DIACETONE ALCOHOL AND 50% CASTOR OIL) UNTIL IT OVERFLOWS. SCREW A GAGE INTO THE PLUG HOLE AS SHOWN AND PLACE THE OLEO STRUT IN A VERTICAL PRESS AS ILLUSTRATED. APPLY 2800 POUNDS PRESSURE FOR 10 MINUTES AND EXAMINE FOR LEAKS ESPECIALLY AT THE SOLDER JOINT AND PACKING GLAND NUT.

FIG. 53A PRESSURE TEST OF OLEO STRUT

AFTER THE OLEO STRUT HAS PASSED THE PRESSURE TEST OF 2800 LBS. EMPTY THE FLUID FROM THE STRUT. PUSH THE PISTON INTO THE CYLINDER AS FAR AS IT WILL GO AND STAND UP IN A VERTICAL POSITION. FILL THE STRUT WITH FLUID UNTIL IT OVERFLOWS AND REPLACE THE SCHRADER PLUG. PUMP UP THE STRUT TO 208 LBS. WITH A HIGH PRESSURE HAND PUMP AND RUN THE STRUT IN ON A MACHINE THAT WILL MOVE THE STRUT AT LEAST HALF THE LENGTH OF ITS TOTAL TRAVEL A MINIMUM OF 500 CYCLES.

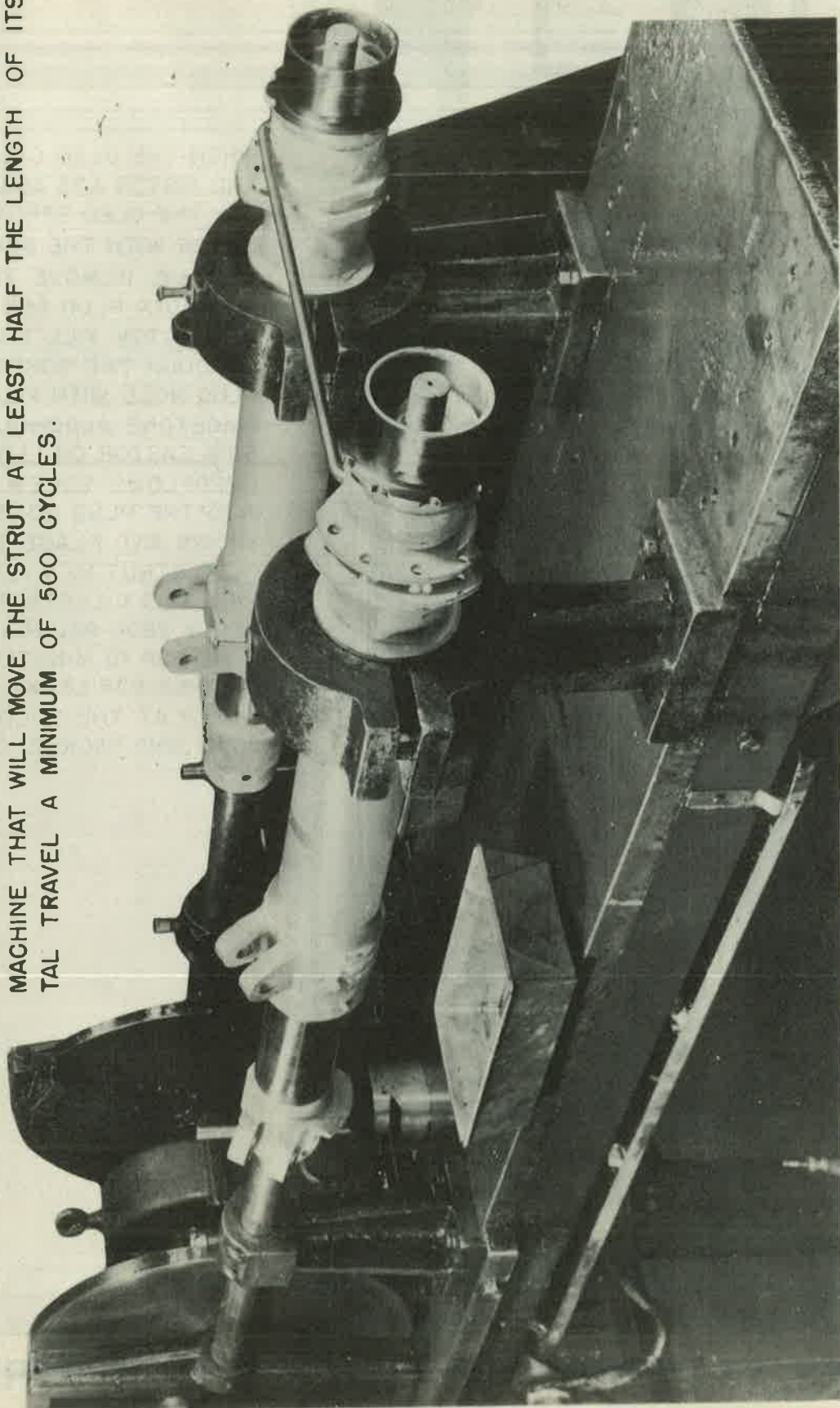


FIG. 53B RUNNING THE OLEO STRUT IN



AFTER HEATING THE PLUNGER AND CYLINDER AND APPLYING THE PRELIMINARY COATING OF SOLDER, DROP THE PLUNGER INTO THE TOP OF THE CYLINDER AND TURN IT INTO THE CYLINDER WITH A SPANNER WRENCH AS ILLUSTRATED IN FIG. 51. WHEN THE PLUNGER IS SEATED FIRMLY LAY A STEEL RULE ACROSS THE TOP OF THE CYLINDER SO THAT IT CONTACTS THE PLUNGER AT THE COTTER HOLE AS SHOWN. THE BOTTOM OF THE COTTER HOLE SHOULD BE FLUSH WITH THE RULE TO ALLOW INSTALLATION OF THE COTTER WHEN THE UPPER TRUNNION CAP AND PLUNGER NUT ARE INSTALLED. IF THIS TEST SHOWS THE COTTER HOLE TO BE TOO LOW REMOVE THE PLUNGER AND BUILD UP THE SOLDER JOINT OR INSTALL ANOTHER PLUNGER. NEVER INSTALL A PLUNGER NUT THAT CAN NOT BE SAFETYED WITH A COTTER AS THE NUT WILL TURN OUT AND LOOSEN THE UPPER TRUNNION CAUSING FAILURE OF THE OLEO STRUT ASSEMBLY.



FIG.53C CHECKING COTTER HOLE LOCATION  
IN PLUNGER

AFTER THE GLAND NUT IS TURNED COMPLETELY OUT OF THE CYLINDER THE PISTON WITH THE GLAND NUT, PACKING, PACKING RING, SLEEVE AND PISTON BEARING MAY BE REMOVED FROM THE CYLINDER AS ILLUSTRATED. THE METERING PIN WILL COME OUT WITH THE PISTON ASSEMBLY.

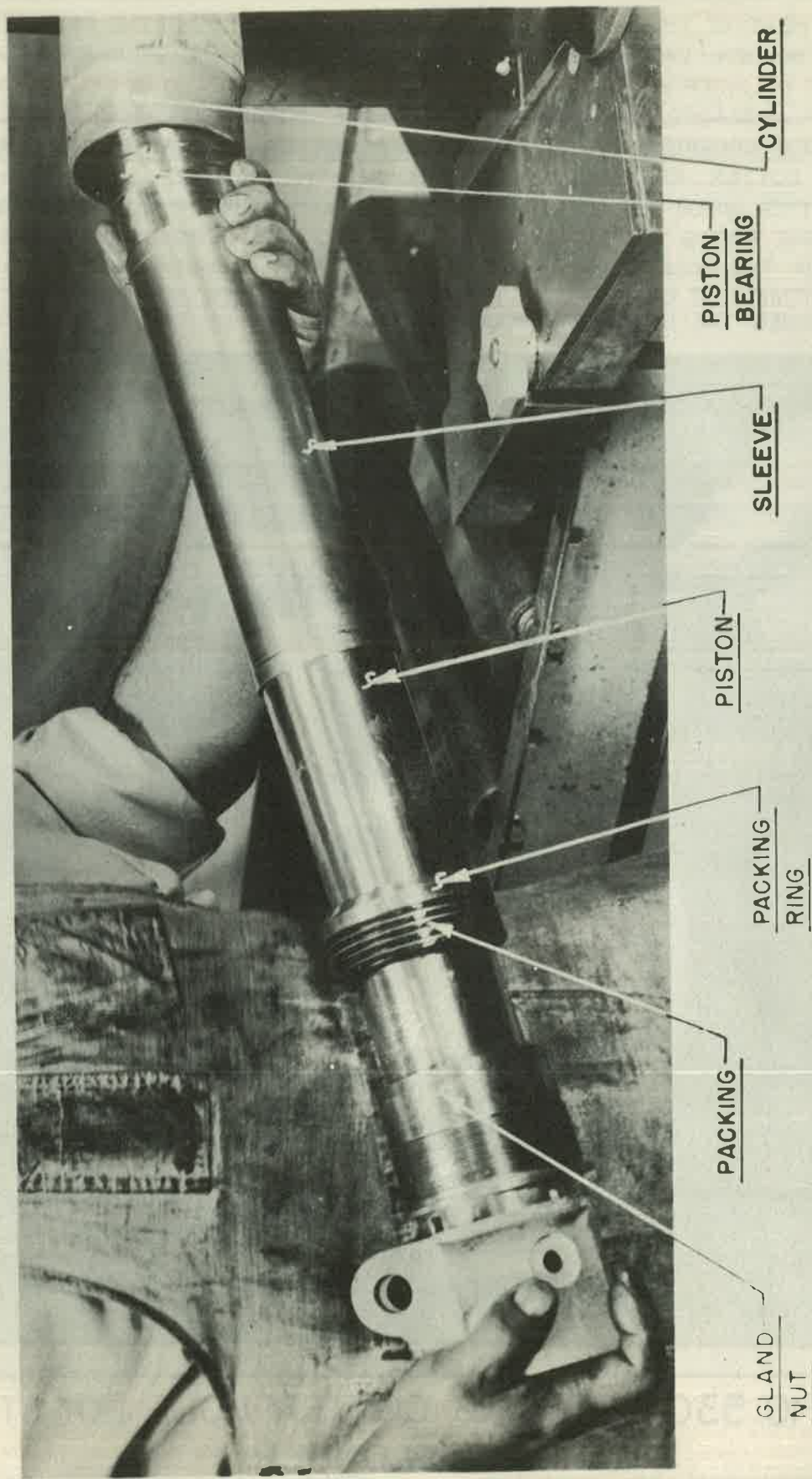


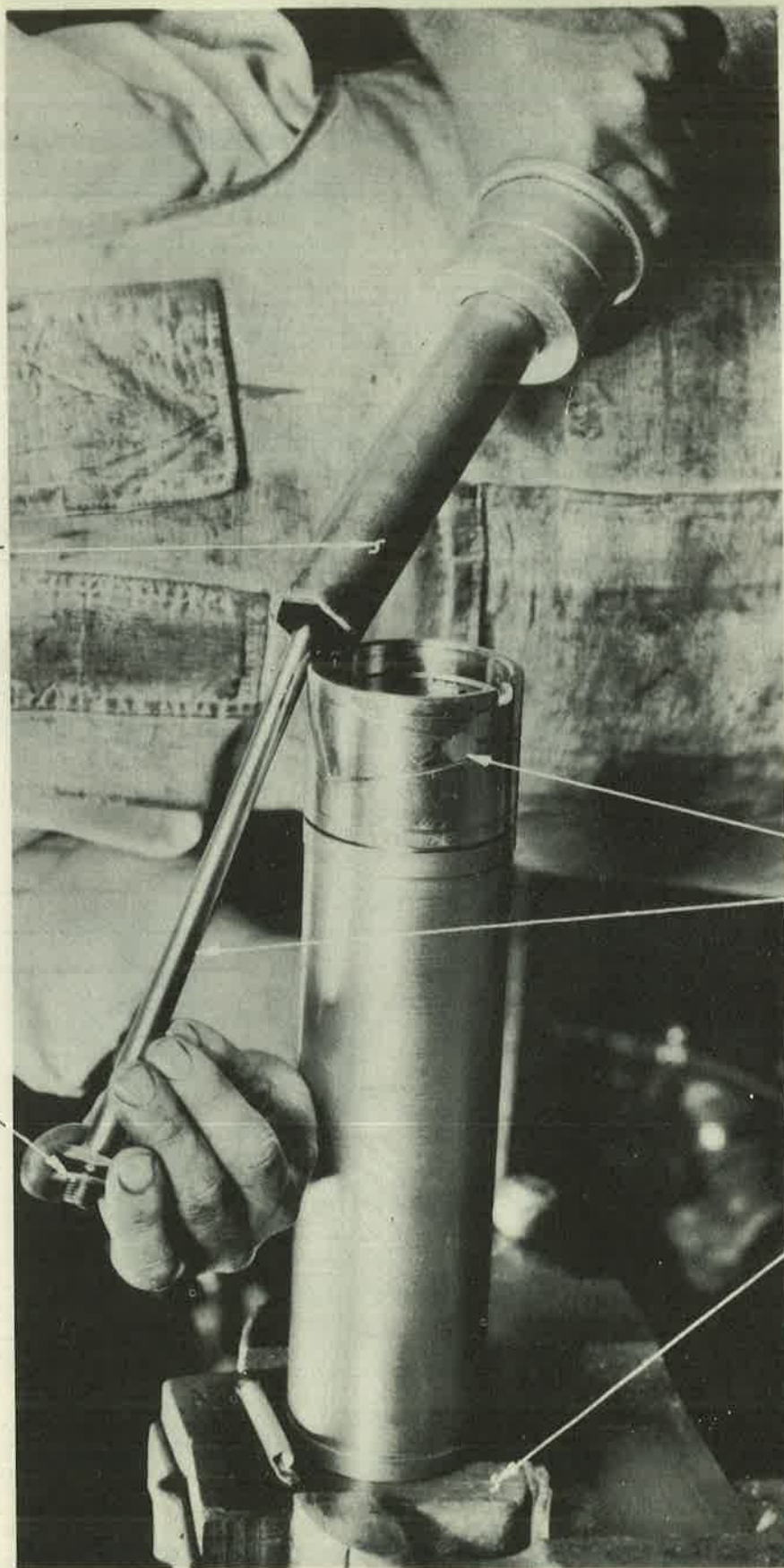
FIG. 53D REMOVING PISTON ASSEMBLY FROM CYLINDER



TO REMOVE THE METERING PIN SECURE THE PISTON IN A WOODEN BLOCK CLAMP AND HOLD THE CLAMP IN A VISE. USE A SPECIAL METERING PIN WRENCH AND TURN OUT THE METERING PIN TO FREE IT FROM THE PISTON. NOTE: WHEN REINSTALLING A METERING PIN A NEW COPPER WASHER MUST ALWAYS BE USED. NEVER REINSTALL A USED WASHER.

—COPPER WASHER

—METERING PIN WRENCH



WOODEN BLOCK CLAMP

METERING PIN

TO REMOVE SET SCREWS FROM PISTON BEARING CLEAN OUT SOLDER ON SCREW HEADS AND REMOVE THE SCREWS.

FIG. 53E REMOVING METERING PIN FROM PISTON



TO DISASSEMBLE THE PISTON REMOVE THE SOLDER ON THE HEADS OF THREE LOCK SCREWS ON THE PISTON BEARING, REMOVE THE LOCK SCREWS AND TURN THE BEARING OFF THE PISTON. THE PISTON SLEEVE, PACKING RING, PACKING, AND GLAND NUT MAY NOW BE REMOVED FROM THE PISTON.

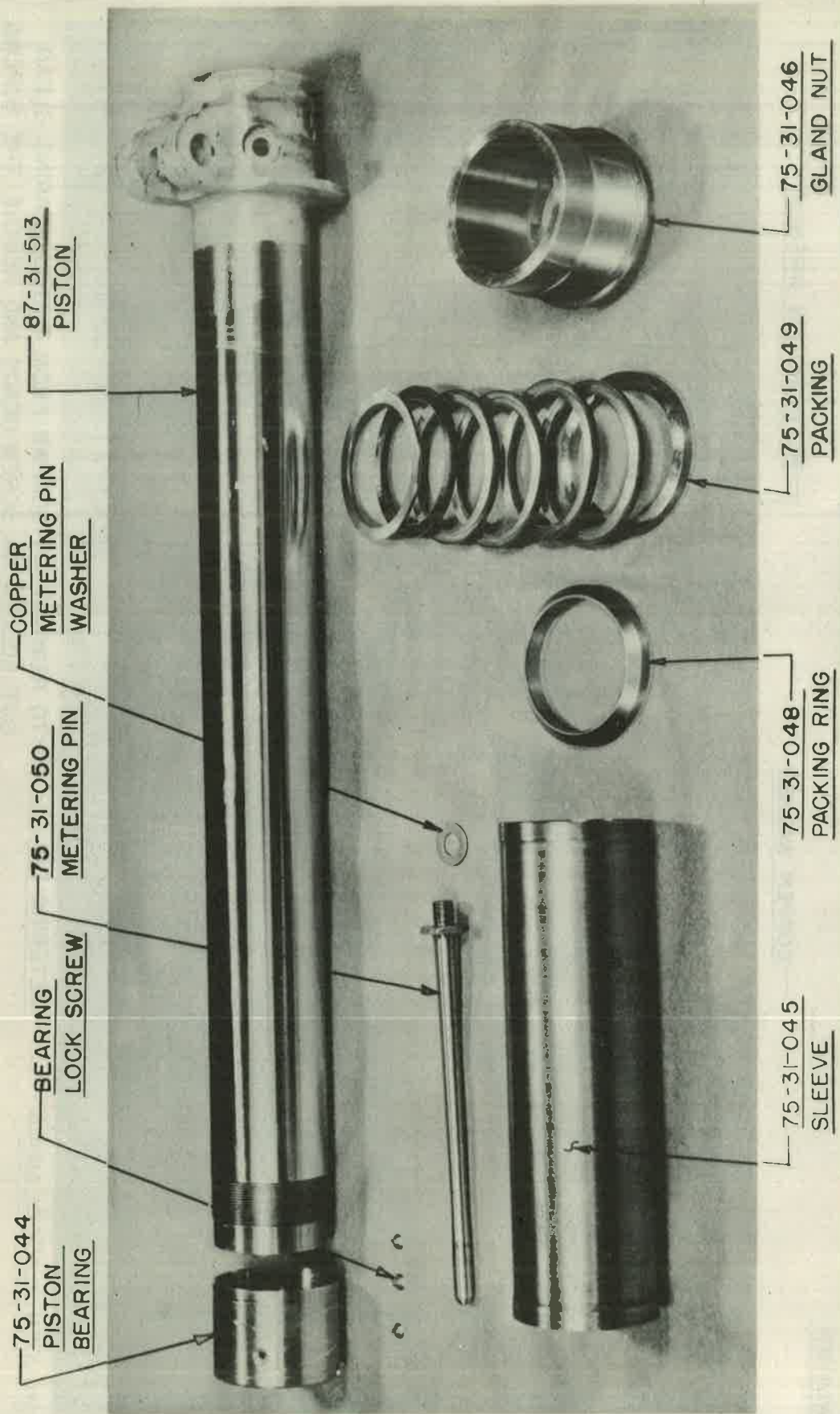


FIG. 53F OLEO STRUT PISTON DISASSEMBLED

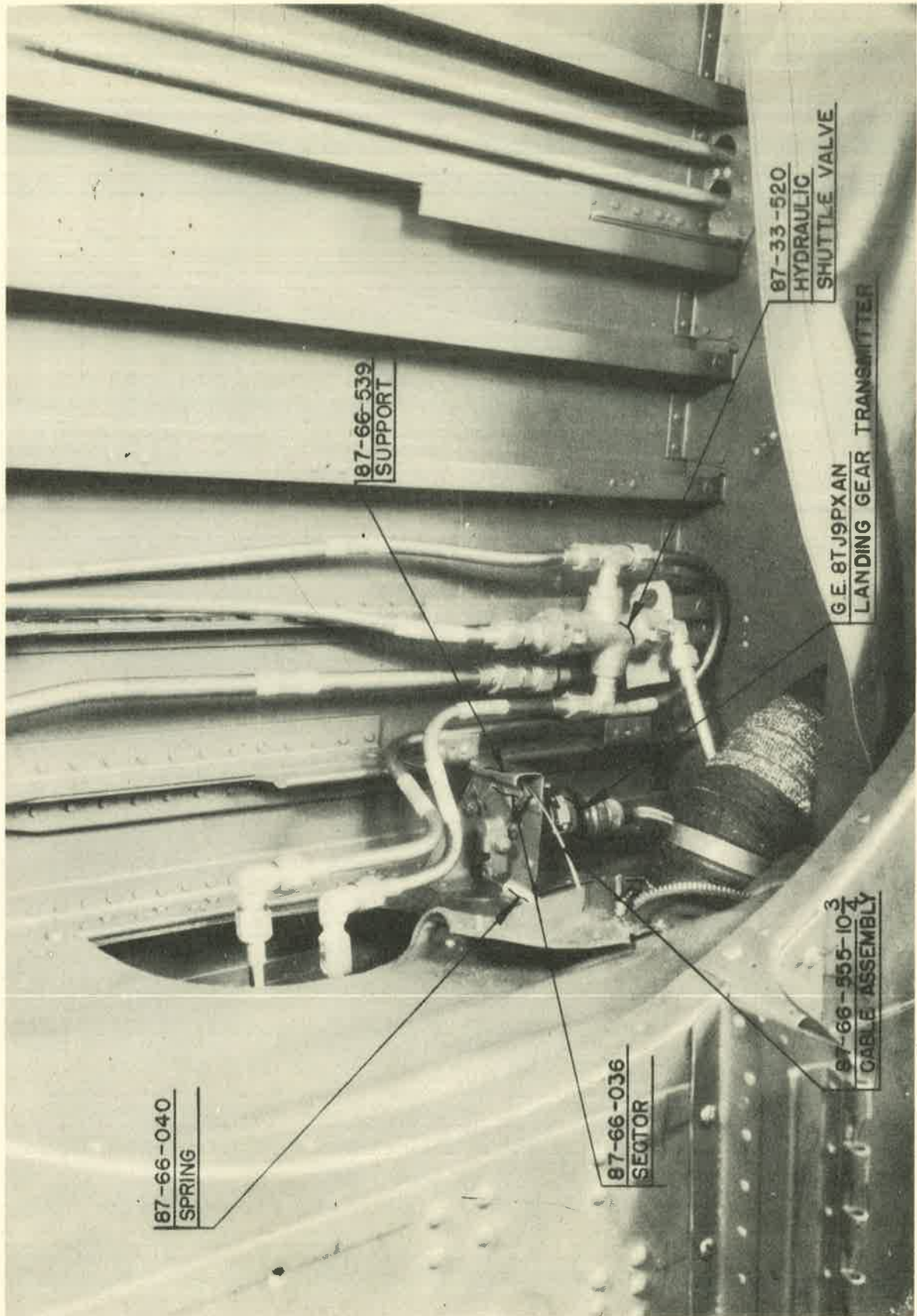
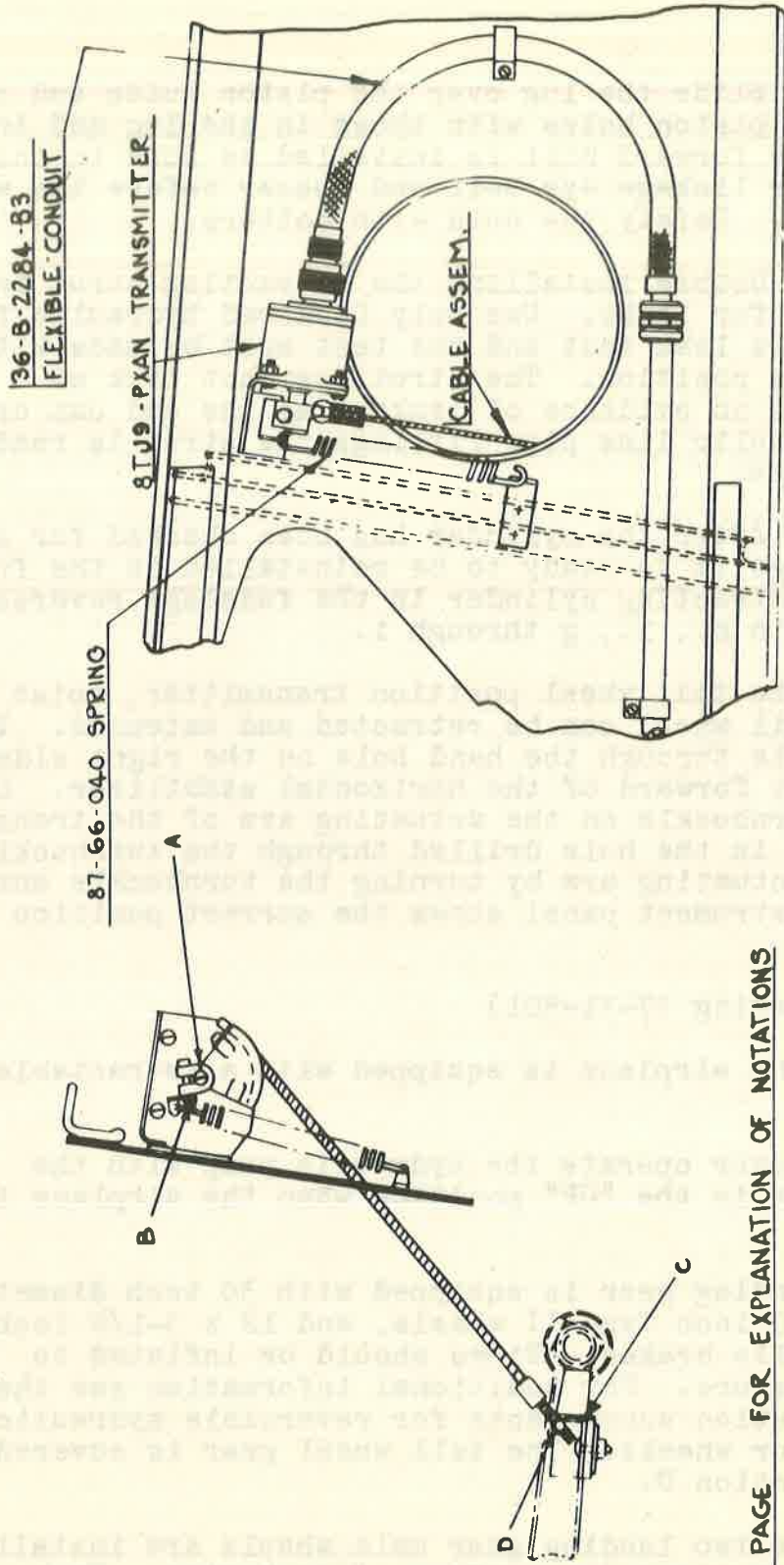


FIG54 LANDING GEAR - POSITION TRANSMITTER  
H-87A-2 & H-87A-3





REF DWG. 87-66-035-1



SEE PAGE FOR EXPLANATION OF NOTATIONS

FIG. 55

LANDING GEAR POSITION

TRANSMITTER H-87A-2 & H-87A-3

(10) Slide the lug over the piston guide and onto the piston, line up the piston holes with those in the lug and insert the rear bolt. When the forward bolt is installed be sure to install the position transmitter linkage eye bolt and spacer before the washer and nut are replaced. Safety the nuts with cotters.

(11) Before installing the retracting strut in the airplane test the strut for leaks. Use only Lockheed hydraulic fluid #5 or equivalent for this leak test and the test must be made with the piston in the mid-stroke position. The strut must not leak at 2500 P.S.I. If there is no evidence of leakage at the end cap or end bushing or the two hydraulic line pipe fittings the strut is ready to reinstall in the fuselage.

(12) After the cylinder has been checked for proper piston motion and leakage it is ready to be reinstalled in the fuselage. To install the retracting cylinder in the fuselage reverse the procedure outlined in d., l., g through i.

To adjust the tail wheel position transmitter, hoist the airplane so that the tail wheel can be retracted and extended. The transmitter is accessible through the hand hole on the right side of the fuselage immediately forward of the horizontal stabilizer. Loosen the lock nuts on the turnbuckle on the actuating arm of the transmitter and insert a pin in the hole drilled through the turnbuckle. Extend or retract the actuating arm by turning the turnbuckle until the indicator on the instrument panel shows the correct position of the tail wheel.

#### F. Landing Gear (Drawing 87-31-501)

1. General: The airplane is equipped with a retractable landing gear.

WARNING: Never operate the hydraulic pump with the landing gear valve lever in the "UP" position when the airplane is resting on its wheels.

The main landing gear is equipped with 30 inch diameter, smooth contour tires, 30 inch Type II wheels, and 12 x 3-1/4 inch Hayes reversible hydraulic brakes. Tires should be inflated to 40 lbs. per sq. in. pressure. For additional information see the Hayes Industries instruction supplements for reversible hydraulic brakes and smooth contour wheels. The tail wheel gear is covered by the preceding Sub-Section D.

2. Struts: The two landing gear main wheels are installed in an identical manner on the under surface of each wing. Each landing gear has an oil-air shock absorber strut (Drawing No. 87-31-510) which rotates aft about trunnions on the top of the strut. During retraction, bevel gears rotate the strut approximately 90° so that the wheel lies flush in the wing. The landing gear has a retracting assembly and one side brace link, per side.



The upper set of retracting links are attached to the piston end of the retracting strut and the retracting arms. The lower retracting links and side brace are attached to the lower oleo strut trunnion. The bevel gears at the upper end of the oleo strut serve as structural members as well as rotating the strut during retraction. Torque loads on the piston are transmitted through the scissors links to the cylinder and the bevel gears in turn transmit this torque from the cylinder to the landing gear fittings on the wings. Retracting arms connect the upper and lower retracting links and revolve around a fixed axis in the wing.

3. Retracting Mechanism: The retracting mechanism consists of a pair of hydraulically operated retracting struts, one in each wing panel, directly forward of the wheel pocket. Extension of the retracting strut causes the landing gear to retract into the lower surface of the wing. The strut piston has a travel of 11.062 inches for full retraction. Each retracting strut has two sets of mechanical locks which are operated by the over-travel of an internal sliding pawl. The mechanical locks consist of two sets of radial segments, retained in square broached holes in the piston, which are positively cammed into and out of the locked position by the pawl.

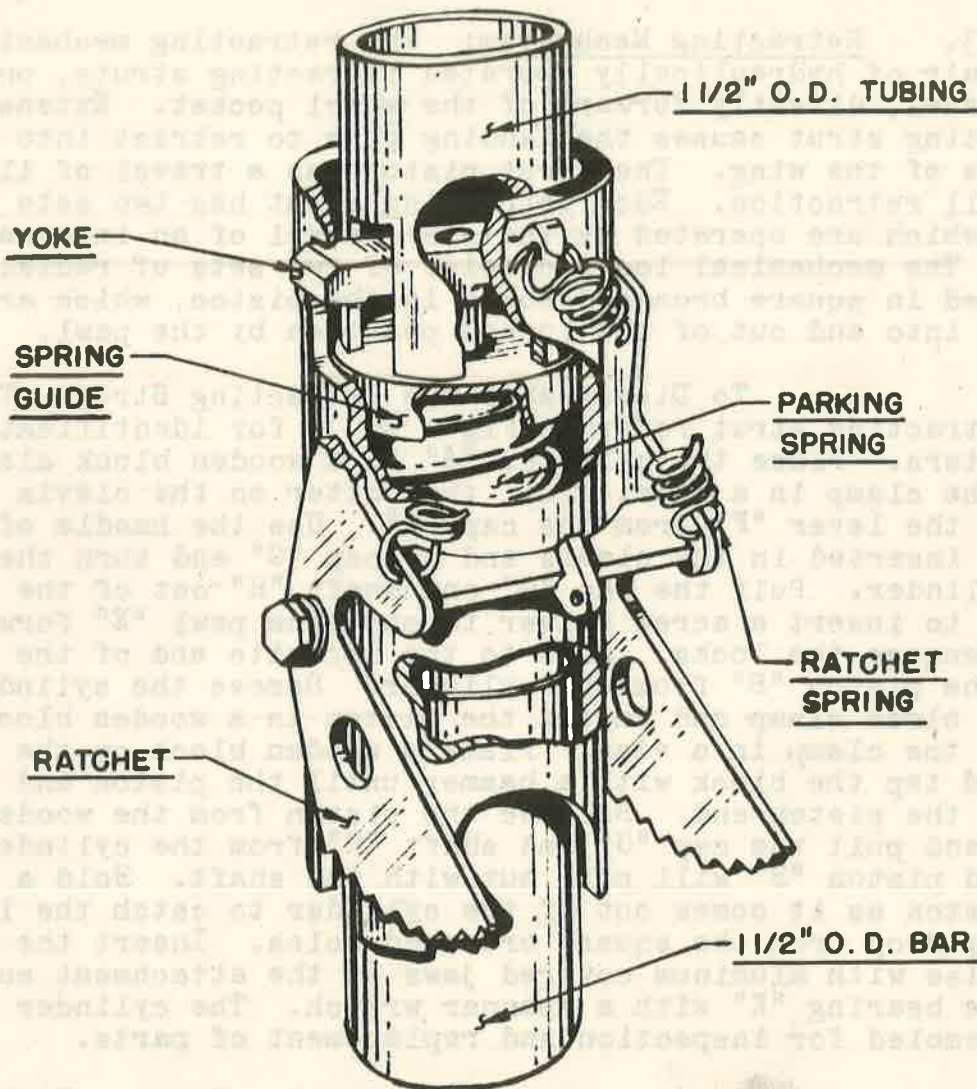
a. To Disassemble the Retracting Strut: To disassemble the retracting strut refer to Fig. 52 . for identification of parts by letters. Place the cylinder "A" in a wooden block clamp and insert the clamp in a vise. Pull the cotter on the clevis pin and remove the lever "F" from the cap "G". Use the handle of a spanner wrench inserted in the clevis end of cap "G" and turn the cap out of the cylinder. Pull the cap "G" and shaft "H" out of the cylinder far enough to insert a screw driver to push the pawl "E" forward enough to disengage the locks. Move to the opposite end of the cylinder and pull the piston "B" from the cylinder. Remove the cylinder from the wooden block clamp and insert the piston in a wooden block clamp and safety the clamp in a vise. Place a wooden block on the piston end "C" and tap the block with a hammer until the piston end turns freely. Remove the piston end. Release the piston from the wooden block clamp and pull the cap "G" and shaft "H" from the cylinder, the pawl "E" and piston "B" will pull out with the shaft. Hold a hand under the piston as it comes out of the cylinder to catch the locks "D" as they drop from the square broached holes. Insert the cylinder in a vise with aluminum covered jaws at the attachment end and turn out the bearing "K" with a spanner wrench. The cylinder is now disassembled for inspection and replacement of parts.

b. To Assemble the Retracting Strut. Replace all worn cups and parts and coat the cups with Lockheed Hydraulic Fluid #5 or equivalent. Assemble the strut by reversing the procedure outlined above.

4. Warning System: The locks inside the retracting strut actuate an electrical switch through a plunger and a bellcrank, thereby controlling the operation of a "KLAXON" warning signal in the cockpit. A cam on the throttle control rod in the cockpit actuates another electrical switch in the landing gear warning



CUT A PIECE OF TUBING 1 1/2" O.D. AND APPROXIMATELY 3" LONG. CUT TWO 3/4" SLOTS ABOUT 1" DEEP OPPOSITE EACH OTHER ON ONE END OF THE TUBING. PLACE THE SLOTTED TUBING ON THE SPRING GUIDE WITH THE SLOTS STRADDLING THE YOKE AS ILLUSTRATED. PULL THE RATCHET OUT TO ALLOW THE YOKE TO MOVE DOWN WHEN PRESSURE IS APPLIED WITH AN ARBOR PRESS. APPLY ENOUGH PRESSURE TO DEFLECT THE PARKING SPRING UNTIL THE TOP FACE OF THE SPRING GUIDE IS FLUSH WITH THE BOTTOM OF THE "WINDOW" IN THE HOUSING THROUGH WHICH THE YOKE EXTENDS.



PLACE A 1 1/2" O.D. BAR, APPROXIMATELY 2" LONG, ON END ON THE TABLE OF AN ARBOR PRESS AND SET THE HOUSING ASSEMBLY, WITH THE SLOTTED GUIDES POINTING DOWNWARD, OVER THE BAR. THE BAR WILL TAKE THE LOAD, WHEN APPLIED, INSTEAD OF THE SLENDER GUIDES ON THE HOUSING ASSEMBLY.

**FIG. 56 REMOVING YOKE FROM HOUSING ASSEMBLY**

WHEN THE SPRING IS DEFLECTED SUFFICIENTLY AS ILLUSTRATED IN FIG. LIFT THE YOKE UP TO FREE IT FROM THE HOLE IN THE SPRING GUIDE AND PULL THE YOKE FROM THE HOUSING ASSEMBLY THROUGH THE "WINDOW" AS SHOWN. AFTER THE YOKE IS REMOVED RELEASE THE PRESSURE ON THE PARKING SPRING GRADUALLY SO THAT NO DAMAGE TO THE PARTS WILL RESULT.

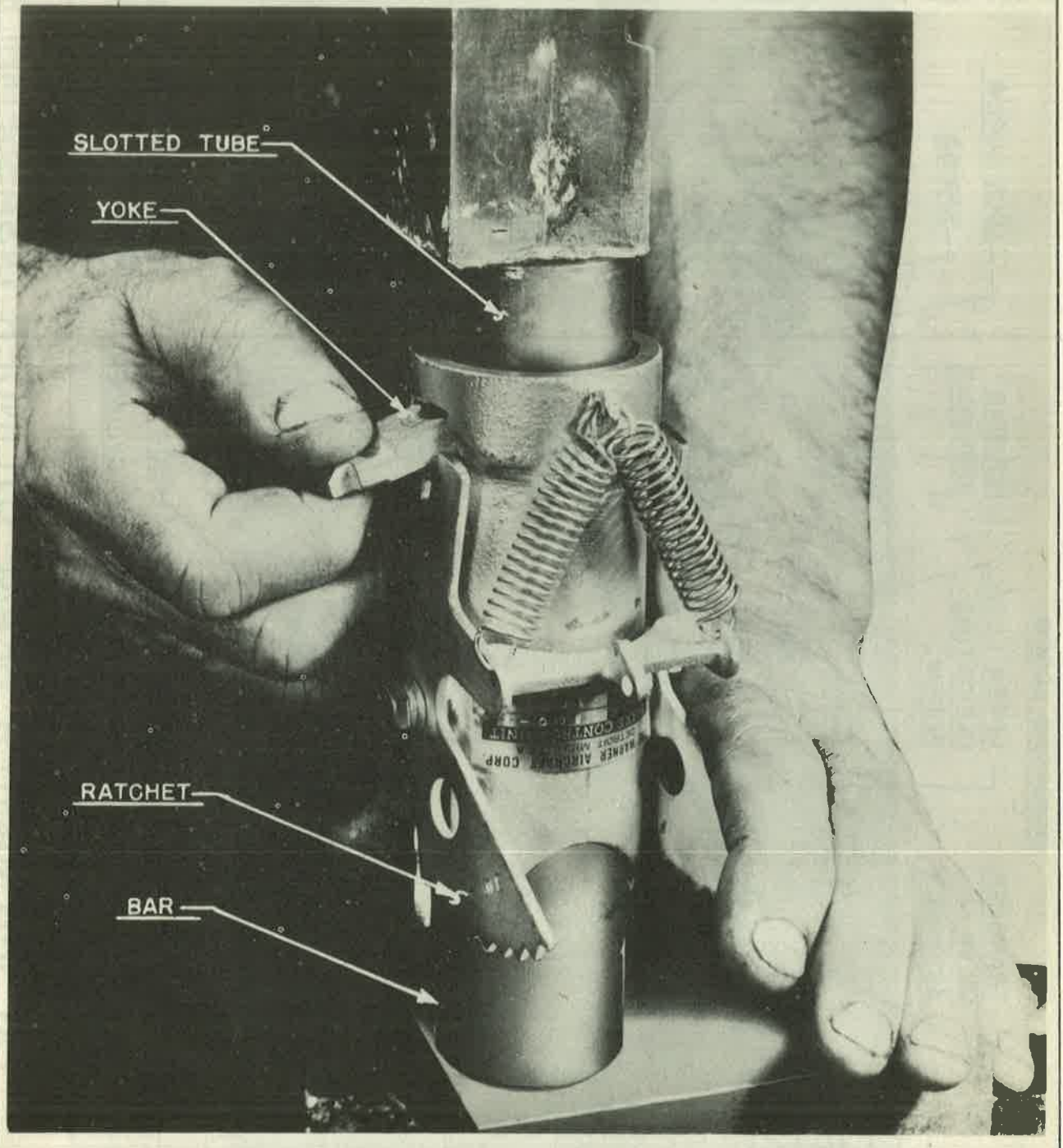


FIG. 56A REMOVING YOKE FROM HOUSING ASSEMBLY



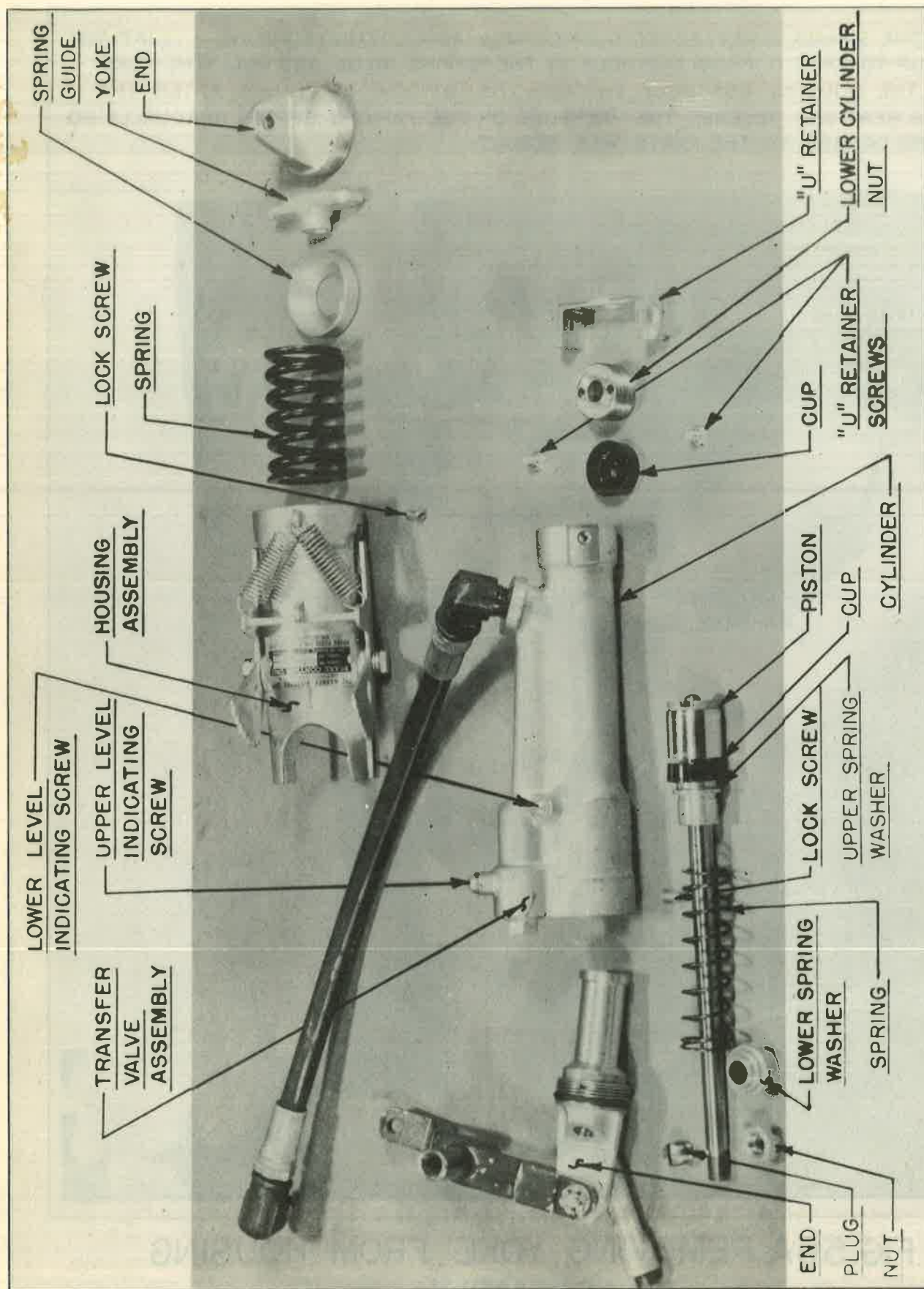


FIG. 56B MASTER BRAKE CYLINDER DISASSEMBLED



## **BRAKE OFF**

THIS PACKING IS ABOVE THE LIQUID LEVEL AND HAS NOTHING TO DO WITH THE OPERATION OF THE UNIT.

UPPER LEVEL INDICATING SCREW. KEEP LIQUID TO THIS LEVEL.

TRANSFER VALVE ASSEMBLY. SCREWED DOWN TIGHTLY ON GASKET.

THERE MUST BE A VENT HOLE IN FILLER OPENING PLUGS.

LOWER LEVEL INDICATING SCREW. IN CASE OF TROUBLE INSPECT HERE FOR LOWEST PERMISSIBLE LEVEL.

THIS SPACER HOLDS THE COMPENSATING VALVE OPEN UNTIL BRAKE IS APPLIED.

OPEN LIQUID PASSAGE BETWEEN MASTER CYL. AND RESERVE CHAMBER INSURES COMPLETELY FILLED SYSTEM UNDER ATMOSPHERIC PRESSURE EVEN DURING THE MOST RAPID TEMP. CHANGES. SLIGHT LIQUID LOSSES IN THE SYSTEM WITH THE BRAKE OFF WILL BE SUPPLIED FROM THE RESERVE CHAMBER.

RETURN SPRING HOLDS UNIT AND BRAKE PEDAL IN RELEASED POSITION.

TO AVOID RATCHET MOVEMENT WHEN APPLYING THE BRAKE, CABLE OR WIRE TO THE INSTRUMENT PANEL FOR SETTING THE PARKING BRAKE MUST HAVE SLACK IN EXCESS OF THE PISTON TRAVEL.

## **BRAKE APPLIED**

LIQUID LEVEL IN THE RESERVE CHAMBER MOVES WITH THE PISTON. THIS MOVEMENT IS MADE POSSIBLE BY THE VENT HOLE IN THE PLUG.

THIS GASKET SEALS PRESSURE IN SYSTEM.

THIS DISC VALVE HAS NOTHING TO DO WITH THE UNIT IN OPERATION AS PRESSURE IS SEALED BY THE GASKET AS INDICATED ABOVE.

COMPENSATING VALVE CLOSED BY PRESSURE IN CYLINDER

LIQUID UNDER PRESSURE IS FORCED INTO THE WHEEL CYLINDER APPLYING THE BRAKES.

ROTATED SECTIONAL VIEW THESE LINES INDICATE THE TRANSMISSION OF FORCE THRU ENTIRE UNIT.

PARKING SPRING INEFFECTIVE AS FORCE IS TRANSMITTED THRU THE PARKING SPRING LOCK AS SHOWN.

THE PARKING SPRING LOCK MUST REMAIN IN POSITION SHOWN WHEN THE BRAKE IS NOT TO BE PARKED. THIS WILL BE OBTAINED BY PROPER SLACK IN THE RATCHET CABLE

TRAVEL OF THE LOWER FITTING EQUALS THE PISTON TRAVEL.

EXTENDING FORCE FROM PRESSURE APPLIED TO THE BRAKE.

## **BRAKE PARKED**

TO PARK BRAKE—PULL ON THE RATCHET CABLE; DEPRESS PEDALS AND KEEP TENSION ON THE RATCHET CABLE; RELEASE PRESSURE ON PEDALS; RELEASE THE RATCHET CABLE

TO RELEASE PARKED BRAKE—PRESS ON BRAKE PEDALS, THIS CAUSES RATCHET TO RELEASE.

ALTERNATE FILLER AND BLEEDER OPENING MAY BE USED IN LIEU OF THE FILLER PLUGS IN UPPER END FITTING. THERE MUST BE A HOLE IN FILLER OPENING SCREW.

ALTERNATE TRANSFER VALVE DESIGN, WITH OUT GLAND, USING MOLDED PACKING OF ROUND CROSS SECTION.

UNIT LOCKED BY RATCHET IN THE EXTENDED POSITION. FORCE ON RATCHET OVERCOMES THE TENSION OF THE RATCHET RETURN SPRING. THE EXTENSION FORCE APPLIED TO THE RELEASE BRAKE REMOVES THE LOAD FROM THE RATCHET WHICH IS SNAPPED BACK TO THE RELEASED POSITION BY THE RATCHET RETURN SPRING. THE UNIT IS RETURNED TO FULLY RELEASED POSITION BY THE CONTROL UNIT RETURN SPRING WHEN THE LOAD ON THE BRAKE PEDAL IS REMOVED.

EXTENDING FORCE COMPRESSES PARKING SPRING.

PARKING SPRING DEFLECTION. CONTRACTION OF THE LIQUID IN SYSTEM OR SLIGHT LEAK WHILE PARKED IS COMPENSATED BY EXTENSION OF PARKING SPRING WHICH DECREASES THE SPRING DEFLECTION. IF A LEAK IS SUFFICIENT TO CONSUME THE ENTIRE PARKING SPRING DEFLECTION, THE LOAD ON THE RATCHET IS REMOVED AND IT SNAPS BACK TO THE RELEASED POSITION. EXPANSION OF THE LIQUID IS COMPENSATED BY COMPRESSION OF THE SPRING DEFLECTION

TRAVEL OF LOWER FITTING NOW EQUALS PISTON TRAVEL PLUS PARKING SPRING DEFLECTION.

OPERATION OF THE HYDRAULIC PART OF UNIT AS EXPLAINED IN ADJACENT COLUMN.

PULL ON CABLE WHILE PARKING BRAKE AS PER INSTRUCTIONS ABOVE.

RATCHET RETURN SPRING

NO EXTENDING FORCE AFTER SETTING OF RATCHET

**FIG. 57 OPERATION  
BRAKE MASTER CYLINDER**



**FILLING AND BLEEDING INSTRUCTIONS FOR HYDRAULIC BRAKE CONTROL UNIT**  
 BEFORE STARTING TO FILL AND BLEED THE SYSTEM THE FOLLOWING PRECAUTIONS SHOULD BE TAKEN

1. BE SURE THAT THE PROPER LIQUID IS USED (LOCKHEED BRAKE FLUID 5 OR EQUIVALENT)
2. BE SURE THAT THE LIQUID IS CLEAN AND FREE FROM CHIPS. STRAIN IF NECESSARY.
3. DO NOT LEAVE THE BRAKE FLUID UNCOVERED. THE BUTYL ALCOHOL OR ETHER WILL EVAPORATE CAUSING A HIGHER CONCENTRATION OF CASTOR OIL, WHICH MAY CAUSE IMPROPER FUNCTIONING, ESPECIALLY IN COLD WEATHER.
4. WHENEVER THE TRANSFER VALVE IS LOOSENED OR TIGHTENED, HOLD THE UNIT FIRMLY, AS THE END FITTINGS ARE NOT DESIGNED FOR TWISTING LOADS.

### TO FILL AND BLEED THE ENTIRE SYSTEM UPON INSTALLATION

1. ATTACH EMPTY CAN TO FILLER OPENING OF CONTROL UNIT
2. ATTACH FLUID LINE FROM TANK UNDER 6 TO 9 P.S.I. PRESSURE TO WHEEL BLEEDER OPENING
3. OPEN TRANSFER VALVE BY UNSCREWING IT 5 COMPLETE TURNS (SEE NOTE 4 ABOVE)
4. OPEN THE WHEEL BLEEDER AND ALLOW THE LIQUID, UNDER PRESSURE, FROM THE TANK TO FILL THE SYSTEM AND THE EMPTY CAN, ATTACHED TO THE FILLER OPENING ON THE CONTROL UNIT. WHEN SUFFICIENT LIQUID IS IN THE CAN, ATTACHED TO THE FILLER OPENING, THE UNIT SHOULD BE PUMPED, AS DESCRIBED BELOW, MAINTAINING THE 6 TO 9 P.S.I. PRESSURE ON THE WHEEL BLEEDER TO PREVENT AIR FROM BEING TRAPPED IN THE BRAKE CYLINDER.
5. PUMP THE LIQUID INTO THE SYSTEM BY DEPRESSING THE BRAKE PEDAL RAPIDLY, BUT ALLOWING IT TO RETURN VERY SLOWLY UNTIL THE LIQUID EXPELLED AT THE WHEEL BLEEDER IS FREE OF AIR BUBBLES.
6. CLOSE THE WHEEL BLEEDER WHILE PEDAL IS IN NORMAL (BRAKE OFF) POSITION AND REMOVE PRESSURE LINE FROM WHEEL BLEEDER OPENING.
7. WHEN APPLYING THE BRAKE AFTER CLOSING THE SYSTEM, EXCESSIVE PEDAL TRAVEL WILL BE OBSERVED. AFTER APPLYING THE BRAKE SEVERAL TIMES, NORMAL PEDAL TRAVEL WILL BE OBTAINED DUE TO RESIDUAL AIR BEING EXPELLED FROM THE CONTROL UNIT BY THESE APPLICATIONS OF THE BRAKE. IF ABNORMAL TRAVEL STILL EXISTS, IT INDICATES AIR BEING TRAPPED IN THE SYSTEM OR EXCESSIVE LINING CLEARANCE
8. REMOVE THE FILLING CAN AND REPLACE THE FILLER OPENING PLUG OR SCREW. BE SURE THE FILLER PLUG OR SCREW HAS A VENT HOLE.
9. REMOVE UPPER LEVEL INDICATING SCREW AND ALLOW LIQUID TO RUN OUT UNTIL IT REACHES HOLE LEVEL. REPLACE LEVEL INDICATING SCREW. KEEP FEET OFF BRAKE DURING THIS OPERATION.
10. CHECK THE ENTIRE SYSTEM FOR LEAKS BY PARKING THE BRAKES AND WATCHING THE POSITION OF THE PARKING SPRING YOKE AS EXPLAINED IN THE ADJACENT LOWER CONTROL UNIT VIEW.

FILLER OPENING

ALTERNATE FILLER OPENING PLUG OR SCREW IN EITHER FILLER OPENING MUST HAVE 1/16" DIA. VENT HOLE.

TRANSFER VALVE ASSEMBLY USE 1/2 SOCKET WRENCH. OPEN ONLY WHEN FILLING AND BLEEDING THE ENTIRE SYSTEM. HOLD UNIT FIRMLY WHEN REMOVING OR INSTALLING VALVE ASSEMBLY.

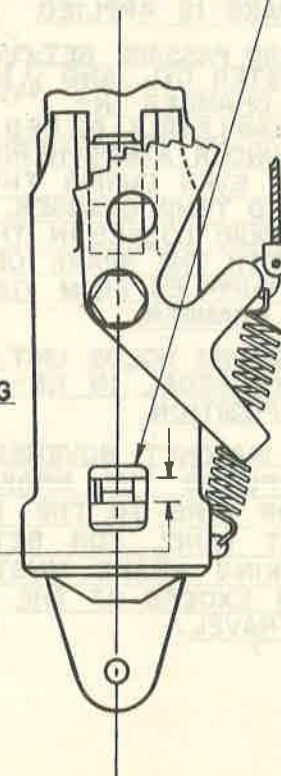
SEEPAGE WILL BE OBSERVED DURING FILLING OPERATION

UPPER LEVEL INDICATING SCREW

LOWER LEVEL INDICATING SCREWS  
 NOTE: BRAKE MUST NOT BE APPLIED OR PARKED WHEN CHECKING LIQUID LEVEL

AS LONG AS THE YOKE DOES NOT TOUCH THE BOTTOM, PRESSURE IS MAINTAINED IN THE SYSTEM BY THE PARKING SPRING.

R.H. CYLINDER UNIT  
 VIEW LOOKING FORWARD



**FIG.58 HYDRAULIC BRAKE CONTROL UNIT SERVICE INSTR.**



system. Position indicator transmitters (Type 8TJ9PXAN), connected to the inboard retracting arms in each wing panel are located in the wheel pockets. These transmitters are electrically connected to the position indicator on the instrument panel.

To Adjust the Position Transmitter: With wheels down and the battery switch in the "BAT" position, loosen the nut designated as "B" (See Fig. 55) and turn the transmitter shaft "A" with a screw driver until the image of the wheel indicator on the instrument panel is in the "DOWN" position. Tighten nut "B" and check position on indicator. If it has undertraveled or overtraveled, correction may be made by tightening or loosening nut "D" slightly. Above the flap and wheel indicator and to the left of the fuel pressure warning light is installed a landing gear warning light which operates in conjunction with the "KLAXON" and flashes red when the engine is throttled down to 1000 R.P.M. for a landing and the wheels are not in the "locked down" position.

5. Filling and Bleeding the Hydraulic Brake System: Fig. 58. gives the method for filling and bleeding the brake system recommended by the master cylinder manufacturer.

6. Installation and Disassembly: a. To Remove the Complete Landing Gear Assembly from the Wing Panel:

- (1) Remove the leading edge wing fillet.
- (2) Remove the landing gear leading edge fairing and outboard fairing door.
- (3) Unbutton the outer wheel fairing and remove the wheel and tire from the axle.
- (4) Working through the wheel pocket:
  - (a) Remove the canvas wheel pocket lining.
  - (b) Partially retract the landing gear so that the upper retracting links and retracting strut piston end through bolt is accessible through the wheel pocket. (See Fig. 49B ).
  - (c) Disconnect the landing gear position indicator linkage at the fitting on the inboard retracting arm. (See Fig. 49C ).
  - (d) Remove the through bolt which connects the retracting strut piston end to the upper retracting links.
  - (e) Return the retracting strut piston completely into the strut and disconnect the hydraulic lines.
  - (f) Remove the three nuts which attach the retracting cylinder in the wing to its support and pull the cylinder through the wheel pocket.



(g) Remove the through bolt which attaches the retracting arms to the panel at the remote pivot points.

(5) Working Under the Wing Panel:

(a) Remove the bolts which connect the lower links to the lower oleo strut trunnion and pull the lower links from the trunnion.

(b) Disconnect the side brace link at either end.

(c) Disconnect the hydraulic brake line at the inner wheel fairing and at the clip on the oleo cylinder and lower trunnion.

(d) Remove the upper trunnion and wing attachment bolts and lower the oleo from the wing.

(6) Pull the retracting arms through the wing far enough to disconnect the lower retracting links.

(7) Remove the retracting arms and upper links through the wheel pocket.

(8) The bellcrank which operates the switch in the warning horn circuit is accessible through a hole in the wing immediately forward of the upper trunnion bearings. It may be removed by disconnecting the retaining spring and pushing the arm upward and forward.

b. To Install and Adjust the Landing Gear: This installation is a reversal of the procedure outlined above. Since all links are of fixed lengths there are no adjustments to be made for camber, caster, toe-in, etc. The only adjustment possible is that of reducing back lash between the bevel gears; this is accomplished by removing the shim above the pinion gear and placing it below the gear.

c. To Adjust the Warning System:

(1) Landing Gear Switch: This switch needs to be adjusted after installation of the retracting strut. The adjustable bolt at the bottom of the bellcrank on each retracting strut should be set to move the switch to the "OPEN" or "OFF" position when the locks are fully engaged.

(2) Throttle Switch: The location of the actuating cam on the throttle rod in the cockpit should be adjusted to actuate the warning signal when the engine is throttled to 1000 R.P.M. and the gear is not locked down. To adjust the cam on the throttle rod in the cockpit, loosen the bolt which fastens the cam to the throttle rod and slide the cam forward or aft as necessary to actuate the warning signal properly.

7. To Disassemble and Assemble the Shock Absorber Strut:

a. To disassemble the shock absorber strut, first remove the axle housing from the piston, by removing the two bolts. Hold the cylinder in a wooden block clamp and remove the plunger nut at the upper end of the cylinder. Pull the upper trunnion cap and slide the upper trunnion assembly off the cylinder. Unscrew the eight cap screws holding the two lower trunnion halves together and pull the trunnion halves apart. Remove the two trunnion facer plates and four segments. Pull the cotter and remove the nut and washers from the four pinion gear attaching bolts. Pull the bolts and remove the two segments and the support. The shims will come out with the pinion gear. Pull the cotters and remove the nuts and washers on the two bolts, one attaching the scissor links to the lugs on the piston and the other attaching the links to the lugs on the cylinder. Remove the bolts and spacers and pull the links free of the cylinder and piston lugs. Loosen the set screw in the cylinder and turn the packing gland nut out of the cylinder with a spanner wrench. Pull the piston assembly from the end of the cylinder. The piston assembly is composed of the gland nut, packing and packing rings, piston sleeve, piston bearing and metering pin. If it is desired to disassemble the piston, place the piston in a wooden block clamp and secure the clamp in a vise. Remove the solder from the three lock screws on the piston bearing and turn the bearing off the piston with a spanner wrench. The sleeve, packing ring, packing and gland nut can now be slid off the piston. The metering pin can be removed from the piston with the special metering pin wrench. NOTE. Never replace a used gasket when reinstalling a metering pin.

b. To assemble the shock absorber strut: The assembly of the oleo strut may be facilitated by following the alphabetical order of assembly shown in the parts block of Fig. 53. The cylinder assembly should proceed through step (I) (cylinder and plunger) and then the complete piston assembly should be installed. Care must be exercised, in tightening the cylinder bearing nut, to avoid compression of the packing gland.

The oleo strut should be tested for leakage at this stage of the assembly. The test should be accomplished by filling the cylinder with approximately 2 quarts of 50/50 castor oil and alcohol, and subjecting the strut to a pressure of 2800 lbs./sq. in. for 10 minutes. The cylinder is filled through the hole, provided for the Schrader plug, in the upper side of the cylinder. The piston is in the retracted position at the start of filling, but is slowly extended by hand, as the fluid flows into the cylinder. This helps to eliminate air that would become trapped in the cylinder, if it were left extended while being filled. A high pressure gage is screwed into the Schrader plug hole, and a compressive force is applied on the piston end of the strut, until the gage reads 2800 #/sq.in. At the end of 10 minutes, the force is released, and the strut is examined for leakage of fluid - about the solder joint at the top of the cylinder assembly where the plunger is screwed



into the cylinder, - at the packing gland near cylinder bearing nut, - and, at the metering pin where it is screwed into the piston. Leakage at the metering pin can be seen by looking into the bottom end of the piston.

Another test should be conducted on the oleo strut after it has passed the test described above. Approximately one quart of the fluid should be withdrawn from the cylinder, and air forced in until a pressure of 204# per sq. in. is indicated on the gage. The strut should be put aside in an upright position, with the piston end down. At the end of 8 hours, the oleo strut should be examined as in the first test.

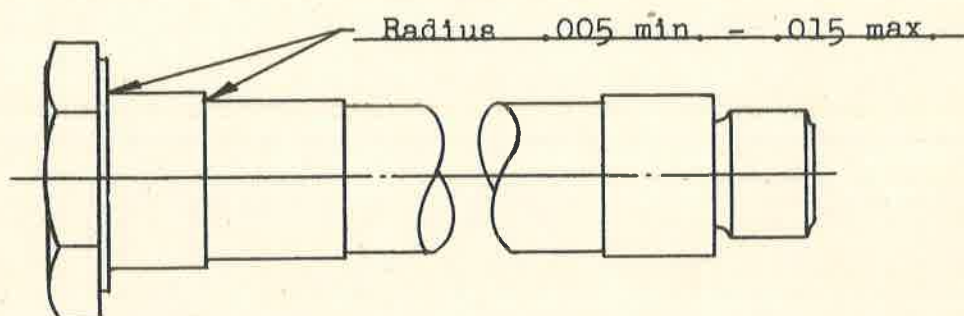
The assembly of the oleo strut should be continued in the alphabetical order shown in the parts block of Fig. 53, when the leakage tests have been satisfactorily completed.

Next, the bevel gear (75-31-036) should be placed between the two flanges provided for it on the fitting (87-31-506-6). It should be shimmed (to a snug fit), only between its outer face and fitting flange, with respect to the oleo strut center line.

The pinion (75-31-035-1) should be fitted between the flanges provided for it on the cylinder housing, and shimmed so that backlash on teeth is from .000 to .002". Shims 75-31-072, 75-31-073, 75-31-076, 87-31-051, and 87-31-052 may be used as required for the installation of the gear and pinion. A left and

right hand segment (87-31-574 L/R) is placed on either side of the two flanges which hold the pinion, and a support (87-31-530) is placed adjacent to the bottom segment. Support, segment, pinion, and segment are assembled to the flanges on the cylinder with a bolt (AN6-25), washer (AN960D616), nut (AN310-6), and cotter (AN380C3-3).

Links (87-31-526-1 & 87-31-526-2) are attached to lugs provided on the cylinder and piston, with a bolt (73-31-054), spacer (73-31-056), washer (AN960-1016), nut (AN320-10), and cotter (AN380-C4-4). The links are joined by a bolt (75-31-055), washer (AN960-916), nut (AN320-9), and cotter (AN380-C4-4). NOTE: Before installing the scissors links inspect bolts (73-31-054) for a radius of .005 min., .015 max. in the two places shown in figure below. If the radius is greater than .015, the bolts must be re-worked or replaced to obtain the correct tolerances.



Inspect the floating spacer (75-31-056) for wear and scoring. Badly worn or scored spacers are to be replaced. Thoroughly clean the links and inspect the bushings for wear and scoring. Badly worn or scored bushings are to be replaced. When these bushings are replaced it will be necessary to drill a new grease passage hole in the bushing to align with the grease passage in the link. Inspect the links for grease passages from the grease fitting down through to the bushing. If any grease passages are found that have not been drilled, they shall be drilled to align with the vertical grease passage on both sides which are fitted with zerk fittings. By means of a grease gun, force some grease through each of the grease fittings to assure proper lubrication action. Coat the surfaces of the bushings, spacers and bolts before re-installing the scissors links on the oleo. Snug up the nuts and then back them off one castellation and install the cotters. It is very important that the bolts are not drawn up tight to avoid binding of the bushing and spacers. Periodic inspections and greasing of the scissors links are required to assure satisfactory operation of the parts at all times.

Finally, the axle assembly (87-31-520) is installed in the bottom end of the piston and is secured by a bolt (AN-28-54), nut (AN320-8), and cotter (AN380-3C-4). The piston and axle assembly must butt together with no clearance. The clip (87-31-038) may be added to the assembly when the landing gear is installed on the wing panel.



right hand segment (45-51-51) is placed on either side of the  
 and a spacer (45-51-51) is placed between the two segments.  
 and a spacer (45-51-51) is placed between the two segments.  
 and a spacer (45-51-51) is placed between the two segments.  
 and a spacer (45-51-51) is placed between the two segments.

Link (45-51-51) is placed on either side of the  
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Link (45-51-51) is placed on either side of the  
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 and a spacer (45-51-51) is placed between the two segments.  
 and a spacer (45-51-51) is placed between the two segments.  
 and a spacer (45-51-51) is placed between the two segments.

Link (45-51-51) is placed on either side of the  
 and a spacer (45-51-51) is placed between the two segments.  
 and a spacer (45-51-51) is placed between the two segments.  
 and a spacer (45-51-51) is placed between the two segments.  
 and a spacer (45-51-51) is placed between the two segments.

A pressure test, of the oleo strut assembly using 50/50 alcohol and castor oil must show no leaks at 2800 pounds per square inch. Check specifically the solder joint, and the packing and metering pin on the cylinder assembly.

8. The following are general instructions covering the maintenance, use, and inspection of air-oil type shock absorber struts.

a. The fluid level will be checked as follows:

(1) Deflate the strut by backing off the filler plug slightly and allowing the air to escape slowly past the copper gasket at the plug seat. This will prevent damage to the valve core caused by the sudden rush of high pressure air past its seat. DO NOT ATTEMPT TO REMOVE THE FILLER PLUG WITHOUT FIRST COMPLETELY DEFLATING THE STRUT IN THIS MANNER.

(2) Back off the filler plug slightly, until all "fizzing" of air and fluid ceases.

(3) Remove the filler plug and check the fluid level, which should be flush with the filler plug hole when the strut is fully collapsed and the airplane is in normal taxiing position.

b. Filling Procedure: (1) Fill the strut through the filler plug until the fluid is level with the hole. (Use Lockheed Hydraulic Fluid #5 or equivalent)

(2) Insert the plug loosely and cause the strut to completely extend and collapse several times, preferably by raising and lowering the airplane with a hoist or jack, to eliminate air traps in the strut.

(3) Remove the plug and again check the fluid level. When additional fluid is added, the procedure specified in (2) above should be repeated each time until the proper fluid level is obtained.

(4) Replace the filler plug carefully so as not to damage the threads or the valve stem. The copper gasket should be replaced to avoid leaks. In an emergency a standard 1/2 inch copper-asbestos gasket may be used.

c. Inflation: (1) With the fluid at the proper level, inflate the strut through the air valve, using a high pressure air pump, hand operated. The proper amount of inflation is 204 lbs. per sq. in. In no case will cylinders charged with compressed air be used to inflate the struts.

(2) Rock the airplane while inflating, so that the strut will alternately extend and compress, to overcome packing



friction. When fully inflated, both the struts must have the proper extension under a full load of a two inch piston travel or 7.5 inches between the two attaching bolt centers on the torque linkage.

(3) Any checking or adjusting of the strut inflation should be done on a reasonably level surface, sheltered from the wind, with the airplane in taxiing position and fully loaded. Be sure the struts have been extended and compressed several times before checking or adjusting.

d. Air Valves. (1) The air valves are similar in design and function to those used in automobile tires; however, they are especially designed for use in air-oil shock absorbers, employing special composition seat material instead of rubber. When replacing valves, be sure to obtain valve cores for air-oil shock absorbers and not ordinary tire valve cores.

(2) After inflation, test the valve, the valve core, and the filler plug carefully for leaks by using soapy water. Usually leaks around filler plug, valve or other parts will be evident by a seepage of fluid.

(3) Small amounts of air can be removed from the strut by depressing the valve core, provided that extreme care is used to allow the air to escape slowly, to avoid damage to the valve seat. This can be accomplished by supporting the tool, used to depress the core, against the lip of the valve stem.

(4) Care should be exercised to prevent damaging the filler plug and air valve assembly by excessive tightening of the air-hose connection, by improper use of tools, or by using the filler plug as a stop for a hoist attachment or hitch. When using the pump, if leakage at the hose connection to the air valve can not be stopped by hand tightening, the fitting gasket should be replaced. Wrenches or pliers should never be used on this connection.

e. Packing. (1) If the packing gland leaks, as evidenced by fluid seepage or by air bubbles when soapy water is applied, the packing nut should be tightened firmly but not excessively. Before tightening, the air pressure must be released from the strut as the packing cannot be tightened properly under pressure. If normal tightening will not stop the leak, the packing must be replaced. Whenever this becomes necessary, the piston tube should be carefully inspected for excessive scoring, roughness, or an out of round or bent condition.

(2) Replacement of the packing is an operation requiring much care to prevent roughening or tearing of the feather-edged lip of the packing ring. The leak-preventing property of the rings depend on the smoothness and good fit of this lip against the working surface of the strut parts. Whenever possible, this work should be done by a depot or service squadron; as follows:

- (a) Be sure that all the air pressure is removed from the strut.
- (b) Remove the filler plug and drain oil.
- (c) Unscrew the packing nut, taking care to remove all safetying devices.
- (d) Pull out the piston tube assembly, using a slight bumping action if necessary to loosen the packing.
- (e) Remove the piston bearing, piston sleeve and piston ring and remove the packing. The tightness of the threaded connection of the piston head to the piston tube should be preserved as much as possible, since this is usually the only means of preventing the strut from coming apart in flight. When it is necessary to remove the piston head, care should be exercised not to damage the threads or the outside surface. The connection should be carefully tightened and safetied when reassembling. If excessive looseness in the threads is observed, the piston head should be replaced.
- (f) Install the new packings in the same arrangement as the original ones. Wet the packing rings with shock absorber fluid before installation.
- (g) Insert the piston in the cylinder, and insert each packing ring into the gland separately, in their proper order. Tighten packing nut firmly but not excessively.
- (h) If facilities are available, the strut should be run-in after replacing the packing. This should be done on a machine which will move the piston in and out through at least half its total travel, a minimum of 500 cycles. The strut should be fully serviced with fluid and air before running in.

WARNING: No cleaning fluid other than alcohol should be used to clean or flush out struts or strut parts.

## 9. To Disassemble the Master Brake Cylinder Units.

- a. Remove the transfer valve assembly using a 7/16 wrench. Then unscrew the disc retainer at the inner end of the transfer valve assembly with a 7/16 wrench, remove the disc, wash, blow out, and clean all parts.
- b. Remove the lock screws, located in the upper and lower end fittings. In the manufacture of the unit the end fittings are lined up and machined together with the housing or cylinder to which they belong. If disassembling more than one unit at a time, it is important to keep the parts of the different units separate. Remove, by unscrewing, both end fittings, turn the unit upside down and remove the cotter pin and nut, which will be found at the lower end. If the piston rod turns with the nut, insert a clean wooden hammer handle into the open end of the cylinder, which is now pointing down, and press on handle. This will force the piston rod with the nut up and offer a chance to hold the rod under the nut. After the nut has



been removed, the two halves of the unit can be pulled apart. One half is the "Housing-Complete Assembly" containing the parking spring and ratchet; the other is the "Cylinder-Complete Assembly" and "Transfer Valve Assembly" containing all parts which have to do with the hydraulic operation of the unit. Proceed with disassembling of the cylinder as follows:

Pushing gently on the piston rod protruding from the cylinder assembly, the rod and piston assembly can be pushed out of the cylinder. The lower rubber cup will either come out with the rod or stay in the cylinder, either of which is satisfactory. After the lower rubber cup, lower spring washer and return spring have been removed, hold the assembly by the upper spring washer which partly extends into the upper rubber cup and tap the end of the piston rod gently on a wooden board if necessary. This will cause the washer to slide off and then the "U" retainer which fits into the groove of the rod can be removed. Next pull off the rubber cup, after this has been done, remove the cotter pin at the opposite end of the piston rod which retains a small washer and light spring and remove both. Next, hold the piston tightly in a vice with copper covered jaws to prevent marring, grip it only at the head end of the piston to prevent distortion, which would cause binding of the threads, when removing the piston rod retaining nut, which is screwed into the piston. After that has been done, the rod can be pulled out of the piston and the seat formed by the shoulder of the rod and the inside of the piston can be inspected and cleaned. If the seat is found badly damaged due to a hard particle in the fluid, it is recommended that the rod and piston be replaced by a new piston rod lapping assembly which includes the rod, piston, and retaining nut. While the rod is out, inspect the drilled passages. Be sure that they are open by blowing through them.

c. It will normally not be found necessary to remove the parking spring from the "Housing-Complete Assembly". If for some reason it is desired, proceed as follows: Remove the ratchet return spring, place a 1-5/8 diameter by 2 inches long bar on end on table of an arbor press and set housing, with the slotted guides pointing downward, over it. By doing so the load, when applied will not be taken on the slender guides extending downward. Cut two 3/4" wide by 1" deep slots at one end of an approximately 6" long piece of 1-3/4" diameter tubing. Place this piece on the spring guide with the slots straddling the yoke. Turn the ratchet to allow the yoke to move down, apply pressure with the arbor press to deflect the parking spring until the top face of the spring guide is flush with the bottom of the "window" in the housing, through which the yoke extends. While holding the spring in this

position lift the yoke and pull it out sideways through the "window". The spring and guide can then be removed.

(d. Any parts found worn should be replaced by new parts..

#### 10. To Assemble Master Brake Cylinder.

a. When reassembling, hold the transfer valve assembly upside down, drop in the disc and make sure it lies flat on its seat to avoid damaging it when screwing in the retainer. Before reinstalling the transfer valve assembly, make sure that the gasket is in place at the bottom of the well in the cylinder and that it is in good shape. This gasket has nothing to do with the filling and bleeding of the system but must hold tight against the pressure in the system when the unit is in operation. It may be easier to reinstall the valve assembly if the gland and the two packings are removed from the valve before it is screwed in part way so that the start of the thread is approximately flush with the top surface. The two packings are then installed into the well one at a time and the gland is screwed on.

b. Before assembling, grease the entire inside of the housing with heavy grease of high melting point, preferable a rocker arm lubricant, for corrosion protection. When installing the parking spring, be careful not to let the spring snap up against the light bridge on the casting as this may damage the part.

c. The assembling operation is an exact reverse of the disassembling operation and is briefly outlined below:

(1) Insert the piston rod into the piston, then assemble and tighten the retaining nut. Install the light valve spring, washer and cotter pin. Next, slip the upper rubber cup over the rod. Do not forget the "U" retainer under the upper spring washer since the unit will not operate without it. After this washer is in place, hold the piston end down (long end up), place the return spring on the washer and then the lower washer on the spring. If the lower cup came out of the cylinder, slip it over the rod next. Holding the valve in this upside down position to insure proper position of the return spring on the washers, put some brake fluid on the cups to facilitate the entrance into the cylinder, and then slide the cylinder over the rod assembly, looking through the hole in the opposite end of the cylinder to properly line up the rod. A gentle push on the rod will cause the cups



to slip into the bore. Next, slip the "Housing-Complete Assembly" over the rod protruding from the cylinder. Insert a clean wooden hammer handle into the open end of the cylinder and press on it. This will cause the rod to come through the housing assembly so that the nut can be installed. The shaft should protrude not more than  $1/32"$  to  $3/64"$  over the nut as it would otherwise hit the end fitting. After the cotter pin has been inserted, grease the threads and end face of the lower fitting with heavy grease and screw it on, until the holes for the locating screw line up. During the last few turns the heavy parking spring is being depressed which causes considerable drag. Use some heavy grease on the threads of the upper end fitting and locating screw, as this will protect threads from corrosion and seal against slight seepage during filling and bleeding operation. If desired, a non-hardening sealing compound such as keypaste may be used. Apply sparingly to keep grease or compound away from brake fluid which is in contact with upper end fitting.

(2) If the nipple or elbow installed in the  $1/4"$  pipe tapped hole in the cylinder has been removed, or if it is being installed in a new replacement unit, thread lubricant should be used on the threads.

#### 11. Servicing Master Cylinder Unit.

With brakes applied: Improper operation of brake system in this condition may be due to any of the following reasons:

First:- Incomplete filling and bleeding, causing air to be trapped in the system. The presence of air in the system can be detected by a "soft" feeling of the brake pedals which is due to the compression of the trapped air.

Second:- The gasket under the transfer valve not holding tight due to the valve not being tightened sufficiently, or some dirt being lodged on the gasket.

Third:- Some dirt being held on the compensating valve, holding it open.

The presence of a slight leak as described in the second and third reasons can be determined by the fact that the brake pedals feel solid when the brake is fully applied, but with continued constant pressure the pedal gives slowly, due to the fluid being forced through the leak. Under normal conditions these leaks cannot be detected from the outside, as the fluid in either case returns to the reserve chamber.



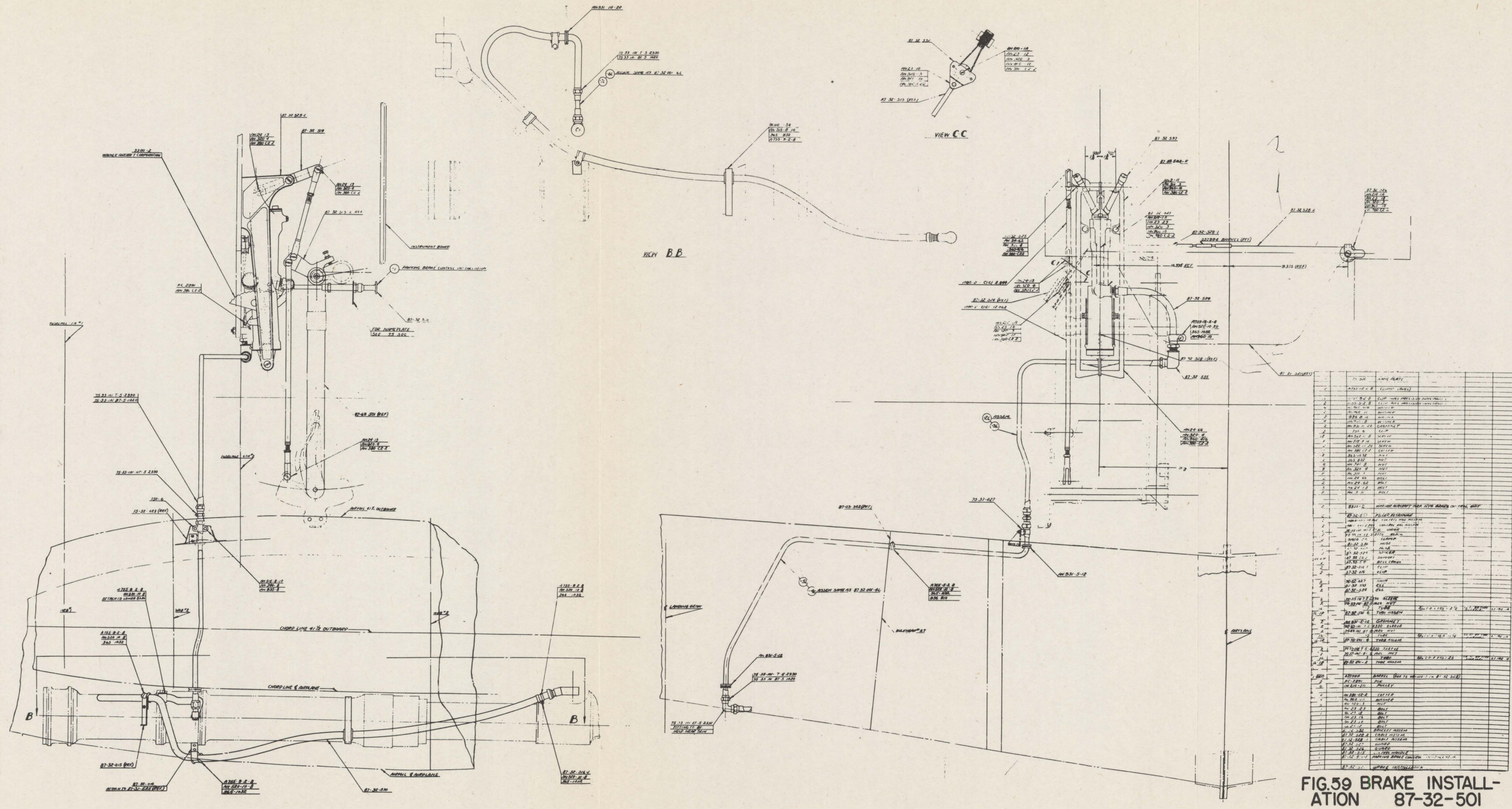


FIG.59 BRAKE INSTALLATION 87-32-501





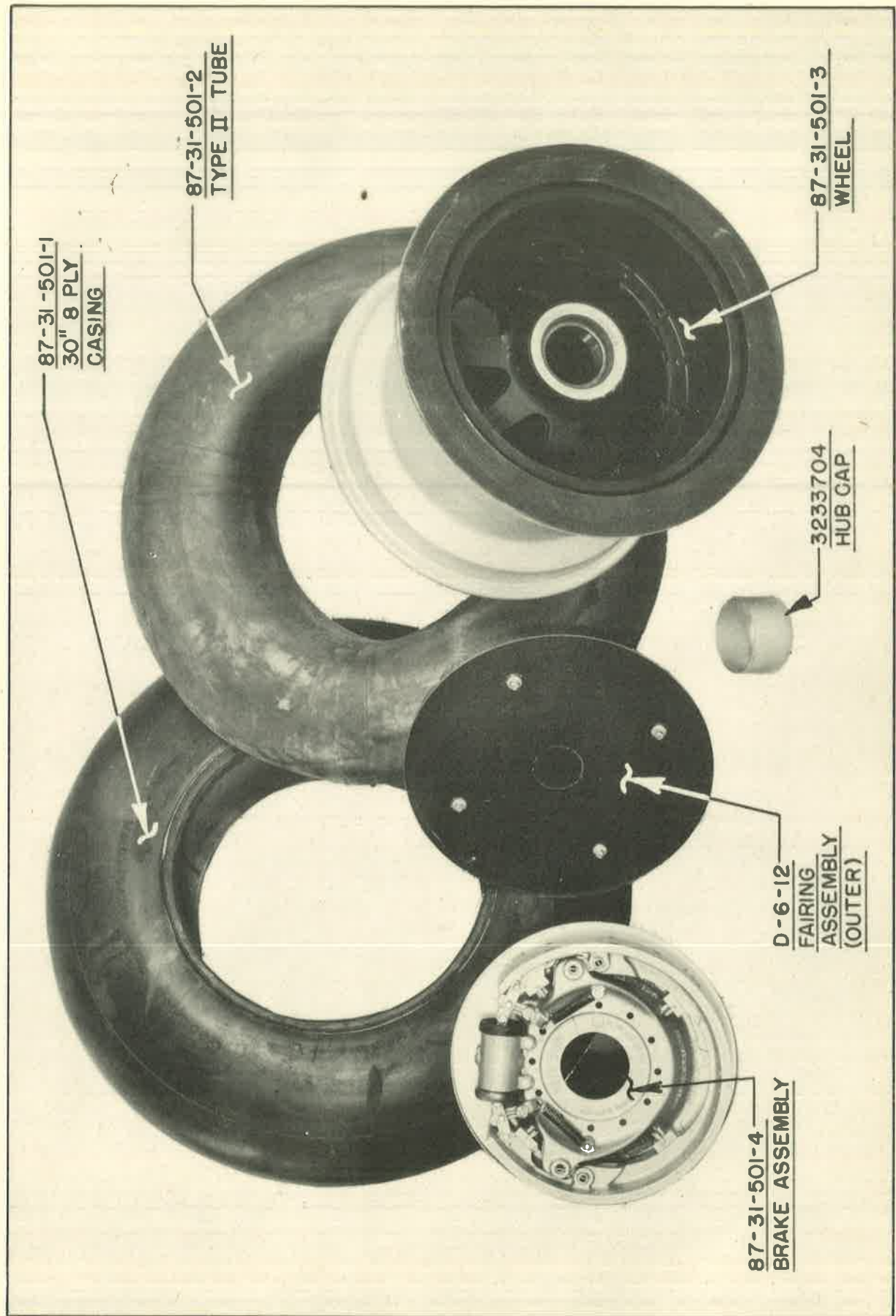


FIG. 60 WHEEL AND BRAKE ASSEMBLY DISASSEMBLED





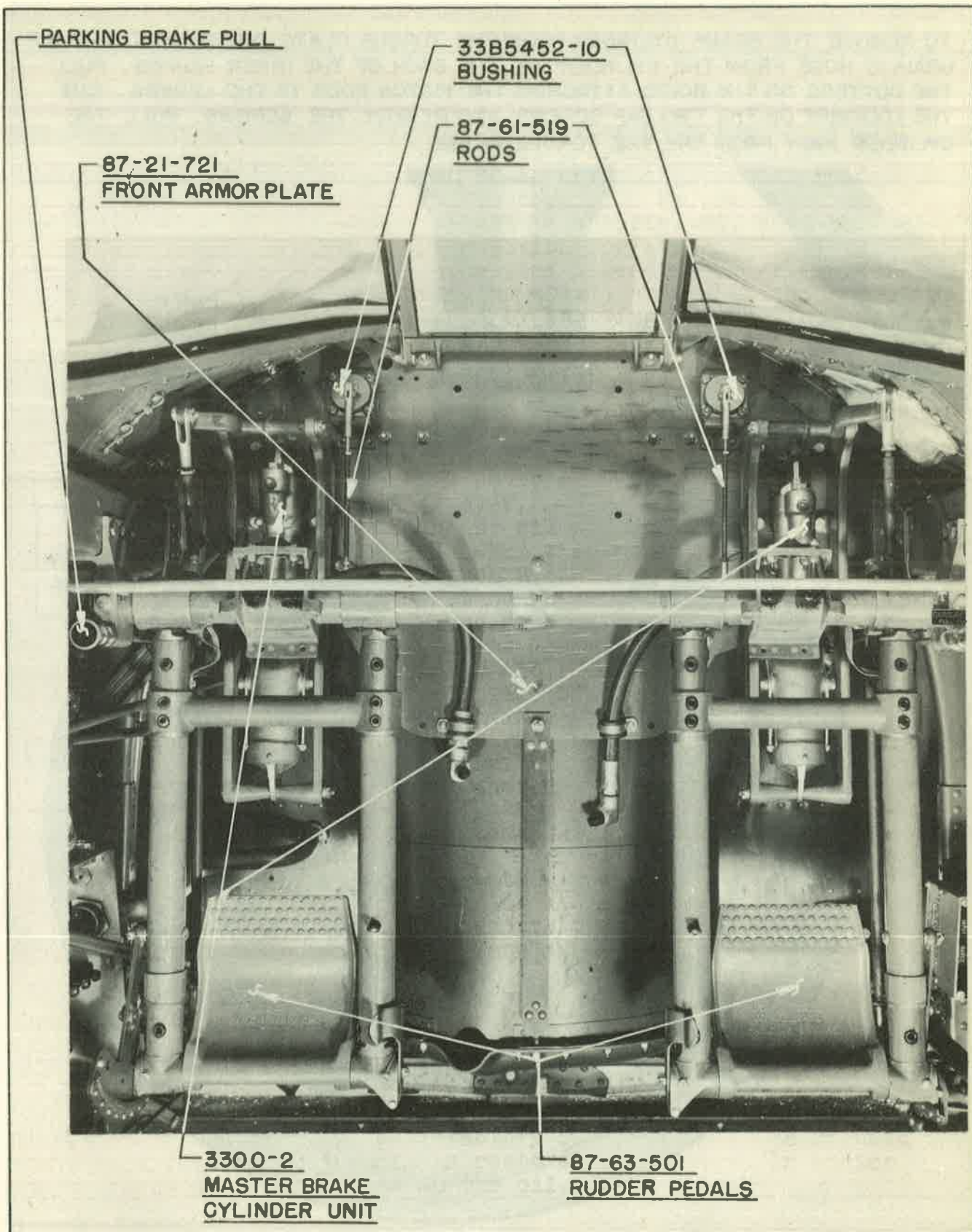


FIG. 61 RUDDER PEDALS  
& MASTER BRAKE CYLINDERS



TO REMOVE THE BRAKE CYLINDER FROM THE TORQUE PLATE DISCONNECT THE HYDRAULIC HOSE FROM THE CYLINDER AT THE BACK OF THE INNER FAIRING. PULL THE COTTERS ON THE BOLTS ATTACHING THE PISTON RODS TO THE LEVERS. CUT THE LOCKWIRE ON THE TWO CAP SCREWS AND REMOVE THE SCREWS. PULL THE CYLINDER AWAY FROM THE TORQUE PLATE.

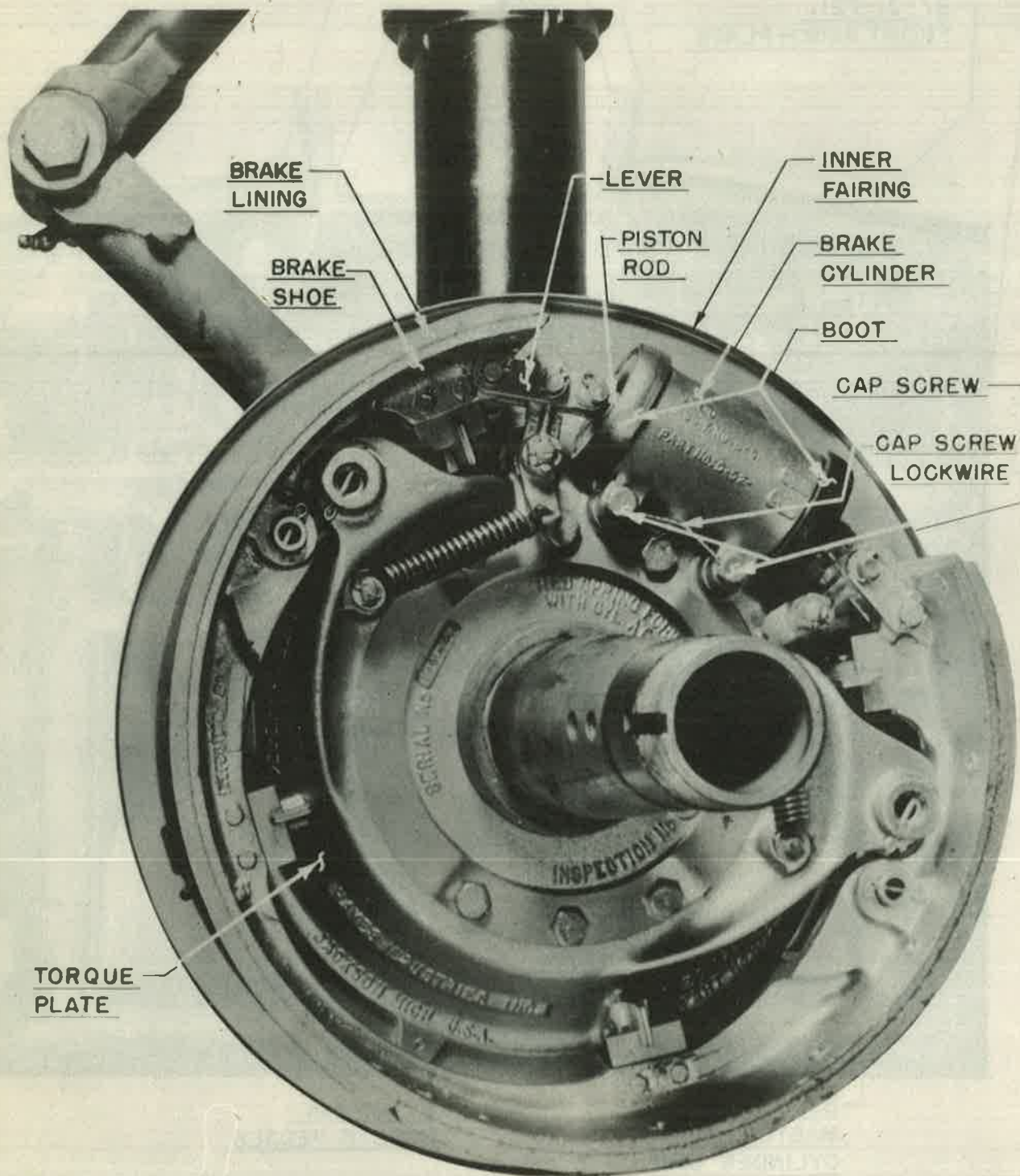


FIG. 61A HYDRAULIC BRAKE AND TORQUE PLATE ASSEMBLY

TO DISASSEMBLE THE BRAKE CYLINDER PULL THE PISTON RODS FROM THE BOOTS AT EITHER END OF THE CYLINDER. REMOVE THE TWO END BOOTS AND THE PISTONS, CUPS AND SPRING WILL PUSH OUT OF THE CYLINDER. BEFORE REASSEMBLING THE BRAKE CYLINDER INSPECT THE TWO PISTON CUPS FOR SCORED OR CUT EDGES. IF THE CUPS ARE INJURED IN ANY WAY OR SHOW SIGNS OF DETERIORATION REPLACE THEM WITH NEW CUPS.

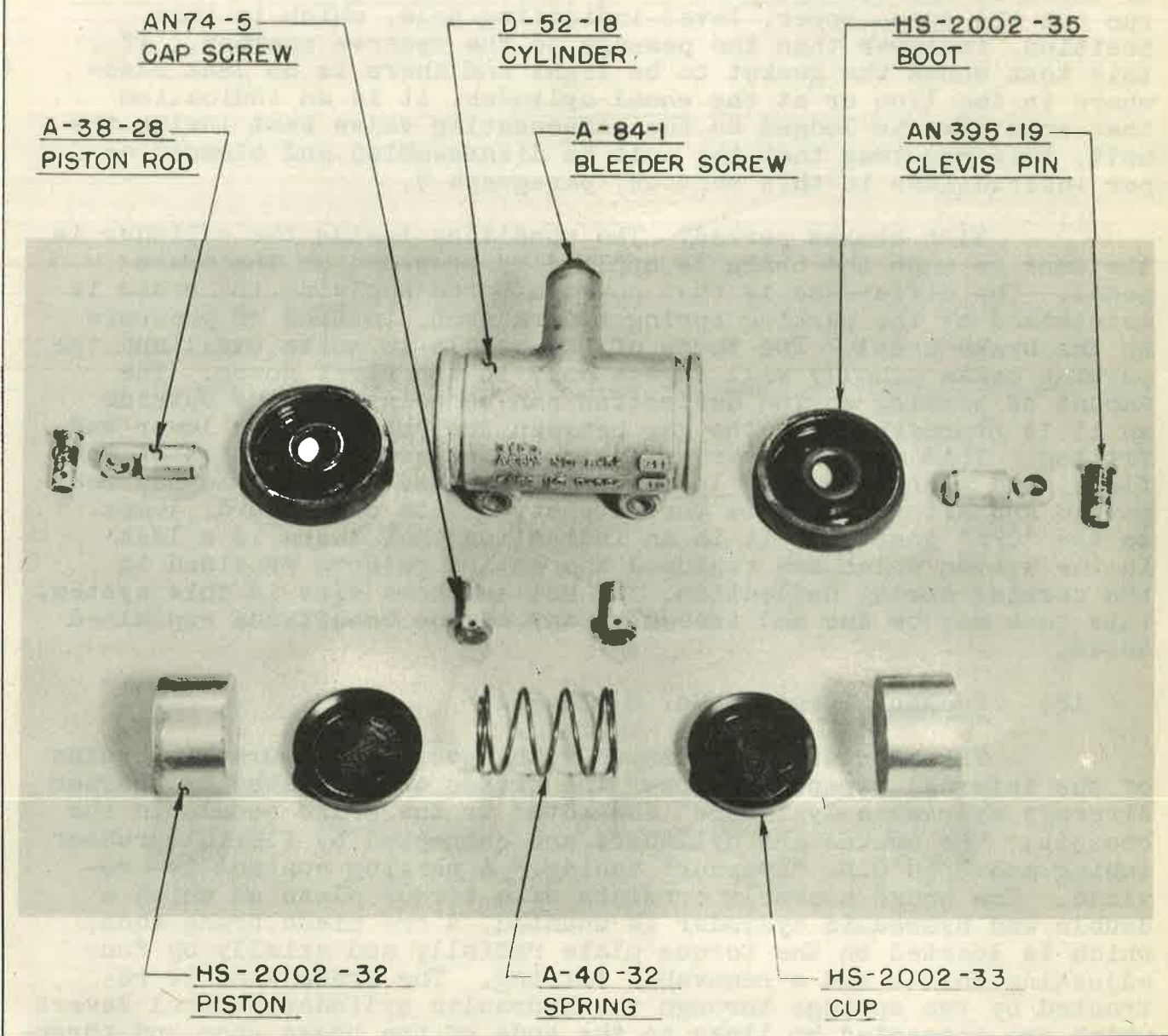


FIG.61B BRAKE CYLINDER DISASSEMBLED



A leaking gasket under the transfer valve assembly can be easily determined as follows: With the brake off, remove the lower, level-indicating screw and allow fluid level in the reserve chamber to come down to this level. Replace lower, level-indicating screw and remove upper, level-indicating screw. Move rudder pedal either forward or backward as far as possible, so as to have the reserve chamber sufficiently low; no fluid will run out of this hole. Keeping the rudder pedal in this position, apply the brake. If there is any leakage past the transfer valve gasket, fluid will run out the open, upper, level-indicating hole, which in this position, is lower than the passage to the reserve chamber. If this test shows the gasket to be tight and there is no leak elsewhere in the line or at the wheel cylinder, it is an indication that some dirt is lodged on the compensating valve seat inside the unit, this requires that the unit be disassembled and cleaned as per instructions in this section, paragraph 9.

With brakes parked: The condition inside the cylinder is the same as when the brake is applied by pressure on the brake pedal. The difference is that now the force applying the brake is maintained by the parking spring and ratchet, instead of pressure on the brake pedal. The throw of the pedals is quite small and the parking brake usually will engage only in the first notch. The amount of parking spring deflection can be seen from the outside as it is represented by the gap between the yoke and the lower end fitting. This gap will vary with expansion and contraction of the fluid, and with the fluid losses due to leaks. If a brake has been parked and after some time the ratchet, of its own accord, jumps to the "OFF" position, it is an indication that there is a leak in the system which has consumed the entire reserve provided in the parking spring deflection. If not anywhere else in this system, this leak may be due and traced to any of the conditions explained above.

## 12. Brakes (Drawing No. 87-32-501)

The airplane is equipped with reversible hydraulic brakes of the internal expanding type. The brakes are actuated by "Warner Aircraft Hydraulic Cylinders" connected to the brake pedals in the cockpit. The brakes and cylinders are connected by flexible rubber tubing and 5/16 O.D. "Everdur" tubing. A parking control is provided. The brake assembly consists of a torque plate on which a double end hydraulic cylinder is mounted, a one piece brake shoe, which is located on the torque plate radially and axially by four adjusting points and a removable fairing. The brake shoe is retracted by two springs through the hydraulic cylinder control levers which are connected by links to the ends of the brake shoe and through piston rods to the pistons in the hydraulic cylinder. The forward spring is painted red and the aft spring is black. (The black spring is of higher tension than the red spring). The forward spring is attached to the hydraulic cylinder control link which is attached

to the toe of the brake shoe. Because of the difference in the tension of the fore and aft spring, when the brake is applied with the airplane moving forward, there is no back lash to take up due to the shifting of the shoe. However, when the brakes are applied and the airplane is stopped, if it tends to roll backwards, the entire shoe assembly rotates on the torque plate and the torque is taken through the link on the toe end of the shoe which now becomes the heel. The brakes operate with the same amount of brake fluid either in the forward or reverse direction, and the only difference between the right and left hand brake assembly is the position of the red and black spring.

The fairing is a separate stamped part and can be removed from the torque plate. This plate is equipped with the four holes with removable covers, through which the brake clearance can be checked.

The brake cylinder is a separate part and is not a part of the torque plate, so it can be removed and replaced in case of damage. This cylinder is equipped with the conventional pistons and rubber seal cups held against the pistons by springs.

Installation of Brake: When the brake is installed on the airplane, the operating cylinder should be at the top, so that all air can be bled out of the cylinder. When the brakes are installed, a check should be made to see that the red and black spring are in the correct position.

Disassembly of Brake: If it is necessary to disassemble the brake to reline the shoe or replace the cylinder, this can be done in the following manner.

- (1) Remove the brake from the landing gear.
- (2) Remove fairing from the torque plate by removing 9 screws.
- (3) Pull out cotter pins which hold ends of the two springs, after which the washers and springs can be removed.
- (4) Pull cotter pins on end of pins holding adjusting bellcranks and remove pins after which the links can be slid out through the slot in the brake band.
- (5) Throw link towards the center. This will allow the heel and toe of the shoe to be lifted up and the entire brake shoe can be removed from the torque plate.
- (6) The brake shoe can now be relined or replaced, if the shoe is relined, cement the new lining on the shoe with "Water Glass" or silicate of soda. If the cylinder is to be removed, unscrew the nuts from the two clevis bolts and remove the two cap screws holding the cylinder to the torque plate.



Assembly and Adjustment of the Brake: Before assembling, the brake cylinder should be washed with alcohol and the pistons and cups lubricated with castor oil or hydraulic brake fluid. DO NOT USE MINERAL OIL.

(1) To assemble reverse the above procedure.

(2) The brake should be adjusted with a radial clearance of between .007 and .010 at all four points through the holes provided in the torque plate, and if for any reason the pedal travel should be too great, this can be decreased by decreasing the clearance as long as the brake does not drag. In making the radial clearance adjustment, apply the brake after the preliminary adjustment is made and re-check the adjustment to take care of any spring which might occur in the adjusting bellcrank. It is also advisable to rotate the wheel while checking each point to get an average clearance due to any eccentricity in the brake drum.

The brakes are operated by the pilot pressing the treadle on the rudder pedal forward. The motion extends the hydraulic strut and forces oil thru the lines to the brake cylinders in the wheels.

WARNING:

Do not operate the brake when the wheel is removed from axle. If the brake is operated with the wheel removed, it is possible to injure the brake by springing the brake shoe out of shape. If this is done, the brake will not release properly and it will be necessary to replace or remove the shoe, and round it up, so that it will drop back in the brake drum freely without toe or heel hitting.

Description and maintenance of the hydraulic cylinders is fully covered in data supplied by the manufacturer and is included in Section V, E., of this handbook.

Alternate Procedure for Filling Brakes

Figure 58 shows the set-up which has been satisfactorily used at the factory for filling the brake system with fluid. The brakes must be in the "OFF" position in order to fill the system. The fluid line from the container is screwed into the bleeder plug hole. The filler plug on top of the master cylinder must be next removed. A fitting should be screwed into the filler plug hole and a hose attached which should drain into a can to prevent the fluid from overflowing in the cockpit. The stop-cock at the container should now be opened enough to register approximately 6 to 9 lbs. per sq. in. fluid pressure. The fluid is forced through the system and out the filler plug hole. Allow enough fluid to overflow into the can to make sure the system is full of fluid but free of air pockets. Then shut off the stop-cock. Remove the hose from the filler plug hole and insert the filler plug. Disconnect the fluid line and insert the bleeder plug. Test the brakes, making sure that no leaks exist in the system.

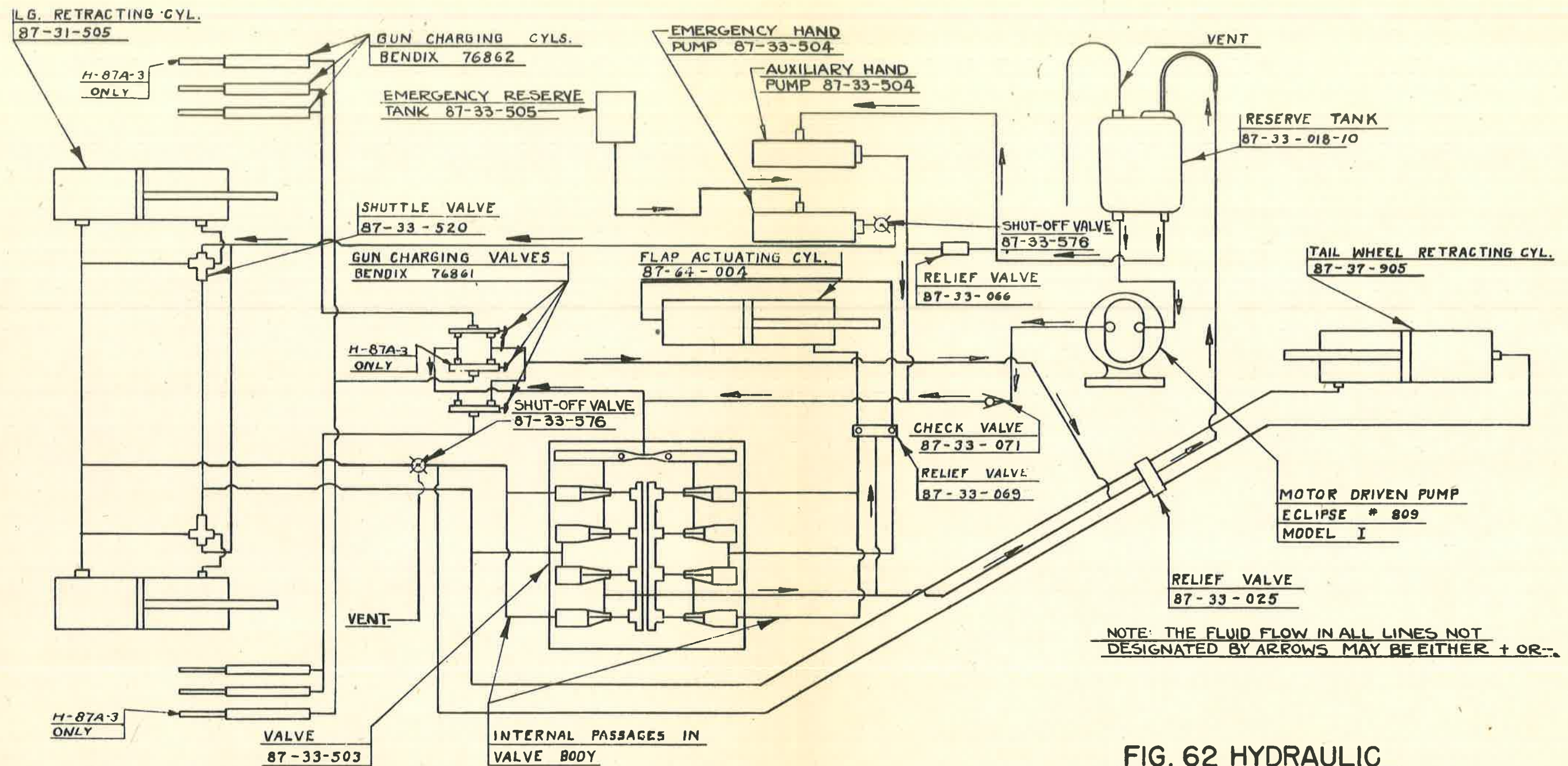


FIG. 62 HYDRAULIC  
SYSTEM H-87A-2 AND H-87A-3





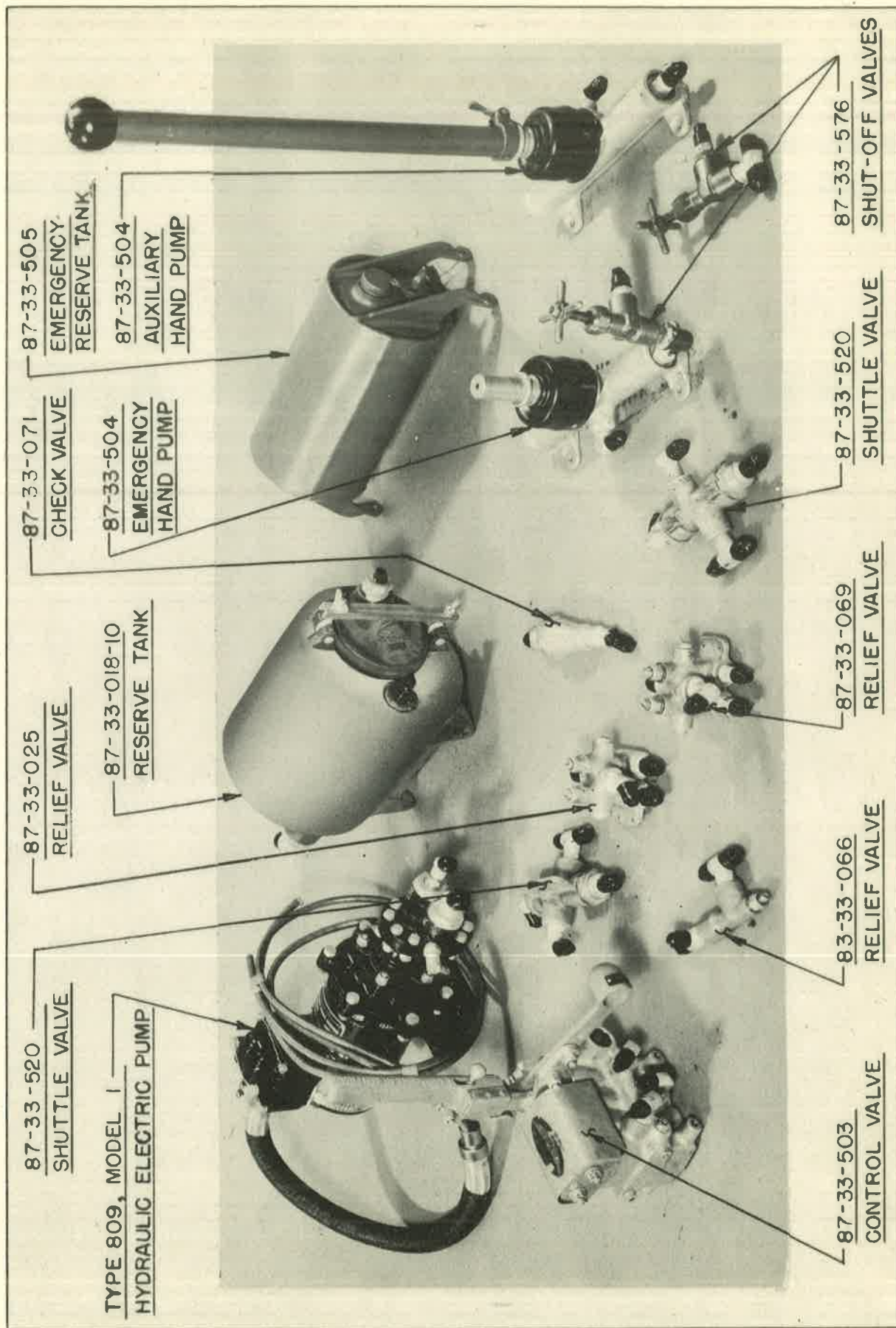


FIG. 63 HYDRAULIC SYSTEM - COMPONENTS





F. Hydraulic Controls - (Drawing No. 87-33-501 AK 571 - AK 590)  
(Drawing No. 87-33-701 AK 591  
and subsequent)

1. General:

The hydraulic controls consist of an electrically driven hydraulic pump for operating the retractable landing gear, tail wheel and wing flaps. There are two single cylinder, reciprocating, double action hydraulic hand pumps attached to the floor of the cockpit on the right hand side. The outboard pump is the auxiliary hand pump and operates the hydraulic system when the electric motor driven pump fails. The inboard pump, painted red, is for emergency use only and is operated only after failure of the rest of the system. This emergency hand pump is connected separately to the landing gear only, and will not lower the tail wheel. The emergency hand pump is fed from the emergency reserve hydraulic tank mounted on the forward side of the firewall on the right hand side. Two shut off valve assemblies (87-33-576) have been incorporated in the emergency hand pump system, one on the pump outlet line directly aft of the pump cylinder and the other in the return line from the landing gear retracting strut on the cockpit floor, forward of the hydraulic control valve. These valves should always be closed except when the emergency hand pump is being operated. The valve on the floor on the left hand side of the cockpit allows the hydraulic fluid in the landing gear retracting strut to be vented overboard. This relieves any back pressure from being built up in the retracting strut when the emergency hand pump is in operation. The tubing material in the hydraulic controls is "Everdur" or stainless steel tubing throughout, except vent and drain lines which are aluminum alloy.

The hydraulic system should be kept filled with "Lockheed Hydraulic Fluid No. 5" or equivalent (See Sec. III. A., 11) to the line shown at the filler neck on the reserve tank.

In no case should a mineral base oil be used.

The strainer plug on top of the emergency auxiliary tank, forward of the antispill valve assembly, should be removed and the strainer cleaned occasionally.

2. Electric Pump:

The electric pump assembly is the Eclipse No. 809 Model 1 (24 Volts --- 64 Amp. Max.). The pump is equipped with an integral relief by-pass valve adjusted to 1000 pounds per square inch pressure. The pump assembly is accessible through the baggage compartment door, and may be removed as a unit by disconnecting the hydraulic lines, electric wires and removing the motor mounting bolts.



a. Construction: The hydraulic electric pump consists of a spur gear type pump mounted on a 24 volt electric driving motor. The motor armature shaft is connected to the upper gear shaft of the pump unit by a flexible coupling. The pump head incorporates an inlet and outlet port for external pipe line connections. The pressure relief valve is also assembled on the pump head and provides a means of limiting the outlet pressure at 1150 P.S.I. An oil seal, installed on the drive end of the upper spur gear shaft, prevents leakage of oil into the electric motor housing from the pump housing. The spur gear mechanism consists of two gears on shafts. The upper gear shaft incorporates a flexible coupling which is keyed to the armature shaft and provides the driving force for the pump. The lower gear is meshed with the upper gear and its shaft is retained in the two pump housing sections. The pump housing is the split type held together by 8 bolts and two cap screws. The two pump housing sections are held in alignment by two staked pins through the pump flanges.

b. Installation: (1) The unit is mounted, by means of a bracket provided on the motor housing, just forward of the battery installation to minimize the weight of cable and to reduce voltage drops in the wires. A type B-6B switch; located on the control stick below the grip, controls the operation of the pump.

(2) Connect the inlet port of the pump to the hydraulic supply tank.

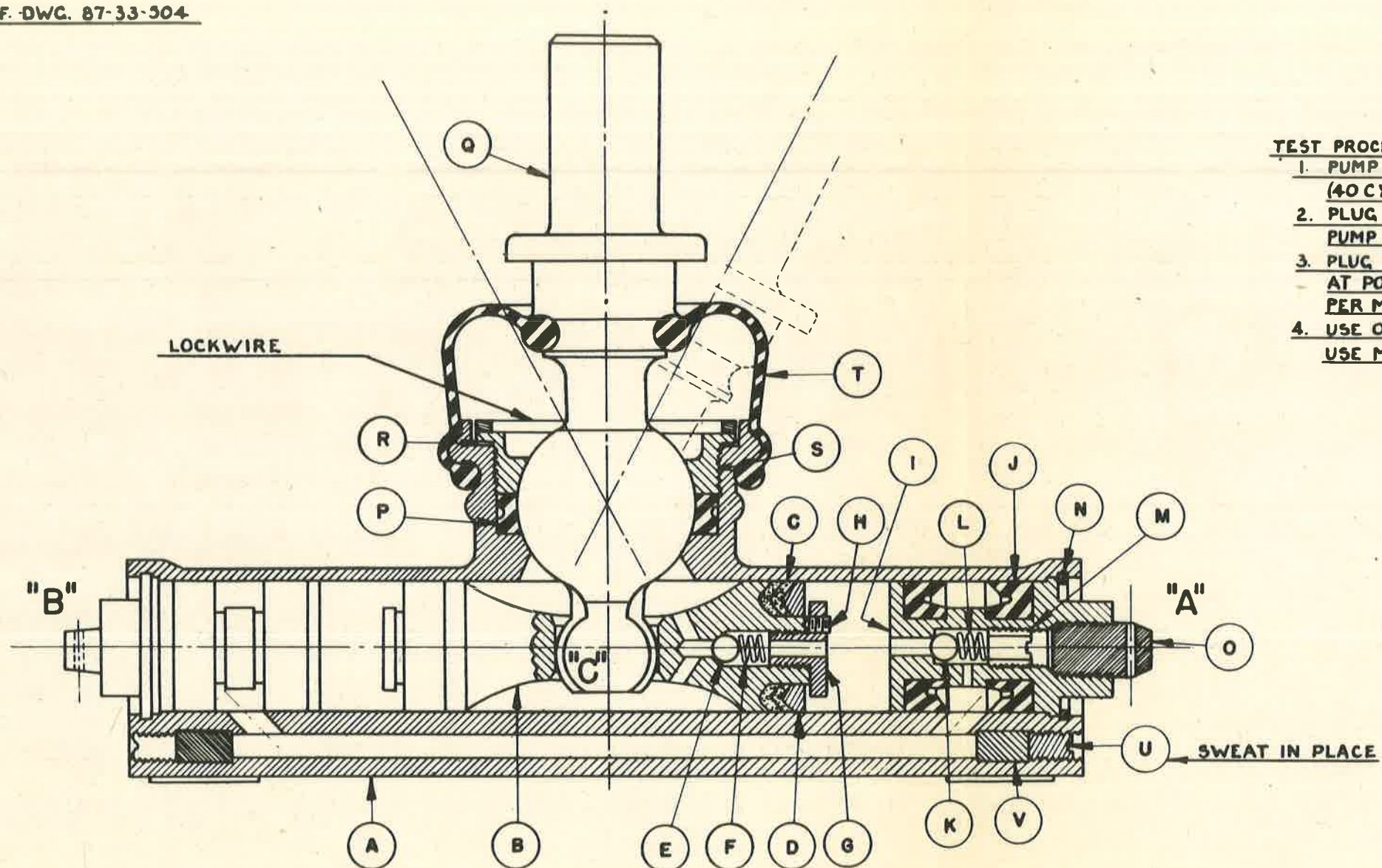
(3) Connect the outlet port of the pump to the system supply line.

c. Service and Repairs:

(1) If the electric motor fails to operate or operates at too low speed the possible cause may be low voltage due to a discharged battery. Check the battery and recharge it if necessary. It may be also due to loose or corroded battery terminals. Clean, tighten and coat with vaseline. If these are not the cause, check the wiring connections for loose or high resistance connections. Check brushes for binding or worn brushed not properly seated, also excessive brush side play. Check for a dirty commutator, rough or pitted commutator shorted, grounded or open motor armature, grounded or open motor field coils, defective switch. If the motor shows low output pressure or capacity, check system for insufficient fluid supply, low setting of relief valve, leak in line or valves, low operating speed, loose fittings or improper fluid. For erratic output or pressure check for air in the pump lines. If the pump overheats, check for worn or binding parts or sustained operation at high pressure.

| REF               | PART NO.    | NAME OF PART        | No. Made | REF              | PART NO.    | NAME OF PART           | No. Made | REF               | PART NO.  | NAME OF PART    | No. Made | REF | PART NO.  | NAME OF PART | No. Made |
|-------------------|-------------|---------------------|----------|------------------|-------------|------------------------|----------|-------------------|-----------|-----------------|----------|-----|-----------|--------------|----------|
| A                 | 87-33-067   | BODY                | 1        | C                | 87-33-062   | RETAINER               | 2        | M                 | 87-33-055 | RETAINER        | 2        | S   | 87-33-052 | NUT          | 1        |
| PISTON ASSEMBLY ~ |             |                     |          | H                | 87-33-504-2 | #10-32 ALLEN SET SCREW | 2        | N                 | 87-33-070 | SNAP RING       | 2        | T   | 87-33-051 | BOOT         | 1        |
| B                 | 87-33-048   | PISTON              | 1        | VALVE ASSEMBLY ~ |             |                        |          | O                 | 895-71    | PLUG ~          | 3        |     |           |              |          |
| C                 | 87-33-064   | PACKING             | 4        | I                | 87-33-049   | VALVE                  | 1        | BALL INSTALLATION |           |                 |          | U   | 87-33-052 | PLUG         | 2        |
| D                 | 87-33-063   | PACKING RING        | 2        | J                | 87-33-059   | CUP-PACKING            | 4        | P                 | 87-33-054 | PACKING         | 1        | V   | 87-33-057 | PIN          | 2        |
| E                 | 87-33-504-1 | HARDENED STEEL BALL | 2        | K                | 87-33-504-1 | HARDENED STEEL BALL    | 2        | Q                 | 87-33-528 | BALL-PISTON END | 1        |     |           |              |          |
| F                 | 87-33-058-2 | SPRING              | 2        | L                | 87-33-058-1 | SPRING                 | 2        | R                 | 87-33-053 | SHIM            | 1        |     |           |              |          |

REF. DWG. 87-33-504



**TEST PROCEDURE:**

1. PUMP MUST DELIVER ONE QUART FOR 80 STROKES (40 CYCLES) MAX. AT 500 P.S.I. PRESSURE
2. PLUG PORT "B" APPLY 2500 P.S.I. PRESSURE AT PORT "A" PUMP MUST NOT LEAK MORE THAN 5 DROPS PER MINUTE.
3. PLUG PORT "A" AND "B" APPLY 2500 P.S.I. PRESSURE AT PORT "C" PUMP MUST NOT LEAK MORE THAN 5 DROPS PER MINUTE.
4. USE ONLY HYDRAULIC BRAKE FLUID FOR TEST. DO NOT USE MINERAL OIL.

**FIG. 64 HYDRAULIC HAND PUMP H-87A-2 & 3**





d. Disassembly: To disassemble the electric motor driven hydraulic pump, disconnect the electric conduit from the battery and the inlet and outlet hydraulic lines from the ports on the pump face. Remove the bolts attaching the electric motor bracket to the fuselage shelf and remove the assembly from the fuselage. Place the pump assembly in a vise so that the electric motor mounting bracket is engaged between the jaws of the vise. Cut the lockwire on the two cap screws and remove the screws. Engage the heads of the eight through bolts with a wrench and turn the lock nuts off the inboard side of the pump flange with another wrench. Release the assembly from the vise and turn it so that the pump housing is horizontal. Drive the two staked pins from the pump flanges with a punch and light hammer. The port face of the pump can now be separated from the pump body by lightly tapping around the port face with a wooden hammer. After the port face has been removed, the spur gears can be pulled from the pump housing. Extreme care should be exercised in the handling of the spur gears so that they do not become scratched or nicked. When overhauling more than one pump at a time, it is advisable to keep the spur gears in sets so that they may be reinstalled as on the original installation. The pump body can now be separated from the motor housing by removing the four lock nuts around the pump body flange. After the pump body is removed from the electric motor the oil seal may be removed for inspection or replacement by unscrewing the slotted nut in the pump body. Disassembly of the relief valve on the port face of the pump simply requires the removal of the cap and unscrewing the relief spring retainer.

e. Assembly

Before assembly, thoroughly clean all parts and examine them carefully for signs of wear and damage, and the presence of foreign matter such as metal chips, grit, dirt, etc. In the event that any foreign matter is found the complete hydraulic system should be drained and thoroughly cleaned. To assemble the electric motor driven hydraulic pump, reverse the procedure noted in d.

3. Hand Pumps:

The hand pumps ( No. 87-33-504) are two single cylinder, reciprocating, single acting pumps. Each cylinder is equipped with an intake check, and a discharge check valve. The inboard hand pump is the emergency pump and operates the landing gear only. To operate the emergency hand pump, open the left hand valve on the floor





of the cockpit just forward of the hydraulic control valve and the right hand valve installed directly aft of the emergency hand pump cylinder, and transfer the pump handle from the outboard to the in-board pump. NOTE: The emergency system will lower the landing gear with the control lever in any position. WARNING: The tail wheel will not lower with the emergency system. LAND TAIL HIGH.

Removal: The hand pumps may be removed from the floor of the cockpit by disconnecting all hydraulic lines and removing the eight hold-down bolts, four on each pump.

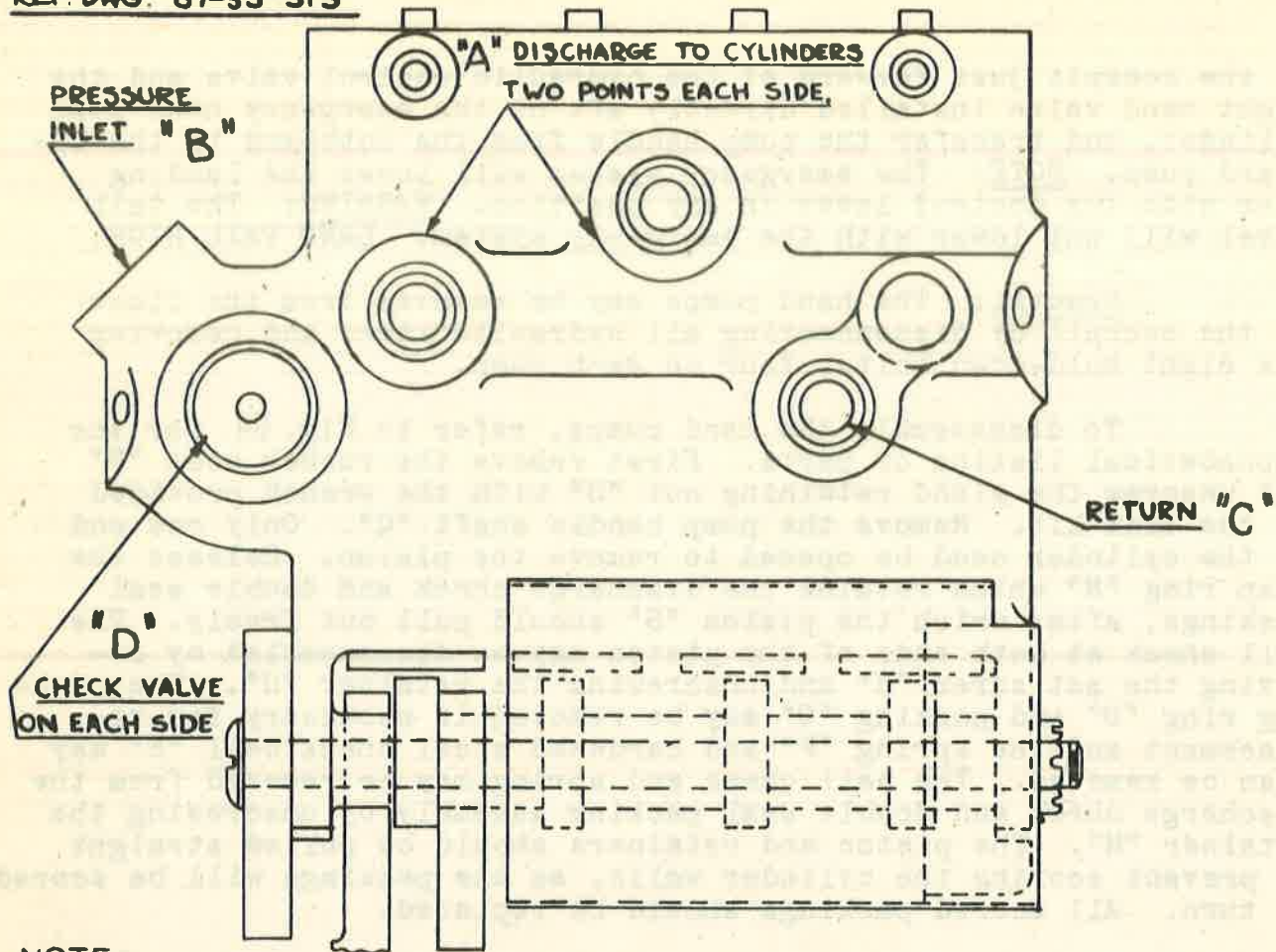
To disassemble the hand pumps, refer to Fig. 64 for the alphabetical listing of parts. First remove the rubber boot "T" and unscrew the gland retaining nut "S" with the wrench provided in the tool kit. Remove the pump handle shaft "Q". Only one end of the cylinder need be opened to remove the piston. Release the snap ring "N" which retains the discharge check and double seal packings, after which the piston "B" should pull out freely. The ball check at both ends of the piston may be disassembled by removing the set screw "H" and unscrewing the retainer "G". The packing ring "D" and packing "C" may be removed if necessary for replacement and the spring "F" and hardened steel check ball "E" may also be removed. The ball check and spring may be removed from the discharge check and double seal packing assembly by unscrewing the retainer "M". The piston and retainers should be pulled straight to prevent scoring the cylinder walls, as the packings will be scored in turn. All scored packings should be replaced.

To assemble the hand pumps, reverse the procedure noted above. Before the ball checks are reseated, clean both the ball and seat thoroughly, place ball on seat and tap lightly. In assembling the rubber packings, care must be taken not to damage the feather edges of the packings, for a small cut will cause unsatisfactory pump performance. The best results for installing packings will be obtained by thoroughly wetting the packings and mating the parts with Lockheed Hydraulic Fluid No. 5 or equivalent. (See Sec. III A., 11) Test the hand pumps after assembly as follows: Pumps must deliver one fifth Imperial gallon for 80 strokes (40 cycles) maximum at 500 P.S.I. pressure. When a pressure of 2500 P.S.I. is applied to either of the three ports with the other ports plugged the pump must not leak more than 5 drops per minute. NOTE: Use only Lockheed Hydraulic Fluid No. 5 or its equivalent (Sec. III A., 11) for this test.

#### 4. Control Valve:

The control valve assembly on the left hand side of the cockpit (Drawing No. 87-33-503) consists of two operating handles connected to two cam shafts. The cams operate a series of poppet valves for the control of the fluid flow. The entire assembly is removed from the airplane by disconnecting the hydraulic lines and removing the bolts attaching the valve to a bracket on Station No. 5 bulkhead.





NOTE:

1. TEST AT 2500<sup>\*</sup>/IN<sup>2</sup> (SEE TEST NOTES BELOW)
2. MINIMUM VALVE TRAVEL TO BE .040"
3. ALL PASSAGES MUST BE CLEAN AND FREE FROM DUST, GRIT AND FOREIGN MATTER.

TEST:

BOOST WITH HAND PRESSURE AT 2500<sup>\*</sup>/IN<sup>2</sup> AS FOLLOWS:

A. WITH VALVES IN NEUTRAL POSITION APPLY PRESSURE THRU EACH OF FOUR POINTS "A" SEPARATELY, THERE SHOULD BE NO LEAKAGE AT "B", "C", "D"

B. WITH VALVE IN NEUTRAL POSITION APPLY PRESSURE AT "B" & "C" SEPARATELY, THERE SHOULD BE NO LEAKAGE AT ANY OF FOUR POINTS "A"

FIG. 65 HYDRAULIC CONTROL VALVE  
PRESSURE TEST DATA

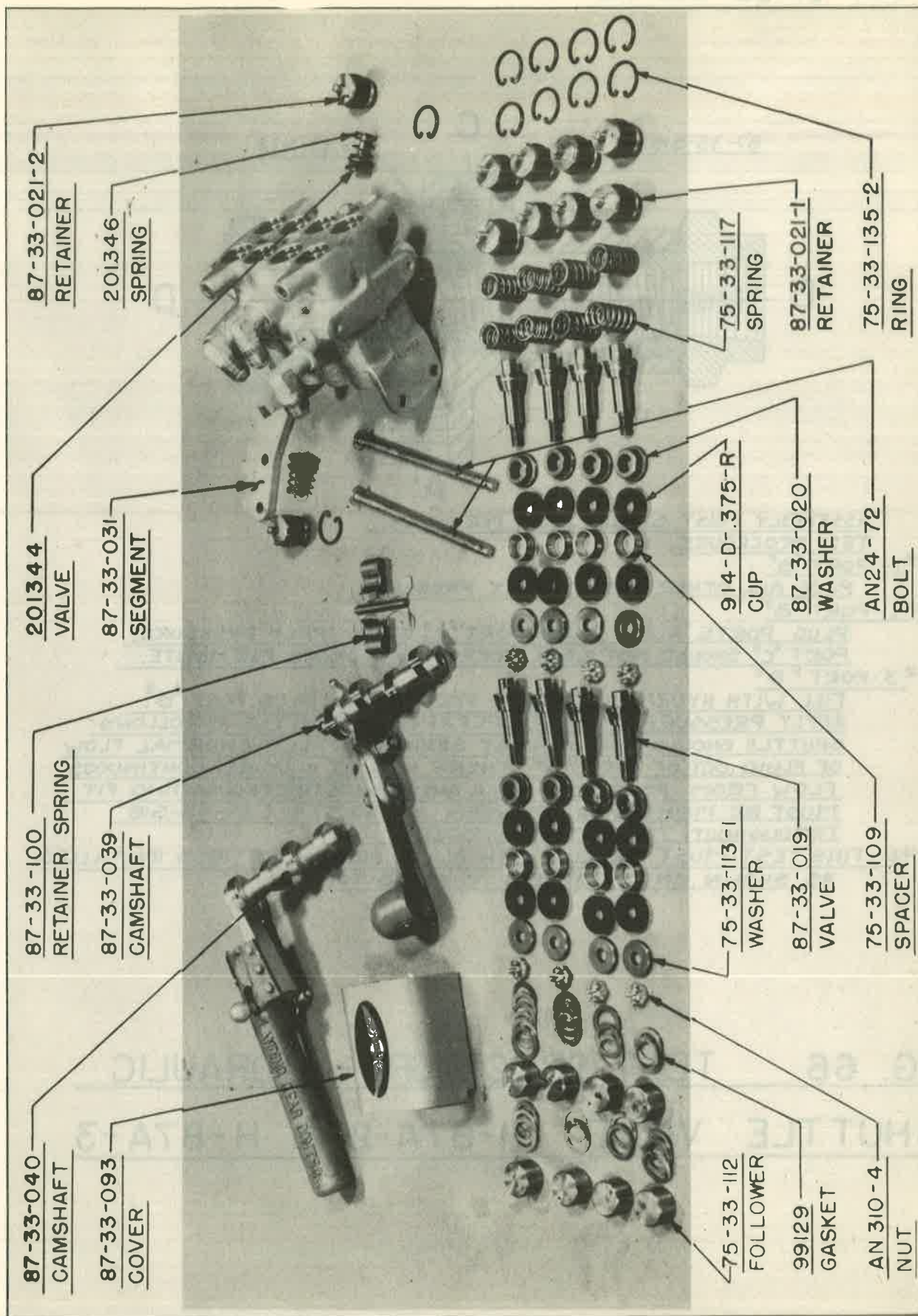
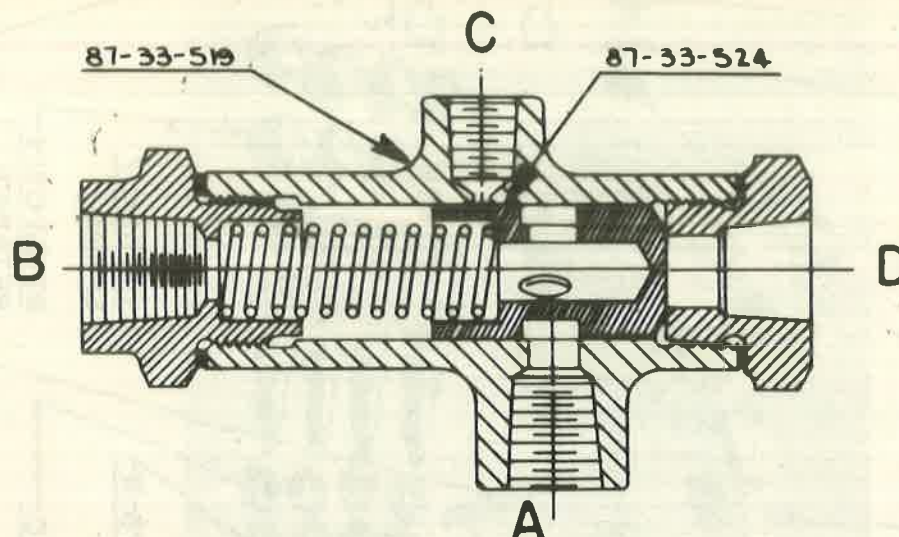


FIG. 65A HYDRAULIC CONTROL VALVE DISASSEMBLED





ASSEMBLY MUST STAND 2500\* PER SQ. IN.  
TEST PROCEDURE

\*1- PORT "B"

PLUG ALL OTHER PORTS; APPLY PRESSURE.

\*2- PORT "B"

PLUG PORTS "A" & "D". LEAVE PORT "C" OPEN. APPLY PRESSURE.  
PORT "C" SHOULD NOT LEAK MORE THAN 5 DROPS PER MINUTE.

\*3- PORT "D"

FILL WITH HYDRAULIC FLUID AT PORT "B". THEN PLUG PORT "B".  
APPLY PRESSURE TO PROVE OPERATION OF SHUTTLE AS FOLLOWS:  
SHUTTLE SHOULD MOVE AGAINST SPRING TO ALLOW NORMAL FLOW  
OF FLUID OUT OF PORT "A". THERE WILL BE A SMALL CONTINUOUS  
FLOW FROM PORT "C". FREE AND UNRESTRICTED SLIDING FIT  
MUST BE MAINTAINED BETWEEN 87-33-524 & 87-33-519  
THROUGHOUT THE ENTIRE STROKE.

\*4- THIS TEST MUST BE RUN WITH ALL HYDRAULIC FITTINGS INSTALLED  
AS SHOWN ON 87-33-501 & 87-33-701

FIG. 66 TEST PROCEDURE - HYDRAULIC  
SHUTTLE VALVE H-87A-2 & H-87A-3

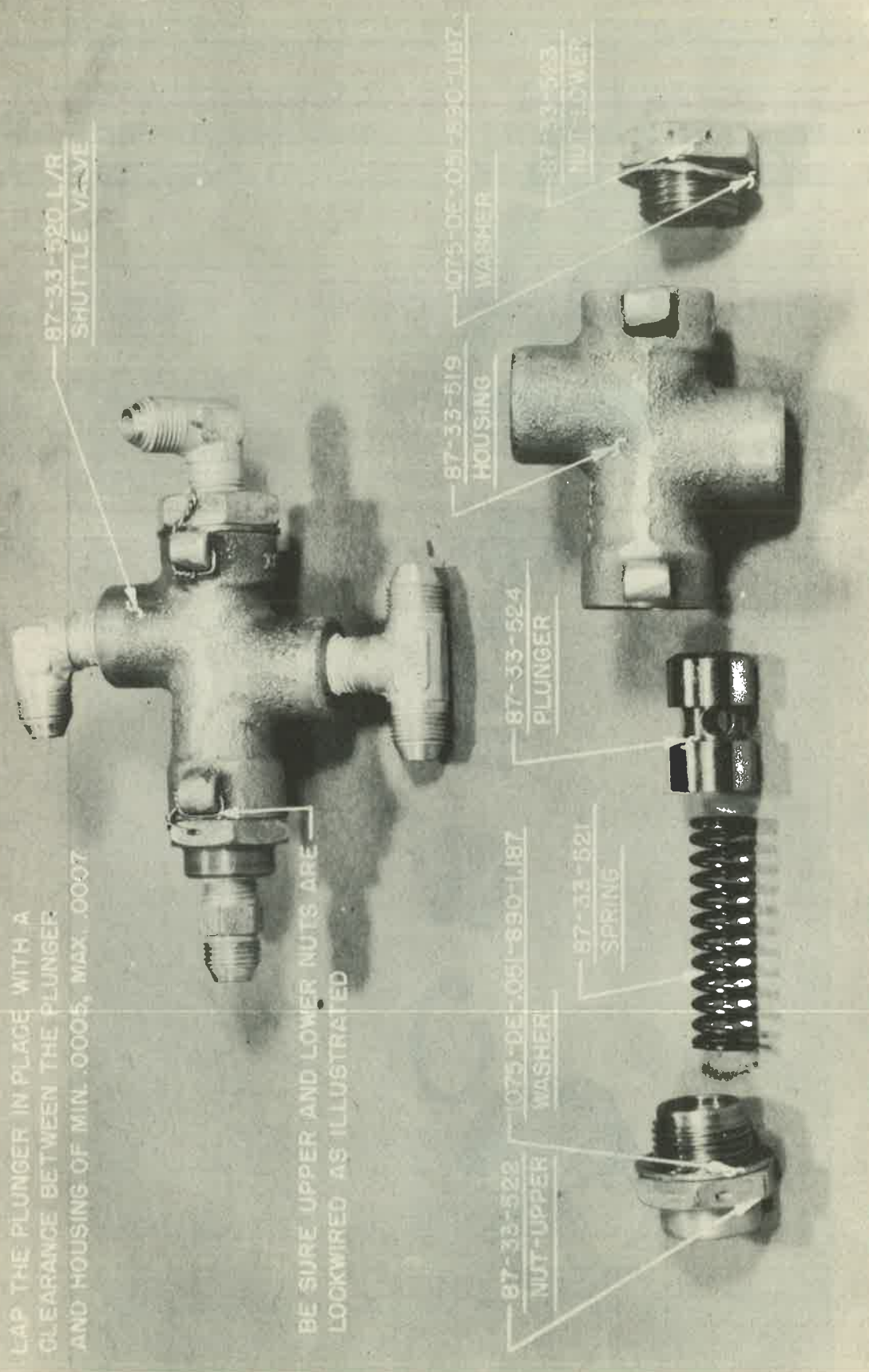


FIG. 66A SHUTTLE VALVE ASSEMBLED AND DISASSEMBLED



TO DISASSEMBLE THE CHECK VALVE TURN OFF THE STOP NUT, RELEASE THE SNAP RING WITH A SNAP RING WRENCH AND TURN THE VALVE BODY SO THAT THE BUSHING, SPRING AND VALVE WILL FALL OUT.

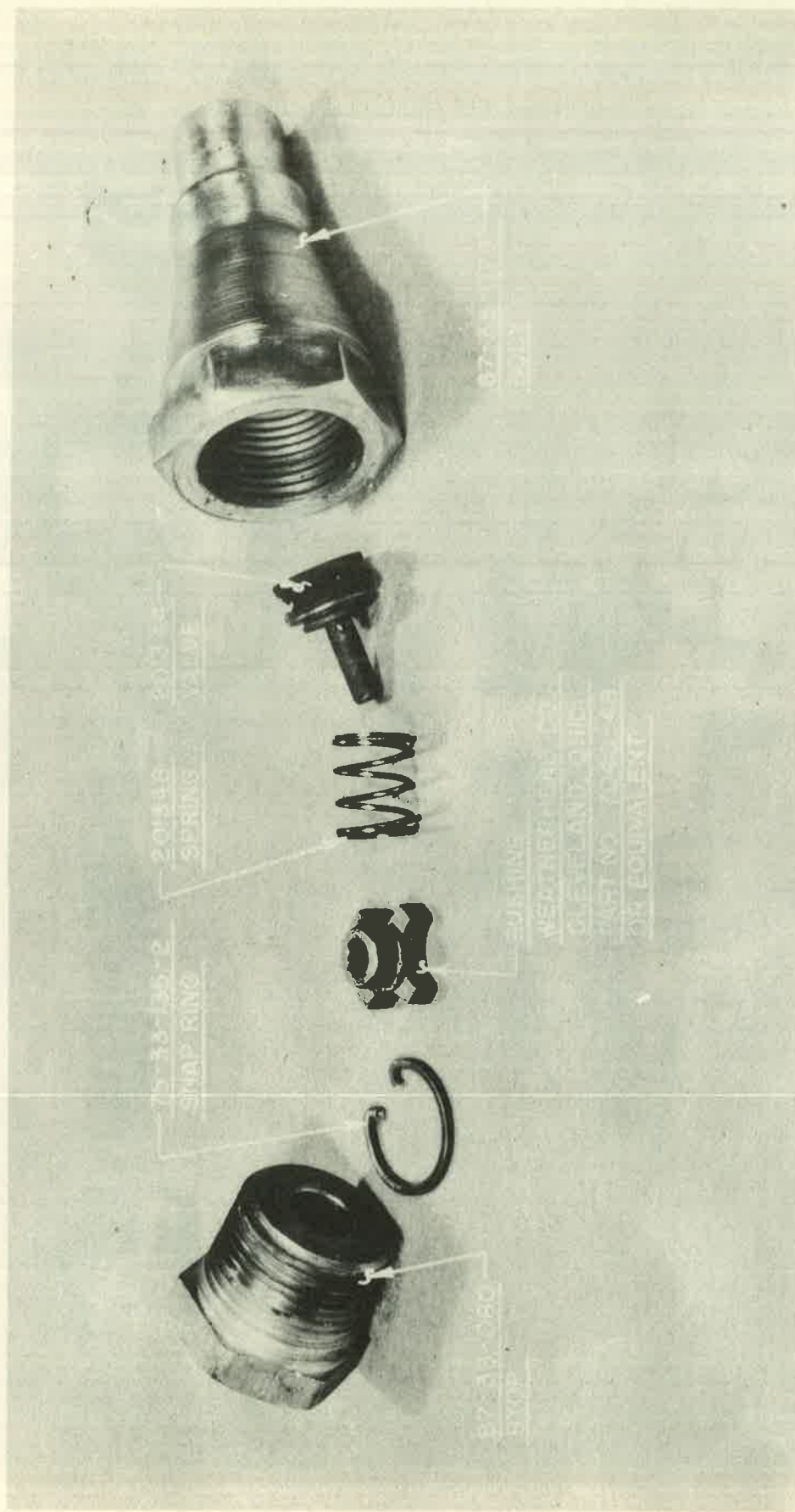
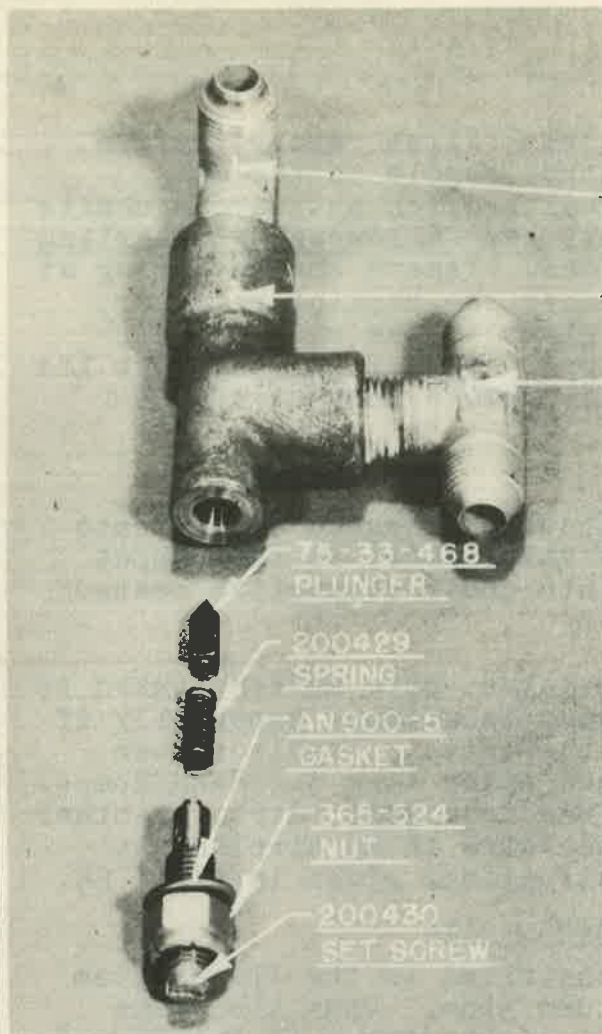


FIG. 66B HYDRAULIC CHECK VALVE DISASSEMBLED

TO DISASSEMBLE RELIEF VALVES REMOVE SET SCREW ASSEMBLY AND TURN THE VALVE BODY SO THAT THE SPRING AND PLUNGER WILL DROP OUT.



75-33-101-RT-6-2330

TEE

87-33-066-1

BODY

75-33-101-ST-6-2330

TEE

87-33-026

BODY

895-100

1/8" PIPE PLUG

75-33-468  
PLUNGER

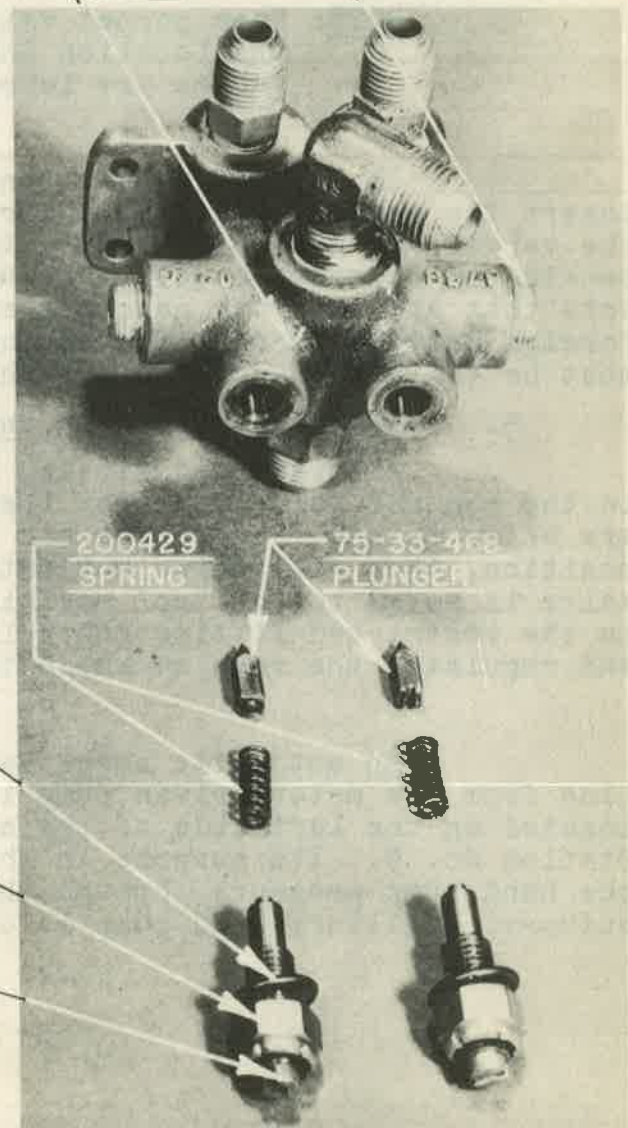
200429  
SPRING

AN 900-5  
GASKET

365-524  
NUT

200430  
SET SCREW

NOTE: SET VALVE TO BY-PASS AT 1500 LBS. PER SQUARE INCH.



200429  
SPRING

75-33-468  
PLUNGER

AN 900-5  
GASKET

365-524  
NUT

200430  
SET SCREW

NOTE: SET VALVE TO BY-PASS AT 1800-2000 LBS. PER SQUARE INCH.

FIG.66C RELIEF VALVES DISASSEMBLED



To dismantle the valve proper, first remove the two bolts which hold the landing gear control handle to the cam assembly, then withdraw the two thru-bolts which act as cam shafts for the actuating cams. Next, pull out cam followers by inserting a small hooked rod in the holes provided. Remove the snap ring at the rear of the poppet valve, then remove the packing retainer, packing and spring. Insert a screw driver in the slot in the poppet valve shaft and holding the poppet valve firmly against its seat to prevent damaging the oil seals, remove the nut at the opposite end of the shaft.

NOTE: Each poppet valve should be tagged to indicate its location in the valve body, as the poppet valves are lapped into their respective seats.

In assembling the control valve, care must be taken to insert the poppet valves in their proper locations, especially if the valves are not to be lapped into the seats. Handle rubber packing in accordance with instructions under Item 3., Hand Pumps. Note that all internal passages are free from grit, dirt, or other foreign matter. Before installing the valve in an airplane it must be tested in accordance with instructions given in Fig. 65.

#### 5. Restricted Fitting and Check Valve

A restricted fitting is installed in the flap system in the control valve boss for the return line. When the flaps are being raised, due to the air loads on the flaps in the "down" position, they will raise automatically as soon as the control valve is moved to the "up" position. The  $3/64$  inch diameter orifice in the restricted fitting controls the flow of oil in this condition and regulates the rate at which the flaps move upward.

An automatic check valve is installed in the pressure line from the motor-driven pump in the fuselage. This valve is located on the left side of the airplane directly forward of Station No. 9. Its purpose in the system is to prevent by-passing the hand pump pressure through the electric hydro pump when the outboard auxiliary hand pump is operated.

REF. DWG. 87-21-624

VIEW "A"

FUEL PRESSURE  
LINE ( $\frac{1}{4}$ " O.D.) CARB.  
TO PRESSURE GAUGE.

EXTRA

IGNITION PLUG

"A"

ELECTRICAL SYSTEM  
FIREWALL JUNCTION BOX

FIREWALL, LOOKING AFT.

OIL PRESSURE  
LINE ( $\frac{1}{4}$ " O.D.)

MANIFOLD  
PRESS. LINE.  
 $\frac{1}{4}$ " O.D.

VACUUM  
LINE ( $\frac{1}{8}$ " O.D.)  
TO VAC. PUMP

PRIMER  
LINE ( $\frac{1}{8}$ " O.D.)  
FROM WOBBLE  
PUMP

$\frac{1}{4}$ " O.D. PRIMER  
TO MANIFOLD

COOLANT TEM.  
CAPILLARY R.H.  
CYL. HEAD

TACHOMETER

OIL INLET TEM.  
CAPILLARY

ENLARGED VIEW, CONNECTOR PANEL

FIG. 67 CONNECTOR PANEL H-87A-2 & H-87A-3



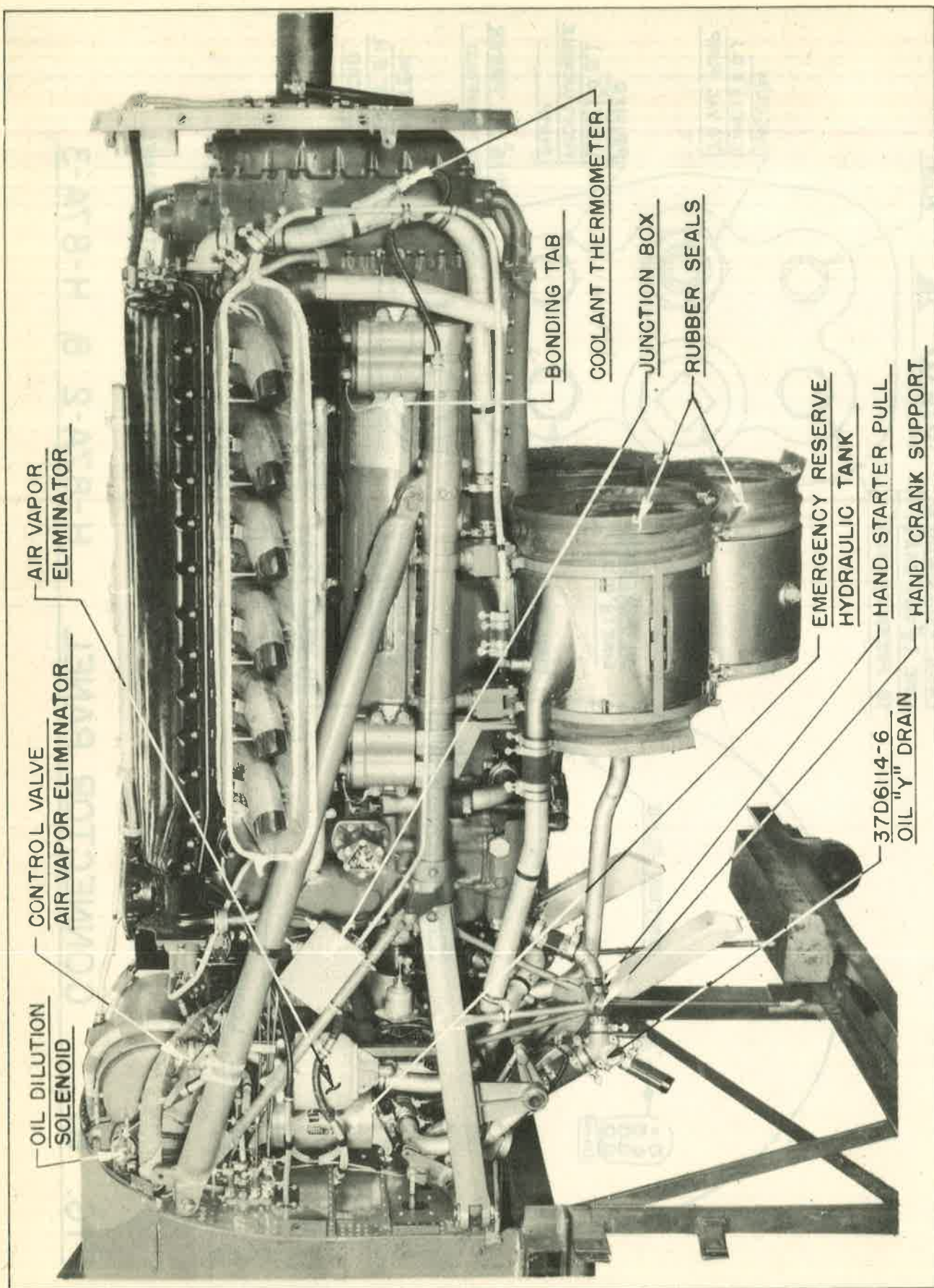


FIG. 68 POWER PLANT - RIGHT SIDE



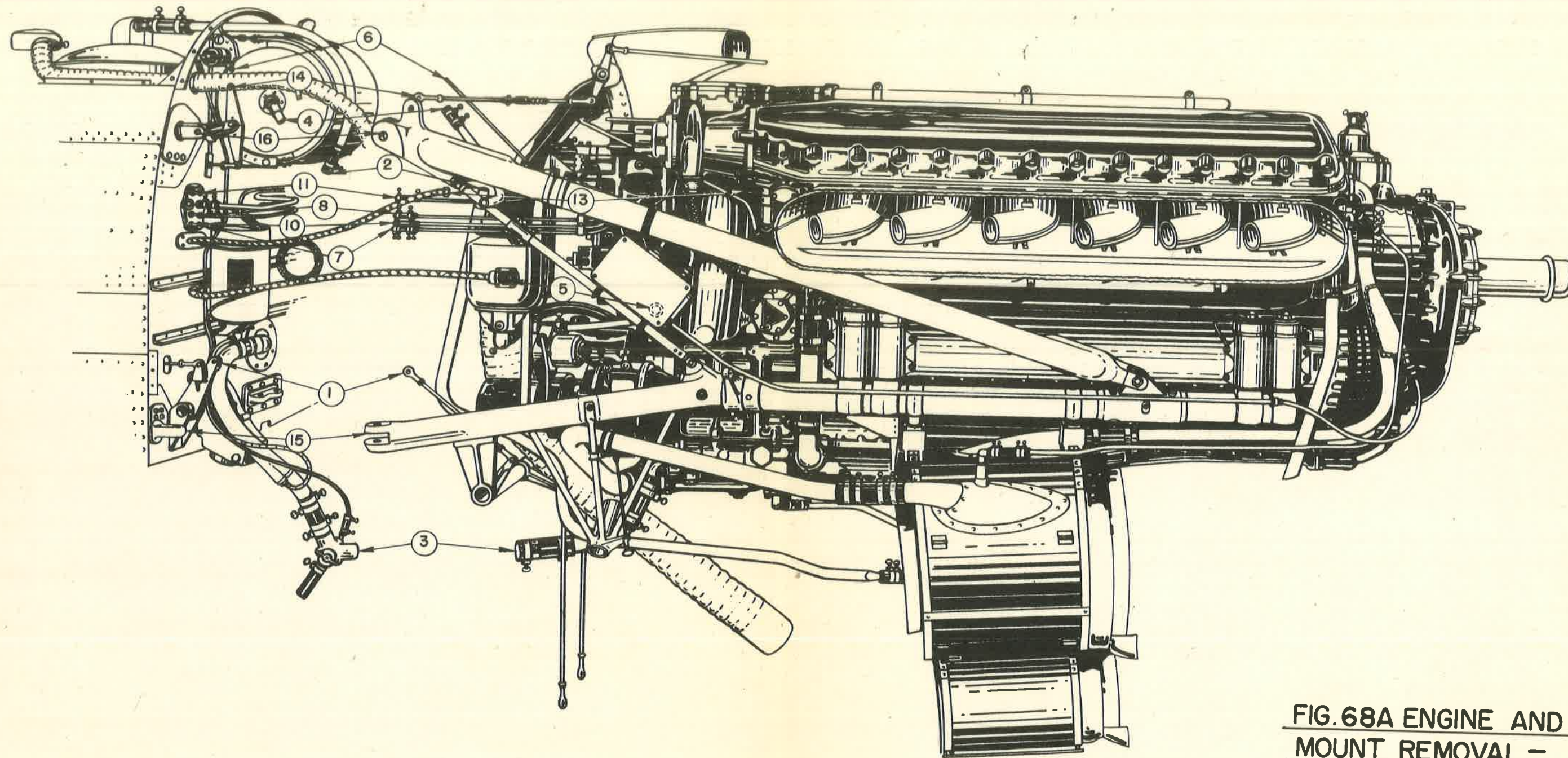


FIG. 68A ENGINE AND  
MOUNT REMOVAL -  
RIGHT SIDE



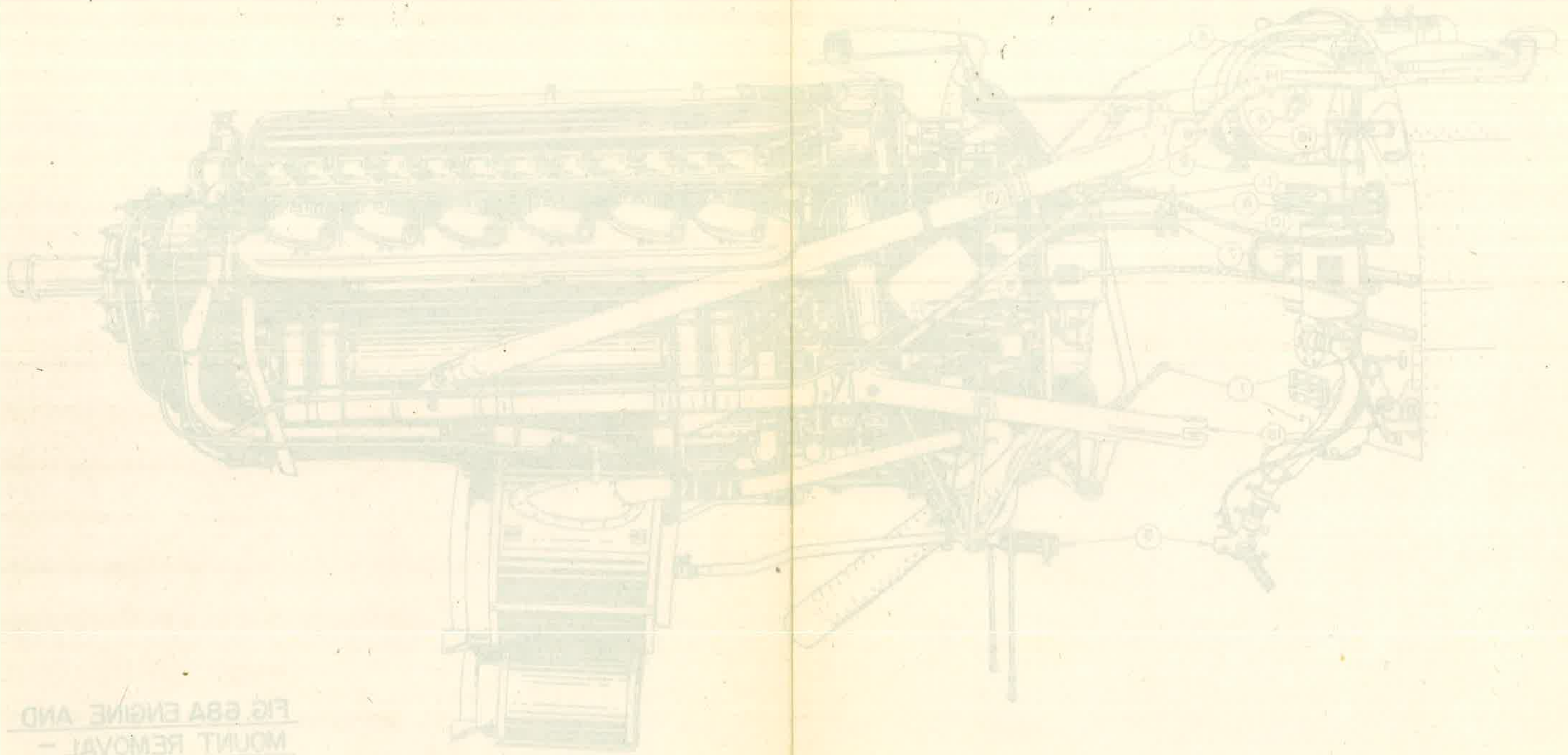


FIG. 68A ENGINE AND  
MOUNT REMOVAL -  
RIGHT SIDE

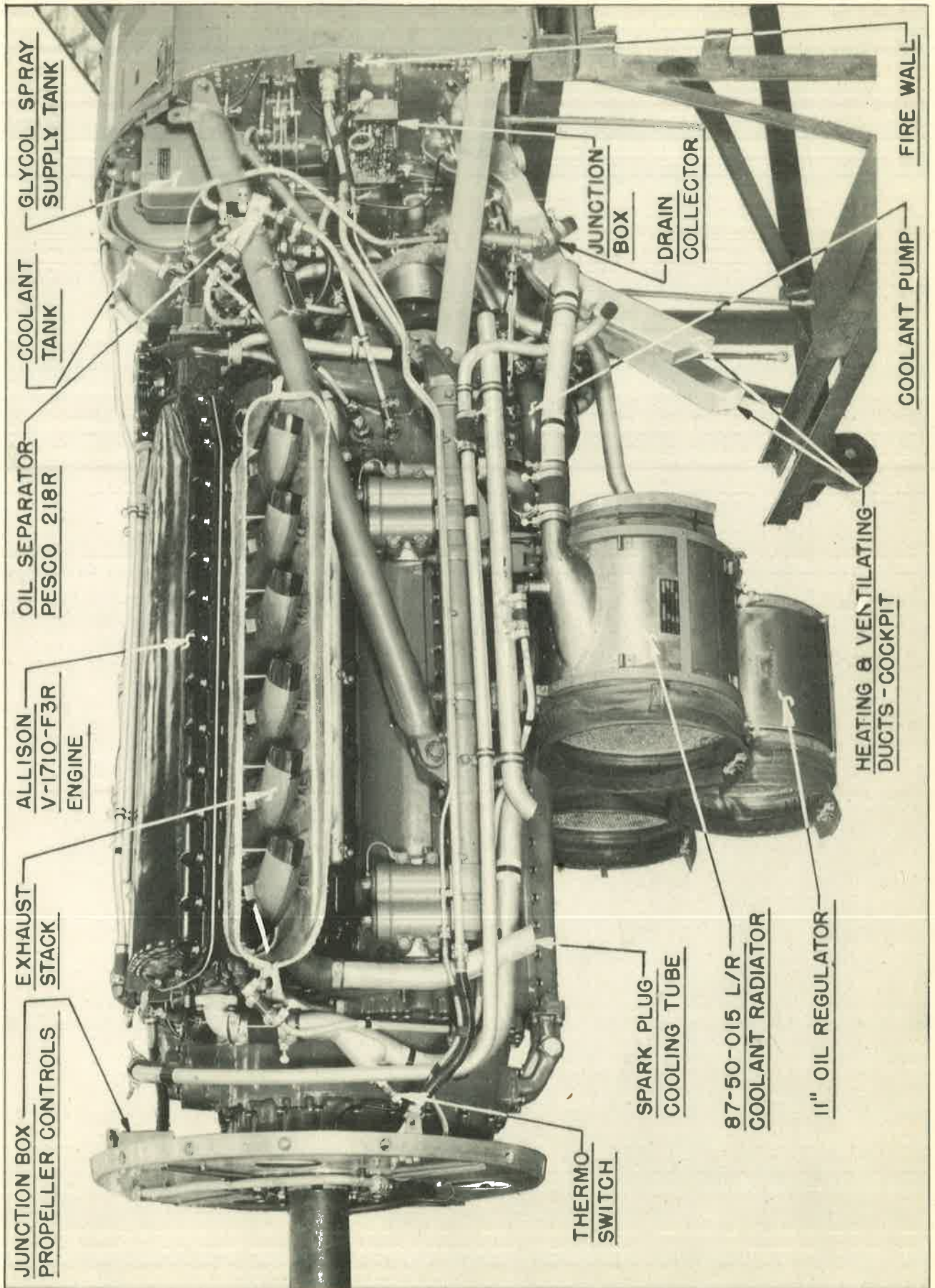
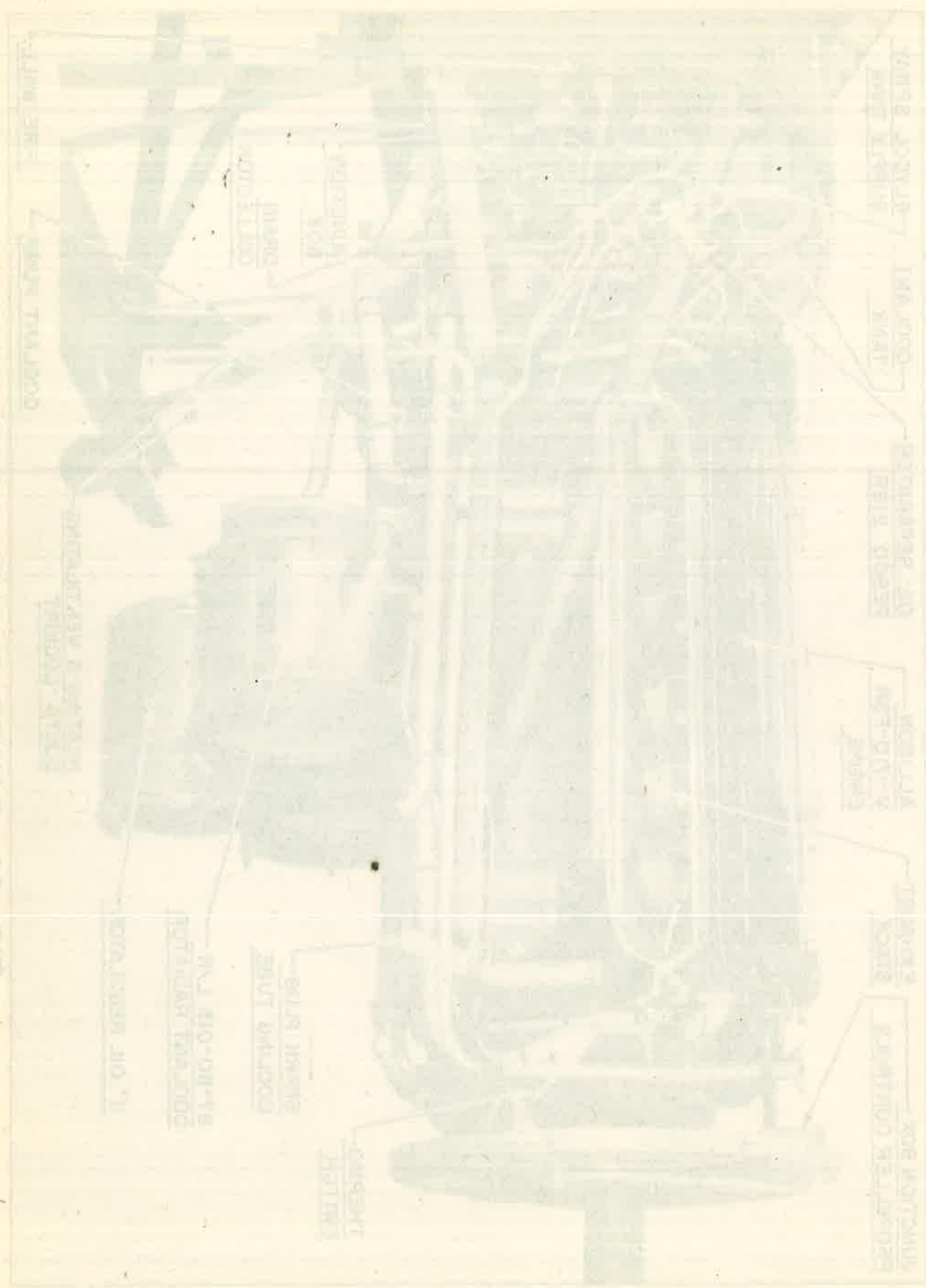
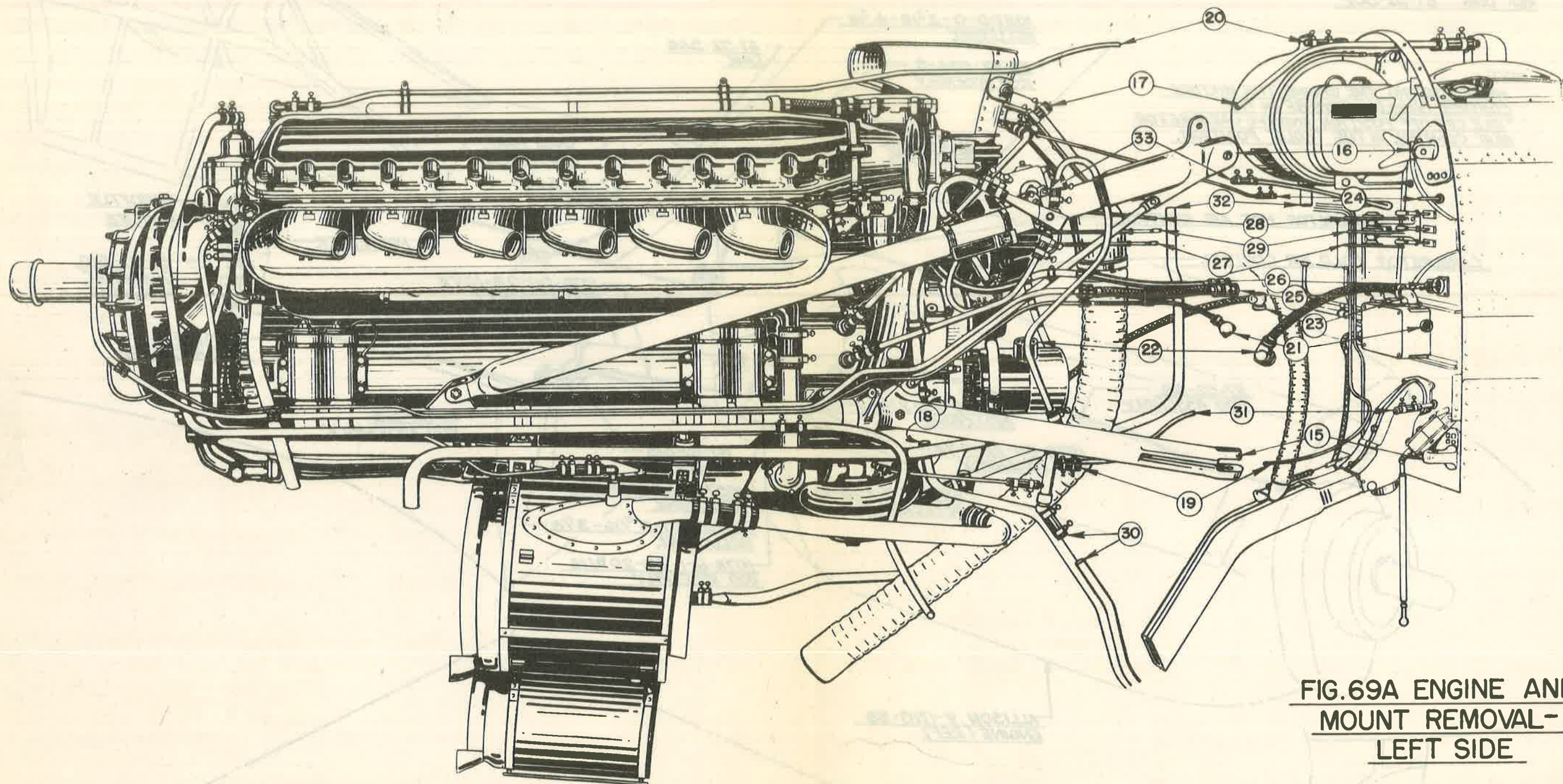


FIG. 69 POWER PLANT - LEFT SIDE



FIG. 88 POWER PLANT - LEFT SIDE





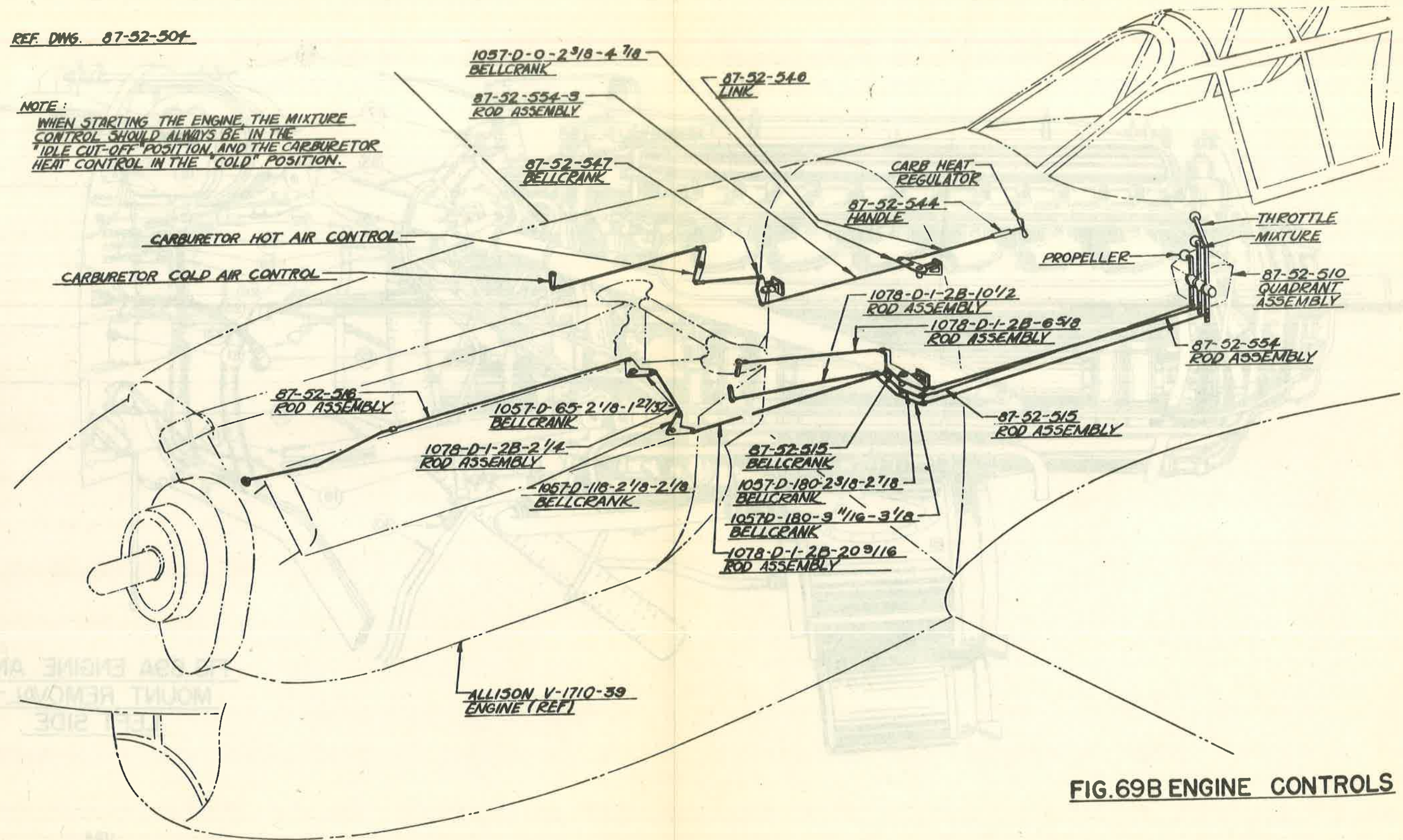
**FIG.69A ENGINE AND  
MOUNT REMOVAL-  
LEFT SIDE**



REF. DWG. 87-52-501

**NOTE:**

WHEN STARTING THE ENGINE, THE MIXTURE CONTROL SHOULD ALWAYS BE IN THE "IDLE CUT-OFF" POSITION, AND THE CARBURETOR HEAT CONTROL IN THE "COLD" POSITION.



**FIG.69B ENGINE CONTROLS**



REF. DWG. 87-46-506

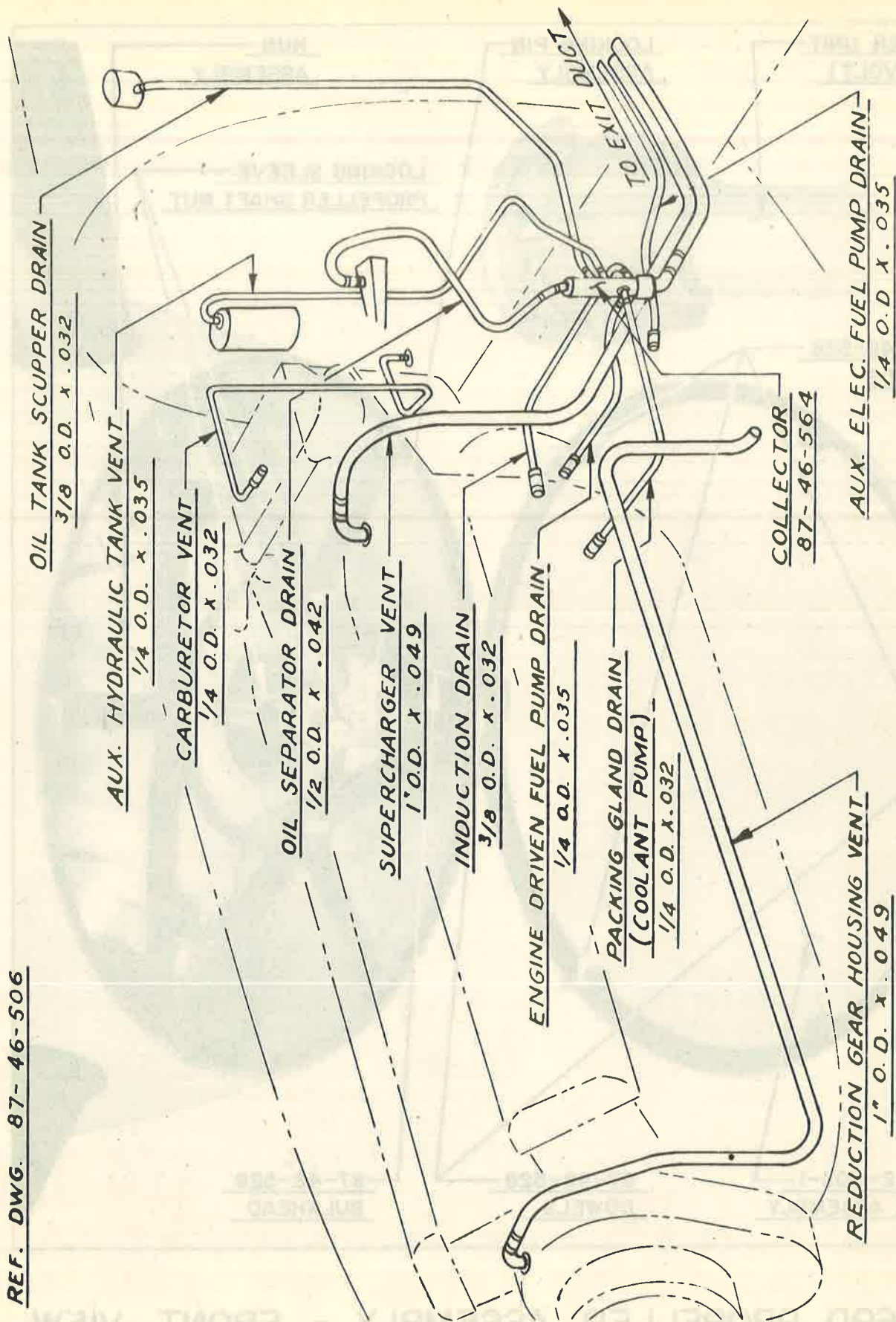


FIG. 69C BREATHER & VENT INSTALLATION



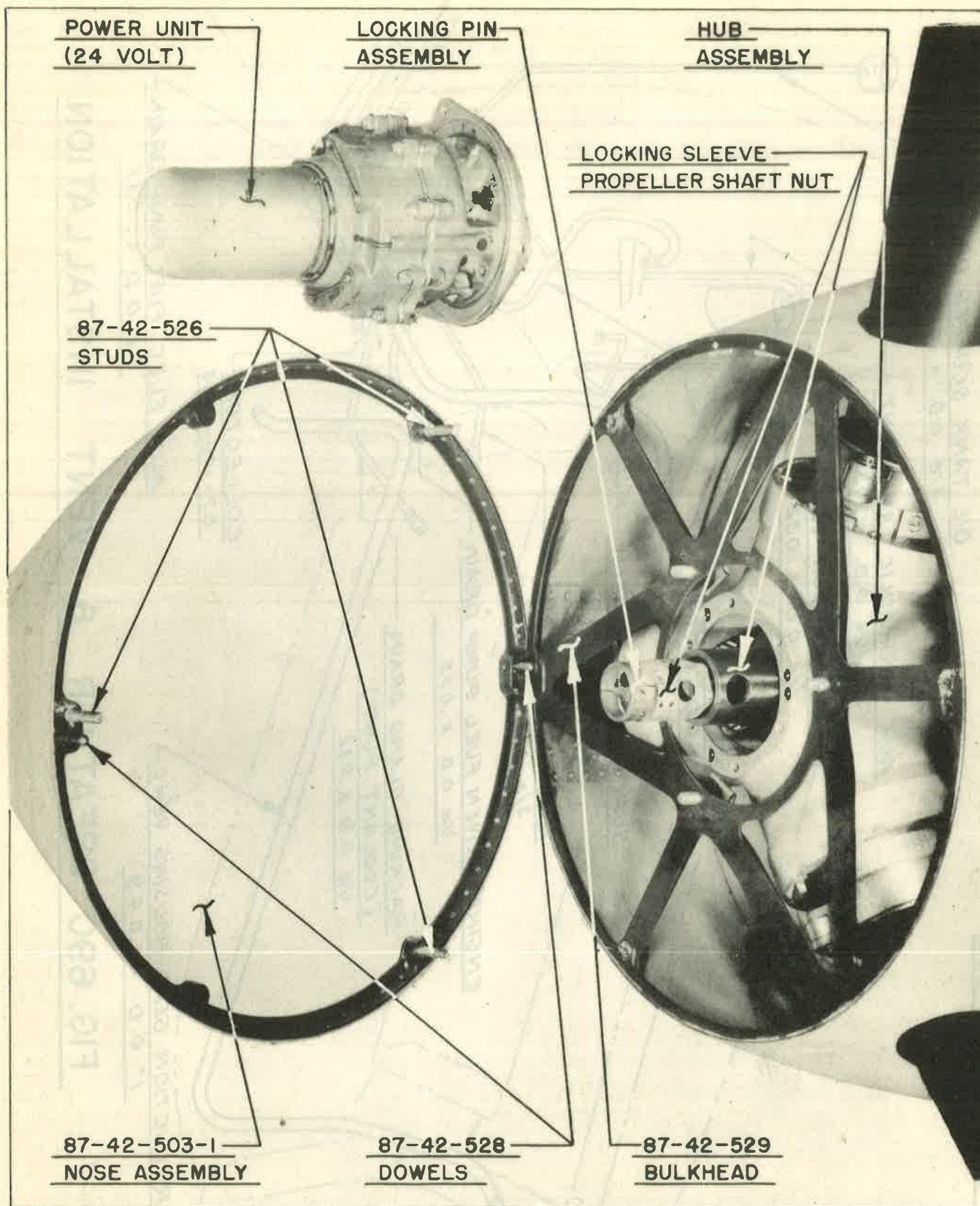


FIG.69D PROPELLER ASSEMBLY - FRONT VIEW

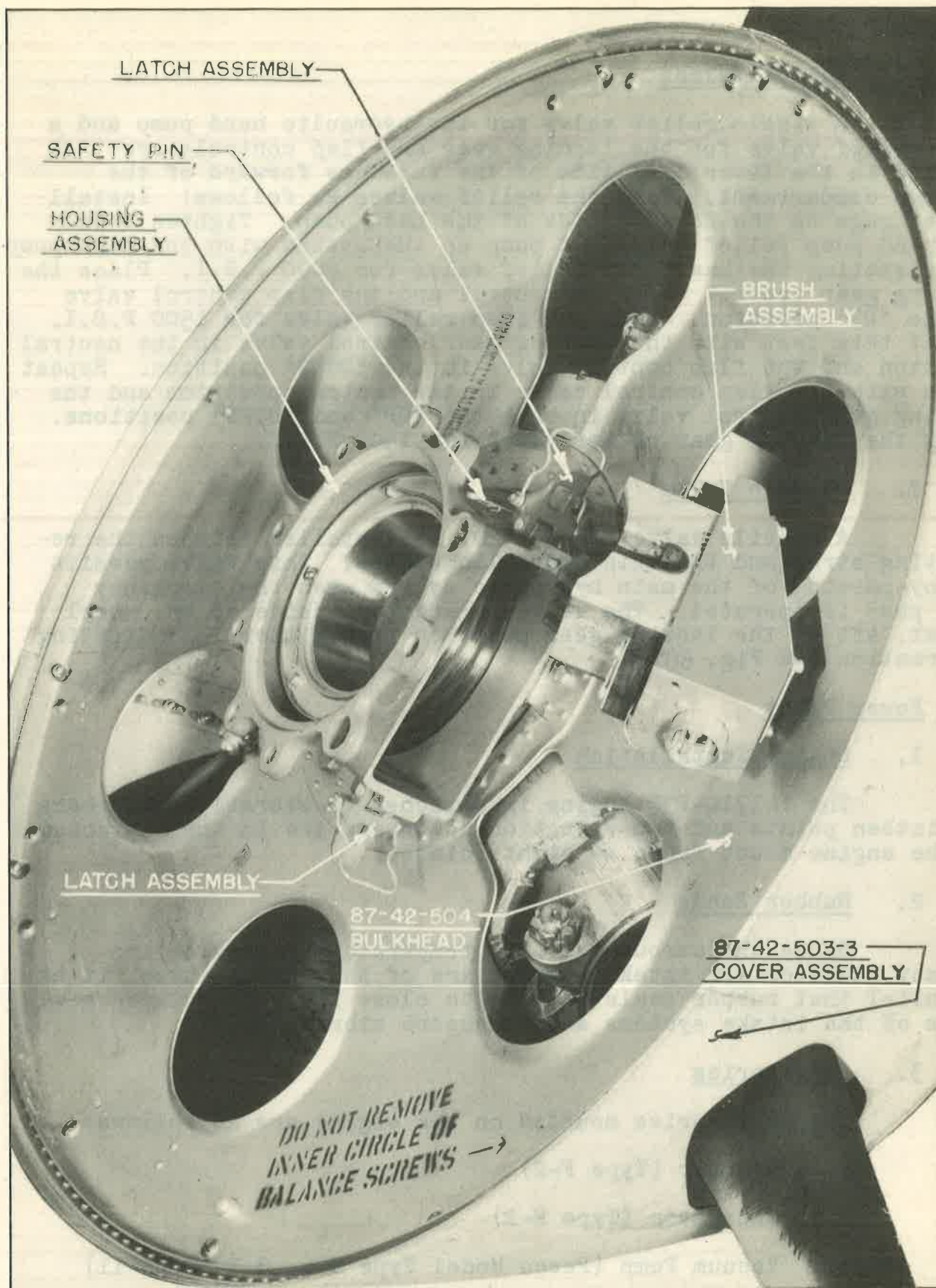


FIG. 69E PROPELLER ASSEMBLY - REAR VIEW



## 6. Relief Valves

A single relief valve for the hydraulic hand pump and a twin relief valve for the landing gear and flap controls are located in the lower left side of the fuselage forward of the stowage compartment. Test the relief valves as follows: Install a test gage on the forward side of the hand pump. Tighten down the hand pump relief valve and pump up the system with the hand pump after setting the hand pump relief valve for 2000 P.S.I. Place the landing gear control valve in neutral and the flap control valve in the "UP" position. Test the flap relief valve for 1500 P.S.I. Repeat this test with the landing gear control valve in the neutral position and the flap control valve in the "DOWN" position. Repeat again with the flap control valve in the neutral position and the landing gear control valve in both the "UP" and "DOWN" positions. Check the landing gear relief valve for 1500 P.S.I.

## 7. Shuttle Valve

A shuttle valve (87-33-520) is installed between the retracting strut and the main hydraulic system. This valve permits the by-passing of the main hydraulic system when the emergency hand pump is operated. The valve is located inside of the wheel pocket, aft of the landing gear position transmitter. For testing information see Fig. 66.

## G. Power Plant

### 1. Engine Installation

The V-1710-F3R engine is attached to vibration absorbers at sixteen points and the vibration absorbers are in turn attached to the engine mount frame at eight points.

### 2. Rubber Seals

Since the carburetor, oil temperature regulator and coolant radiator air intake systems are of the ramming type, it is essential that rubber seals be used to close the gaps between sections of the intake systems and to absorb vibrations.

### 3. Accessories

The accessories mounted on the engine are as follows:

- a. Starter (Type F-2)
- b. Generator (Type M-2)
- c. Vacuum Pump (Pesco Model Type B-6, B-7, or B-11)

- d. Fuel Pump (Type G-9)
  - e. Tachometer 27930
  - f. Propeller Governor (100006-1)
4. Removal of the Power Plant, Including the Mount and The Accessories Attached to it
- a. Remove all engine cowl on airplanes AK721 and subsequent. Break all drain connections to the drain fairing on the left hand side of the lower rear engine cowl.
  - b. Drain the following:
    - (1) Coolant System
    - (2) Engine Oil System
    - (3) Fuel System (excluding tanks)
  - c. The propeller and spinner should be removed.
  - d. Remove the cowl flaps and former as a single unit.
  - e. Remove the oil inlet temperature capillary bulb; coil capillary and attach to the firewall.
  - f. Disconnect the following on the right hand side of the airplane forward of the firewall. (See Fig. 68A ).
    - (1) Cowl flap control assembly
      - (a) Remove the push-pull rods from the bellcrank on the fuselage and the one on the control rod.
      - (b) Disconnect the brace from the lower right hand motor mount by removing two bolts.
      - (c) Detach the inboard support assembly, on the leading edge at the wing match angle, by removing two bolts.
    - (2) The 1 1/2 O.D. oil return line from the oil regulator on the right hand forward side of coolant tank.
    - (3) The 1 1/2" O.D. oil inlet line at the hose connection on the right hand bottom side forward of the "Y" drain cock. (On the right leading edge.)
    - (4) Disconnect the coolant overflow on the right hand side of the coolant tank.



(5) Disconnect the line to the booster coil box at the plug on its inboard side, (5).

(6) Tachometer line at the rear of the left cylinder bank, (13).

g. Disconnect the following on the right side of the airplane at the firewall.

(1) The 1/4" O.D. oil dilution "IN" line at the hose connection (6) above the oil dilution valve.

(2) The 1/4" O.D. oil pressure line at the connector panel, (lower outboard connection, 7) on the right top of the firewall.

(3) The 1/4" O.D. manifold line at the connector panel. (Second lowest outboard connection, 8)

(4) The 1/4" O.D. primer line at the connector panel. (Bottom inboard connection, 10)

(5) The 1/4" O.D. fuel pressure line at the connector panel. (Top outboard connection, 11)

(6) Carburetor air intake valve control at the firewall bellcrank, (14)

h. Disconnect the following on the left hand side of the airplane forward of the firewall. (See Fig. 69A ).

(1) The 1/2" O.D. oil vent lines at their tee connection (17) on the left hand top forward side of the coolant tank.

(2) The 1" O.D. supercharger vent line at the hose connection (18) inboard of the engine mount truss assembly.

(3) The 1/2" O.D. coolant vent line (20) at the top of the expansion tank. (Tank to cylinder heads.)

(4) Remove the fuel line to the engine fuel pump at the wobble pump top (Airplanes AK571 thru AK720 - Electric Auxiliary Pump on Airplane AK721 and subsequent.)

(5) Disconnect the wobble pump control rod at the bellcrank just forward of the firewall. Disconnect both arms of bellcrank. (Airplanes AK571 thru AK720)

(6) Remove the wobble pump control rod. (From bellcrank to the wobble pump on Airplanes AK571 thru AK720)

(7) Disconnect the vacuum line at the connection (33) to the relief valve inboard of the oil separator (7)

i. Disconnect the following on the left hand side of the airplane at the firewall.

(1) Break all electrical connections at the junction box:

(a) Engine coolant outlet temperature conduit (outboard connection, 21)

(b) Generator conduit (top outboard connection, 22).

(c) Starter conduit (center top connection 23)

(d) Carburetor heat control conduit (inboard top connection)

(2) Propeller governor and pitch control conduit (25) at the firewall (outboard and above junction box)

(3) Ignition cable at the firewall (26) (inboard of the propeller governor control connection). Ground the plug in the special socket provided on the engine mount.

(4) Disconnect the throttle control (27) at the bellcrank, forward of the firewall.

(5) Disconnect the mixture control (28) at the bellcrank forward of the firewall.

(6) Disconnect the propeller governor control rod (29) at the bellcrank on the firewall.

(7) Disconnect the line from the drain collector to the exit duct at the hose connection (30) just below the collector.

(8) Disconnect the 3/8" O.D. scupper drain line from the oil tank at the firewall hose connection (31)

(9) Disconnect the 1/4" O.D. emergency hydraulic tank vent line at the drain collector (19).

j. At the center line of the airplane.

(1) Disconnect the carburetor vent line at the top rear of the carburetor.



(2) Remove the coolant line between the expansion tank and coolant pump. (Connection (32) on bottom of tank).

(3) Remove the heating and ventilating ducts at the leading edge connection.

(4) Remove bonding of the engine mount to the fuselage.

NOTE: When removing the power plant and engine mount as a single unit on airplanes AK721 and subsequent, it will not be necessary to disconnect any drain or vent lines from the drain collector except the 3/8" O.D. oil tank scupper drain and the 1/4" O.D. emergency hydraulic tank vent line. The drain collector on airplanes AK721 and subsequent, is attached to and will remain with the lower left hand engine mount truss assembly.

k. Attach the engine hoisting sling to the engine and relieve the strain on the engine mount attaching bolts.

l. Remove the two 3/4" bolts, which hold the lower engine mount truss (15) to the fuselage frame.

m. Remove the two 1/2" bolts, which holds the top engine mount (16) to the fuselage frame.

n. Remove two 5/16" bolts which attach the engine mount "V" brace to the firewall at the bottom part on the center line.

o. The power plant must be removed directly forward without being raised or lowered until all parts remaining on the fuselage have been cleared.

5. To Reinstall The Power Plant Assembly. - Reverse the procedure outlined above for the removal of the power plant assembly.

6. To Remove The Power Plant From The Mount. - Follow the procedure outlined above in items a. thru k. and then proceed as follows:

a. Remove the following connections on the right hand side of the engine.

(1) Coolant temperature line at junction to the coolant tube forward of the right hand cylinder bank.

(2) 1 3/4" O.D. engine outlet coolant tube at the hose connection preceding entrance into the cylinder bank at the front of the motor.

(3)  $\frac{1}{2}$ " O.D. vent line to cooler at the connection on the right forward side of the cylinder bank. Remove the tube by breaking the connection at the right hand cooler.

(4) Remove the booster coil box on the motor mount brace by breaking the connection on the top and inboard side. Remove the clips holding the oil temperature line to the lower mount and remove the line and box as one unit.

(5) Carburetor heat control rod at the connection to the bellcrank on the carburetor intake.

(6)  $\frac{1}{4}$ " O.D. oil pressure line at the connection to the engine on the rear lower side.

(7)  $\frac{1}{2}$ " O.D. oil vent line at its connection aft of the right cylinder bank.

(8)  $\frac{1}{4}$ " O.D. vent line at the connection to the carburetor on the top right hand side.

(9) Spark plug air cooling line from the right air intake duct.

(10) Remove  $\frac{3}{4}$ " O.D. fuel line from the fuel pump to the air vapor eliminator.

(11) Remove  $\frac{3}{4}$ " fuel line from the air vapor eliminator to the carburetor. (Airplanes AK571 - AK720)

(12) Remove the air vapor eliminator assembly by removing the four bolts attaching its support at the top to the motor mount and one bolt attaching it at the bottom. (Airplanes AK571 - AK720)

b. Remove the following connections on the left hand side of the engine.

(1)  $1\frac{3}{4}$ " O.D. engine outlet coolant tube at the hose connection preceding entrance into the cylinder bank at the front of the motor.

(2) The coolant temperature line at junction with the coolant tube at the forward end of the engine.

(3)  $\frac{1}{2}$ " O.D. vent to the cooler at the connection on the side of the cylinder bank. Remove the tube by breaking the connection at the left hand cooler.

(4)  $\frac{1}{4}$ " O.D. drain line at the fuel pump. Break the line at the collector and remove.



(5)  $\frac{1}{2}$ " O.D. oil vent line at its connection aft of the left hand cylinder bank.

(6)  $\frac{1}{4}$ " O.D. line at the motor connection in the rear. Break the connection at bottom of the oil separator and remove the tube.

(7)  $\frac{1}{2}$ " O.D. vacuum gage line at the outboard connection on the vacuum pump.

(8) The mixture control rod at the connection on the left hand side of the carburetor.

(9) The throttle control rod at the connection on the left hand side of the carburetor.

(10) The propeller control rod at the bellcrank connection back of the left hand cylinder bank. Remove the push pull rod.

(11) The spark plug air cooling line from the left air intake duct to the left cylinder bank.

(12) The fuel air intake tube from the left air intake duct.

c. Remove the following connections on top of the engine.

(1) The electrical propeller control conduit at its connection to the propeller governor.

(2) 1" O.D. front breather line at the hose connection on top of the reduction gear housing. Break the line at the drain collector and remove the tube and clip attached to the lower engine mount. On airplanes AK721 and subsequent disconnect the line at the hose connection on top of the reduction gear housing. Break the line at the rear cowl outlet fairing instead of the drain collector, remove the clips and tube from the lower engine mount.

(3)  $\frac{1}{2}$ " O.D. vent tube to the coolant tank at the "T" connection on the forward left side inboard of the cylinder banks.

(4)  $\frac{1}{4}$ " O.D. primer line at the connection on top of the motor.

(5) 1" O.D. rear breather line at the connection to the rear of the motor between the ends of the cylinder banks. Break the connection at the drain collector and remove the tube. On airplanes AK721 and subsequent break this line at the vent fairing on the rear engine cowl instead of at the drain collector.

(6) 5/8" O.D. supercharger vent line at the connection adjacent to the rear breather connection.

(7) Two 1/4" O.D. distributor drain lines rear in-board connection to the motor on the right and left cylinder banks.

(8) 1/4" O.D. fuel pressure line connection to the carburetor.

(9) The ignition cable at its cross connection at the rear of the motor in front of the carburetor air intake.

d. Remove the following connections on the bottom of the engine.

(1) 1" O.D. oil outlet line. Break the hose connection at the motor outlet on the rear of the engine, and at the hose connection to the top of the oil regulator, and remove the tube.

(2) 1 3/4" O.D. tube on the left hand pump inlet, at hose connection to pump on rear of engine.

(3) 1 3/4" O.D. tube, right hand pump inlet, at the hose connection to the pump on the rear of the engine.

(4) 1" O.D. expansion tank outlet at the hose connection on the rear of the engine at the pump inlet.

(5) 1/4" O.D. tube coolant pump packing gland drain, on the left hand side.

(6) 1/4" O.D. induction drain on the center line to the collector drain.

(7) 1 1/2" O.D. oil inlet line at the connection to the motor on the right hand side.

(8) 1 1/4" O.D. oil return line. Break at the hose connection on the oil regulator.

(9) Remove the air inlet ducts from the coolant and oil regulator by disconnecting the clamps which hold the duct seals to the radiators.

(10) Remove the oil regulator and coolant radiators as one unit by removing the 8 bolts attaching the support installation to the fittings on the lower engine mount.

e. Remove the following connections at the back of the engine.

(1) 1/4" oil dilution line at the connection to the oil dilution "Y" at back of carburetor.



(2) Generator cable at the connection on top of the generator.

(3) 3/4" fuel line at the outboard connection on the fuel pump. Break connection at the wobble pump (Airplanes AK571 thru AK720-Electric Auxiliary Pump on Airplane AK721 and subsequent) and remove tube.

(4) Starter conduit at the junction to the starter box.

f. Remove the following connections at the front of the engine.

(1) Break all connections to the propeller junction box mounted on the left hand aft side of the forward engine bulkhead.

(2) Disconnect the conduit to the brush assembly at the brush assembly on the right hand forward side of the forward engine bulkhead.

(3) Remove the brush assembly.

(4) Remove the forward engine bulkhead from the reduction gear housing.

(5) Remove the bonding from the front shock absorbers to the engine.

g. Remove the sixteen bolts attaching the engine vibration absorbers to the engine and remove the mount sideways.

#### 7. Engine Controls (Drawing No. 87-52-504)

A type B-21 engine control assembly has four main mixture control positions: "IDLE CUT-OFF", "AUTOMATIC LEAN", "AUTOMATIC RICH", and "FULL RICH". The "AUTOMATIC RICH" position should be used for all normal flight conditions including take-off, climb, and level flight at military power ratings. The extreme rear position of the mixture control is "IDLE CUT-OFF". To start the engine the mixture control should be in the "IDLE CUT-OFF" position and then moved to "AUTOMATIC RICH" as soon as the engine starts to fire. The auxiliary fuel pump must be operated to build up and maintain pressure in the carburetor during the starting operation. Continue to operate the auxiliary fuel pump until the engine pump is delivering a constant pressure of 12 - 16 pounds. The carburetor air heater control is located on the right side of the cockpit forward of the cockpit enclosure control.

#### 8. Propeller

a. Propeller Installation. - The propeller is a Curtiss electrically controlled, three blade, hollow steel, constant speed controllable pitch propeller, on airplanes AK571 - AK610 and a three blade dural propeller on airplanes AK611 and subsequent

REF. DWG. 87-50-702

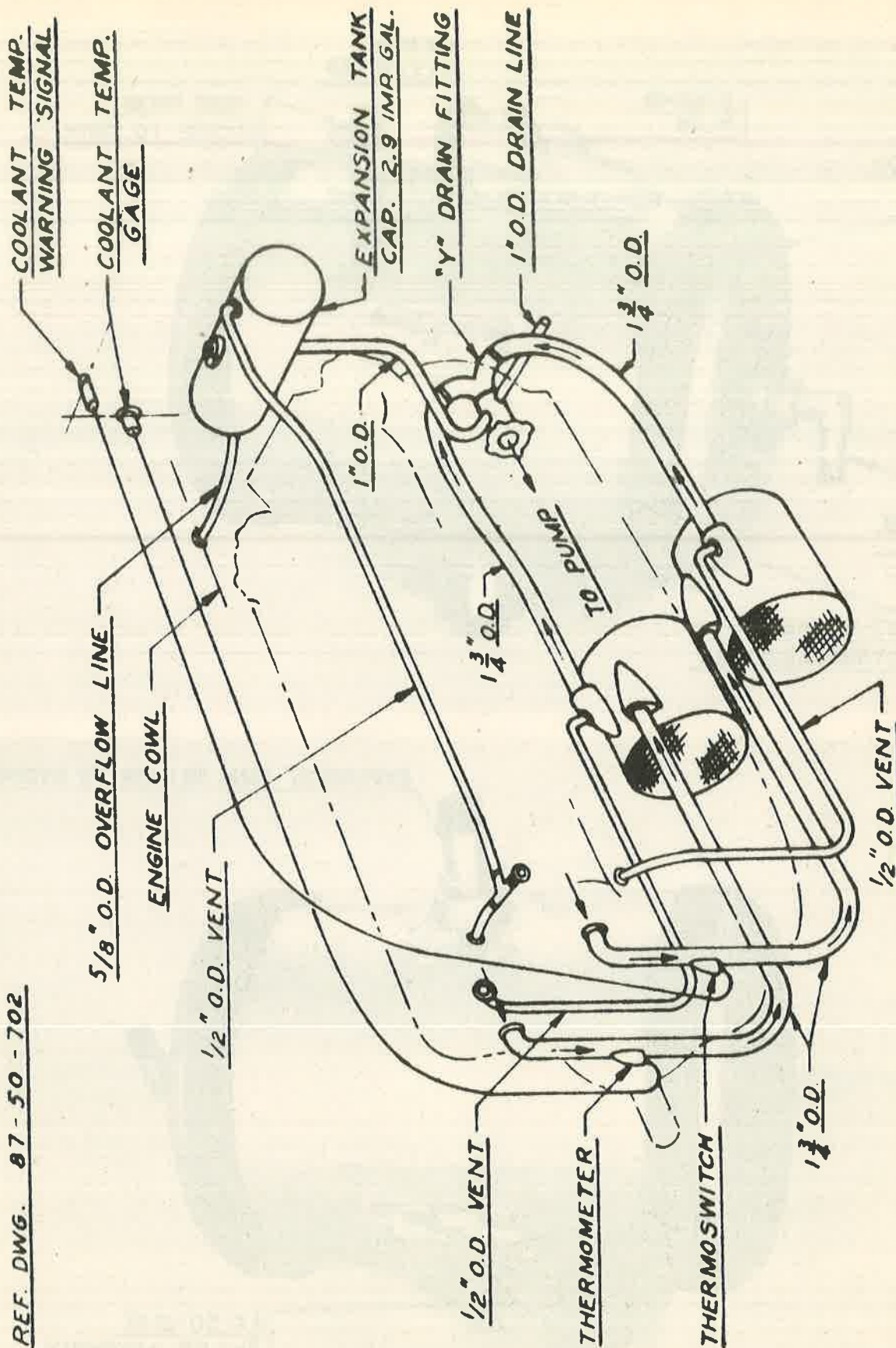


FIG.70 COOLANT SYSTEM



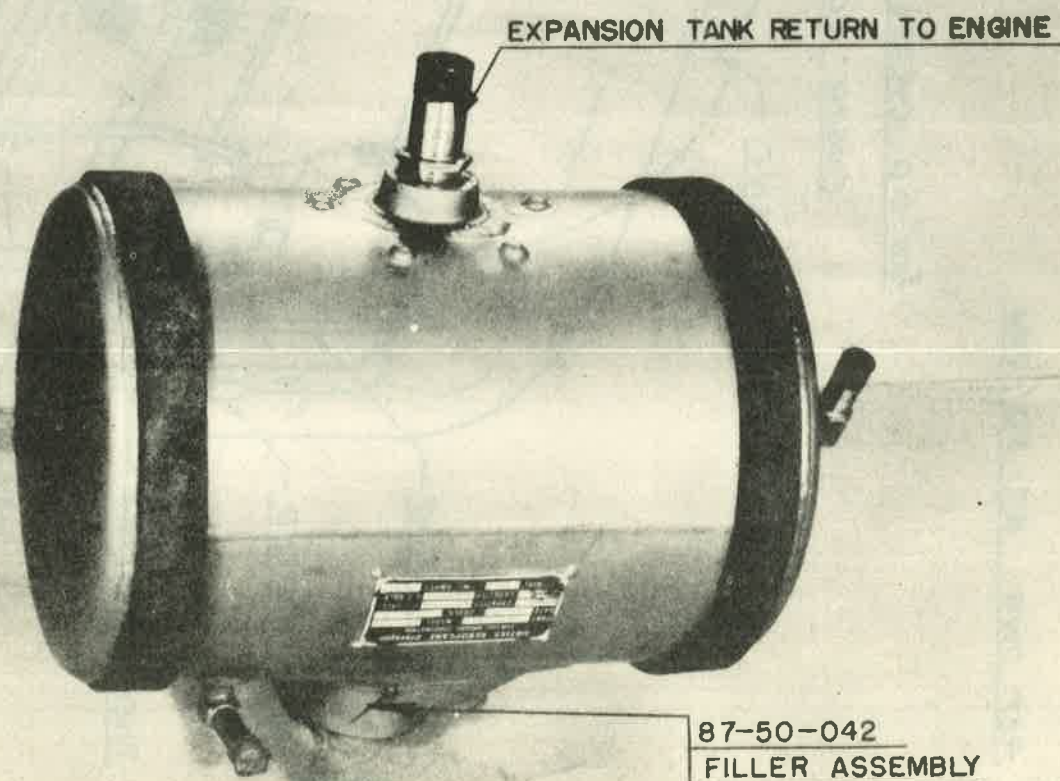
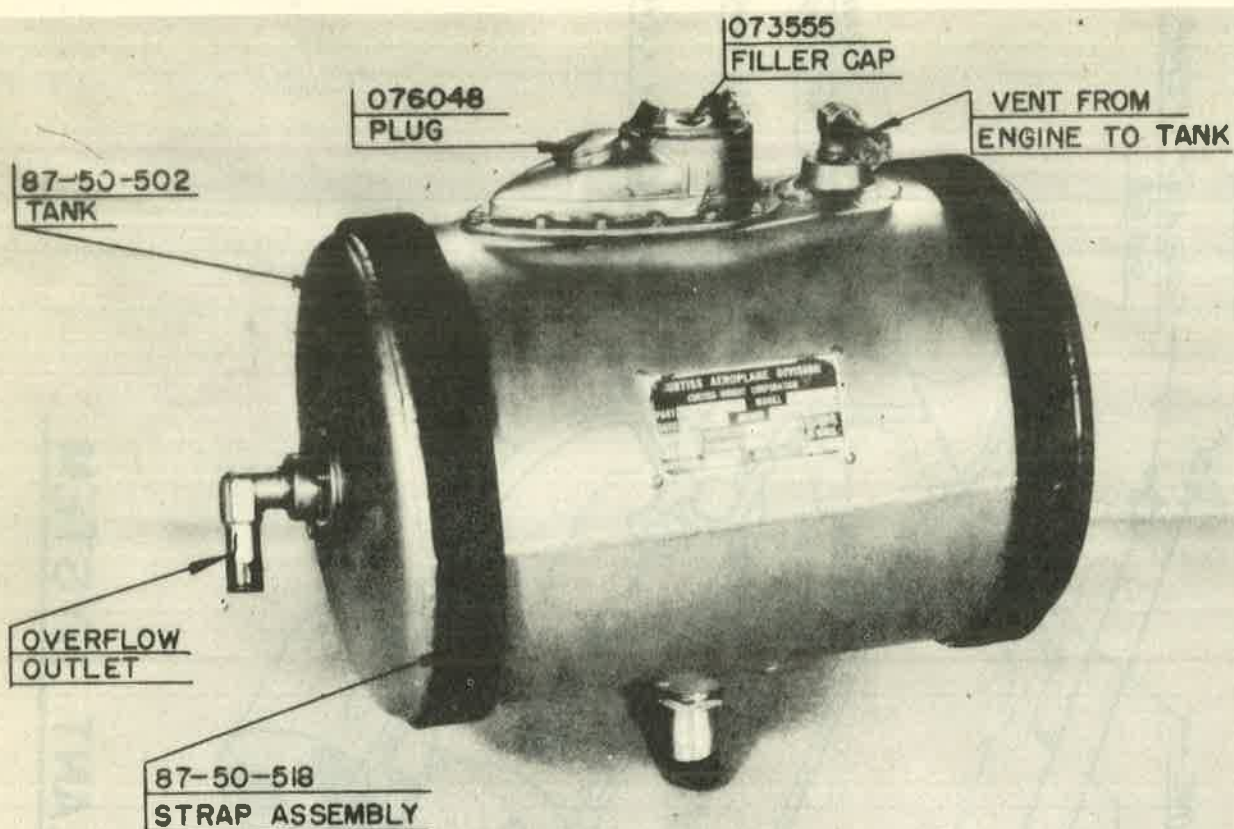


FIG. 71 COOLANT TANK H-87A-2 & H-87A-3

The propeller pitch is controlled either automatically or by manual selection from the switch on the lower left hand side of the main switch panel.

b. To Remove the Propeller and Spinner Assembly

- (1) Operate the propeller to maximum low pitch.
- (2) Remove the right hand section of the engine cowl and work through the hand holes in the forward engine cowl bulkhead.
- (3) Disconnect the flexible conduit from the brush holder cap assembly.
- (4) Remove the safety pin from the top and bottom brush holder latch assembly.
- (5) Raise the brush holder latches and remove the brush holder cap carefully to avoid damage to the brushes.
- (6) Remove the three elastic stop nuts attaching the spinner nose cone to the aft section and remove the nose cone.
- (7) Remove the cap screws and the three nuts from the flange of the propeller power unit assembly, remove the power unit assembly, the neoprene seal and the grease seal from the propeller.
- (8) Remove the locking pin assembly, the locking sleeve, and insert a bar completely through the two holes in the propeller shaft nut and turn the nut off.
- (9) The propeller may now be removed from the propeller shaft. Exercise extreme care when removing the propeller to avoid damage to the propeller shaft threads.

NOTE: The propeller weighs approximately 375 pounds. Therefore it is advisable to use at least three men to remove this assembly. Place the propeller in a suitable buck. Never allow the blades to support the weight of the propeller. See Figures 69C and 69D.

c. To Remove the Aft Section of the Propeller Spinner from the Propeller Hub.

- (1) Remove the screws from the three cover assemblies on the outer surface of the spinner aft section and remove the covers.
- (2) Remove the outer circle of screws from the rear of the aft bulkhead. Do Not Disturb The Inner Circle of Balance Screws. Pull the aft section forward until it is free of the propeller hub.



d. To Remove the Aft Bulkhead from the Propeller Hub.

(1) Remove the nine nuts and bolts from the inner flange of the propeller hub and lift the bulkhead from the hub.

e. To Assemble the Aft Bulkhead to the Propeller Hub. - Reverse the procedure as noted in Paragraph d.

f. To Assemble the Aft Section of the Propeller Spinner to the Propeller Hub. - Reverse the procedure as noted in Paragraph c.

g. To Assemble the Propeller and Spinner on the Propeller Shaft. - Reverse the procedure as noted in Paragraph b., 1 through 9.

CAUTION: The propeller spinner assembly (Drawing 87-42-502) on each airplane has been statically balanced. Therefore, no attempt should ever be made to interchange parts. If a spinner is disassembled it must be reassembled with all parts bearing the same relative arrangement as originally. After any damage whatever to a spinner which may have destroyed the balance, it must be rebalanced or replaced by a correctly balanced spinner.

9. Coolant System (Drawing No. 87-50-701-50)

The engine is liquid cooled. A centrifugal coolant pump is mounted on the bottom of the accessory housing. The two pump outlets are connected by pipes to manifolds cast along the cylinder jackets. From these manifolds the coolant is metered by orifices to each cylinder. Individual steel sleeves direct the flow up each cylinder barrel to the hottest portions of the cylinder head. Outlets are provided on each end of the cylinder blocks. For a diagram of the coolant system, see Fig. 70. The filler cap is in the top of the expansion tank accessible through a door in the top cowl. It contains a relief valve which opens when pressure in the system exceeds atmospheric pressure by 3 lbs. allowing a mixture of coolant and air to pass through the overflow line. A small check valve connecting the vent passage directly to the tank opens when atmospheric pressure exceeds tank pressure by 1/2 lb. The top forward part of each cylinder jacket is vented directly to the expansion tank. Additional vent lines containing restrictions are installed between the outboard, forward boss on the cylinder jackets and the coolant radiators.

Two blanket rings, 87-50-552, are carried in the duffle bag and should be installed on the front face of the coolant radiators whenever ground temperatures drop below 15°F. (-9°C.). These

vellumoid rings are installed against the front face of each coolant radiator by pressing the ring inside the flange formed by the radiator shell. The rings will reduce the flow of air through the radiators and will greatly aid in maintaining the proper operating temperature during cold weather flying.

The thermo-switch is located in the coolant system line from the left hand cylinder bank to the left hand radiator just forward of the radiator. The thermo-switch operates the coolant temperature warning light on the instrument panel when the coolant temperature exceeds the safe operating temperature 121°C. (250°F.). The thermo-switch may be adjusted while the engine is running as follows:

Remove the left hand engine cowl and remove the thermo-switch bulb by first removing the lockwire and then unscrewing the hexagonal nut. Next unscrew the knurled conduit nut and the aluminum alloy hexagonal nut from the bulb. (Hold the hexagonal nut on the bulb during the operation to prevent rotation of the bulb.) The adjusting screw is in the center of the bulb and may be turned with a screwdriver. Clockwise rotation lowers the temperature and counter-clockwise raises the temperature. (Example: If the light functions at 110°C. (230°F.) turn adjustment screw counter-clockwise until it functions at 121°C. (250°F.). The amount of rotation for a given temperature difference varies with the individual bulb. Therefore it



will be necessary to turn the screw one complete revolution, place the assembly in the coolant line, and determine the change in the reading. Then knowing the change a full turn will produce, the amount of turns to gain the required setting may be computed. After completion of the adjustment reinstall and tighten both nuts on the assembly and safety the locking wire.

a. To Fill System

When filling the coolant system in the three point position a certain amount of air will be left in the forward cylinder jackets. Therefore, the expansion tank must be filled to the top. As soon as the coolant circulates in the system the air, left in the cylinder jackets, will be replaced by the coolant from the expansion tank which in turn will provide the necessary space in the tank for the expansion of the coolant. The system will hold approximately  $12 \frac{2}{5}$  Imperial gallons when filled in accordance with the following recommended procedure which requires ten minutes. With the system completely drained pour in the coolant, taking care that none flows into and thru the overflow outlet assembly, until the liquid rises in the filler neck. This operation requires about five minutes. Add the remainder of the coolant over a period of five minutes. Start the engine and operate until the coolant reaches a temperature of  $85^{\circ}\text{C}$  ( $185^{\circ}\text{F.}$ ). Stop the engine, wait five minutes and investigate the coolant level; if necessary make additions to bring it up to the proper level.

b. When the airplane is being filled in normal flying position it must be understood that no air is being trapped in the cylinder jackets and in order to provide expansion space for the coolant the system must be filled to contain  $\frac{7}{8}$  Imperial gallon in the expansion tank; otherwise the contents of the tank will be discharged through the vent line during the engine warm-up period.

c. Repair and Cleaning of Radiators and Oil Regulators:

Remove the coolant radiators and oil regulator as one unit by removing the 8 bolts attaching the support installation to the fittings on the lower engine mount and disassemble into separate radiator units.

The repair of radiators is a highly skilled operation and should be handled by operators trained in this particular branch of metal work. Emergency temporary repairs may be made as needed, by anyone capable of performing the work. Permanent or major repairs should be made as soon thereafter as possible by the station engineering department, if qualified personnel is available, or by depots.

Extreme care should be exercised to prevent mechanical damage to this equipment during handling and installation or removal.

The parts to be repaired must be thoroughly cleaned prior to any attempt to apply solder. Use 1 to 2 pounds of concentrated soap to 40 gallons of water for a safe and satisfactory cleaning solvent. After thoroughly cleaning, flush the interior with hot running water and then steam for not less than one-half hour. The radiator is so placed that the condensate will drain freely from the bottom. (Oil temperature regulators will be cleaned as above, except that a more extensive use of the solvent will probably be required to insure a high degree of cleanliness.)

After cleaning, leaks will be located by submerging the radiator in warm water with all openings closed, and an air pressure of not more than 10 lbs. per sq. in. applied. (In testing oil regulators for leaks, do not exceed 75 lbs. per sq. in. pressure. Caution: Pressure should be applied and released slowly to prevent any strain or shock to the cores.) Mark each place where bubbles appear with a scratch.

Coolant radiators have been constructed with high melting point solder which has a lead base containing from 5 to 6% silver, developing a high shearing strength and having a melting point of 304° to 370°C. (580° to 700°F.) Temporary repairs may be effected with soft solder, but it is not considered good practice. All permanent repairs to radiators should be made with hard solder. A radiator torch should be used in this type of solder repair work and the temperature at which the solder is applied should never exceed 454°C (850°F.) when repairing radiator structures. When removing defective tubes, first clean the soldered ends of the tube with concentrated hydrochloric acid (muricated acid) with a small brush or swab, followed by swabbing with zinc chloride flux. It is necessary, when removing the core tube on coolant radiators, to cut the tube and remove each end separately, because the solder will harden as soon as heat is removed. For this purpose a core tube cutter should be used. After the tube is cut, the solder on one end will be melted with the torch, and while still molten the tube end may be removed with a wire hook. The opposite end will be removed in the same manner. For replacing the tubes and for any other radiator repairs with hard solder, zinc chloride flux only will be used for cleaning and the solder will be flowed by use of a torch. (Oil regulators are fabricated with soft solder and all repairs on these radiators may be made with a soldering iron. Repairs are made as on the coolant radiators except that in some cases the cleaning for satisfactory soldering will be more difficult. If necessary, concentrated hydrochloric acid may be brushed on to obtain good tinning and solder flow. This will be flushed off, however, as soon as practicable. Pulverized sal ammoniac when added to the zinc chloride flux will also aid solder flow.



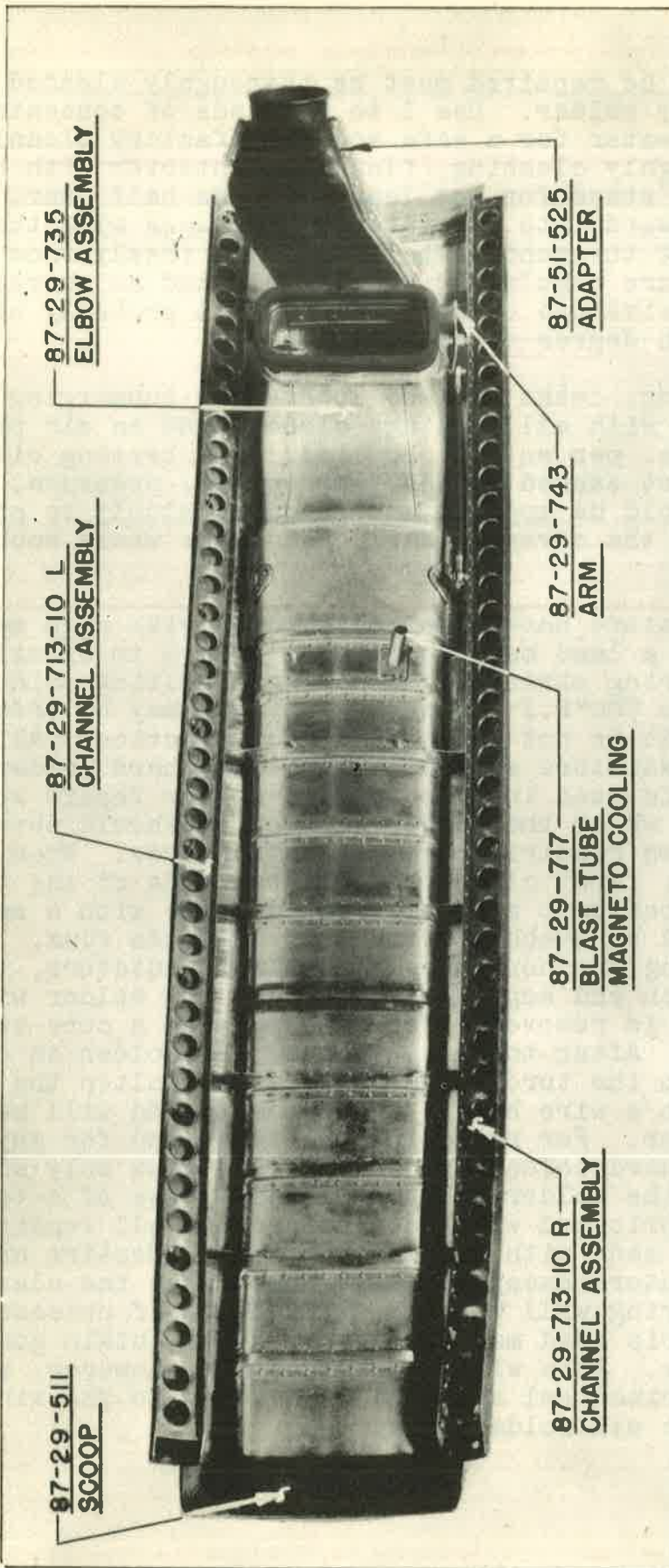


FIG. 72 TOP COWL - SCOOP ATTACHED

After repairs are completed the radiators should be tested for leaks using the same procedure as employed before repairs were made. It will be necessary to clean after repairs because a certain amount of corrosion will take place and definitely weaken the radiator if not properly cleaned. Therefore, after repairing and testing a radiator, it should be thoroughly flushed inside and out with hot running water and again steamed for 1/2 hour, however, this steaming may be omitted if the radiator is to be installed for immediate use, but in this case, any oil regulators will be first thoroughly dried either by immersing in hot light engine oil at a temperature of 121°C (250°F.) and agitating the regulator thoroughly until all bubbling ceases, which will indicate that all the water is evaporated and that the interior of the regulator is completely coated, or by baking in an oven at 121 to 135°C. (250° - 275°F.) for approximately one hour, or until all evidence of moisture has been removed.

Whenever a coolant radiator or oil regulator is to be placed in stock, a hot oil treatment should be applied to remove the moisture and cover the internal surfaces with a protective coating.

10. Exhaust System (Drawing No. 87-48-515)

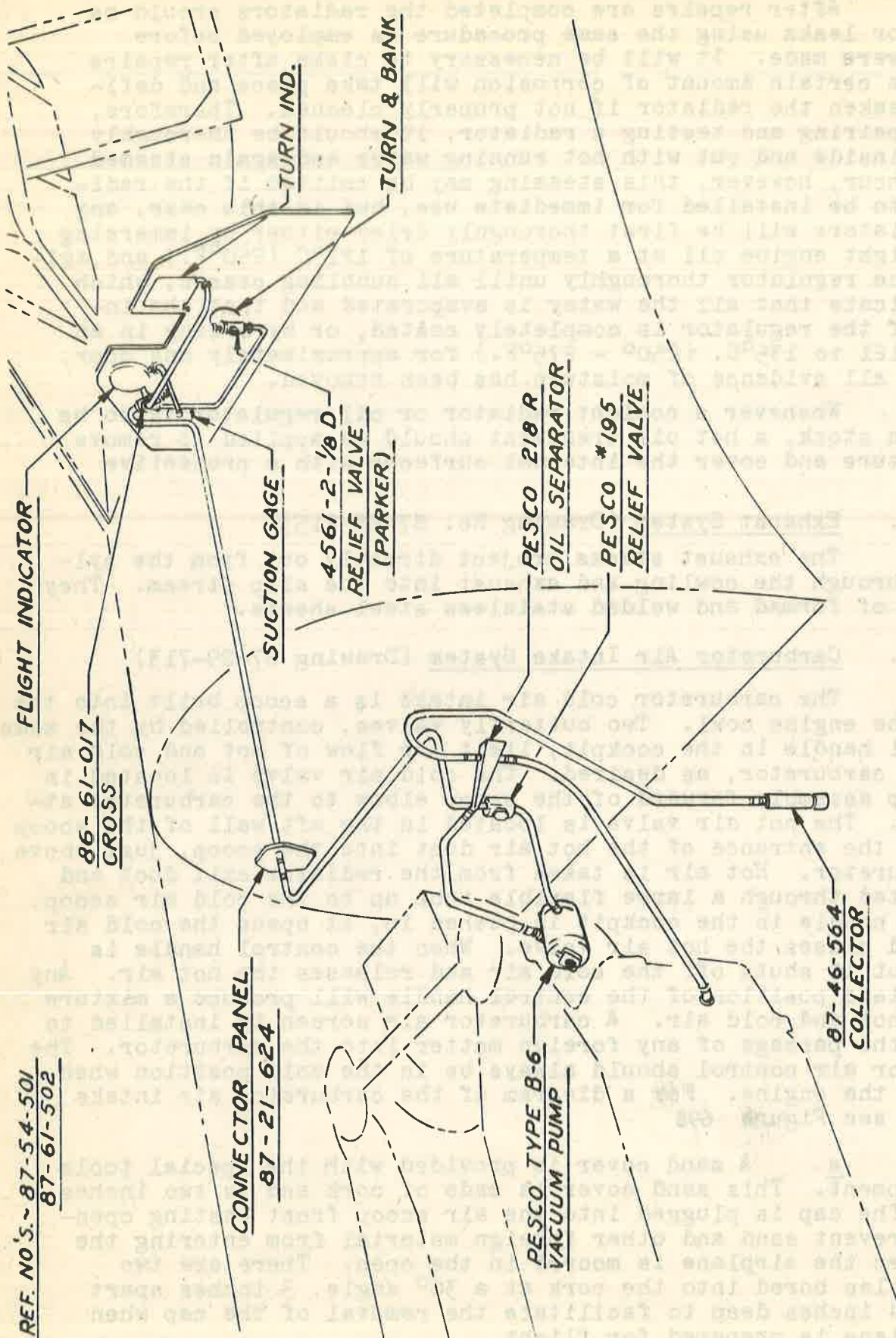
The exhaust stacks project directly out from the cylinders through the cowl and exhaust into the slip stream. They are made of formed and welded stainless steel sheets.

11. Carburetor Air Intake System (Drawing 87-29-713)

The carburetor cold air intake is a scoop built into the top of the engine cowl. Two butterfly valves, controlled by the same push-pull handle in the cockpit, limit the flow of hot and cold air into the carburetor, as desired. The cold air valve is located in the scoop assembly forward of the scoop elbow to the carburetor attachment. The hot air valve is located in the aft wall of the scoop elbow at the entrance of the hot air duct into the scoop, just above the carburetor. Hot air is taken from the radiator exit duct and transmitted through a large flexible tube up to the cold air scoop. When the handle in the cockpit is pushed in, it opens the cold air valve and closes the hot air valve. When the control handle is pulled out it shuts off the cold air and releases the hot air. Any intermediate position of the control handle will produce a mixture of both hot and cold air. A carburetor air screen is installed to prevent the passage of any foreign matter into the carburetor. The carburetor air control should always be in the cold position when starting the engine. For a diagram of the carburetor air intake control. see Figure 69B

a. A sand cover is provided with the special tools and equipment. This sand cover is made of cork and is two inches thick. The cap is plugged into the air scoop front casting opening to prevent sand and other foreign material from entering the scoop when the airplane is moored in the open. There are two finger holes bored into the cork at a 30° angle, 3 inches apart and 1 1/4 inches deep to facilitate the removal of the cap when the airplane is prepared for flight.





**FIG. 73 VACUUM SYSTEM**

12. Vacuum System (Drawing No. 87-54-501)

a. The gyro instruments are operated by the Pesco Type B-6 or B-11 engine-driven vacuum pump. This is a dry sump pump and is designed to eliminate the necessity of feeding lubricating oil into the pump proper. The pump consists essentially of a pair of involute type impellers mounted on steel shafts supported by ball bearings within an aluminum alloy housing. A pair of driving gears pinned to the impeller shafts keeps the impellers properly meshed. Lubrication of the driving gears is accomplished by supplying engine oil to the pump under pressure through an opening in the mounting flange. Inside the pump oil passes through a special metering device directly into the gears. Used oil drains back into the engine through a line connection from the drain hole in the front cover of the pump. The pump has a capacity rating of 600 ft. of free air per minute at 1500 R.P.M. with 4 inches of mercury suction and 1 inch of mercury pressure.

b. One relief valve Pesco #195 is installed in the vacuum pump intake line, located on the left hand side in the engine compartment inboard of the oil separator. This relief valve maintains constant suction throughout varying pump speeds and flight conditions. It is an adjustable, spring loaded disc type valve contained in a heat-treated aluminum alloy body and is designed for a minimum of restriction. The control valve is a bakelite disc contained in the end of a valve guide. A control spring holds the valve against a seat protected by a screen. The tension of this spring can be modified by means of an adjusting screw on the outside of the valve body to provide a range of suction adjustment of 3 to 8 inches of mercury. At 25 hour inspection periods clean the screen and check the connections. At regular engine overhaul periods remove the screened valve seat from the assembly and take out the bakelite disc. Inspect the disc and correct any slight wear by passing it lightly over a flat oilstone. If the wear is excessive, replace the part. See that the valve seat and the adjusting lock nut are fastened by means of safety wire. A Parker 4561-2-1/8D relief valve is installed on the back of the instrument panel in the line to the Turn and Bank Indicator.

c. An oil separator Pesco #218R is installed in the discharge line on the left hand side in the engine compartment. The oil drain line runs to the L.H. side of the engine crankcase. The discharge line from the separator connects to the drain collector on the left hand engine mount truss.

13. Starting System

a. The engine is cranked by a hand electric inertia starter, Type F-2. A foot treadle on the cockpit floor is pushed back to operate a Type D-1 starter switch which allows a direct flow of current from the battery to the starter motor. When the starter has reached the desired speed the foot treadle is pushed forward actuating a Type C-1 starter meshing solenoid and cuts in



the booster coil. Also, by the same movement of the foot treadle the starter switch contact is broken. The first few impulses of the engine in starting will automatically disengage the starter.

b. In case of battery failure the starter may be cranked by hand with the crank and extension provided for this purpose. (Crank and extension shaft are stowed in the fuselage directly opposite the access door.) The engagement of the starter will then be accomplished by a pull on the hand starter button located immediately above the crank.

Caution: Starter crank and extension must be removed immediately after cranking and before actuating starter pull.

14. Ground Check: Operating engines at low R.P.M. or idling speeds should be avoided as much as possible. Low engine operating speeds allow oil deposits to accumulate on the spark plug electrodes, due to low temperatures and fuel lead deposits. After starting the engine and the oil pressures have been established, run the engine at 900 to 1000 R.P.M.'s to warm up, as the temperatures and pressures stabilize, gradually increase the R.P.M. to 1400.

a. Spark Plugs and Ignition: Spark plugs that are not loaded up too badly with oil and fuel lead deposits can sometimes be cleaned out by pulling more power and higher R.P.M.'s. However, extreme care should be exercised not to operate up to 2600 R.P.M. and normal power and manifold pressure in inches of mercury (Hg.) for very long periods on the ground. CAUTION: Avoid all unnecessary low idling speeds preparatory to take-off. When checking the spark plugs and ignition by running on a single magneto, either intake or exhaust, never exceed cruising R.P.M.'s and manifold pressure on the ground, or in flight, to avoid damage or failure of the engine due to detonation from running on one spark plug only in each cylinder. An engine speed of 2200 R.P.M. and 27" Hg. manifold pressure, with the propeller in manual control, is sufficient to obtain a spark plug and ignition check. Spark plug and ignition ground checks made at too low an engine speed (1000 - 1800 R.P.M.) will not give satisfactory results, due to erratic low air flow, fuel metering, distribution and timing.

b. Magnetos: When switched to one magneto at a time, note the loss of revolutions and manifold pressure. NOTE: It is very important to switch back to "BOTH" and leave the switch in that position until the engine has regained the loss of R.P.M. from operating on one magneto, before testing the loss in R.P.M. on the other magneto. Check magnetos with the switch to determine the R.P.M. drop on each magneto. The drop in R.P.M. will be more on the intake (left) magneto than on the exhaust (right) magneto which is timed 6° in advance of the intake magneto. A drop of 50 R.P.M.'s is normal, and a drop of 100 R.P.M.'s or more generally indicates

faulty or defective ignition. If it is found that the engine is smooth on either left (intake) or right (exhaust) magnetos, but rough when the engine is operated with the switch in both "ON" positions and both magnetos operating, check the magneto timing, as this is an indication of too advanced spark timing. CAUTION: These single magneto checks should be made in as short a time as possible, and should not exceed fifteen seconds.

c. Propeller and Governor: Set the propeller control in "MANUAL" and check the propeller and governor operation by adjusting the propeller pitch and throttle to operate the engine at the specified cruising speed (R.P.M.) and manifold pressure. Change the propeller control to the "AUTOMATIC" position and check for the same R.P.M. and manifold pressure.

d. Engine Temperature and Pressure Gauges: Check the engine temperature and pressure gauges, as any irregularity or malfunctioning of the engine can readily be detected by these instruments. If there is any question about the accuracy of the temperatures and pressures recorded, check the recording instruments, particularly the oil and manifold pressure gauges, oil and coolant temperature indicators and tachometer for accuracy.

e. Idling: Set the idle throttle speed adjustment for 600 to 650 R.P.M. and adjust the idle mixture control for maximum power and highest manifold pressure reading insuring the proper idle mixture strength. Reset the idle throttle speed adjustment to the preferred idling speed.

f. Operating Limits: The operation of the engine in excess of the manufacturer's specifications raises the compression pressures and peak temperatures of the engine, inducing pre-ignition and detonation, producing vibration and excessive mechanical stressing of the engine, and will result in shorter engine life, less reliability and ultimate engine failure.



TO FUEL PRESSURE WARNING LIGHT

CONTROL VALVE

FUEL PRESSURE SIGNAL

TO OIL DILUTION VALVE PRIMER

HAND PUMP

TO OIL DILUTION VALVE PRIMER

HAND PUMP

TO OIL DILUTION VALVE PRIMER

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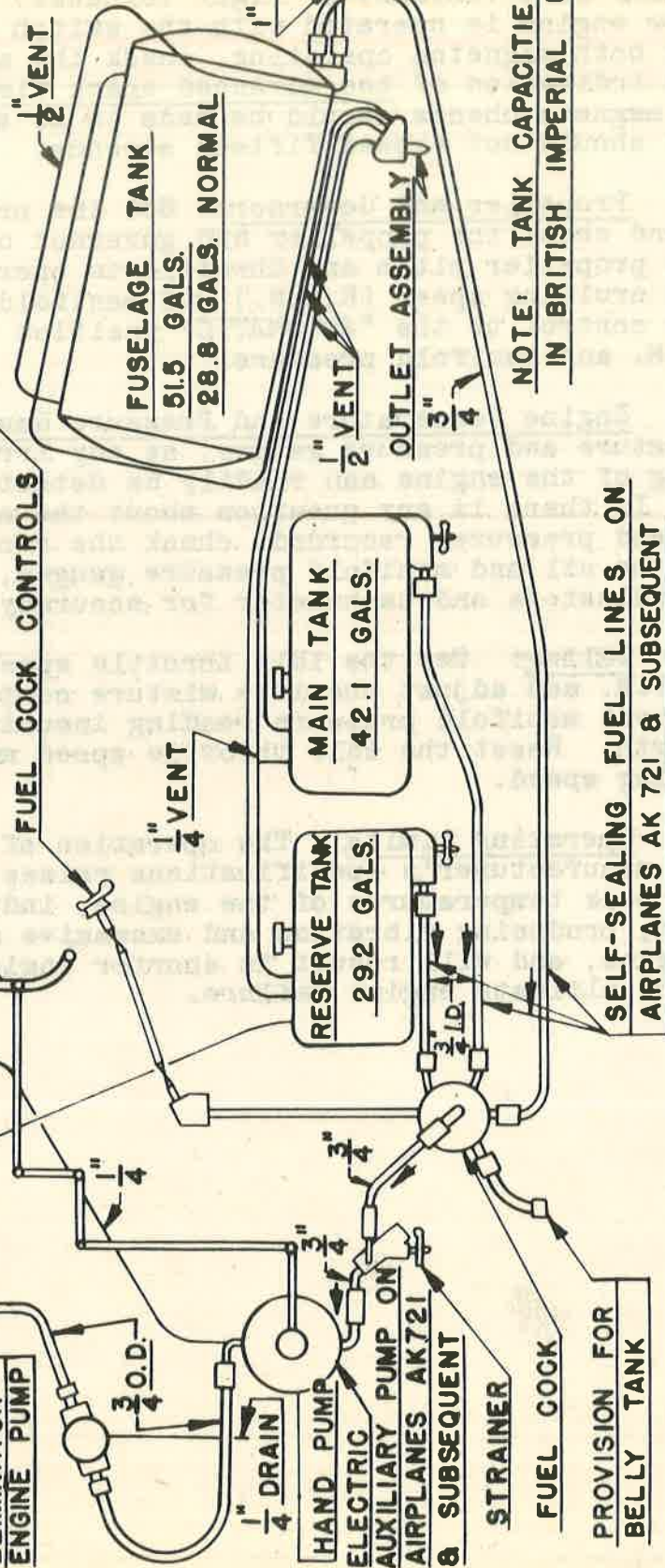
HAND PUMP

TO OIL DILUTION VALVE PRIMER

HAND PUMP

TO OIL DILUTION VALVE PRIMER

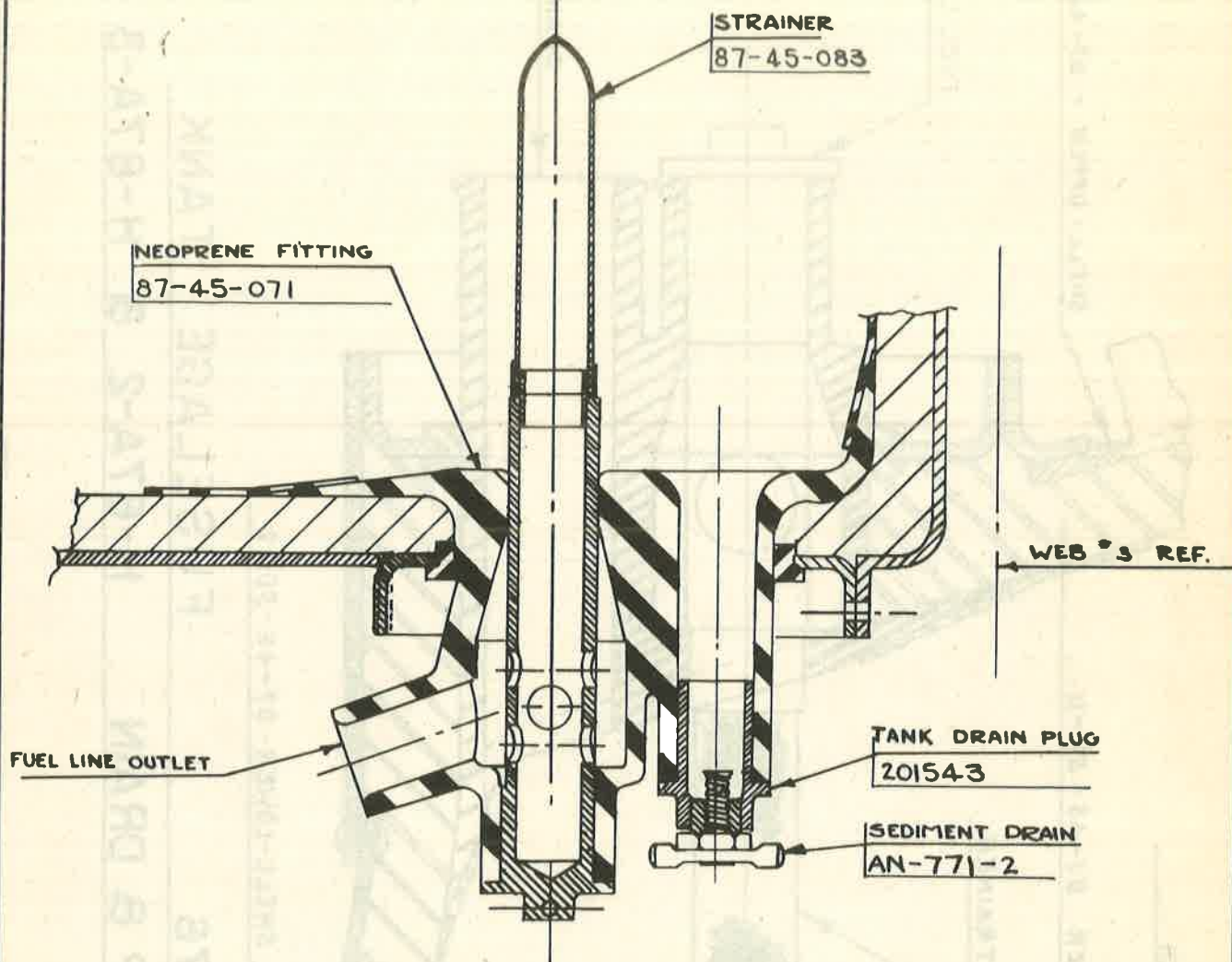
HAND PUMP



NOTE: TANK CAPACITIES ARE  
IN BRITISH IMPERIAL UNITS.

SELF-SEALING FUEL LINES ON  
AIRPLANES AK 721 & SUBSEQUENT

FIG. 74 FUEL SYSTEM H-87A-2 & H-87A-3



**FIG. NO. 75**  
**SUMP ARRANGEMENT**  
**WING FUEL TANK H-87A-2 & H-87A-3**

REF. DWG.'S. - 87-45-504 & 87-45-505



REF. DWG. 87-45-501

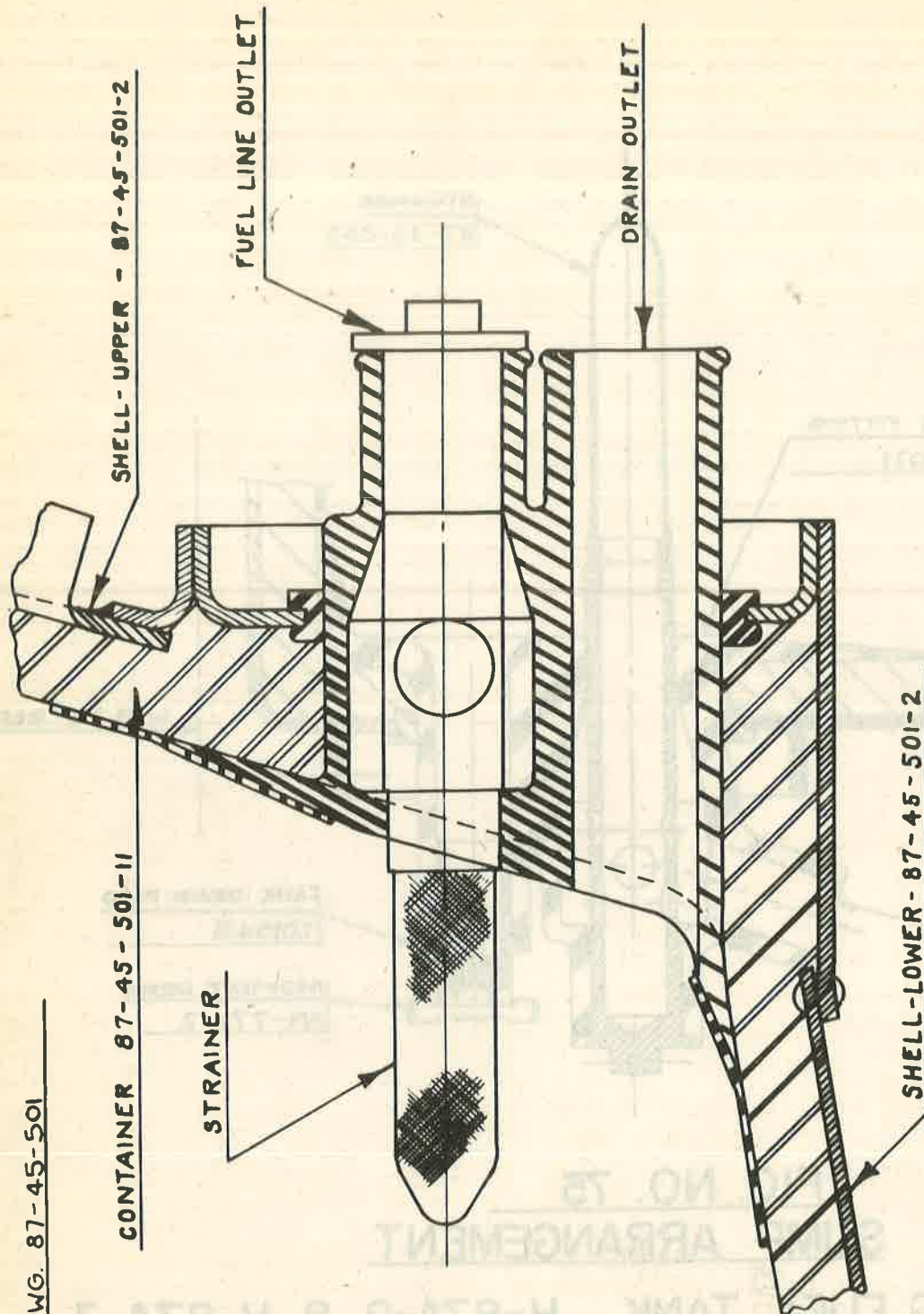
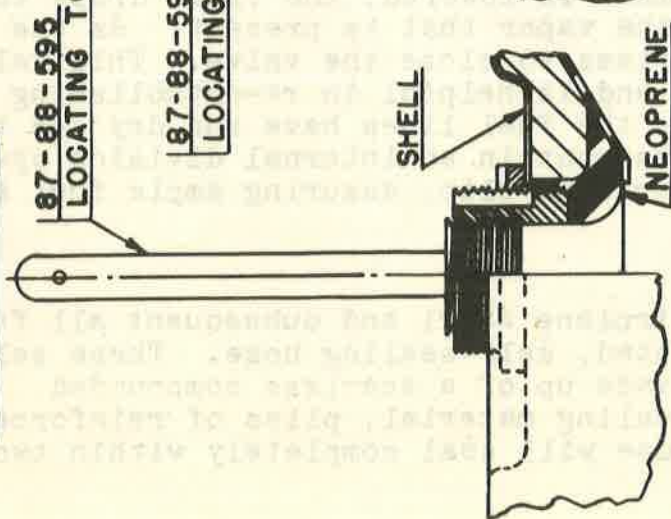


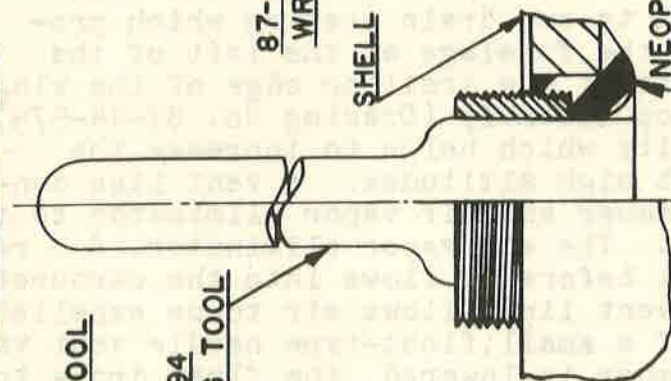
FIG. 76 FUSELAGE TANK  
SUMP & DRAIN H-87A-2 & H-87A-3

SECTION B-B  
ENLARGED VIEW



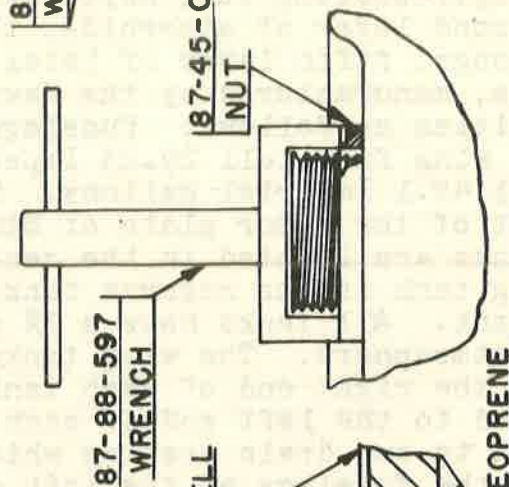
GAGE NECK-LOCATING TOOL INSTALLED

SECTION A-A  
ENLARGED VIEW



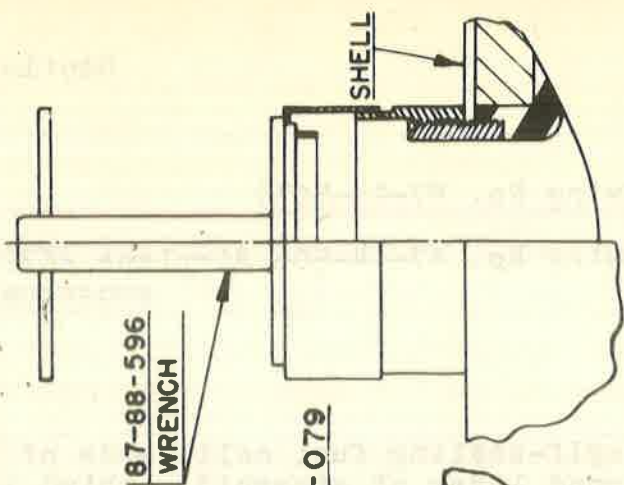
FILLER NECK-LOCATING TOOL INSTALLED

SECTION D-D  
ENLARGED VIEW



GAGE NECK-WRENCH INSTALLED

SECTION C-C  
ENLARGED VIEW



FILLER NECK-WRENCH INSTALLED

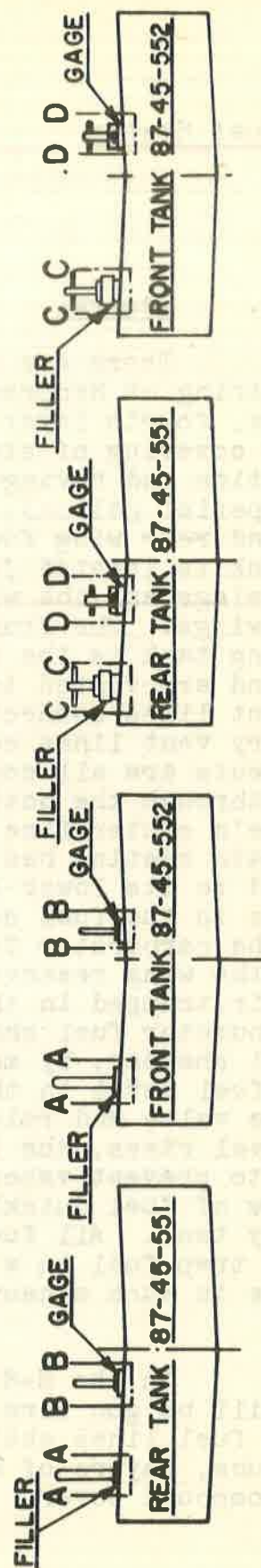


FIG. 77 WING TANK INSTALLATION TOOLS H-87A-2 & 3



H. Fuel System

(Drawing No. 87-44-503)

(Drawing No. 87-44-506 Airplane AK721 and subsequent)

1. General

There are three self-sealing fuel cells made of an inner lining of Neoprene, second layer of steerhide, third layer of Latex, fourth layer of sponge, fifth layer of Latex and an outside covering of steerhide, manufactured by the Hewitt Rubber Corporation and having capacities as follows: fuselage fuel cell 51.5 Imperial gallons; front wing fuel cell 29.23 Imperial gallons; and rear wing fuel cell 42.1 Imperial gallons. The fuselage tank is located just aft of the armor plate at Sta. #5 in the fuselage and the wing tanks are located in the center part of the wings. The front wing tank is the reserve tank and the rear wing tank is the main tank. All tanks have a 3% expansion space and are vented to the atmosphere. The wing tanks have main vent lines connected to the right end of each tank and auxiliary vent lines connected to the left end of each tank. These vents are all connected to one drain casting which protrudes through the bottom of the fuselage at the left of the airplane's center line and aft of the trailing edge of the wings. This drain casting has a scoop assembly (Drawing No. 87-44-575) attached to its lower extremity which helps to increase the pressure in the fuel cells at high altitudes. A vent line connects the carburetor fuel chamber and air vapor eliminator to the top of the wing reserve tank. The air vapor eliminator, A-6 removes air trapped in the fuel before it flows into the carburetor. The carburetor fuel chamber vent line allows air to be expelled from the fuel chamber, by means of a small, float-type needle vent valve. As the fuel level in the chamber is lowered, the float drops to open the valve and releases the vapor that is present. As the fuel level rises, the float rises to close the valve. This valve serves to prevent vapor lock and is helpful in re-establishing a new flow of fuel quickly when the fuel lines have run dry due to an empty tank. All fuel tanks contain an internal division system to trap fuel in a bank or side slip, assuring ample fuel available in such maneuvers.

On the H-87A-3 airplane AK721 and subsequent all fuel lines will be gun fire protected, self-sealing hose. These self-sealing fuel lines shall be made up of a seamless compounded inner tube, layers of self-sealing material, plies of reinforcement and a compound cover. The hose will seal completely within two

minutes after puncture, at a temperature of 25° to 100°F. (-4°C. to 38°C.) and will seal within four minutes after puncture at a temperature of minus 20°F.

ALL CLAMPS AROUND SELF-SEALING HOSE SHOULD BE FINGER-TIGHTENED ONLY. DO NOT USE PLIERS OR OTHER TOOLS:

Excess tightening of these hose clamps will cause the gum rubber layer to squeeze out from under the clamp, causing the clamp to cut into the outer layer and in time, cause failure of the hose.

WARNING: Be sure that all layers of material in the self-sealing hose are firmly sealed together. After installation, be sure that the proper number of layers of material are showing beyond the clamp. Any discrepancy here, will require immediate investigation, as a layer of material may have been pushed into the hose when it was installed on the tube connection, thus closing the fuel passage.

Fuel is pumped from the tanks to the injection type Stromberg-Bendix carburetor by a Type G-9 engine driven fuel pump. A hand booster pump is located in the suction line between the engine driven fuel pump and the selector valve on airplanes AK571 - AK720. On airplanes AK721 and subsequent, an electric fuel pump is incorporated in the system replacing the hand pump. This electrical unit consists of an integral explosion proof electric motor, and a small centrifugal pump. The electric auxiliary pump does not replace the engine driven pump, but is used in conjunction with it. The electric auxiliary pump is controlled by a switch in the cockpit which has two positions, "OFF", and "ON". When starting the engine the switch is thrown to the "ON" position and should remain "ON" for all engine operations. Fuel system failures and forced landings during flight will unquestionably result if there is lack of knowledge on the part of the pilot and service depots regarding the operation characteristics of the fuel system and the proper operations to be performed to insure its normal functioning. All pilots and service personnel should have a thorough knowledge of the following before flying the airplane:

- a. Fuel consumption of the engine, both at cruising and full throttle.
- b. Capacity of each fuel tank.
- c. Location of each fuel valve in the cockpit and the function of each with reference to the operation of the engine.
- d. Location of sight fuel gages.

No tank should be permitted to run entirely dry at any time and the change from one fuel tank to another should be made at the first indication of loss of fuel pressure. The change over from one source of fuel supply to another should be made as follows: While the engine is still running, hold the airplane in level flying position, throttle position unchanged, mixture control on "FULL RICH" and switch the fuel valve to the required position. When the engine is not running, a decided "click" can be heard when the indicating





does not replace the engine driven pump, but is used in conjunction with it. At low altitudes the booster ordinarily is not operated. Its impeller is so designed that fuel can be drawn directly through it by the engine driven pump. At high altitudes where the engine driven pump normally begins to fail due to vapor formation at the relief valve, the electric auxiliary pump is cut in when the pressure in the fuel system drops below 12 pounds and the fuel pressure warning light flashes on. This restores low altitude suction line pressure, and when the fuel flow to the carburetor is restored to 14 pounds the electric auxiliary pump is cut out again. Aside from its main function of providing successful high altitude operation, the booster pump is used to supply the necessary fuel pressure when starting the engine and may be used during take-off to overcome inertia effects in the lines at the time of maximum fuel flow.

The electric auxiliary pump is controlled by a switch in the cockpit which has two positions, "OFF", and "ON". When starting the engine the switch is thrown to the "ON" position. This will provide adequate fuel pressure for starting, warm up and take-off. After taking off and the fuel pressure shows a reading of 12 to 14 pounds, the switch should be returned to the "OFF" position.

NOTE: When the airplane is in flight the pilot should observe the fuel pressure warning light at all times and cut in the auxiliary electric fuel pump whenever the light flashes to restore normal fuel pressure in the system.

Fuel system failures and forced landings during flight will unquestionably result if there is lack of knowledge on the part of the pilot and service depots regarding the operation characteristics of the fuel system and the proper operations to be performed to insure its normal functioning. All pilots and service personnel should have a thorough knowledge of the following before flying the airplane:

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plate is engaged. When the engine is running, this engagement can also be felt through the control handle. It is mandatory that fuel cock settings be determined by this "click" or "feel" and not solely by the position of the control handle pointer in the cockpit. If this precaution is not taken fuel may flow between tanks creating a very dangerous condition. Inability to hear the "click" or "feel" the engagement is usually caused by excessive drag in the fuel cock or by interference of the rods with other parts. Whenever this condition occurs the control linkage will be disconnected at the fuel cock yoke and both the control linkage and fuel cock assembly will be checked for freedom of movement. Drag in the fuel cock assembly can be determined by turning the cock stem yoke with the fingers. CAUTION: Whenever fuel cock controls are disconnected or fuel cock assemblies are removed or replaced, the reassembly of parts must be carefully checked to insure that the valve ports open to the tank positions indicated by the control handle pointer.

e. The air vapor eliminator external unit is a tank type assembly mounted on the right hand engine mounting support just forward of the firewall, to the right of the carburetor housing.

The unit consists of an outer and an inner chamber in which is mounted a float operated needle valve at the top of the assembly. At the base are two openings, the inlet, connecting the outer chamber with the line from the fuel pump; and the outlet, connecting the inner chamber with the line to the carburetor.

At the top of the unit, a line connects the needle valve to an adjustable control air valve, No. 32040, which is set to open at pressures above approximately 12 P.S.I. A vent line connects the control valve to a fuel tank.

As fuel is drawn from the main line by the fuel pump, it enters the outer chamber of the unit and flows upward and into the inner chamber, thence through the outlet to the carburetor. The fuel pump maintains a fuel pressure of about 12 P.S.I.

As the fuel level in the unit rises, the air is forced through the needle valve into the control valve, set to open at 12 P.S.I. and into the vent line.

When the proper fuel level is reached, the float rises and closes the needle valve. A constant pressure of 15 P.S.I. being now maintained.

When air is pumped into the unit, by reason of an empty tank, the pressure drops to approximately 10 P.S.I. As the fuel level lowers, the float drops, allowing the needle valve to open and air to pass into the control valve. As the control valve is set to open at 12 P.S.I. a constant pressure feed of fuel remaining in the unit is fed to the carburetor. The capacity of the

unit is slightly over one gallon and is sufficient to operate the engine for approximately 90 seconds, to guard against engine failure when switching from an empty tank to a full one.

When fuel is again pumped into the unit at 15 P.S.I. pressure, the air in the unit is forced through the control valve into the vent line. When the correct fuel level is reached, the float rises and closes the needle valve.

2. Strainers and Tank Drains

In the bottom of each tank is a sump fitting in which is installed the tank finger strainer, fuel line outlet, and the drain plug, a drain cock for the removal of water. The drain plug is installed directly in the sump fitting in the wing tanks and a remote drain is provided for the fuselage tank. The tank sumps are designed to permit the settling of water to the sump and the removal of this water from the sump without draining the entire tank. Access to the wing tank sumps and drains is through doors in the keel fairing. The drain assembly for the fuselage tank is under the fuselage to the right of the keel fairing and aft of the trailing edge of the wing, also accessible through a door.

Beside finger strainers in each tank there is a Type C-3 fuel strainer in the main fuel line between the selector valve and the hand fuel pump. (Airplanes AK571 - AK720 - Electric Auxiliary Pump Type G-6 on Airplanes AK721 and subsequent) Access to this strainer is gained through the rear engine cowl aft of the shutters. There is also a strainer in the carburetor.

3. Fuel Quantity Gages. Each wing tank is equipped with a float-type sight-gage mounted in the top of the tank with the dial face protruding through the cockpit floor. These gages are individually illuminated.

4. Primer

The engine primer system consists of a supply line from the hand pump (Airplanes AK571 - AK720) and the electric auxiliary pump (Airplanes AK721 and subsequent) to the Parker Type E-2 Primer, located in the cockpit, below the main switch panel, and a line from the primer to the engine intake manifold.



will be slightly over one gallon and is sufficient to operate the engine for approximately 90 seconds, to permit manual engine failure tests without loss of safety from a fuel tank.

The fuel is supplied to the engine by a fuel line which is connected to the fuel tank. The fuel line is covered through the control valve. When the fuel level is reached, the fuel valve and electric fuel valve.

### Engine and Fuel System

In the bottom of each tank is a pump fitting in which is installed the fuel pump. Fuel line, fuel filter, and the drain plug for the removal of water. The drain plug is installed in the pump fitting in the fuel tank and a remote drain is provided for the fuel tank. The fuel tank is designed to permit the settling of water in the pump and the removal of this water from the pump without draining the entire tank. Access to the fuel tank is through the fuel line in the fuel tank. The drain assembly for the fuel tank is under the fuel tank to the front of the fuel tank and all of the fuel tank is the fuel tank. Also accessible through a door.

Outside finger assembly in each tank there is a Type C-3 fuel assembly in the fuel line between the engine valve and the fuel tank. (Aluminum Alloy - AL7075 - Electric Auxiliary Pump Type C-3 on Aluminum Alloy and Aluminum) Access to this assembly is gained through the rear engine and side of the engine. There is also a fuel tank in the engine.

Two fuel tanks. Each fuel tank is equipped with a float-type sight-glass located in the top of the tank with the fuel level. These gauges are individually indicated.

The engine primer system consists of a supply line from the hand pump (Aluminum Alloy - AL7075) and the electric auxiliary pump (Aluminum Alloy) to the fuel tank. The fuel tank is located in the engine, below the main switch panel, and a line from the primer to the engine intake manifold.

The priming system on the engine is independent of the carburetor, and pumping the carburetor throttle will not discharge fuel into the engine, as all fuel is injected by the fuel discharge nozzle to the supercharger inlet; where it is mixed with the air passed through the carburetor throttle openings.

#### Underpriming and Overpriming:

Underpriming is sometimes caused by leaking primer lines and connections, or defective primer pump packing. The fuel supply to the primer, wobble or electric auxiliary pump, should be checked.

Overpriming is first indicated by very weak combustion followed by black smoke discharge from the exhaust stacks. Excessive priming is evidenced by wet spark plugs and fuel appearing at the exhaust stacks. Since the prime fuel is injected directly into the intake manifolds of each cylinder, excess fuel will not be carried off by the supercharger scroll drain, which relieves the scroll housing of excess fuel delivered only by the discharge nozzle which has opened, either by too high fuel pressure being wobbled with the carburetor manual mixture control out of "IDLE CUT-OFF" position or by leakage of the discharge nozzle. Check nozzles for leakage or holding open due to dirt or foreign material. Overpriming also constitutes a dangerous fire hazard, as well as diluting the oil film lubrication of the pistons, rings, and cylinder walls of the engine. EXTREME CAUTION should be exercised to avoid overpriming on either a HOT or COLD engine. To relieve overpriming, crank the engine several revolutions with the switch in the "OFF" position, throttle wide open and mixture control manual in "IDLE CUT-OFF" position. Relief can also be gained by turning the propeller by hand in the direction of rotation. NOTE: Loss of compression (check by rotating the propeller by hand in direction of rotation) due to overpriming may require lubrication of pistons, rings, and cylinder walls with oil, through the valve ports or spark plug holes.

#### 5. Scupper Drains

The wing tank scuppers in the left hand wing fillet are provided with drain lines passing downward through the lower wing skin just to the left of the tank door.

#### 6. Removal of Either Wing Tank

- a. Remove the inboard, fixed landing gear fairing.
- b. Remove the keel fairing.
- c. Remove the wing fillets.
- d. Drain the fuel cells.
- e. Disconnect the vent lines at the top of the fuel cells.



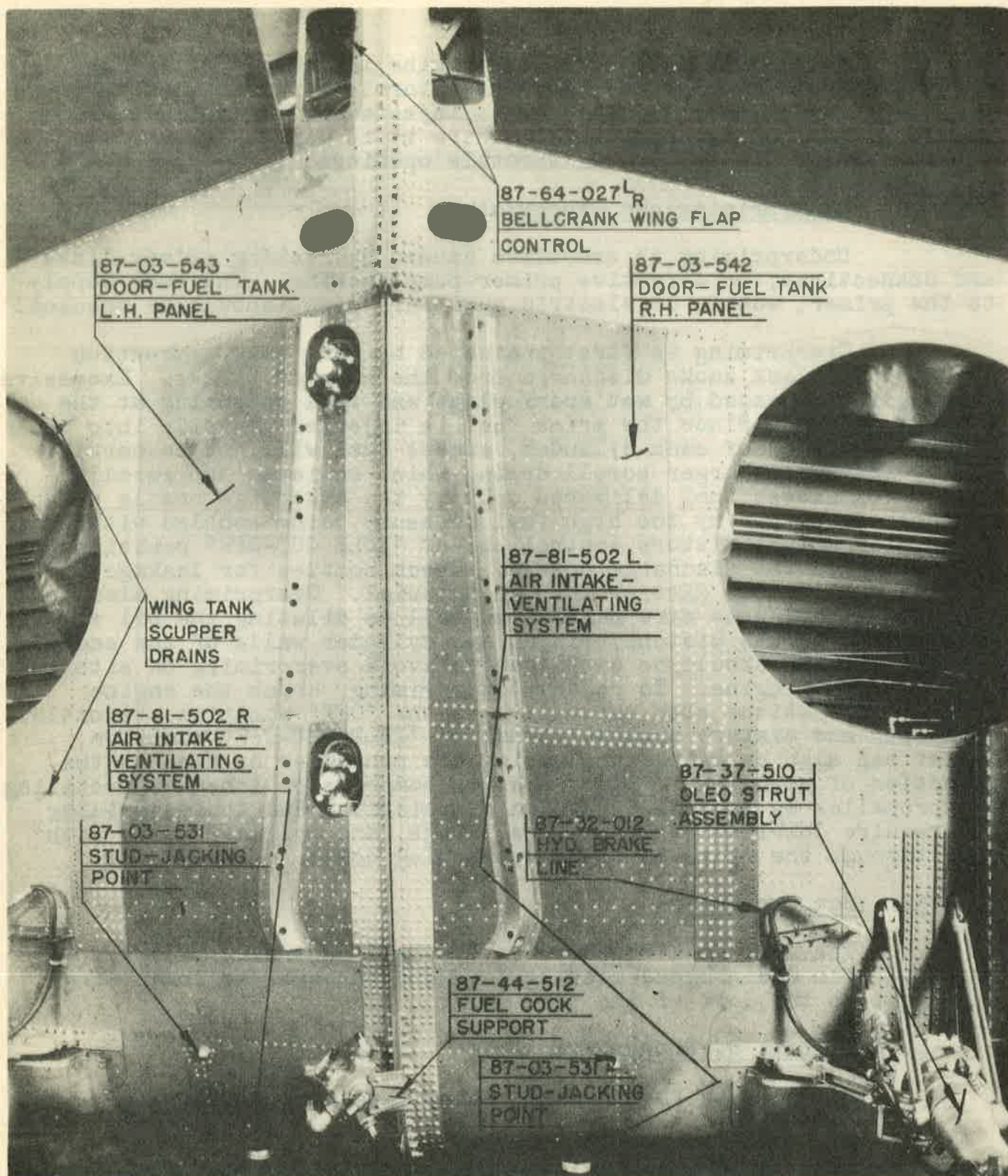


FIG. 78 FUEL TANKS - WING - DOORS  
INSTALLED H-87A-2 & H-87A-3

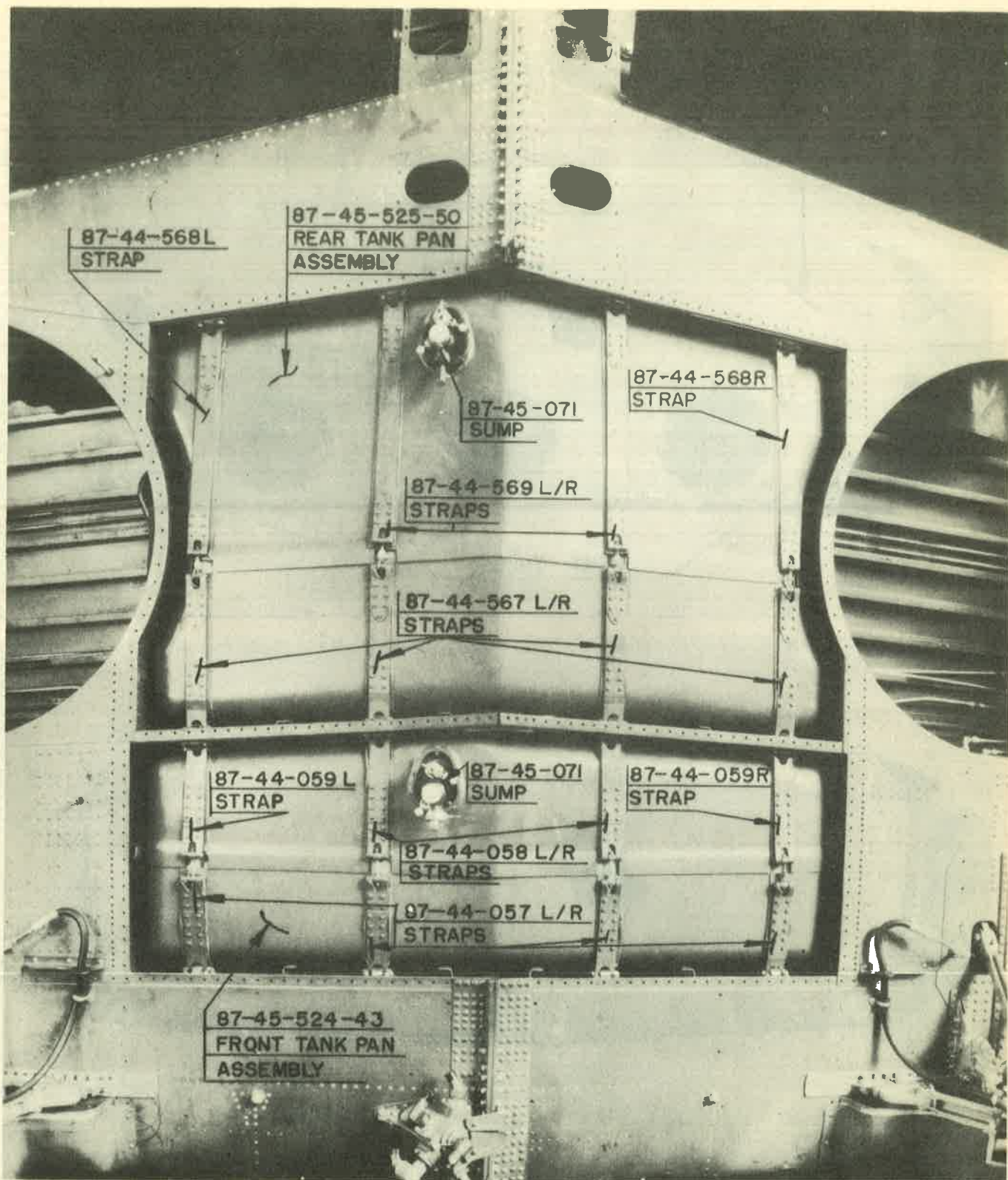


FIG 79 WING FUEL TANKS-INSTALLED  
DOORS REMOVED H-87A-2 & H-87A-3



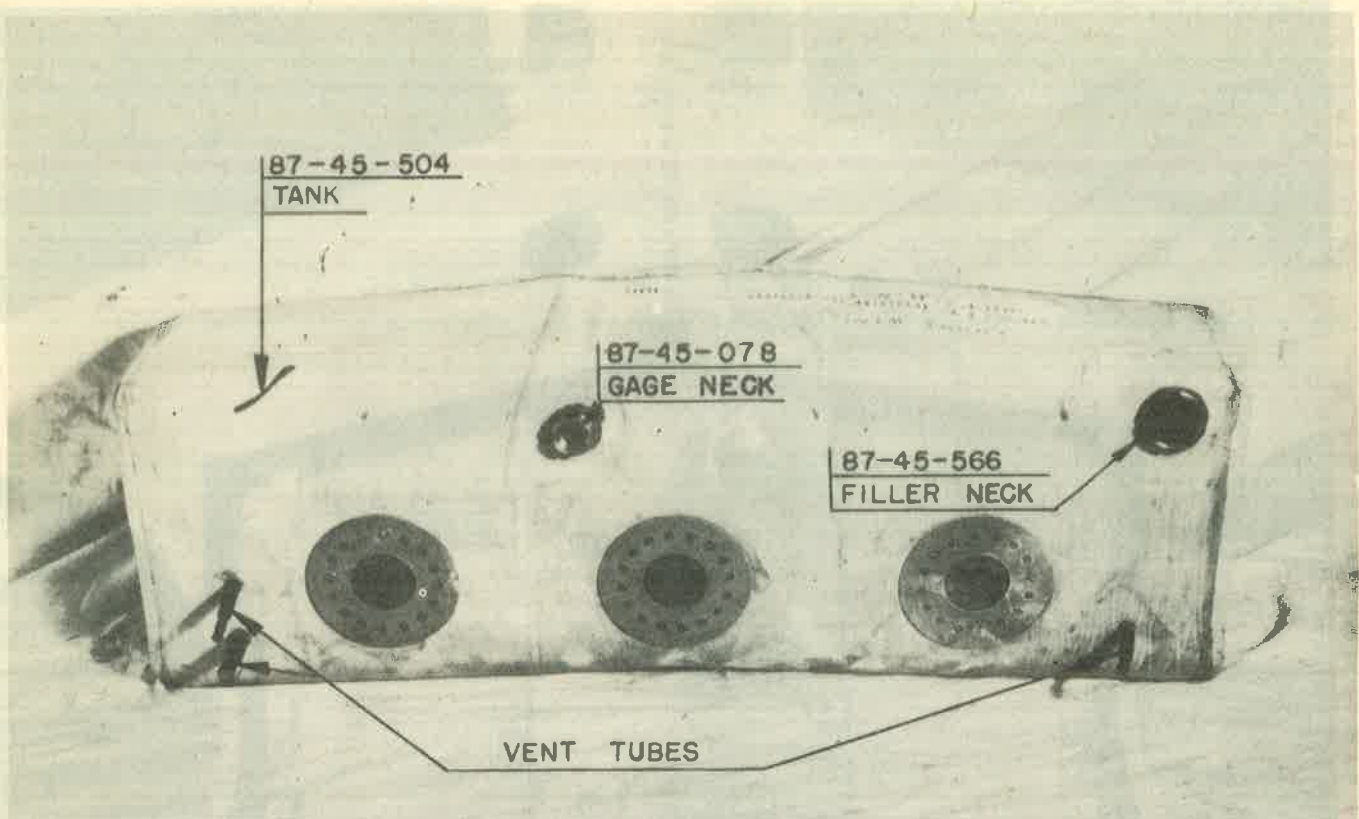


FIG.80 FUEL TANK WING - FRONT  
H-87A-2 & H-87A-3

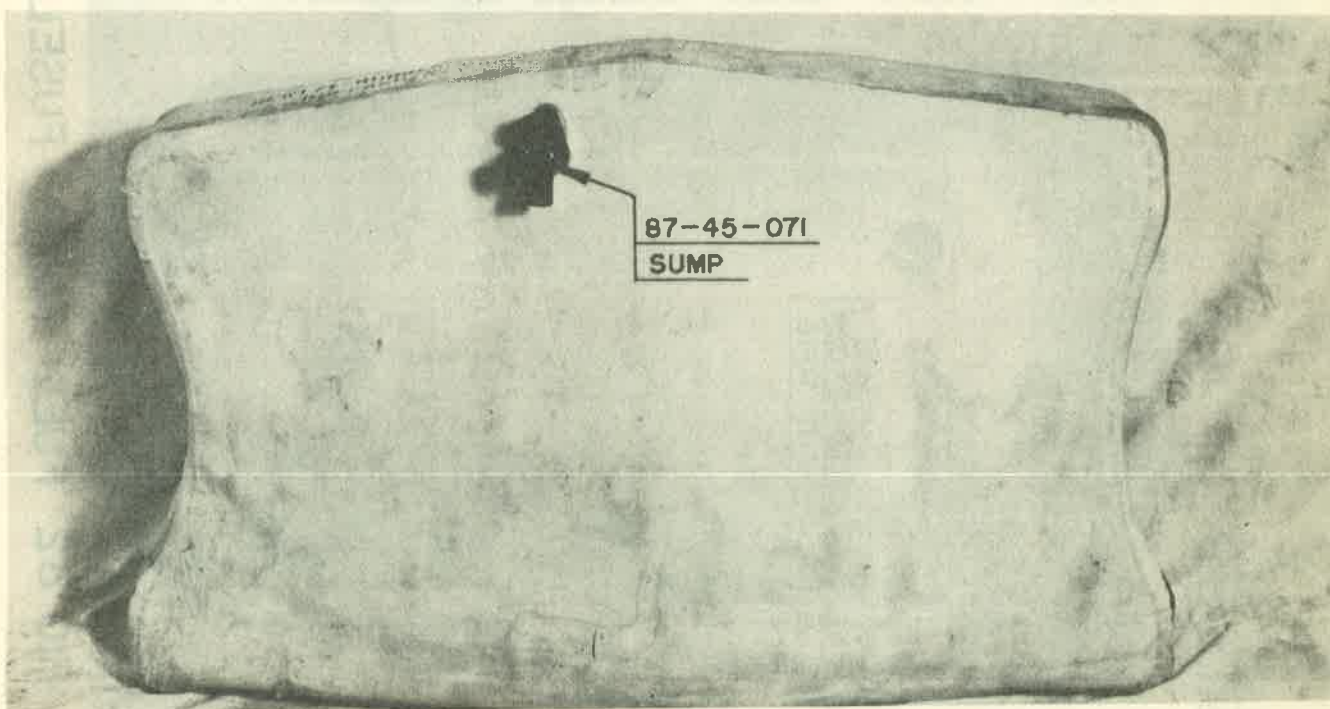
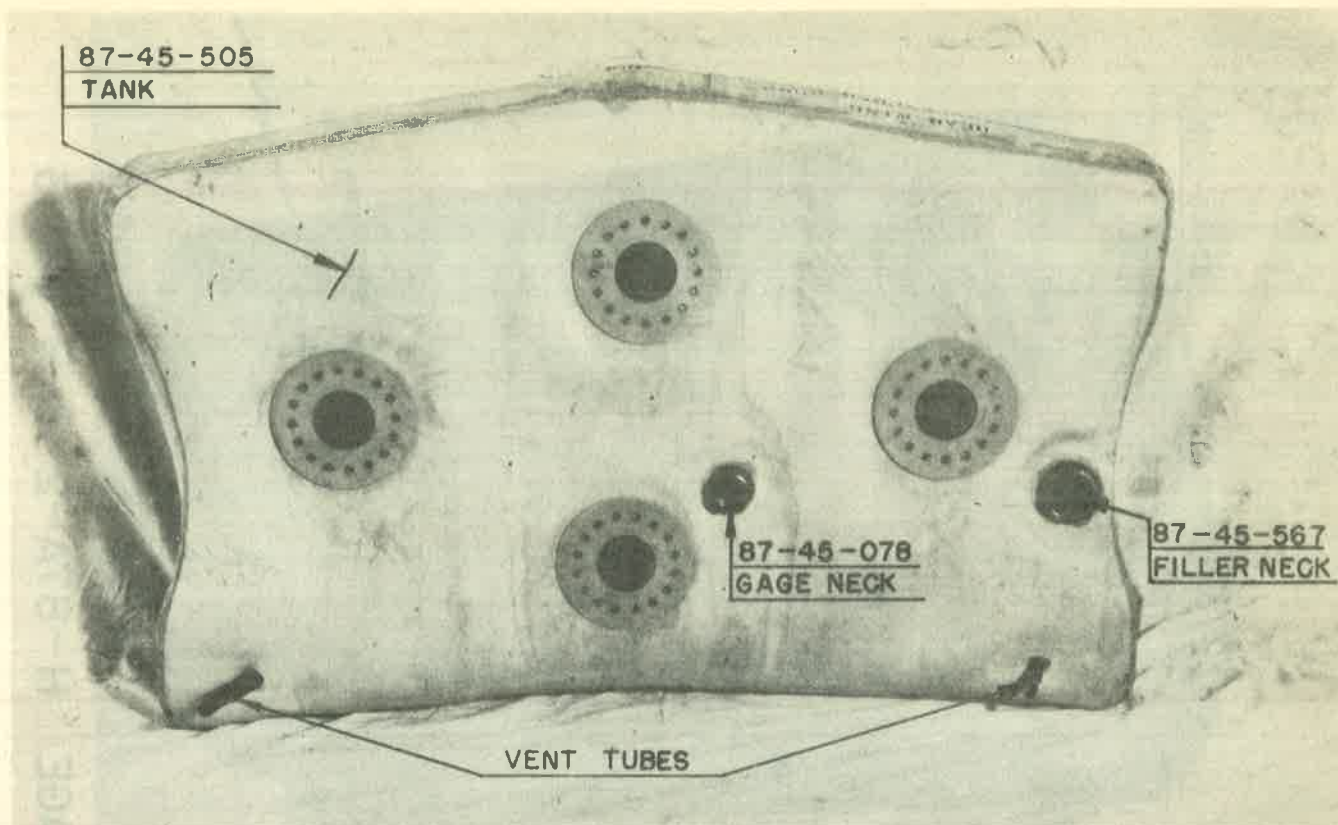


FIG. 81 FUEL TANK, WING-REAR  
H-87A-2 & H-87A-3



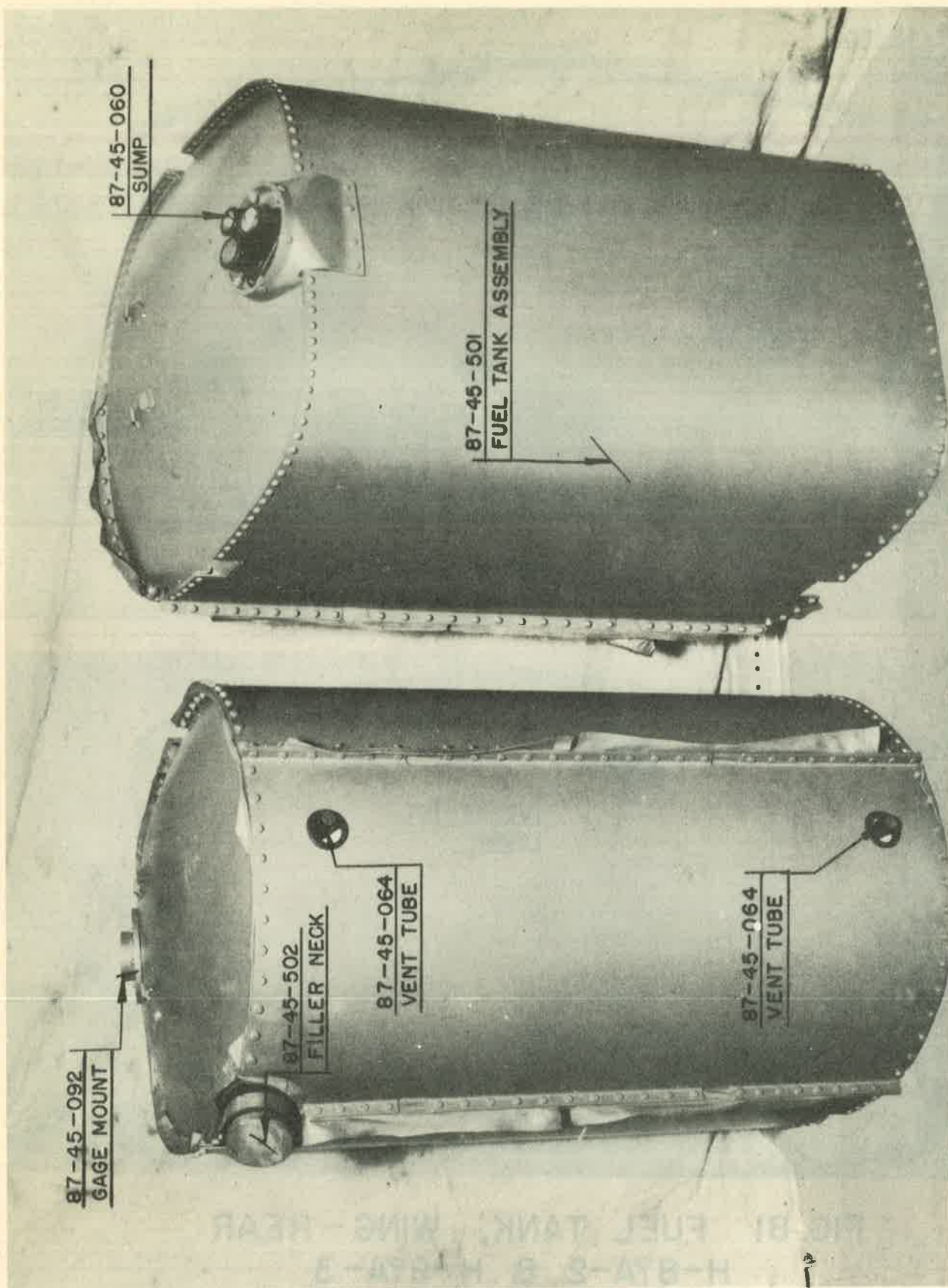


FIG. 82 FUEL TANK - FUSELAGE H-87A-2 & H-87A-3

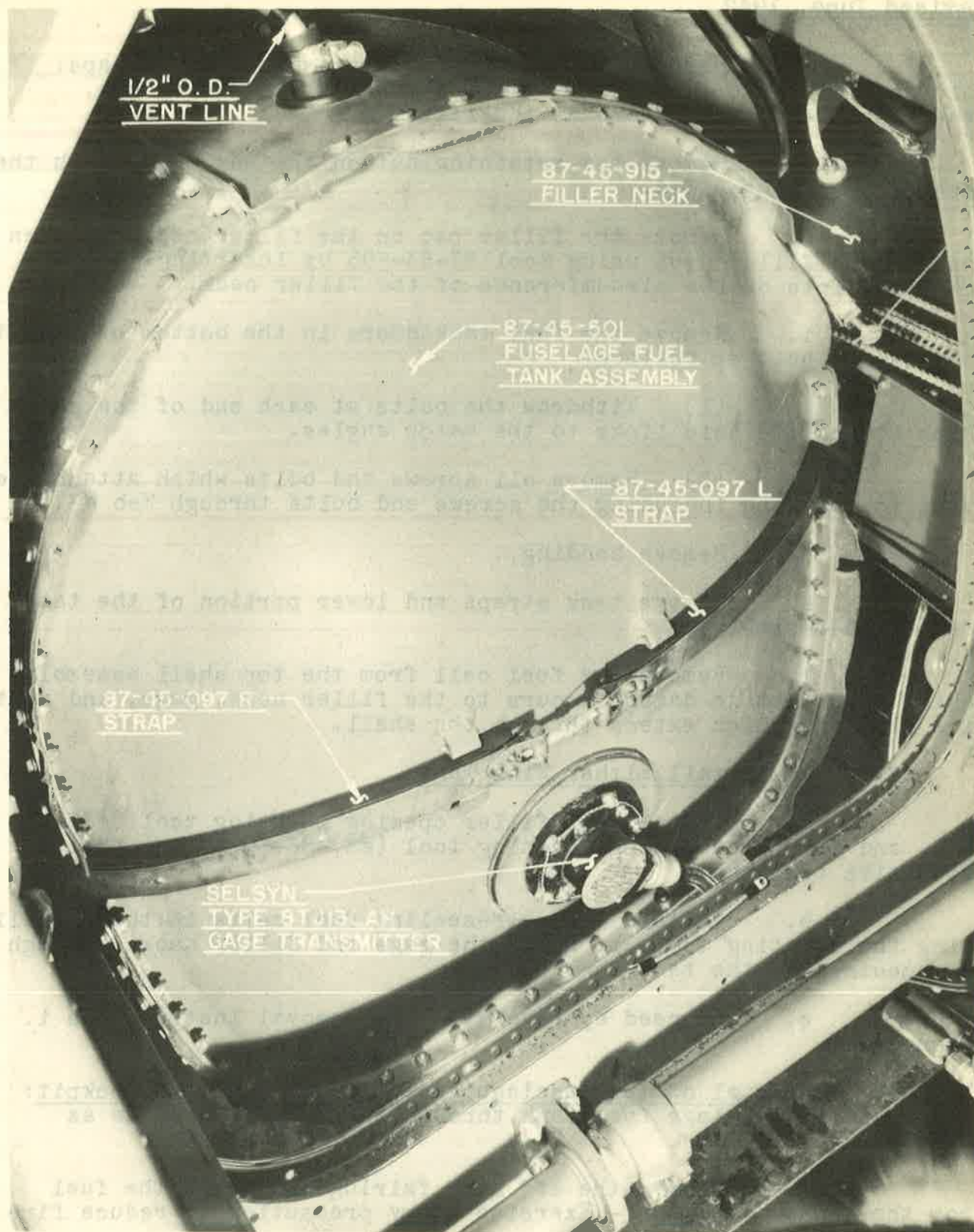


FIG. 83 FUSELAGE FUEL TANK INSTALLATION



f. Remove fuel lines, fuel gages and filler caps. All connections to the self-sealing fuel cells must be broken, otherwise they will be torn at the fittings.

g. Remove the retaining nut on the gage neck with the special wrench provided.

h. Remove the filler cap on the filler neck and then unscrew the filler neck using tool 87-88-596 by inserting the tool into the slots on the circumference of the filler neck.

i. Remove the fuel tank doors in the bottom of the wing as a single unit as follows:

(1) Withdraw the bolts at each end of the skid, which attach the skid links to the match angles.

(2) Remove all screws and bolts which attach the doors to the wing including the screws and bolts through Web #3.

j. Remove bonding.

k. Remove tank straps and lower portion of the tank shell (pan assembly).

l. Remove the fuel cell from the top shell assembly taking care that no damage occurs to the filler neck, gage, and vent line fittings which extend through the shell.

7. To Install Either Wing Tank:

a. Install the filler opening locating tool (#87-88-594), and the gage opening locating tool (#87-88-595) into their respective openings.

b. Install the self-sealing fuel cells in their shells using the locating tools to guide the gage and filler necks through the openings in the tank shells.

c. Proceed by reversing the removal instructions i. through a.

8. Removal of the Fuselage Fuel Tank through the Cockpit:  
To remove the fuselage fuel tank through the cockpit procede as follows:

a. Remove the aft keel fairing and drain the fuel from the tank. CAUTION. - Exercise every precaution to reduce fire hazards.

b. Working through the fuselage access door remove the duffle bag, the radio transmitters on the shelves forward of the door and the top radio shelf attached to bulkheads #8 and #9. Remove the radio receiver and transmitter unit from the shelf aft of the access door.

c. Climb through the access door into the fuselage and disconnect the fuel supply line at the bottom rear of the tank. Disconnect the rear vent line at the top of the tank. Cut the lock-wire and disconnect the turnbuckle at the aft end of the tank and the rear tie-down strap at the top of the tank. Disconnect the bonding tab at the nut plate on the tank to the right of the sump assembly.

d. Working from within the cockpit, remove the pilot's seat.

e. On P-40E-1 airplanes remove the oxygen economizer at the left of the pilot's seat.

f. Remove the pilot's headrest.

g. Remove the armor plate.

h. Remove the bonding tabs one on the right side of the tank and the other on the filler neck.

i. Disconnect the electric conduit at the gage transmitter.

j. Remove the short pipe elbow from the forward vent line on the top of the tank.

k. Cut the lock wires and disconnect the turnbuckles on the forward tie-down and retaining straps.

l. Loosen the two clamps on the filler neck and remove the filler neck cap and adapter. Remove the seven screws around the circumference of the filler neck on the outside of the fuselage skin and remove the nut plate and filler neck.

m. Remove the hydraulic hand pump handle and stow it under the right rudder pedal.

n. Remove the control stick and push-pull rod and lay the assembly on the cockpit floor to act as a skid.

o. Remove the cabin control crank on the right side of the fuselage.

p. Remove the gun sight.

q. Place the landing gear control handle in the "DOWN" position.





r. Place the cowl shutter control in the "OPEN" position and all other controls in their forward positions.

s. Place a pad on the floor of the cockpit.

t. With one man in the fuselage to apply a forward force and one man in the cockpit to grasp the tank at the transmitter and lift it over the bulkhead at Sta #5, move the tank carefully into the cockpit.

u. Move the tank as far forward as it will go and start to tip the rear of the tank upward. Work the tank back and up until it is in a vertical position. Lift the tank straight up out of the cockpit.

v. Remove the fuselage fuel cell from the shell as follows:

(1) Remove bolts through the flanges attaching the top segment of the shell to the remainder. Remove the segment taking care not to damage the vent line fittings on the fuel cell.

(2) Remove the bolts attaching the front end to the shell. Push gage fitting thru and remove end.

(3) Remove the tank from the remaining portion of the shell taking care not to damage any of the fittings.

9. To Install the Fuselage Tank

Reverse the above procedure k. through a.

10. To Repair the Self-Sealing Fuel Cells

See Section VIII, Paragraph G., 1.

11. Fuel Gage (Fuselage Tank)

a. The fuel quantity indicator for the fuselage tank is of the magnetic coupling type G.E. 8DJ11LAE.

b. The fuselage tank is equipped with a General Electric Selsyn Type (8TJ13LAH) Gage Transmitter which is connected to the indicator electrically.

c. To Remove the Fuselage Tank Fuel Quantity Gage:

NOTE: Never remove fuel quantity gages from tanks unless it is absolutely necessary.



(1) To remove the tank portion of the fuel quantity gage, remove the six flange screws and remove the transmitter. Take care to keep magnetic particles away from transmitter magnet and also away from inside of the cup.

(2) Lift the cup from the socket enough to hold it from turning and unscrew cast adapter from the tank. If the cup is allowed to turn, the float stem is liable to be broken off.

(3) Lift the entire unit including the float from the tank, care should be taken when removing the float as it will come out only when major axis of the float is perpendicular to the mounting flange.

d. To Install the Fuselage Tank Fuel Quantity Gage:

Reverse the procedure given above. Be sure that the float is installed in the right position both with respect to the gage and to the tank. See that the cup does not turn when the adapter is screwed into place. The index mark on the flange of the cup is in the plane of the float circle. Locate the index so that for a rising float, the pinion rotates counter-clockwise, when viewed from the pinion end of the shaft.

e. To Adjust the Fuselage Tank Quantity Gage:

(1) Tank must be empty so that float will rest on the bottom of the tank.

(2) Loosen the four screws on top of transmitter and rotate large diameter disk to mid-position of travel.

(3) Connect the transmitter to the indicator and battery, and replace the transmitter in the cup so that the screw holes align and so that the conduit connector points in the desired direction. Note the indicator pointer deflection, remove the transmitter from the cup and rotate the magnet to obtain the same deflection. Grasp the transmitter and push the magnet against the spring, maintaining the angular position of the magnet with respect to the transmitter. Now rotate the shaft until the cross pin aligns with the notches which make indicator read nearest to zero, then release the magnet. This is the rough zero adjustment.

(4) Replace the transmitter in the cup and secure in place with the six flange screws. Now rotate the large diameter disc until the indicator reads exactly zero and tighten the four screws to hold it in place.

(5) Caution Fuselage Fuel Quantity Gage Indicator:  
Under no condition shall a pointer on the fuel quantity gage indicator on the instrument board be removed, except by the manufacturer. Reason: The exact position of the pointer on its shaft is very critical, and a slight error in replacing the pointer will cause the gage to read incorrectly, even though the zero reading be corrected by adjusting the transmitter at the tank. (The dial cannot be removed without removing the pointer).

FIG. 84 OIL SYSTEM



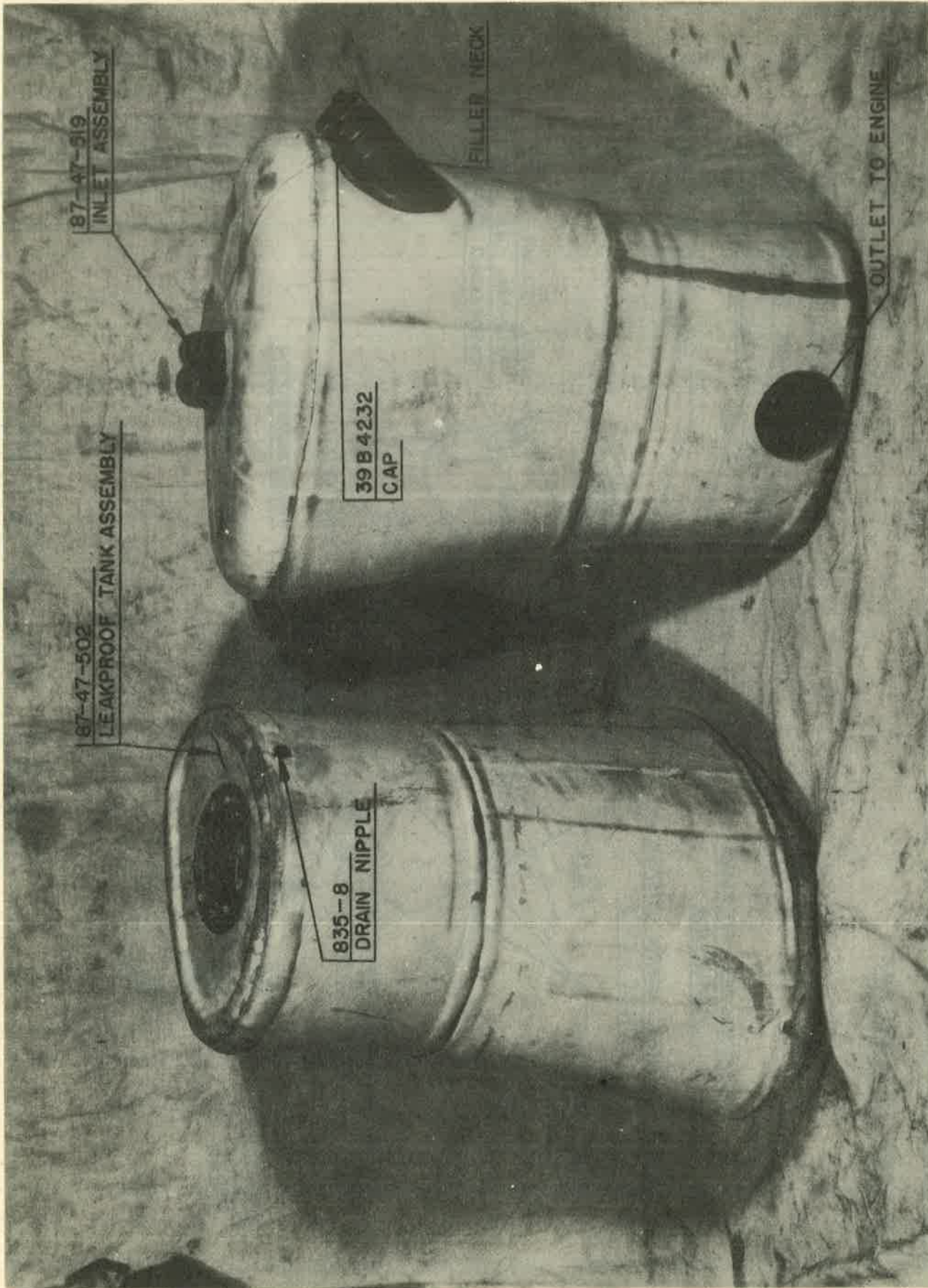


FIG.85 OIL TANK H - 87A - 2 & H - 87A - 3



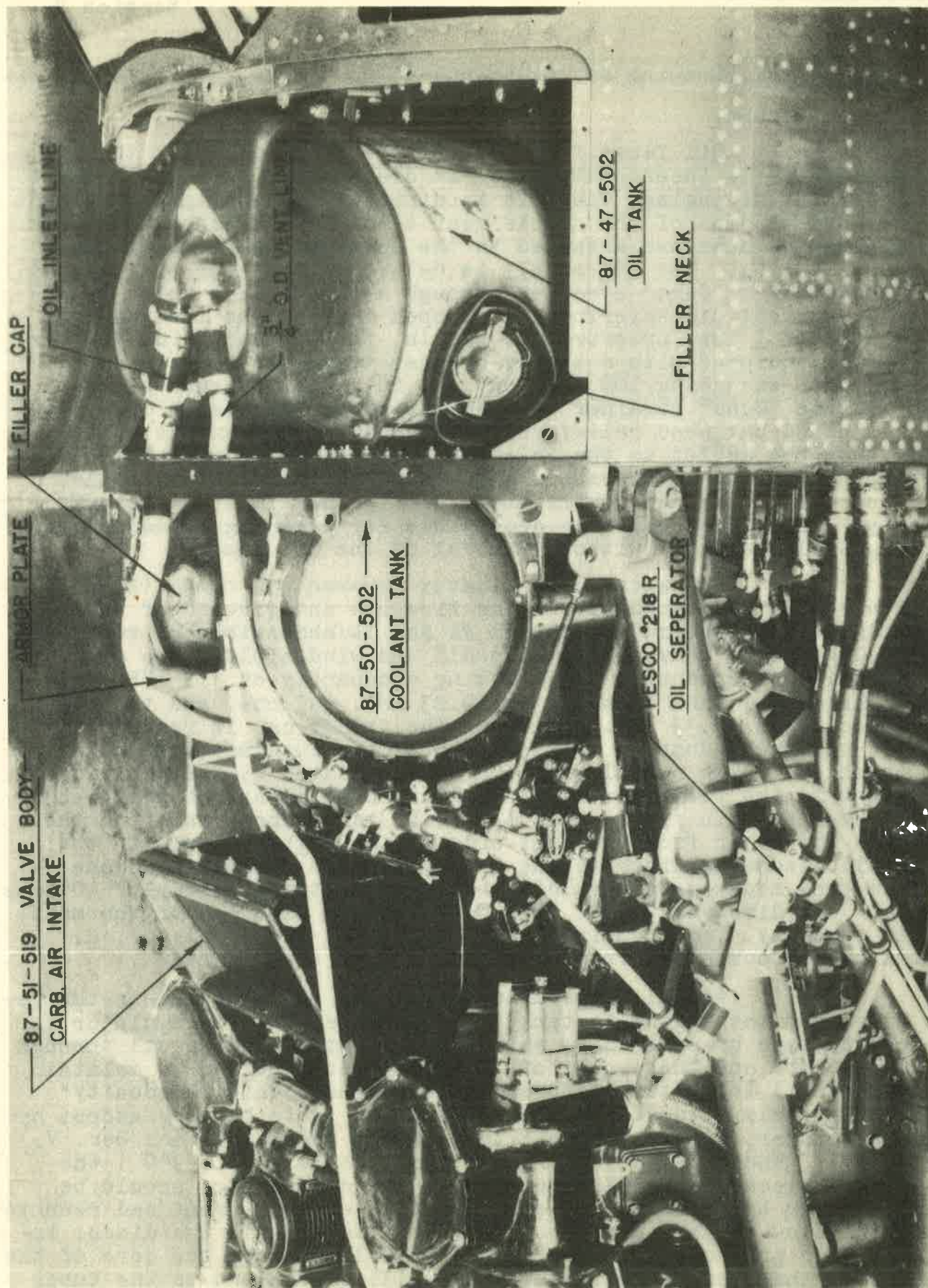


FIG 86 COOLANT & OIL TANKS INSTALLED H-87A-2 & H-87A-3



I. Oil System (Drawing No. 87-46-501-50)1. General

a. Oil flows from the bottom of the oil tank through a line in which is incorporated the "Y" drain cock, to the oil inlet connection to the engine, where it is circulated by one pressure and two scavenging pumps of the simple gear type. The pressure pump and main scavenging pump are arranged in the unit at the right of the accessory housing. The oil supply is delivered from the oil tank to the exterior of a "Cuno" strainer through a check valve which is arranged to prevent oil entering the stopped engine from the tank unless a head of 3 lbs. pressure per sq. in. is exceeded. The "Cuno" strainer is equipped with a safety-by-pass valve set to open at a pressure drop exceeding 100 lbs. per sq. in. Oil pressure at the outlet of the "Cuno" strainer is transmitted to the piston of a spring-opposed balanced relief valve which by passes excess oil directly from the outlet to the inlet of the pressure pump. This arrangement maintains a constant oil pressure at the strainer outlet with increasing strainer restriction, within the limit of the pump capacity. The relief valve is accessible for cleaning or adjustment to change oil pressure, without removal of the oil pump.

b. The externally Linatex covered oil tank, (Drawing No. 87-47-502) is located aft of the firewall and forward of the armor plate installation at Station #2 and is accessible by removing the fuselage cover between the firewall and windshield. The oil tank contains an expansion space having a capacity of 1.2 IMP. gallons. The normal tank capacity is 10.83 IMP. gallons, and the overload capacity is 13.33 IMP. gallons. The filler cap is reached by means of an access door on the left top of the fuselage forward of the windshield. The normal oil level is indicated by the position of a rivet in the filler neck. The tank should always be serviced to the level of this rivet. Two 1/2" O.D. vent tubes, one from the right and the other from the left side of the engine, drain to the tank. All discharge lines in the oil system are collected in one drain casting mounted on the left engine mount truss assembly. Climbs up to 60° and dives up to 90° will be performed with 1/3 of the maximum oil capacity. For repair of oil tanks, see Sec. VIII, G., 2. Linatex may be purchased from Wilkinson Rubber Linatex Ltd.

c. An oil temperature regulator is installed in the return line from the engine to tank. Incorporated in the regulator is a viscosity type by-pass valve which controls the flow of oil through the cooler core and the jacket of the cooler as required to maintain the correct oil inlet temperature to the engine. This "Viscosity" valve is entirely automatic and no adjustment is to be made except by the manufacturer. (To repair oil temperature regulators see Sec. V, G., 9., c.). When ground temperatures fall below 15°F. (-9°C.) the two plywood discs, 87-46-578, carried in the duffle bag, should be installed over the center portion of the oil cooler (front and rear) to reduce the flow of air through the cooler. To install the discs, insert the four protective tubes, 87-45-581-2-12 through the core of the radiator so that the holes in the discs will correspond to the tubes in the core. Slide the discs on the tubes fore and aft of the cooler and pass a lock wire through the tubes to retain the discs in place.

d. For easier starting in cold weather, an oil dilution system is used, which introduces a quantity of gasoline into the oil inlet line at the "Y" drain cock, before stopping the engine. The gasoline is supplied from the fuel pressure gage line. The flow is controlled by a valve which is actuated by a solenoid; and is energized by a switch in the cockpit. Before stopping the engine when a cold weather start is anticipated, hold the oil dilution switch on the "ON" position for a period of 1 to 4 minutes at about 800 R.P.M., the time depending on the anticipated temperature of the next engine start; and (with the exception of an engine which must be stopped by shutting off the fuel to prevent after-firing), shut off the engine in the normal manner, continuing to hold the dilution switch "ON" until the engine stops. Where an engine must be stopped by shutting off the fuel, the engine will first be stopped in this manner and allowed to cool, then restarted and the oil diluted as described above. After the oil has been diluted the engine will be stopped by shutting off the switch. In starting the engine, a normal start should be made without regard to the oil dilution system. However, if after starting the engine, a heavy viscous oil is indicated by oil pressure that is too high, or that fluctuates or falls back when the engine R.P.M. is increased, the oil dilution switch may be pushed "ON" to dilute the oil and correct this condition. This method should be used only when time and extreme temperature conditions do not permit engine warm-up in the normal manner. Over-dilution is likely to result under these conditions because of low oil flow and a cold engine which results in little evaporation until the engine warms up. If dilution is used during warm-up, close observation of oil pressure will be necessary during the time of dilution and through the warm-up and take-off period to determine whether or not the oil has been over-diluted, resulting in low oil pressure. If necessary, immediate take-off may be made after oil dilution has been used without the normal warm-up, provided the oil temperature and pressure is normal and the engine is running smoothly. To obtain sufficient dilution of the oil to facilitate starting, the engine should be allowed to cool, either by idling or stopping after flight, before dilution is begun. Normally it will be found that the engine has cooled sufficiently by the time the airplane reaches the flying line.

Engines equipped with oil dilution which suddenly show a loss of oil pressure or throw oil out of the breather during flight should be checked upon landing. Be sure that the oil dilution valve is in the "closed" position and fully seated. The electric oil dilution switch may be momentarily turned "ON" and "OFF" in an attempt to seat the valve properly. If dilution is the cause of the trouble, satisfactory operation will be resumed when the viscosity of the oil is restored by running the engine and evaporating the gasoline in the oil.



e. Supercharger Drain Line: The supercharger vent line on the rear left side of the motor adjacent to the rear breather line drains into the drain casting.

f. Distributor Drain Lines: Distributor housing drain lines are provided from the distributor housings to the collector drain casting at the leading edge of the wing.

g. There are no strainers in the oil system except the "CUNO" filter installed in the engine.

## 2. To Remove the Oil Tank:

a. Drain Oil system at the "Y" drain cock.

b. Remove the cover on top of the fuselage between stations #1 and #2.

c. Disconnect the two lines at the top of the oil tank. (Oil return line and vent line.)

d. Disconnect engine inlet line at the tank.

e. Disconnect oil tank drain on the rear bottom of the tank.

f. Disconnect scupper drain line at the oil tank.

g. Detach the upper cradle assembly by removing four bolts holding it to the fuselage.

h. Disconnect the scupper drain line at the fitting below the scupper.

i. Remove tank from the rubber mountings in the lower cradle by raising straight up.

## 3. To Install the Oil Tank: - Reverse the above procedure.

4. The oil tank is equipped with a pendulum assembly at the oil outlet which has a travel vertically of  $75^{\circ}$  and horizontally of  $15^{\circ}$  either side of the pendulum center line. When the oil tank is removed from the fuselage, the pendulum may be removed from the tank for inspection by the following procedure:

a. Remove the ten screws that fasten the bottom inspection cover to the tank plate, and remove the cover.

b. Hold the pendulum assembly with one hand through the bottom inspection hole while removing the six screws which attach the pendulum assembly to the oil outlet plate.

c. Carefully remove the pendulum assembly thru the bottom inspection hole.

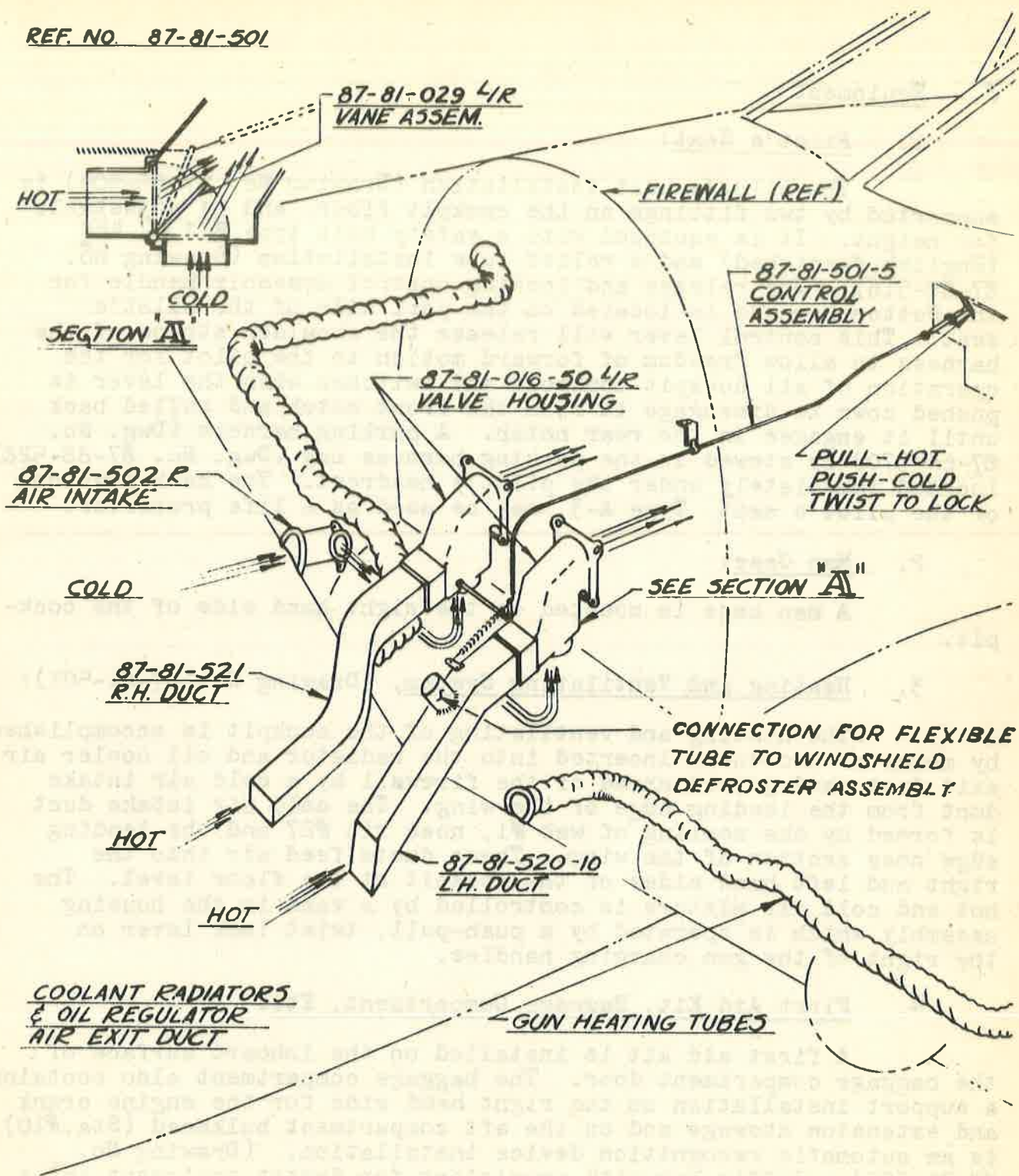
d. The pendulum may now be disassembled by removing the three nuts that fasten the base to the pendulum.

NOTE: When more than one pendulum is disassembled at a time be sure to keep the parts of each assembly together. This is necessary because of the close tolerances of the parts to insure a snug fit of the pendulum, and free rotation in the socket without binding thru its full travel as noted.

e. The pendulum may be reassembled and installed in the oil tank by reversing the procedure 4., a thru d.







**FIG. 86A COCKPIT HEAT AND VENT SYSTEM**



J. Equipment1. Pilot's Seat:

The pilot's seat installation (Drawing No. 87-65-504) is supported by two fittings on the cockpit floor, and is adjustable for height. It is equipped with a safety belt type S.I.S. 445 (English furnished) and a relief tube installation (Drawing No. 87-88-516). The release and locking control assembly handle for the Sutton harness is located on the port side of the pilot's seat. This control lever will release the shoulder straps of the harness to allow freedom of forward motion to the pilot for the operation of all cockpit controls and switches when the lever is pushed down to disengage it from the front notch and pulled back until it engages in the rear notch. A parking harness (Dwg. No. 87-64-570) is stowed in the parking harness bag (Dwg. No. 87-88-528) located immediately under the pilot's headrest. The back cushion of the pilot's seat, Type A-3, may be used as a life preserver.

2. Map Case:

A map case is mounted on the right hand side of the cockpit.

3. Heating and Ventilating System. (Drawing No. 87-81-501):

The heating and ventilating of the cockpit is accomplished by means of two ducts inserted into the radiator and oil cooler air exit duct, and joined ahead of the firewall by a cold air intake duct from the leading edge of the wing. The cold air intake duct is formed by the sealing of web #1, nose rib #27 and the leading edge nose section of the wing. These ducts feed air into the right and left hand sides of the cockpit at the floor level. The hot and cold air mixture is controlled by a vane in the housing assembly which is operated by a push-pull, twist lock lever on the right of the gun charging handles.

4. First Aid Kit, Baggage Compartment, Etc:

A first aid kit is installed on the inboard surface of the baggage compartment door. The baggage compartment also contains a support installation on the right hand side for the engine crank and extension stowage and on the aft compartment bulkhead (Sta.#10) is an automatic recognition device installation. (Drawing No. 87-71-502) a duffle bag with provisions for desert equipment and a kit for small tools is hung in the baggage compartment. On airplane AK646 and subsequent there will be two pockets attached to the front side of the duffle bag to support the mooring kit installation. See fuselage contents, Fig. 35.

5. Armor Plate:

There are three installations of armor plate in the fuselage of both the H87A-2 and -3. (Material in accordance with British Spec. 1T70D.) The first installation is on the forward half of the coolant expansion tank to protect it from gunfire. The second installation is at station #2 between the oil tank and the instrument panel and affords added protection to the oil tank from gun fire aft. The third installation is at station #5 directly behind the pilot's seat and headrest and helps to safe-guard the pilot against gunfire from the rear.

6. Landing Light:

The shield type landing light is a 315 candle power, 15 ampere lamp, and is rated as a 50 hour lamp.

Landing lights should not be burned longer than three minute periods. Burning them longer than three minute periods in case of an emergency may cause the light to smoke the reflector and cut down its efficiency. The reflectors are silver plated and very easily scratched. To clean the reflector, wash it with a piece of cotton saturated with kerosene and then thoroughly dry. The inside of the reflector should not be touched with the hands after cleaning.

The shield type landing lights are set to open 75 degrees; however, they are adjustable between 65 and 80 degrees. To change this angle, it is necessary to remove the light, put it in the open position and loosen the two screws under the motor. This will allow the power unit to slide in either direction desired. If the lights are used every day, 10 or 15 drops of pyroil in the gear box and a small amount of cup grease in the arm slide twice a year is recommended.

7. Static Ground: (Drawing No. 87-88-046-10)

A static ground assembly is fastened to the bottom of the fuselage, on the airplane's center line, forward of the tail wheel door assembly, by two screws. The ground assembly is made of .100 steel wire and 13 inches of .031 closely wound steel spring. The spring is slipped over the wire for a distance of one inch and fastened to the wire with a solder joint. The static ground assembly is set at a  $60^{\circ} \pm 5^{\circ}$  angle to the under surface of the fuselage. This installation will be assembled on airplanes AK596 and subsequent.

K. Cabin - Windshield

## 1. Cabin (Drawing No. 87-25-501)

The cabin enclosure is glazed with "Plexiglas" supported in an aluminum alloy frame. The frame is mounted on four ball-bearing



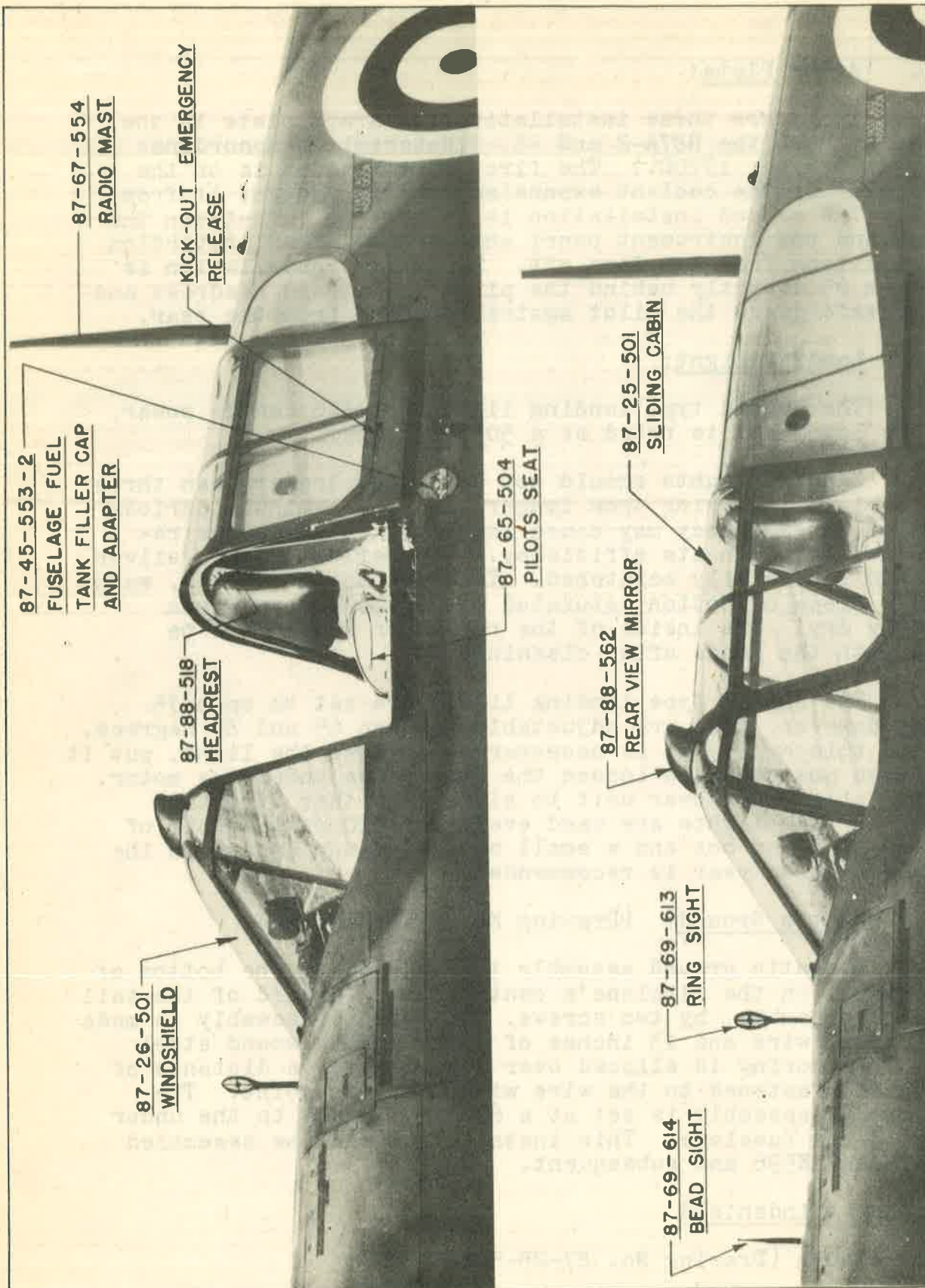


FIG.87 CABIN -OUTSIDE VIEW - OPENED AND CLOSED  
H-87A-2 & H-87A-3



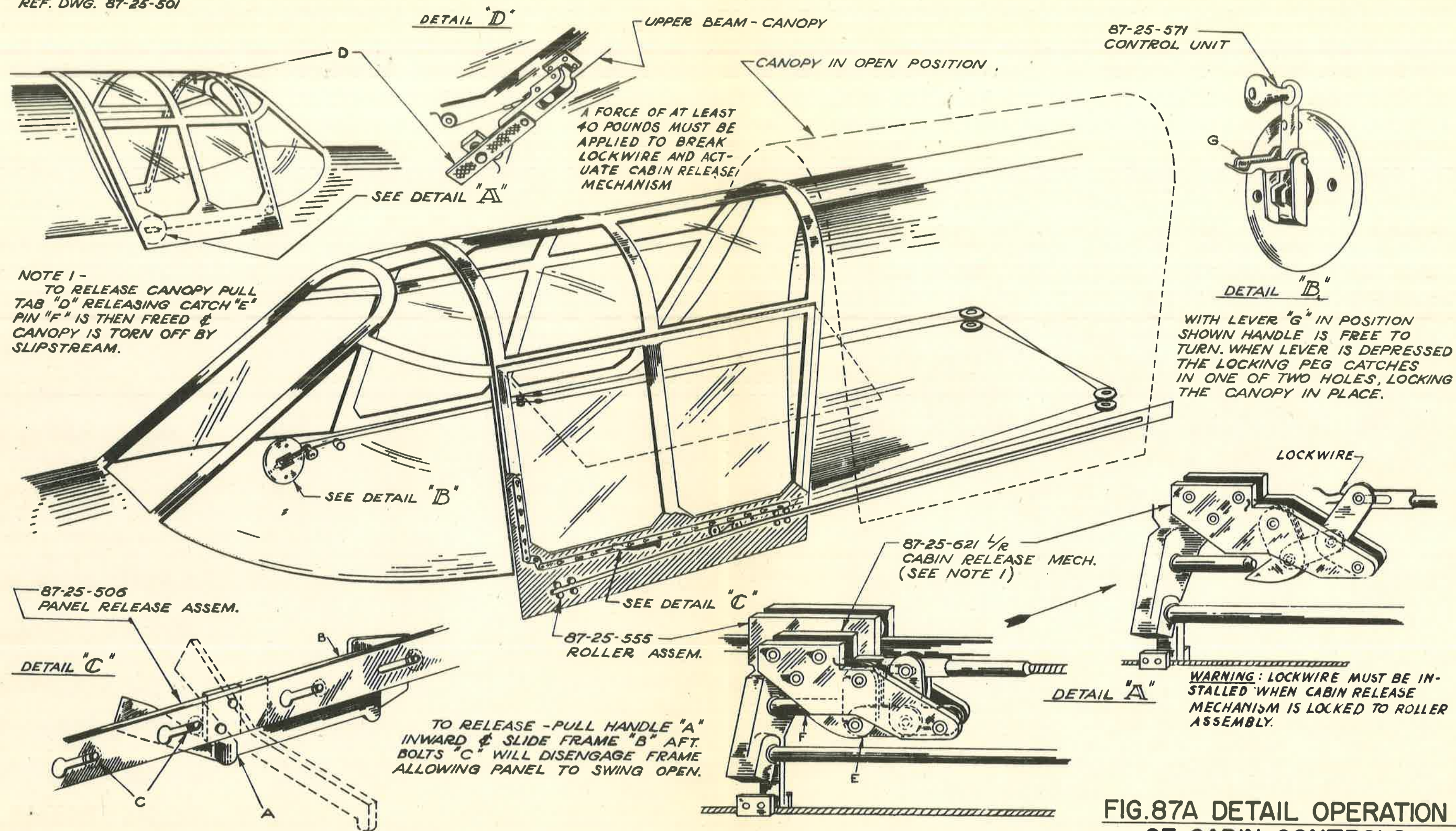


FIG.87A DETAIL OPERATION OF CABIN CONTROLS





roller assemblies which travel on tracks on the sides of the fuselage. It may be moved to the desired fore and aft position by a handcrank located on the forward right hand side of the cockpit. This crank may be disengaged in case of an emergency by pulling out until it is perpendicular to the cockpit side wall. The emergency canopy release, is a lever which is located at the top forward frame of the cabin. In case of an emergency, while in flight, the entire canopy may be released from the fuselage by pulling on this handle. In the event of turnover, on the ground, pull the kick-out release and push open the emergency exit on the left hand side of the canopy. This emergency exit may be operated from the outside by means of a handle located on the lower, rear, left hand cabin frame. When the airplane is on the ground the cabin may be locked by pulling out the hasp, located in the canopy, at the lower, rear, left hand corner of the cabin and inserting a padlock in the hole provided.

2. Windshield (Drawing No. 87-26-501, Airplanes AK571-AK720)

The windshield is made of 1/4" laminated plate glass with a center panel of 1 1/2" bullet resistant glass, mounted in an aluminum alloy frame and sealed with Everseal stripping. The frame is assembled to the fuselage by flush head screws in fibre nuts and may be attached or removed as one unit.

3. Windshield (Drawing No. 87-26-503, Airplanes AK721 and Subsequent)

This windshield is made of 1/4" laminated plate glass, with the exception of the central section, which consists of two sheets of glass separated by a 5/32" air space. The top, or outside sheet, is three ply 9/32" laminated plate glass and the lower or inside sheet is 1 1/2" bullet resistant glass. The frame is assembled to the fuselage by flush head screws in fibre nuts and may be attached or removed as a single unit.

4. Removal and Disassembly:

(a) Windshield Glass: The 1 1/2" bullet resistant glass may be taken out by removing the lower support and top metal strip. The rest of the glass may be taken out by removing the sealing and support strips held to the frame by flush head screws in fibre locks. The bullet resistant glass should be installed with the heavier laminations on the outside surface.

(b) Cockpit Enclosure: The cockpit enclosure may be removed by pulling the emergency release, lifting the canopy off the airplane, and leaving the roller assembly on the track.

(c) Rear Vision Window: The rear vision window may be taken out by removing the support straps and metal retaining strip at its forward edge. Slide the Plexiglas sheet forward and out



of the frame. Care must be taken in the removal of Plexiglas to prevent marring its soft surface.

(d) A rear vision mirror is mounted in a neoprene fairing on the exterior of the top center windshield panel. The fairing is fastened to the windshield by three screws, one at the forward end and two at the aft end. The forward screw protrudes through the windshield frame from the inside of the cabin and screws into the fairing. The two back screws attach the rear of the fairing to the two clips on the outside of the windshield frame. The rear vision mirror may be removed from the fairing after the fairing has been removed from the windshield by unscrewing the one screw that fastens the mirror frame to the fairings center bulkhead.

(e) Care of Plexiglas: The transparent plastic sheets forming the cabin and rear vision "Glass" is called plexiglas. It is rather soft and therefore subject to scratching if not properly cared for.

(f) Handling: If it should become necessary to remove a sheet of plexiglas from its form or handle it at all, make sure that its surface is free from adhering dirt, and paste a piece of soft paper over both faces of the sheet. Any ordinary starch paste (paperhanger's paste is satisfactory) and newspaper or other porous paper will serve. In pasting the paper on the plexiglas be careful not to slide the paper over the plexiglas as particles of grit in the paste will cause scratches. After the plexiglas is re-installed, the paper may be removed after moistening it with a wet sponge. In this manner the surface can be thoroughly protected from accidental scratching.

(g) Polishing: Badly scratched surfaces may be readily polished. A soft felt disc running at a rather low speed (250-500 RPM) wet with a paste made of magnesium carbonate or Tripoli and water may be used for polishing. Care must be taken to keep the polishing wheel moist and not to apply too much pressure to the piece being polished, since if the plexiglas becomes warm, the wheel will put ridges in the surface.

Slight surface scratches are easily removed by rubbing the plexiglas by hand with a soft cloth moistened with a turpentine-chalk mixture or other mild abrasive.

(h) Cleaning Plexiglas: In washing plexiglas care must be taken not to rub hard particles of sand or grit into the surface. The surface should first be rinsed with water and then wiped lightly with a soft cloth. If plexiglas becomes soiled with grease or oil, solvents for the substances such as kerosene or naptha may be used to remove dirt. Solvents for plexiglas such as esters, ethers, ketones, aromatic hydrocarbons or chlorinated hydrocarbons must not be used as cleaners.

REF. DWGS. 87-69-500 & 87-69-701

THE FOUR-GUN INSTALLATION APPLIES TO AIRPLANES  
AK 571 THROUGH 590  
AIRPLANES AK 591 AND SUBSEQUENT WILL INCLUDE  
THE SIX-GUN INSTALLATION

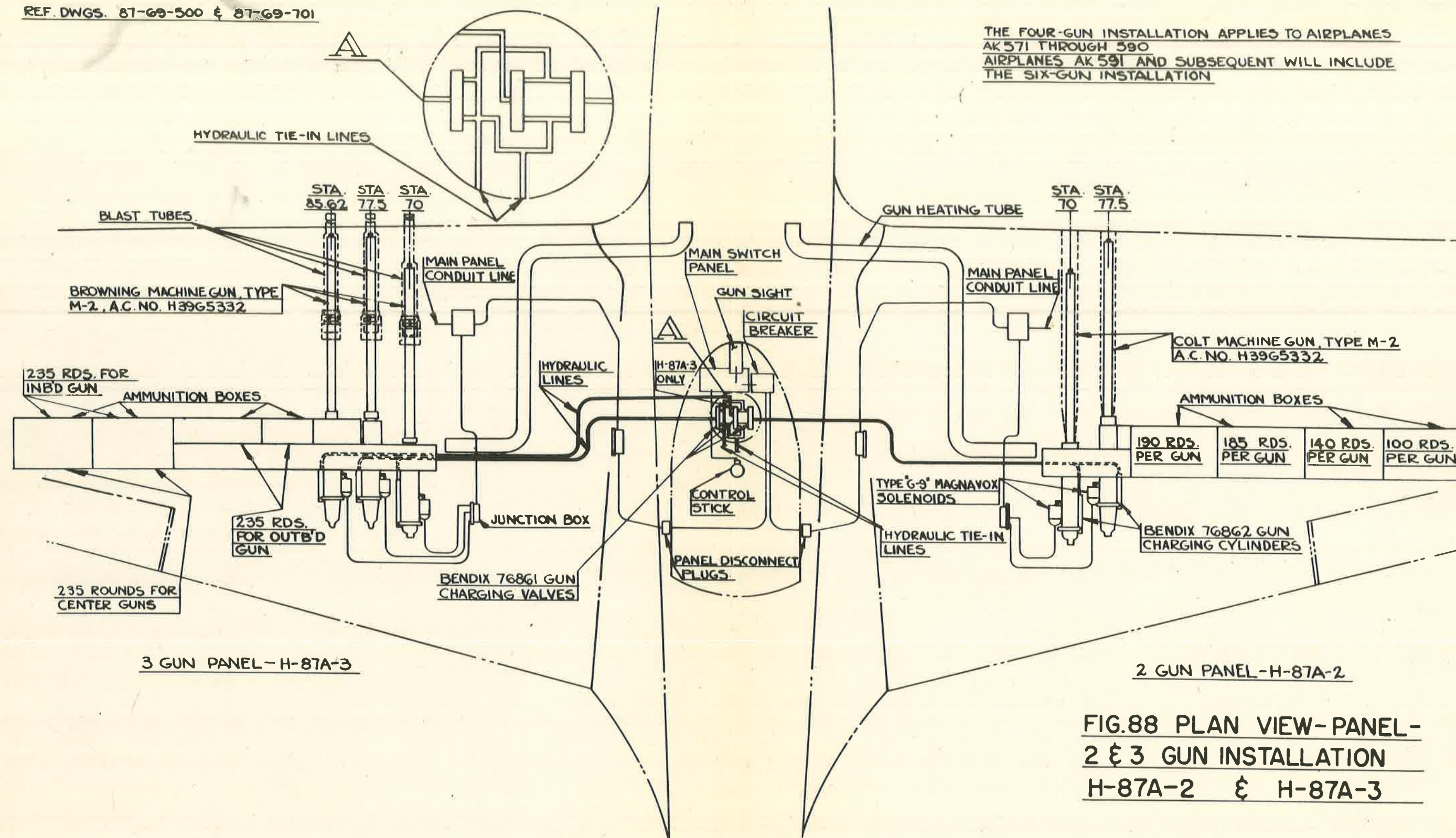


FIG.88 PLAN VIEW-PANEL-  
2 & 3 GUN INSTALLATION  
H-87A-2 & H-87A-3





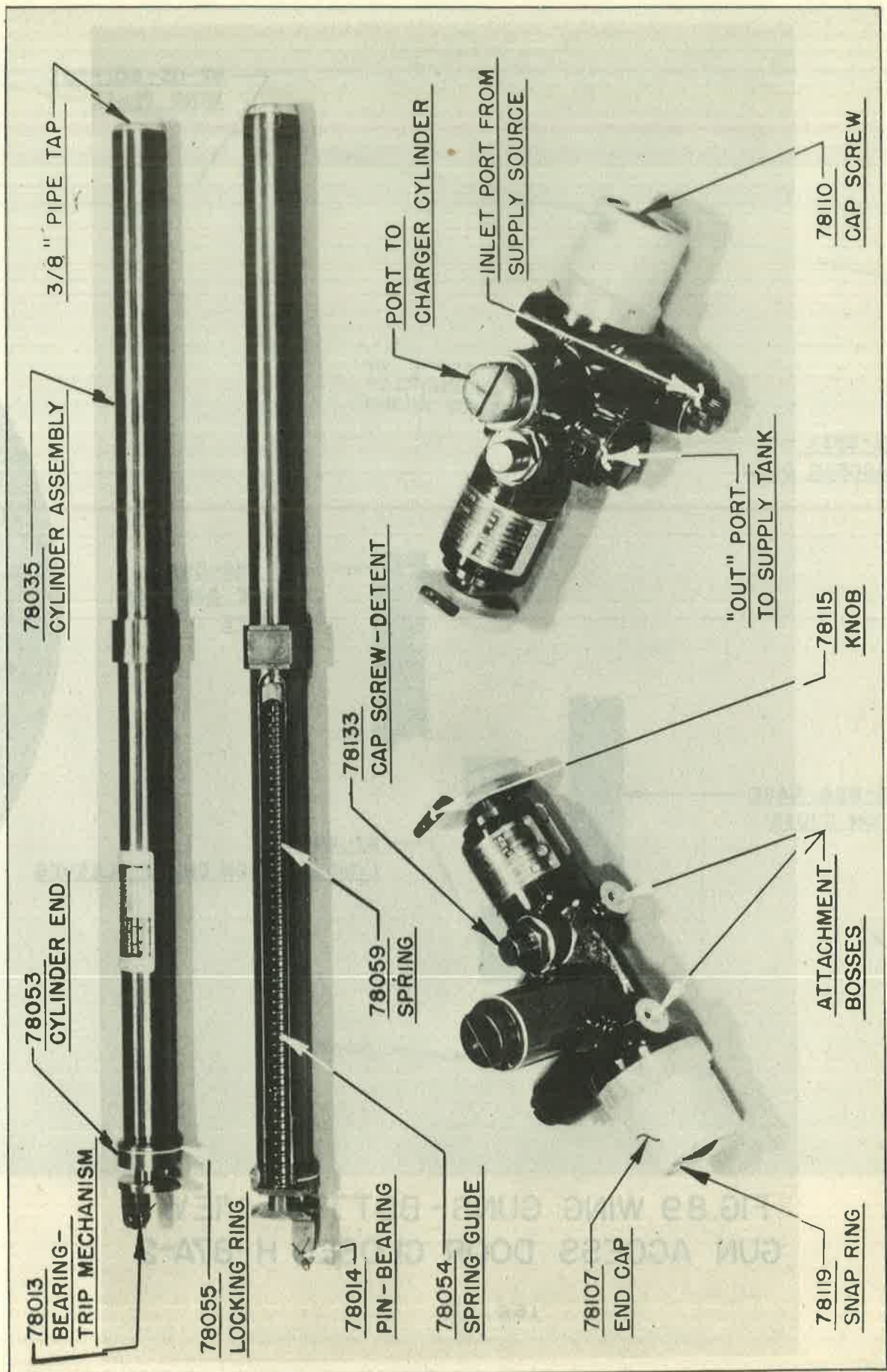


FIG. 88A HYDRAULIC CHARGING CYLINDER AND CHARGING VALVE



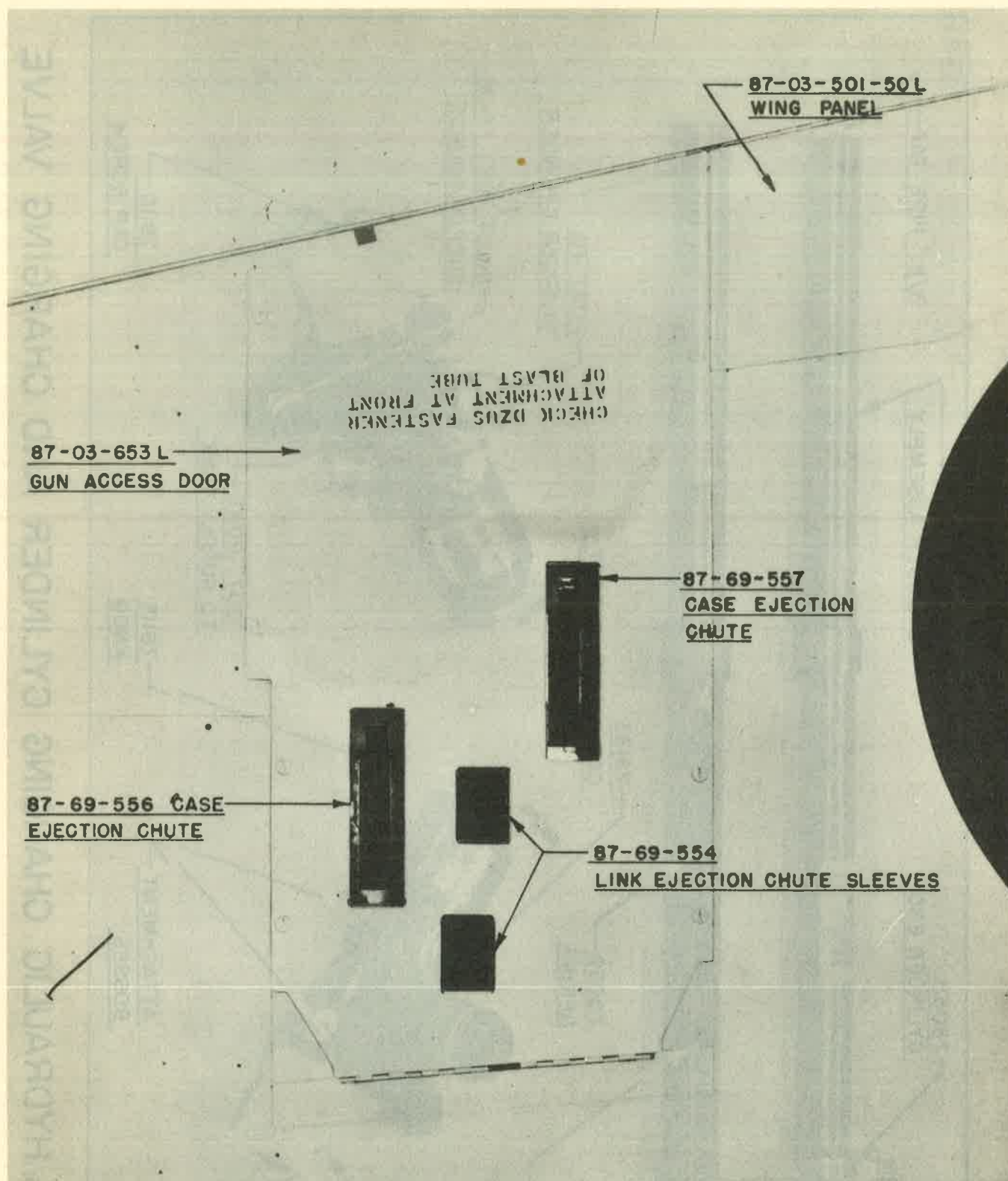


FIG.89 WING GUNS - BOTTOM VIEW  
GUN ACCESS DOOR CLOSED H-87A-2

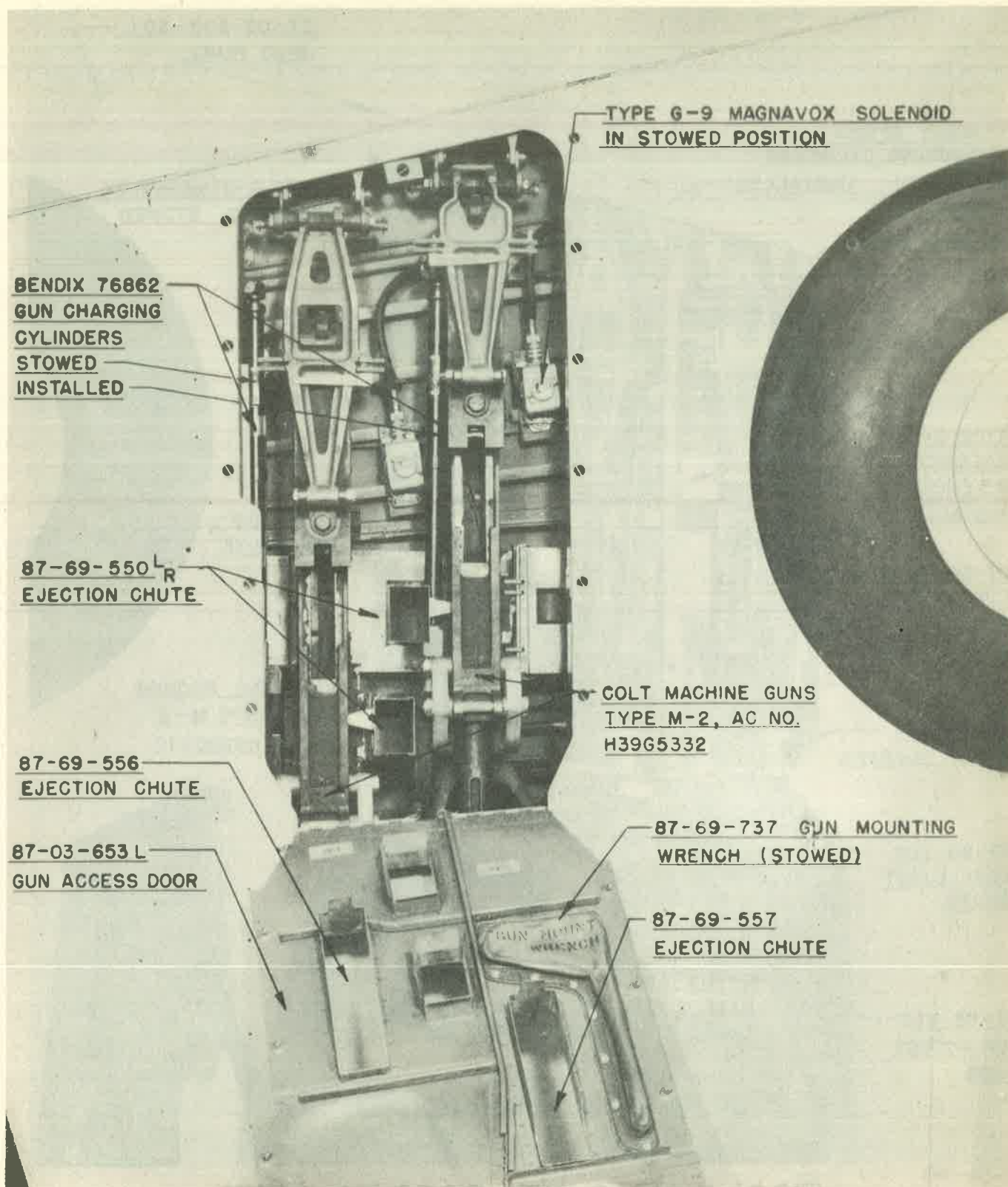


FIG.90 WING GUNS - BOTTOM VIEW  
GUN ACCESS DOOR OPEN H-87A-2



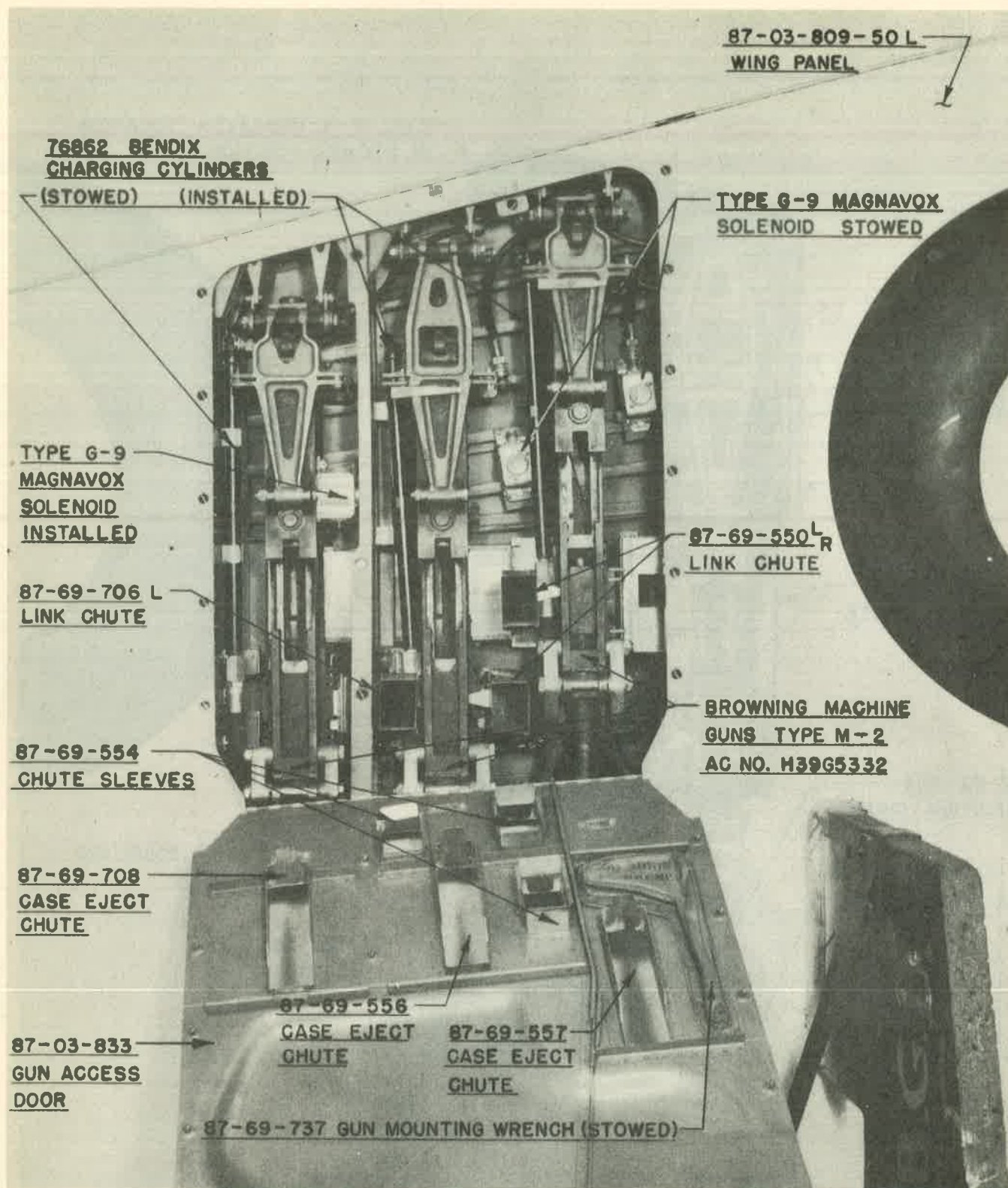


FIG.91 WING GUNS - BOTTOM VIEW  
GUN ACCESS DOOR OPEN H-87A-3

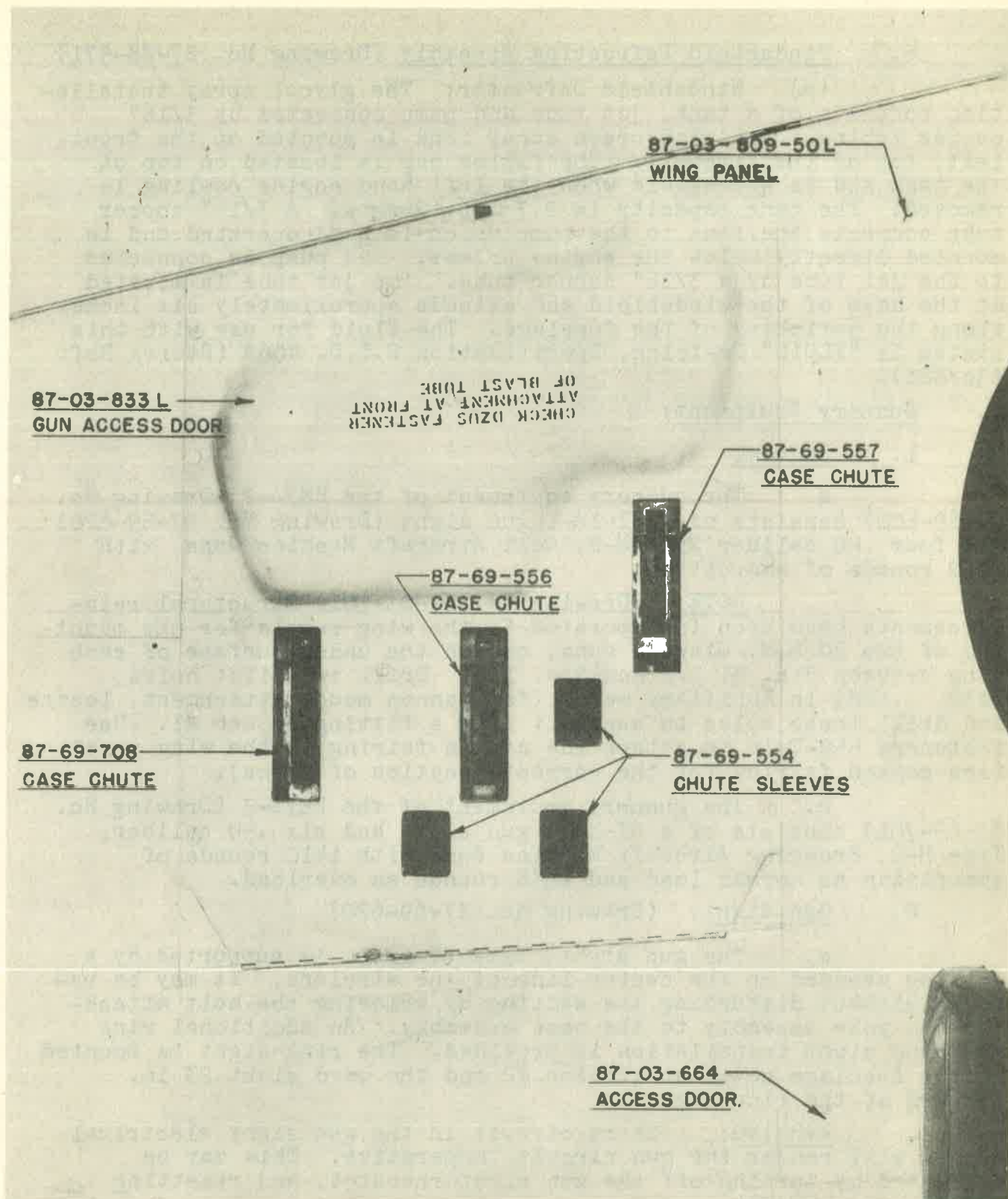


FIG.92 WING GUNS - BOTTOM VIEW  
GUN ACCESS DOOR CLOSED H-87A-3



5. Windshield Defrosting Assembly (Drawing No. 87-88-571)

(a) Windshield Defroster: The glycol spray installation consists of a tank, jet tube and pump connected by 3/16" copper tubing. The windscreen spray tank is mounted on the front, left, top of the firewall. The filler cap is located on top of the tank and is accessible when the left hand engine cowling is removed. The tank capacity is 2.7 Imp. Quarts. A 3/16" copper tube connects the tank to the pump which is hand operated and is mounted directly below the engine primer. The pump is connected to the jet tube by a 3/16" copper tube. The jet tube is mounted at the base of the windshield and extends approximately six inches along the periphery of the fuselage. The fluid for use with this system is "FLUID" De-icing, Specification D.T.D. 406A (Stores Ref. 33c/621).

L. Gunnery Equipment:1. General

a. The gunnery equipment of the H87A-2 (Drawing No. 87-69-500) consists of a ST-1A-1 gun sight (Drawing No. 87-69-620) and four .50 caliber Type M-2, Colt Aircraft Machine Guns, with 2460 rounds of ammunition.

NOTE: (Drawing No. 87-03-501) Structural reinforcements have been incorporated in the wing panels for the mounting of two 20 M.M. Hispano guns, one on the under surface of each wing between Sta. 81 1/2 and Sta. 100. Drill two pilot holes, (#30, .128) in auxiliary web #1 for cannon mount attachment, locate and drill these holes on assembly from a fitting on web #1. Use fasteners 659-D-15 to attach the cannon fairing to the wing panel (see cannon fairing for the correct location of lines).

b. The gunnery equipment of the H87A-3 (Drawing No. 87-69-701) consists of a ST-1A-1 gun sight and six .50 caliber, Type M-2, Browning Aircraft Machine Guns with 1410 rounds of ammunition as normal load and 1688 rounds as overload.

2. Gun Sight: (Drawing No. 87-69-620)

a. The gun sight, Type ST-1A-1, is supported by a casting mounted on the center line of the airplane. It may be removed without disturbing the setting by removing the bolt attaching the yoke assembly to the base assembly. An additional ring and bead sight installation is provided. The ring sight is mounted on the fuselage cover at station #2 and the bead sight 23 in. forward of the ring sight.

WARNING: Short circuit in the gun sight electrical system will render the gun circuit inoperative. This may be corrected by turning off the gun sight rheostat, and resetting the circuit breaker.

b. Sight Adjustment: The sight assembly may be adjusted in a rotational, horizontal or vertical direction. Rotational adjustments may be accomplished by means of two adjustment bolts

H-87A-2

WING VIEW - AMMUNITION BOXES REMOVED

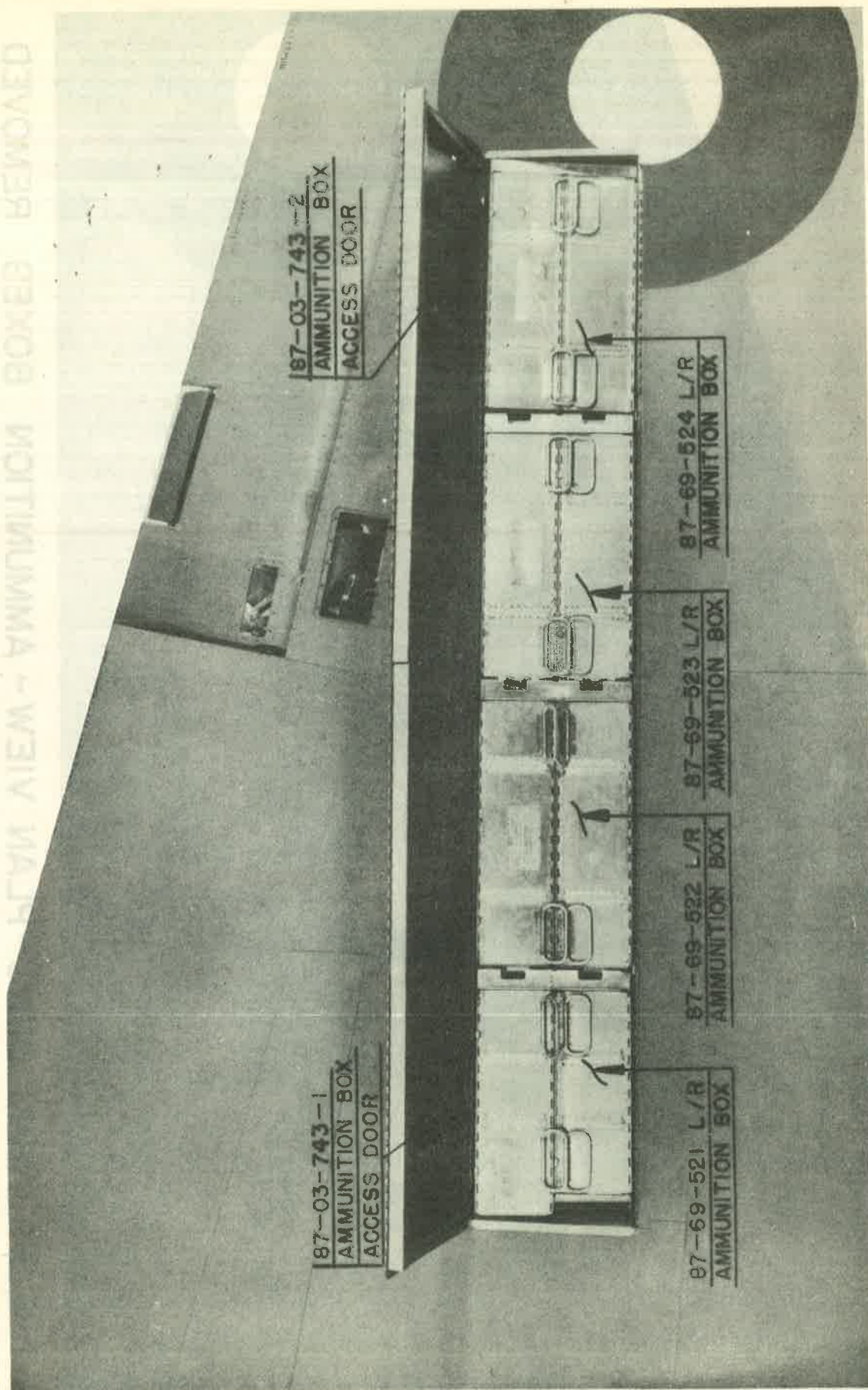


FIG.93 WING GUNS - PLAN VIEW - AMMUNITION BOXES INSTALLED  
H-87A-2



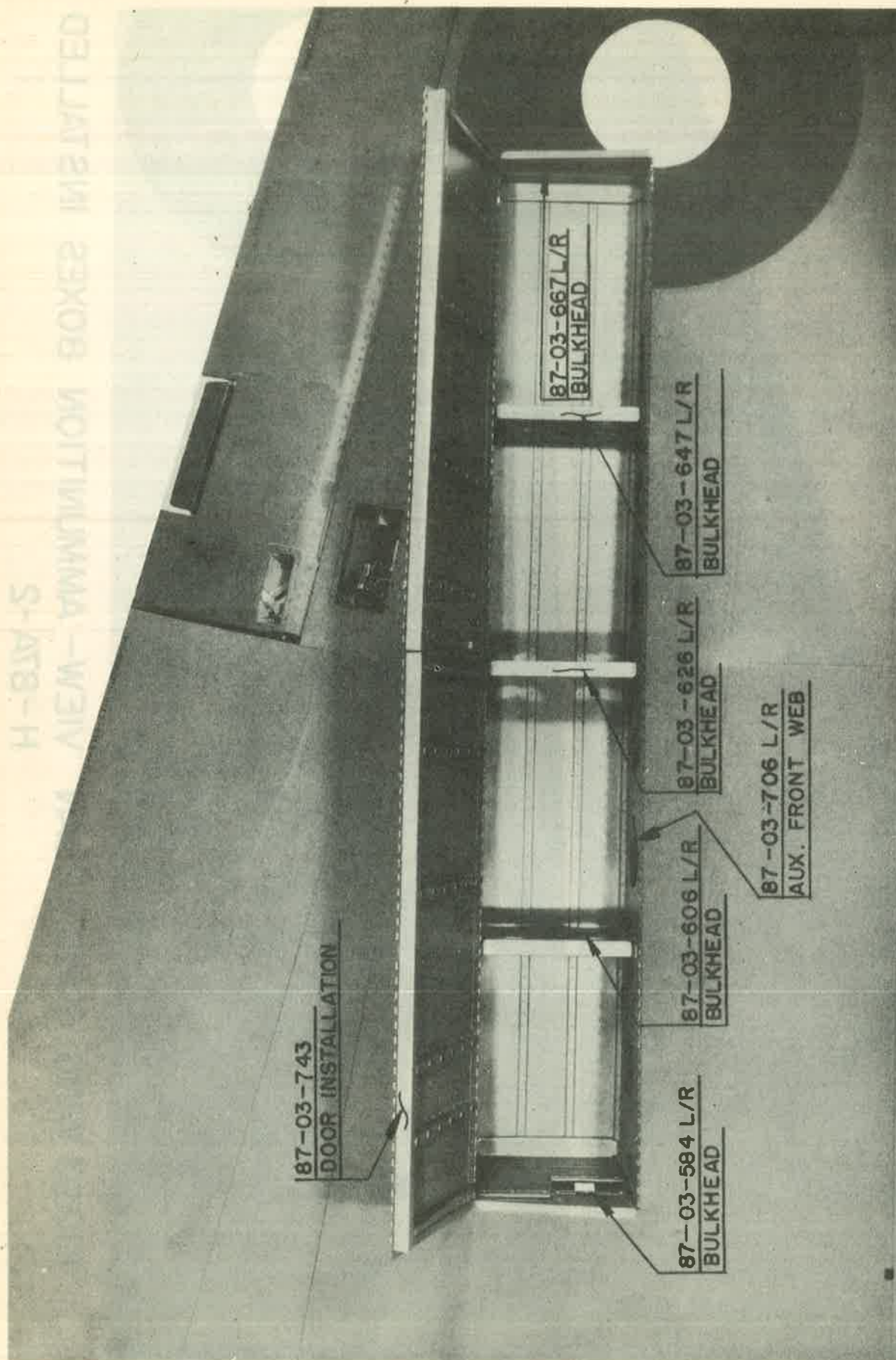


FIG. 94 WING GUNS-PLAN VIEW - AMMUNITION BOXES REMOVED  
H-87A-2

REMOVED H-87A-2  
11020 MIAO COMB - 67A1 AEM - 1240 IMBOV3D AMMUNITION BOXES

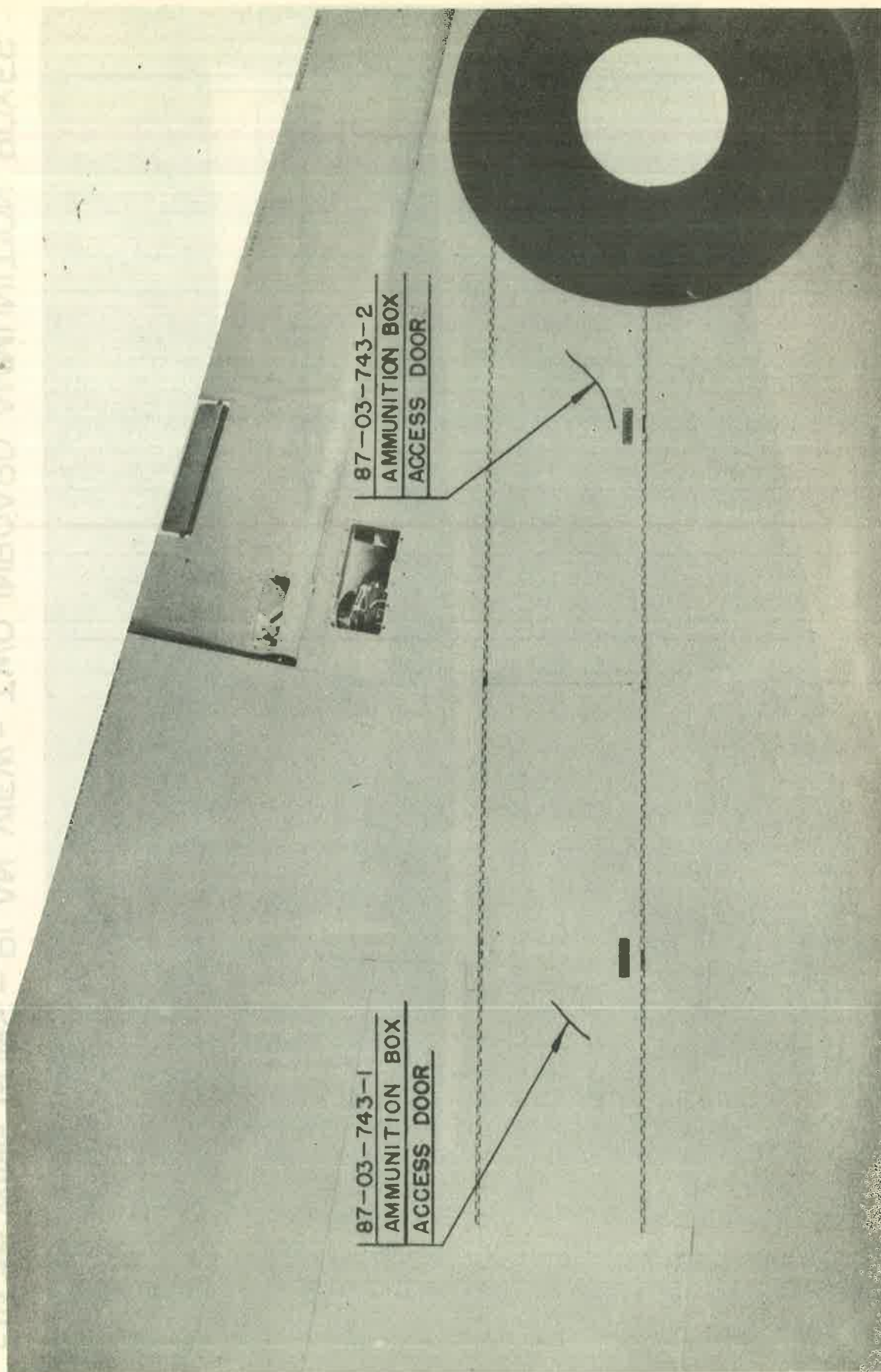


FIG.95 WING GUNS- PLAN VIEW- ACCESS DOORS CLOSED H-87A-2



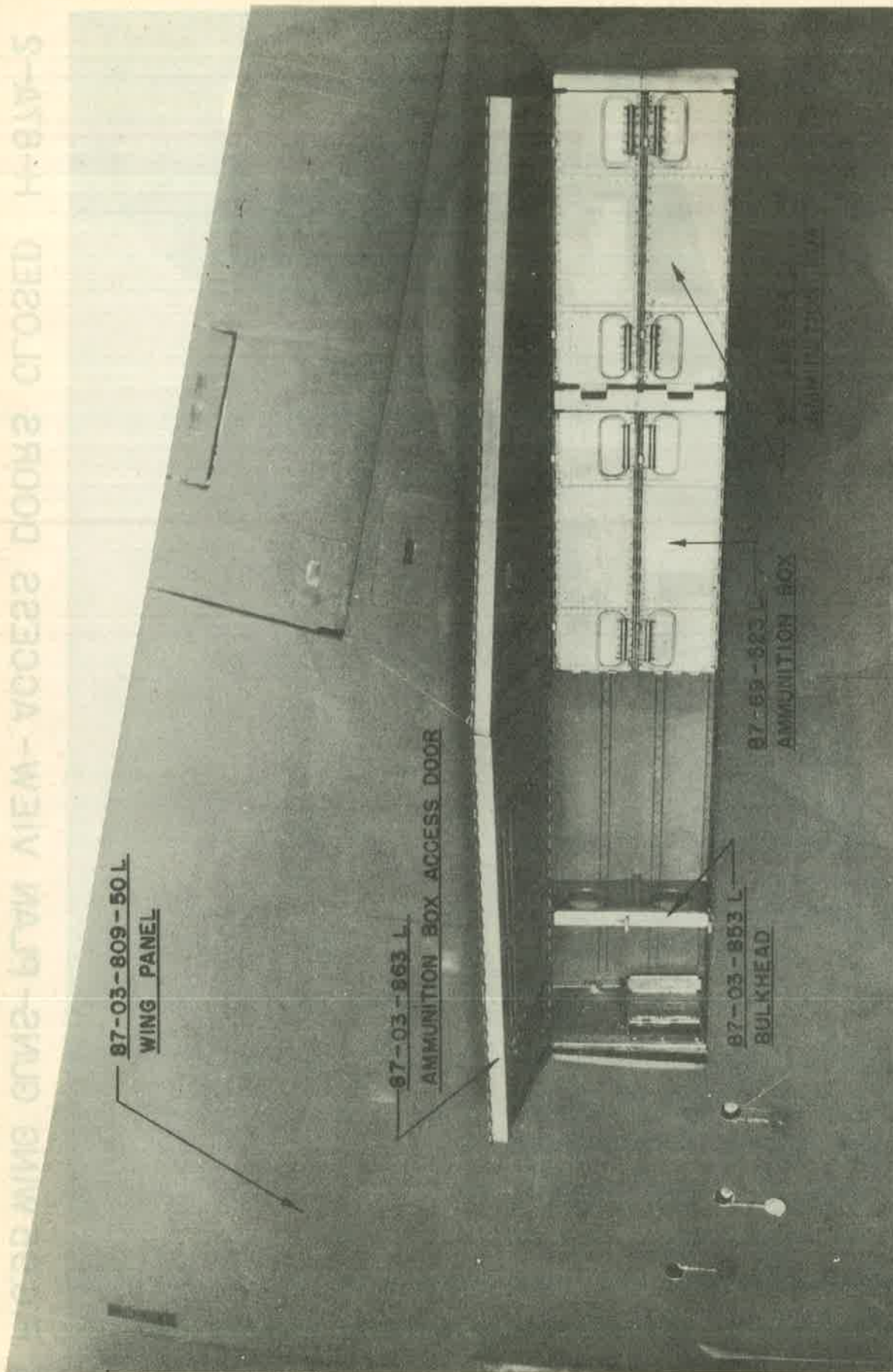


FIG.96 WING GUNS – PLAN VIEW – TWO INBOARD AMMUNITION BOXES  
REMOVED H-87A-3

BOXES 81 CHUTES INSTALLED H-87A-3  
E-478-H NOTIFICATION  
WING PANEL - 87-03-809-50 L

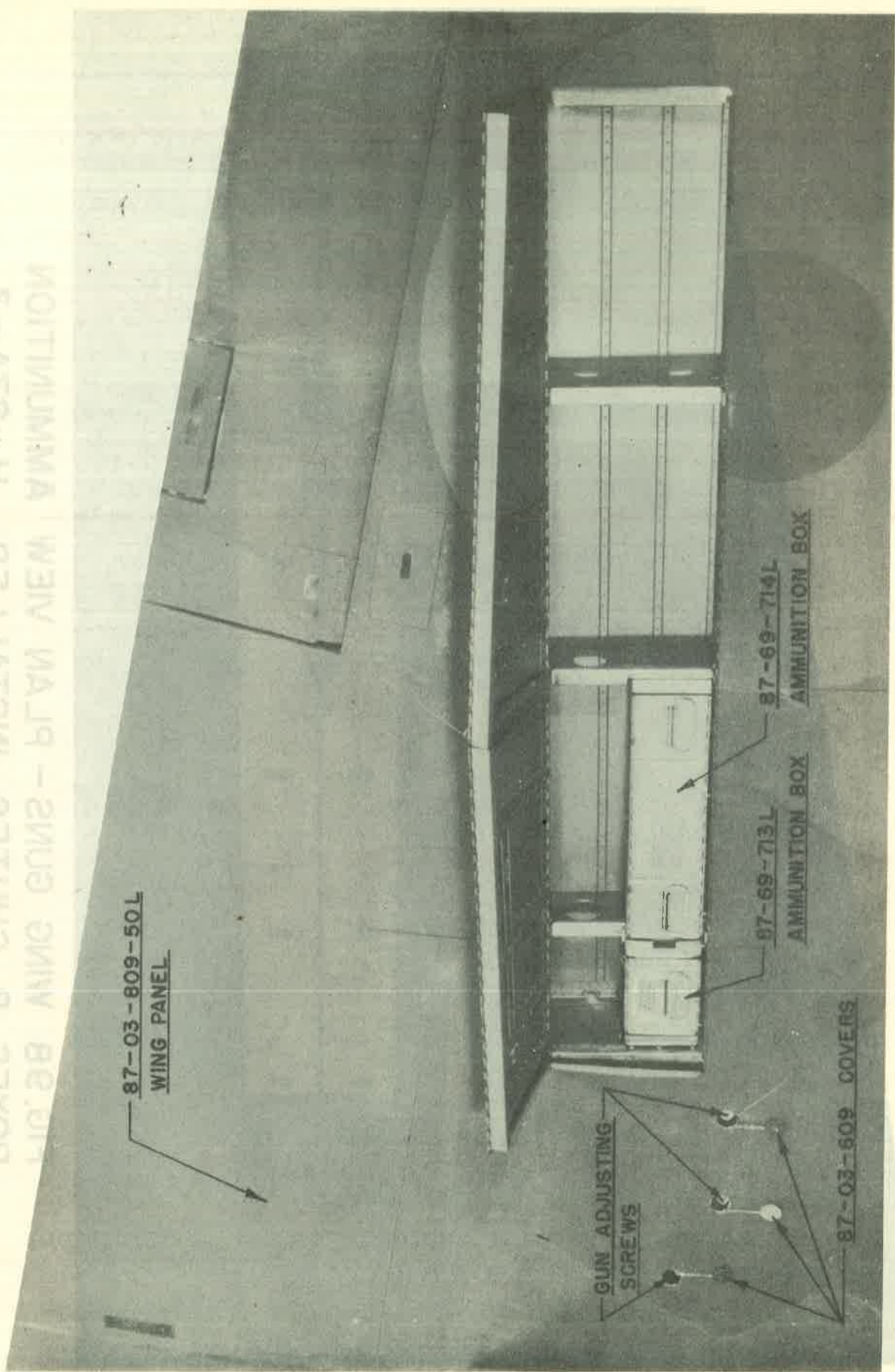


FIG. 97 WING GUNS - PLAN VIEW. TWO OUTBOARD  
AMMUNITION BOXES REMOVED H-87A-3



AMMUNITION BOXES REMOVED H-87A-3  
FIG. 87 WING GUNS - PLAN VIEW TWO OUTBOARD

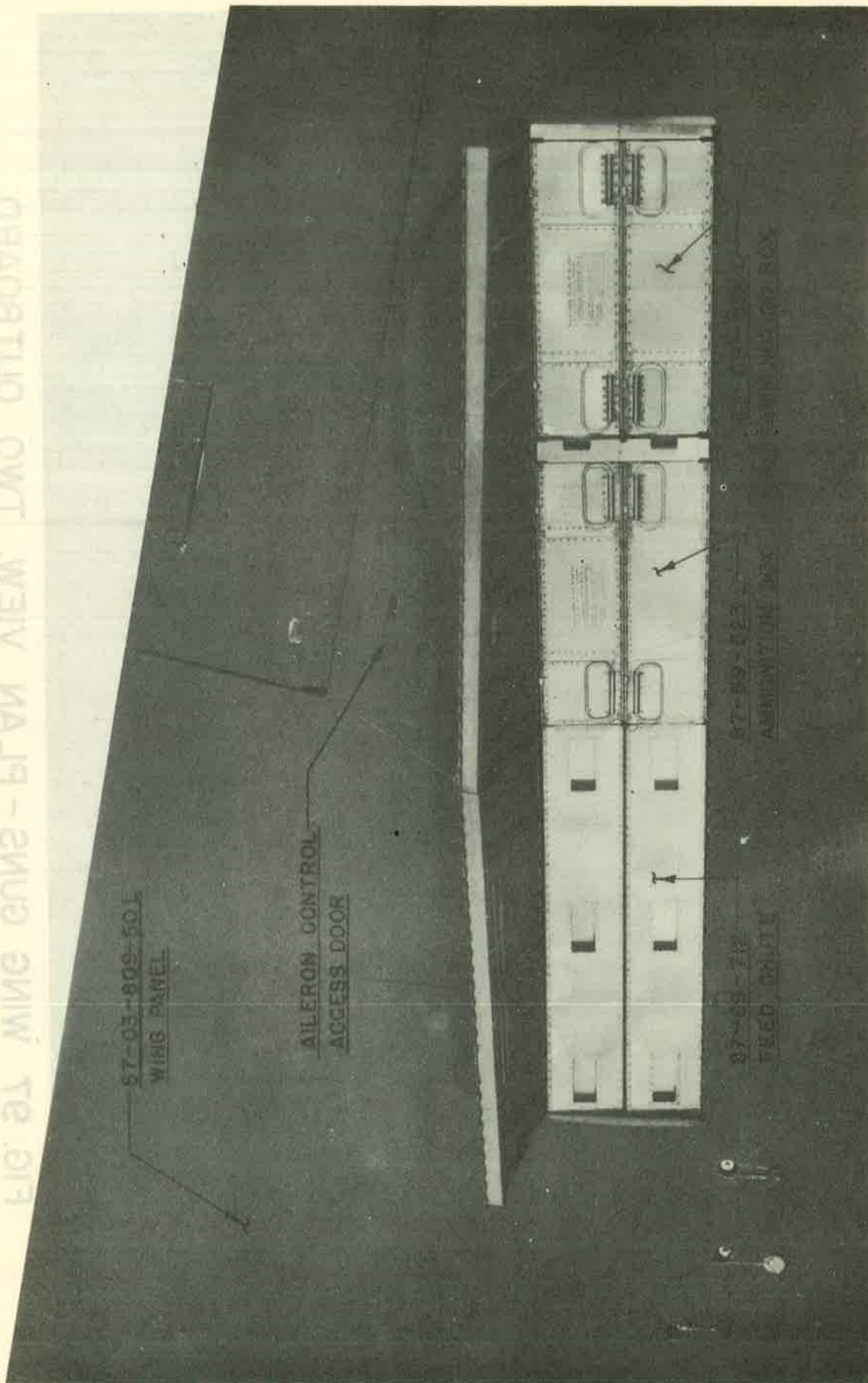


FIG.98 WING GUNS - PLAN VIEW AMMUNITION  
BOXES & CHUTES INSTALLED H-87A-3

on the top side of the connection between the yoke assembly and base assembly, forward of the instrument panel. Four screws, 90° apart, beneath the sight assembly, regulate the horizontal and vertical adjustment. The top and bottom screws control the vertical adjustment and the right and left the horizontal adjustment.

c. Lens Adjustment: The lens may be adjusted by a set screw. The sight should be so adjusted that the graticule image, when viewed as reflected on the mirror and superimposed on a target approximately 500 yards distance, does not change in relation to the target as the head is moved over the field of vision.

d. The H-87A-3 will be equipped with an attachment for a Type G-45 gun camera on the under side of the right wing panel on airplane AK669 and subsequent. Attach camera fairing at the nut plates on the bracket assembly indicated by an arrow on the bottom wing surface.

### 3. Gun Installation:

a. The H-87A-2 gun installation consists of two .50 caliber, Model M-2 Colt Aircraft Machine Guns mounted in each wing. The guns fire clear of the propeller disc.

b. The H-87A-3 gun installation consists of three .50 caliber, Model M-2 Browning Aircraft Machine Guns mounted in each wing. The guns fire clear of the propeller disc.

### 4. Ammunition Boxes:

a. The H-87A-2 installation consists of four double compartment stainless steel ammunition boxes in each wing panel. The front compartments feed the outboard gun and the aft compartments the inboard gun. The capacity for each gun is 615 rounds. The ammunition is fed from the boxes to the guns over roller assemblies. Directions for loading the boxes are on the instruction plates mounted on the top of each box. The cartridges must be joined together between the boxes. The ammunition boxes are accessible through doors in the top surface of the wing.

b. The H-87A-3 installation consists of two single and two double stainless steel ammunition boxes in each wing panel. The normal capacity is 235 rounds per gun. The two leading outboard compartments serve the center gun. The two trailing outboard compartments serve the inboard gun and the two inboard boxes serve the outboard gun. If the guns are to be fired, remove the ammunition boxes, fill and replace in the wing, join the cartridges between boxes and feed the ammunition over the feed rollers and into the feedways of the guns. BE SURE that the first cartridge and link are properly engaged by the belt holding pawl.



# GUN SIGHTING CHART

## H-87A-2

### FOR USE IN ALIGNING GUN SIGHT

GUN INST. DWG. NO. -- 87-69-500

#### UNSYNCHRONIZED GUN

|             |       |       |
|-------------|-------|-------|
| RIGHT INNER | 45.43 | 69.68 |
| LEFT INNER  | 45.43 | 69.68 |
| RIGHT OUTER | 44.39 | 77.18 |
| LEFT OUTER  | 44.39 | 77.18 |

VERTICAL DISTANCE  
FROM GUN TRUNNION  
BOLT TO GUN  
SIGHT REFLECTOR

HORIZONTAL DIS-  
TANCE FROM G  
AIRPLANE TO G  
GUN BORE

MILES PER HOUR  
CALIBRATED - INDICATED

GUN ADJUSTMENT

NOSE DOWN NOSE UP

FIG. 29

50 MILS  
25 DEGREES

PARALLEL TO LEVELING LUGS  
FOR THRUST LINE

PARALLEL TO LEVELING LUGS  
FOR GUNS



# GUN SIGHTING CHART

H-87A-3

FOR USE IN ALIGNING GUN SIGHT  
GUN INSTALL. DWG NO 87-69-701

## UNSYNCHRONIZED GUN

|          |       |       |
|----------|-------|-------|
| RIGHT #1 | 45.43 | 69.68 |
| LEFT #1  | 45.43 | 69.68 |
| RIGHT #2 | 44.39 | 77.18 |
| LEFT #2  | 44.39 | 77.18 |
| RIGHT #3 | 43.39 | 85.16 |
| LEFT #3  | 43.39 | 85.16 |

MILES PER HOUR  
CALIBRATED - INDICATED

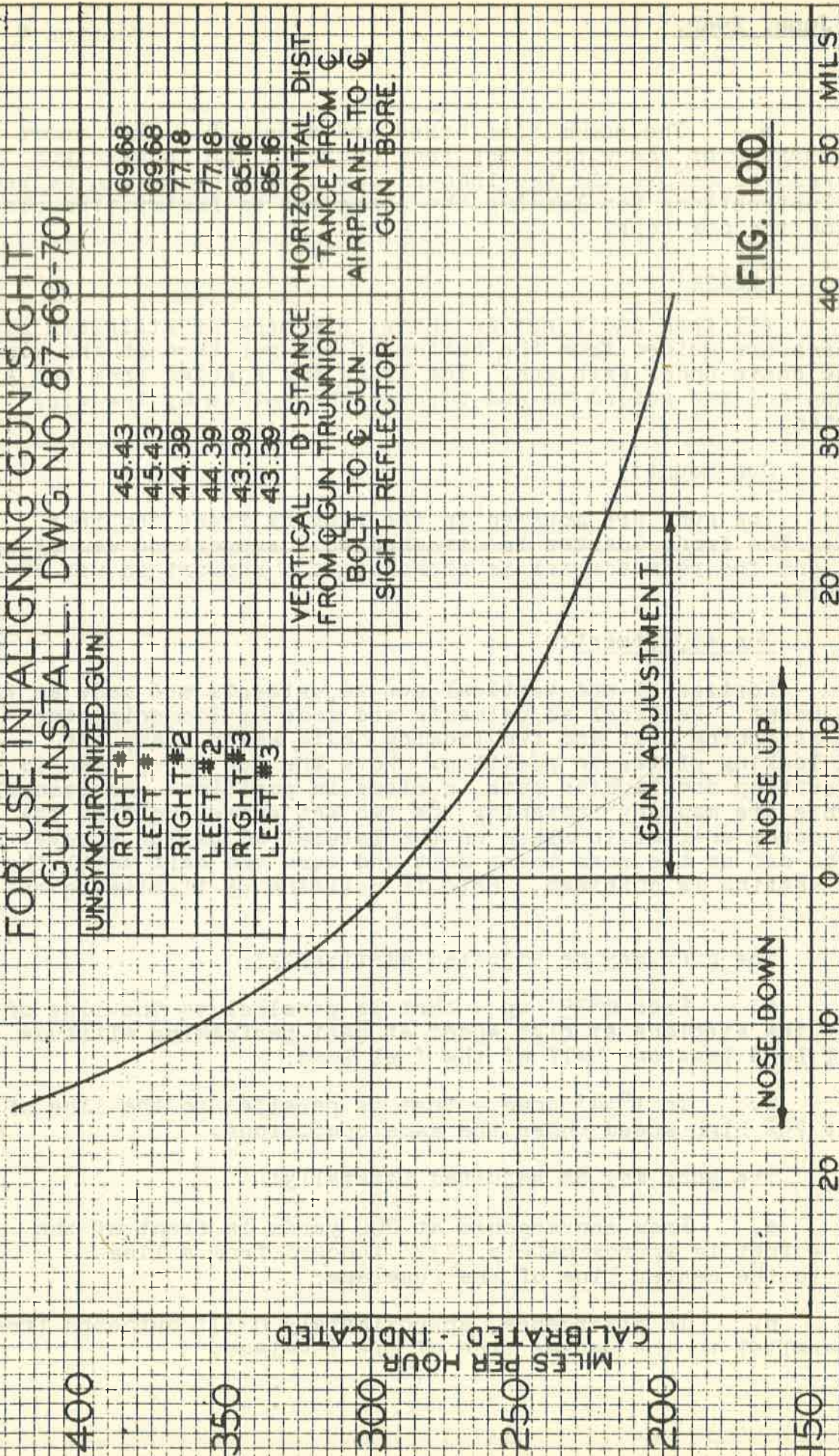


FIG. 100

PARALLEL TO LEVELING LUGS  
FOR GUNS

PARALLEL TO LEVELING LUGS  
FOR THRUST LINE

50 MILS  
2.5 DEGREES



c. The ammunition boxes are accessible thru doors on the top surface of the wing. The feed chute to the inboard gun must be removed before the two inboard ammunition boxes can be removed. Instructions for loading the boxes are on instruction plates mounted on the box tops.

5. Chutes:

All feed and ejection chutes are made of stainless steel. Empty cases are guided from the bottom of the gun through the wing by a case chute under each gun. The links are ejected from the side of the gun and are guided to and through the bottom by the wing link chutes.

6. Gun Mount:

The guns are mounted in the wing by front and rear adapters. The front adapter is attached to a support on web #3 by one bolt and the rear adapter is attached to a support on web #5 by one bolt.

7. Gun Adjustment:

Horizontal and vertical gun adjustments are made at the rear gun mount. Vertical adjustments are made by loosening the rear gun attaching bolt and two locking bolts which clamp the serrated locking plates in position. Move the gun up or down to desired setting and tighten nuts to clamp in position. Horizontal adjustments are made by loosening the two set screws holding the rear gun mount adapter in place on the lateral adjusting sleeve. Loosen the nut on the rear mount bolt and turn the bolt until the required setting is obtained. Hold in position by tightening the set screws.

The guns may be adjusted vertically:

a. From  $0^{\circ}35'$  up - that is parallel to the line of flight of the airplane at high speed at best performing altitude with full load less one half of the fuel load;

b. To  $1^{\circ}14'$  down - that is parallel to the line of flight at 75% high speed under the same conditions.

The guns may be adjusted laterally:

a. From convergence at 200 yards in front of the airplane - that is approximately  $0^{\circ}37'$  inboard from a line parallel to the center line of the fuselage;

b. To divergence, approximately  $0^{\circ}37'$  outboard from a line parallel to the center line of the fuselage.

The adjustments for various flying conditions are given on the gun sighting charts, Fig. 99 and Fig. 100.

8. Controls:

a. The Bendix hydraulic gun charger cylinder and charger valves supply the actuating force to charge the guns without mechanical connections from the charger valves in the cockpit to the guns in the wings. The hydraulic power used to charge the guns is supplied by the hydraulic system through pressure built up by either the electrically driven hydraulic pump or the auxiliary hand pump. The charger valves are mounted just below the main switch panel by two bosses on each valve body tapped for 1/4-20 screws. The gun charger cylinder is mounted on the outboard side of all guns by two brackets and connected to the hydraulic line by a flexible hose. The left charger handle controls the two guns in the left wing and the right handle controls the two guns in the right wing. The outboard guns on the H-87A-3 are controlled by the center handle. The center and inboard guns are controlled as above. WARNING: The landing gear and flap control valve must be in the neutral position before operating the gun charging valves.

b. The guns are electrically fired by a B-1A trigger switch on the control stick grip which actuates a Type G-9 Magnavox solenoid attached to the inboard side of the gun and controlled through the safety switch mounted on the left hand side of the main switch panel. The safety switch has two positions all guns either "ON" or "OFF". When the type G-9 Magnavox solenoid is installed on the gun it may be necessary to adjust the plunger protrusion for proper gun functioning. The armature may be removed for inspection and cleaning by removing the lockwire and the two screws on the face of the solenoid. WARNING: After all gun installations, always check the solenoid action before flights requiring the use of the gunnery equipment.

9. Doors and Covers:

The long, hinged double door aft of web #3 in the top surface of the wing panel is provided for access to the ammunition boxes. The gun access door is in the lower surface of the wing aft of web #3. It is installed with a hinge on its leading edge and DZUS fasteners around the remaining portion of its perimeter. Cover plates are provided for the leading edge of the wing and may be installed by DZUS fasteners when the blast tubes are removed.

10. Wing Gun Installation: To install the wing guns proceed as follows:

- a. Install the front and rear adapters on the gun.
- b. Unbutton the gun access door and remove the charger cylinders and solenoids from their stowage clips and allow them to hang below the wing.



c. Mount the gun by inserting it, muzzle end first, through the gun compartment and guide the muzzle through the holes provided in web #3, #2 and #1.

d. Support the rear of the gun with the drift pin stowed in the pocket on the left gun access door. Insert the drift pin through the rear mount and adapter.

e. Engage the front adapter in the yoke and insert the front mounting bolt.

f. Remove the drift pin from the rear adapter and allow the gun to drop down as far as it will go.

g. Release the toggle on the rear adapter to free the saddle and swing the adapter downward under the gun.

h. Install the solenoid on the inboard side of the gun, tighten and safety the attaching nut.

i. Install the charger cylinder in the brackets on the outboard side of the gun and secure the front end first.

j. Swing the rear adapter up and engage the eye bolt in the saddle. Throw the toggle up to lock the saddle and adapter.

k. Attach the link chute to the side of the gun.

l. Remove the leading edge cover plate and install the blast tube through the opening in the leading edge of the wing.

m. Attach the leading edge cover plate to the wing with two DZUS fasteners.

n. Make the necessary alignments and adjustments in accordance with tactical requirements as to direction of fire, and safety all adjustments.

o. Check the operation of charging control and test the firing solenoid with the guns empty of ammunition by use of the control stick trigger.

p. If the guns are to be fired, remove the ammunition boxes, load in accordance with the instruction plate on the box top, connect links between boxes, feed the ammunition over the feed rollers and into the feedways of the gun.

q. To load the guns use a screw driver inserted from the underside between the gun and feed chute and boost the first round over the belt holding pawl. Charge all guns once and the first round will be held by the bolt. One more charge by the pilot in flight will fully load the gun ready to fire.

r. Close and fasten all doors and covers in the top and bottom surface of the wing. Be sure all Dzus fasteners have the proper tension grip.

NOTE: The above instructions apply to airplanes AK571 through AK590. On airplanes AK591 and subsequent first install the blast tube retainers on the gun barrels. Slide the retainer over the muzzle of the gun to the proper position on the gun barrel jacket. The location of each retainer is approximately as follows: (measures from the muzzle of the gun to the aft end of the retainer)

|               |            |
|---------------|------------|
| Inboard guns  | - 10 3/16" |
| Center guns   | - 15 1/2"  |
| Outboard Guns | - 15 1/2"  |

Guns are supplied with two types of barrel jackets, one having louvers for ventilation, the other having round holes. If the retainer is being installed on a gun having louvers in the barrel jacket, the retainer is secured by three studs inserted with the small diameter head projecting into the louvers. If the barrel jacket has round holes, the retainer is secured with two studs inserted with the large diameter heads projecting into the holes. After inserting, the studs should be tightened, then loosened approximately half a turn, leaving them with the slots in line. If the studs are tight in the retainer, powder residue will form in the threads and cause them to seize. The retainer has been machined to fit loosely on the barrel jacket to prevent residue from causing it to seize on the barrel. After the studs are properly positioned, they should be lockwired around the barrel as illustrated in Fig. 5. When the installation is complete the retainer should be slightly loose on the barrel jacket, but must be secure. Continue the installation as outlined in a. through j.

Insert the blast tube into the leading edge of the wing over the muzzle of the gun. The correct location of each blast tube is given on the name plate attached to the tube. Screw the blast tube onto the retainer on the barrel jacket as far as it will go, then back off the tube approximately half a turn, leaving it with the two locking lugs at the front end of the tube in a vertical position. It is extremely important that the blast tube be backed off approximately half a turn, because if it is tight on the retainer, powder residue will collect in the threads and cause seizure. Slip the leading edge fairing over the blast tube, if necessary moving the shutter so the opening is in the proper location, and button the fairing to the leading edge with the two Dzus fasteners. A lock in the fairing will engage the blast tube lugs and prevent the tube turning off the adapter. If the Dzus fasteners appear to be loose in their securing spring, the springs can be set up by bending them slightly inward. After these operations are completed, it will be noted that the blast tube will contain considerable lost motion at its forward end due to the loose fitting thread in the retainer and



the looseness of the retainer on the gun. This is desirable to prevent seizing after extensive firing. Proceed with the installation as outlined in n. through r.

11. Wing Gun Dismount:

Reverse the preceding instructions, n. through a.

NOTE: The blast tube must be removed before the gun can be dismounted. Removing the gun as given in paragraph 11 leaves the adjustments undisturbed.

12. Gun Action Removal:

The gun action may be removed with the gun in the wing as follows:

- a. Remove the cover plate on the leading edge of the wing.
- b. Remove the blast tube from the leading edge of the wing on airplanes AK571 - 590. On airplanes AK591 and subsequent unbutton the leading edge cover plate and unscrew the blast tube from the gun at the leading edge of the wing.
- c. Unfasten the gun access door.
- d. Detach the feed chute from the inboard gun on the H-87A-2. On the H-87A-3 detach the feed chutes from the inboard and center guns and the link chute on the outboard gun.
- e. Remove the rear mounting bolt.
- f. Drop the gun down to clear web #5. Release the toggle and swing rear adapter under the gun.
- g. Remove the hydraulic gun charger.
- h. Remove the back plate from the gun and withdraw the bolt and driving pin and the gun barrel with the barrel extension and lock frame from the gun.

13. Gun Heater:

A gun heater installation (87-81-516) has round openings in the leading edge of the wing panels which take warm air from the oil cooler and coolant radiator exit air duct and transmits the warm air to both sets of wing guns by means of a flexible rubber tubing. This gun heater unit prevents gun freezing.







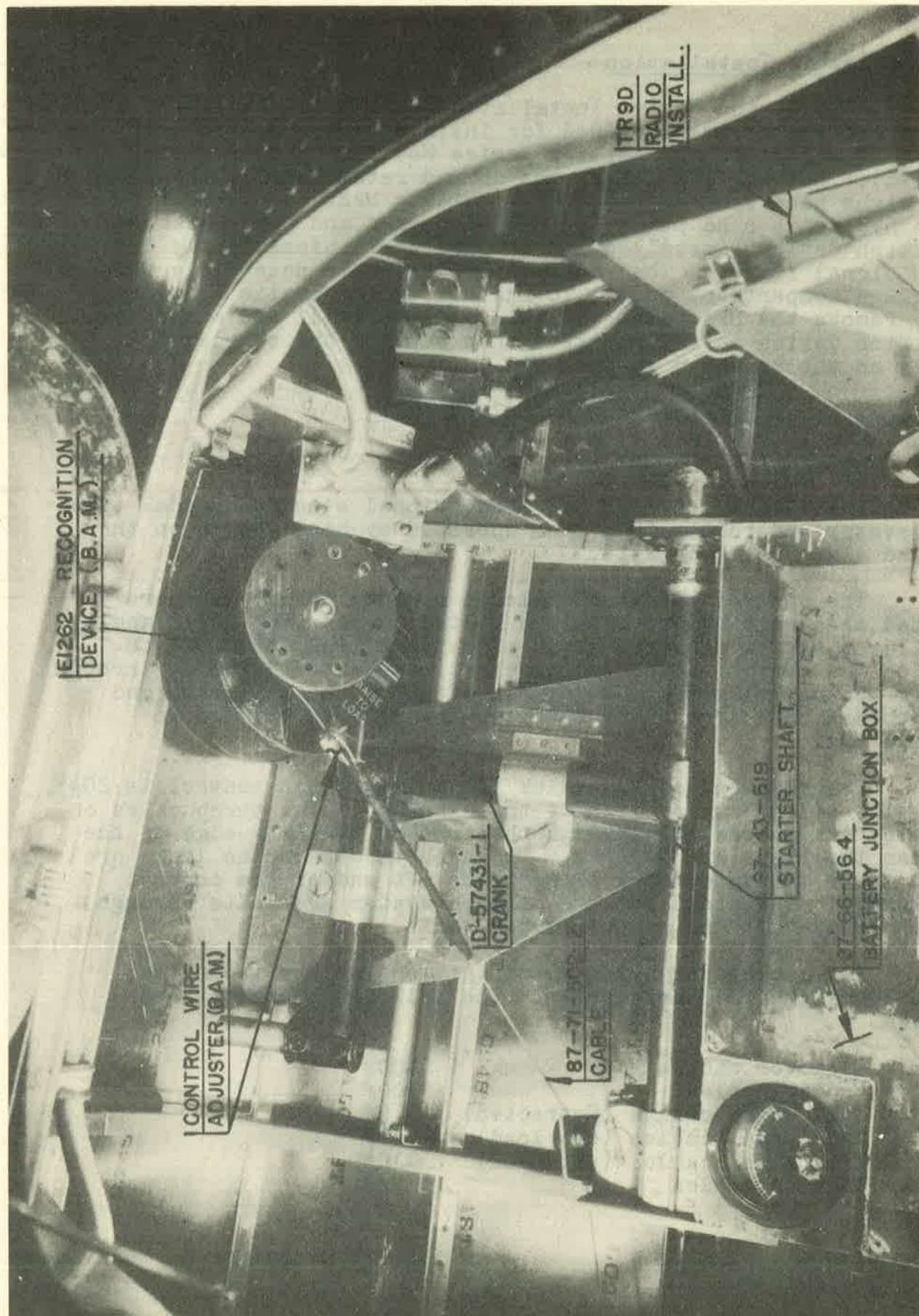


FIG. 102 AUTOMATIC RECOGNITION DEVICE INSTALLATION  
H-87A-2 & H-87A-3



## M. Pyrotechnic Installation

1. Recognition Device Installation 4 or 6 flares (87-71-502) Brackets and cables are provided for installing the damped rate control and automatic recognition device No. E-1262 (customer furnished). See Fig.102. When the damped rate control, installed on the right hand side of the cockpit with a bracket assembly between the two hydraulic hand pumps, is pulled upward and then released the recognition device (installed in the fuselage) automatically discharges signal flares. The recognition device is accessible through the baggage compartment door. To install the automatic recognition device, remove the brackets 87-71-512 and 87-71-511 and mount the recognition device on the brackets then replace the completed assembly on the bulkhead at Sta. #10.

## N. Flight Controls (Drawing No. 87-64-501)

### 1. General:

The flight controls are conventional stick and pedal type, with elevator and rudder trim tabs operated by hand wheels on the left hand side of the cockpit.

The control stick and aileron control torque tube are supported as a unit by two bearings bolted to the wing match angle. Each aileron system consists of an adjustable link connected to an arm on the control stick torque shaft, and extending down through the wing to the bellcrank; cables run aft from the bellcrank and then outboard to a drum which operates the aileron through an eccentric arm.

The movement of the stick for full aileron control is  $20\frac{1}{2}^{\circ}$ , either side of the center line of the airplane. The turnbuckles on the cables are accessible through the inboard trailing edge of the wing when the flaps are lowered. The adjustments on the links are located above the upper wing skin at the aft end of the control torque shaft. The stops for the aileron system are bolts through the arms on the aft end of the torque shaft.

All cables requiring specified tension are tested for correct loading by a tensionmeter. The following tensions are specified

|                               |      |
|-------------------------------|------|
| Elevator cables               | 100# |
| Rudder cables                 | 100# |
| Tail wheel cables (Retracted) | 0#   |
| Tail wheel cables (one load)  | 40#  |
| Tail wheel cables (extended)  | 110# |
| Aileron cables                | 90#  |

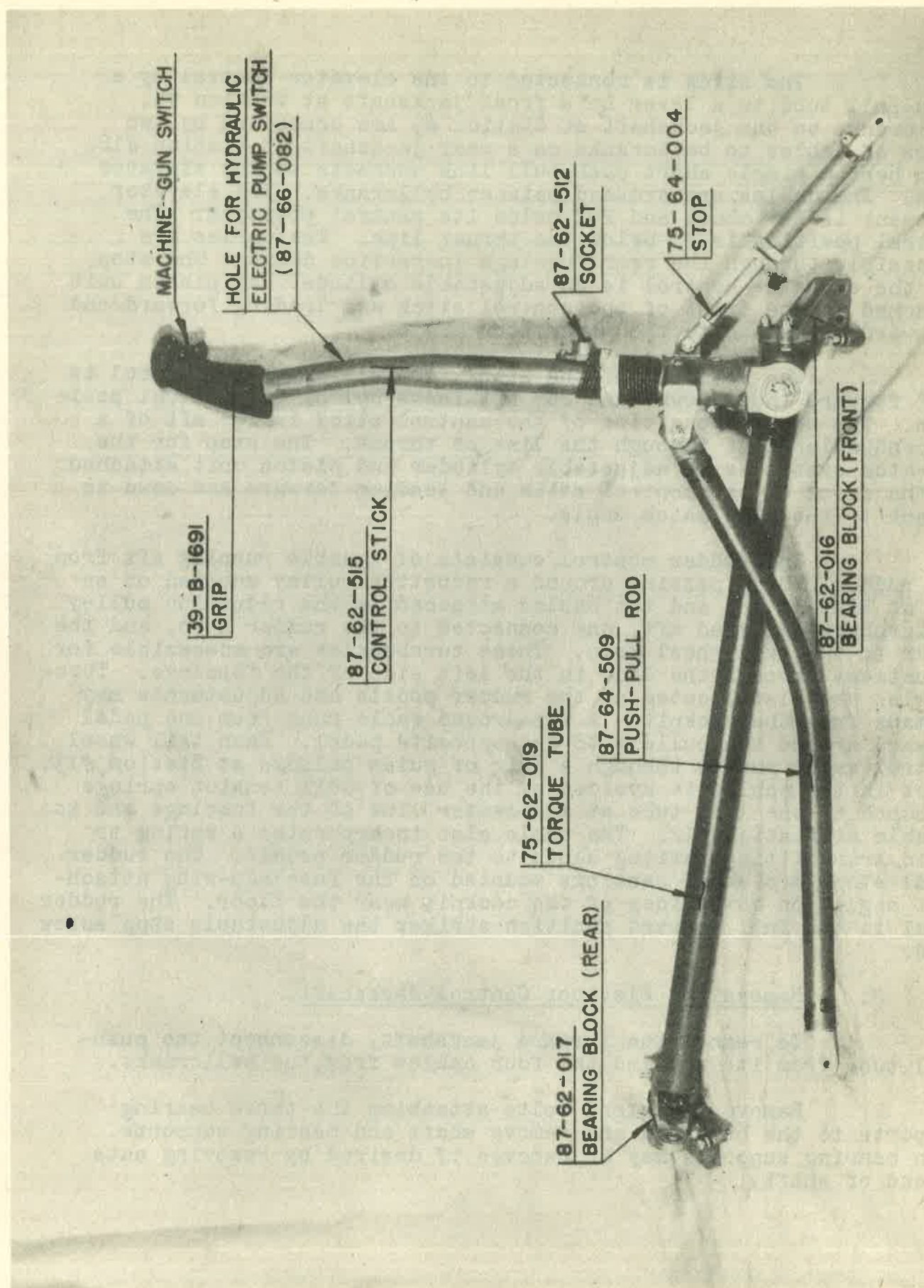


FIG. 103 CONTROL STICK ASSEMBLY H-87A-2 & H-87A-3



The stick is connected to the elevator control by a push-pull tube to a lever on a front jackshaft at Station #5. Bellcranks on the jackshaft at Station #5 are connected by two pairs of cables to bellcranks on a rear jackshaft at Station #16. From here a single short push-pull link connects to the elevator horn. The cables are crossed between bellcranks. The elevator movement is  $30^{\circ}$  above and  $20^{\circ}$  below its neutral position. The neutral position is  $2^{\circ}$  below the thrust line. The cables are accessible through the rear fuselage inspection doors. The stop for the elevator control is an adjustable cylinder and piston unit attached to the front of the control stick and leading forward and downward to attach to the wing match angle.

The movement of the stick for full elevator control is  $17\frac{1}{2}^{\circ}$  forward (nose down) and  $26^{\circ}$  aft (nose up) of the neutral position. The neutral position of the control stick is  $1\frac{1}{2}^{\circ}$  aft of a perpendicular line through the line of thrust. The stop for the elevator system is an adjustable cylinder and piston unit attached to the front of the control stick and leading forward and down to attach to the wing match angle.

The rudder control consists of a cable running aft from the rudder pedal, passing around a reduction pulley mounted on an arm at Station #8, and two cables attached to the reduction pulley by turnbuckles, lead aft, one connected to the rudder horn, and the other to the tail wheel horn. These turnbuckles are accessible for adjustment through the door in the left side of the fuselage. Turnbuckles are also located at the rudder pedals and adjustments may be made from the cockpit. A run-around cable runs from one pedal forward around two pulleys to the opposite pedal. Each tail wheel control cable passes through a pair of guide pulleys at Station #13. Slack in the cables is avoided by the use of coil tension springs attached to the lift tube at the center line of the fuselage and to a cable at Station #12. The cable also incorporates a spring to avoid transmitting taxiing shock to the rudder pedals. The rudder pedal stops are small castings mounted on the fuselage-wing attachment angle, on both sides of the cockpit near the floor. The rudder pedal in the full forward position strikes the adjustable stop screw head.

## 2. Removal of Elevator Control Jackshaft.

To remove the forward jackshaft, disconnect the push-pull tube from its arm and the four cables from the bellcranks.

Remove the eight bolts attaching the three bearing supports to the bulkhead and remove shaft and bearing supports. Then bearing supports may be removed if desired by removing nuts at end of shaft.

The rear jackshaft may be removed by disconnecting the cables and link and then removing the four bolts which attach the bearings to their supports.

The pedals are readily adjustable, forward and aft, to any one of three positions. This is done by means of a release mechanism on the inboard side of each pedal. The proper operating position is to be selected before flight.

### 3. Trim Tab Control:

The elevator trim tab and rudder servo trim tab controls are mounted on the left hand side of the cockpit. Motion is transmitted by chain and sprocket drive to a gear box mounted just forward of the rear elevator jackshaft. From this box three flexible shafts (2 for elevator, 1 for rudder) transmit motion to the tab control actuator unit. Short tie rods connect these actuators to the individual tabs. Control chain tension is adjustable by turnbuckle accessible through the baggage compartment door.

Whenever it is necessary to coordinate the actuator units and the tabs, the actuators are to be adjusted in accordance with the following instructions. The center of travel of the eye terminal of the actuator can be obtained by rotating it to the required position. This will not affect the cockpit control unit setting. The eye terminal may now be connected to the tab control bellcrank or lever, making sure that the connecting pin fits tightly in the holes. If a correction for the neutral setting is required after connection to the bellcrank or lever, it must be made by disconnecting the eye terminal from the bellcrank or lever, and rotating the terminal to the new setting. Care should be taken to make sure that the neutral setting is such that the travel is within the  $1 \frac{3}{4}$ " maximum travel of the actuator. The rods from the bellcrank, or lever, to the tab horns are to be adjusted by means of the adjustable rod ends.

If after extended service the tab control actuator unit develops end play it may be adjusted by backing off the end play adjustment locknut. Then disconnect the eye terminal at the tab horn. The barrel nut should then be held by hand to keep it from rotating and the eye terminal rotated a half turn maximum. The locknut should then be set and the take-up checked by applying end pressure in both directions to the eye terminal. If end play is not corrected the operation should be repeated. If the eye terminal will rotate freely, and no play is perceptible the unit may then be reconnected.

4. Flap Controls: See Sec. V, A., 6.

5. Aileron Controls: See Sec. V, A., 5.



## O. Electrical System (Drawing No. 87-66-655)

### 1. General:

The electrical system is a single wire, grounded negative installation. All electrical cables are carried in aluminum or flexible conduit. Junction boxes or disconnect plugs are provided at all points of junction of the electrical wiring to facilitate connection and replacement of wiring.

### 2. Ignition System:

The Type 32226 ignition switch is mounted on the left side of the main switch panel.

### 3. Generator System:

Current is supplied to the storage battery by a 50-ampere Type M-2 generator, controlled from a generator control panel mounted in the engine compartment.

### 4. Hydraulic Pump Motor:

The pump for the hydraulic system is driven by an Eclipse Type 809 Model 1 (24 Volt ----64 Amp. maximum) motor. For additional information on this pump see F., Sec. V, paragraph 2.

### 5. Switches and Rheostats: (Drawing No. 87-66-560 H-87A-2) (Drawing No. 87-66-910 H-87A-3)

The gun trigger switch, type B-1A, is located on the grip on the control stick. A type B-6B switch for the landing gear hydraulic motor is located on the control stick below the grip. (Drawing No. 87-66-082-6). The landing gear warning horn switch (operated by a cam on the throttle rod) is located just forward of the throttle quadrant. The landing gear warning horn cut-off switches are located on the landing gear junction boxes near the leading edge of the panel. On the right hand side of the cockpit outboard of the shutter control lever is a fire extinguisher crash switch. A remote contactor switch is installed on the right hand side of the cockpit forward of the map case. In addition to the above, the following switches and rheostats are installed on the main switch panel directly below the instrument panel.

- (a) Gun Switch, Type B-5A
- (b) Camera Switch, Type B-5A
- (c) Aileron Trim Tab Switch, Type B-11
- (d) Spotlight Switch, Type B-5A
- (e) Running Light Switch, Type B-7A
- (f) Fluorescent Light Switch, Type B-5A
- (g) Fuel Gage (Wing Tanks) Light Switch, Type B-7A
- (h) Landing Light Switch, Type B-9A

- (i) Oil Dilution Switch, Type B-6B
- (j) Pitot Heater Switch, Type B-5A
- (k) Coolant Test Switch, Type B-11
- (l) Generator Switch, Type B-5A
- (m) Propeller Switch (Circuit Breaker) Type 100602-1
- (n) Propeller Manual - Automatic Switch, Type 102911
- (o) Main Battery Switch, Type A-9
- (p) Ammeter, Type D-2
- (q) Compass Rheostat, Type C-1, 45 ohms.
- (r) Gun Sight Rheostat, Type D-1, 50 ohms.
- (s) Flight Light Rheostat, Type F-1, 25 ohms.
- (t) Inboard Gun Circuit Breaker (87-66-570-30)
- (u) Outboard Gun Circuit Breaker (87-66-570-35)
- (v) Bomb Circuit Breaker (87-66-570-30)
- (w) Gun Sight Circuit Breaker (87-66-570-15)
- (x) One Extra Circuit Breaker (87-66-570-15)
- (y) One Extra Circuit Breaker (87-66-570-20)
- (z) One Extra Circuit Breaker (87-66-570-2)

#### 6. Circuits Passing Through The Ignition Switch:

The ignition switch must be on "BOTH" before the following circuits can be closed; the starter solenoid, the pitot heater, carburetor temperature gage, fuel quantity gage and the propeller control circuits.

#### 7. Electrical Bonding:

All parts are bonded according to specification, and replacement should be made with clamps, bolts, metal strips, pig-tails, etc. similar to those provided in the original installation.

#### 8. Battery:

A type G-1 battery, capacity 24 volt, 34 ampere hour, supplying the electrical power, is accessible through the fuselage access door. A battery drain casting is located on the center line of the under surface of the fuselage aft of the trailing edge of the wings. The drain casting is connected to the battery box by rubber tubing.

For additional information on care and servicing of battery see Sec. VI, para. F.



|     |                                          |
|-----|------------------------------------------|
| 1   | Oil Switch Solenoid, Type 1-22           |
| 2   | Pilot Heater Switch, Type 1-22           |
| 3   | Ignition Switch, Type 1-22               |
| 4   | Generator Switch, Type 1-22              |
| 5   | Propeller Switch (Ignition) Type 10000-1 |
| 6   | Propeller Switch (Ignition) Type 10000-1 |
| 7   | Main Battery Switch, Type 1-22           |
| 8   | Ignition Switch, Type 1-22               |
| 9   | Ignition Switch, Type 1-22               |
| 10  | Ignition Switch, Type 1-22               |
| 11  | Ignition Switch, Type 1-22               |
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| 98  | Ignition Switch, Type 1-22               |
| 99  | Ignition Switch, Type 1-22               |
| 100 | Ignition Switch, Type 1-22               |

## 6. Ignition Switch Through the Ignition Switch

The ignition switch shall be on "BOTH" before the following circuits can be closed: the starter solenoid, the pilot heater, the propeller temperature gauge, fuel quantity gauge and the propeller control circuit.

## 7. Electrical Bonding

All parts are bonded according to specification, and replacement should be made with clean, bolt, metal strap, etc., similar to those provided in the original installation.

## 8. Battery

A type 6-1 battery, capacity 24 volt, 24 ampere hour, supplying the electrical power, is accessible through the fuselage access door. A battery drain wiring is located on the center line of the water surface of the fuselage aft of the trailing edge of the wing. The drain wiring is connected to the battery box by rubber tubing.

For additional information on care and servicing of battery see Sec. VI, Para. 7.



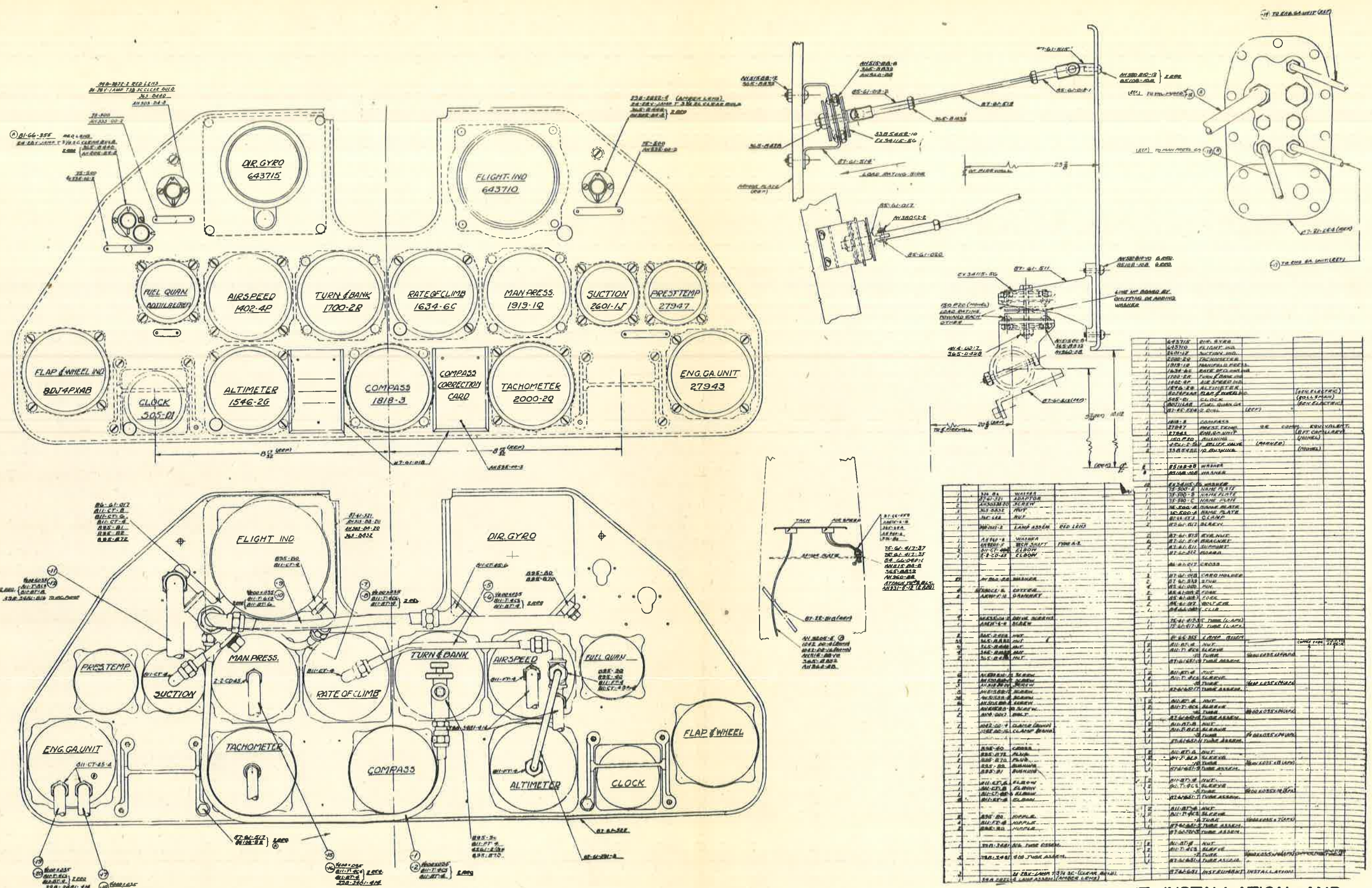


FIG.104 INSTRUMENT INSTALLATION AND GYRO HOOK-UP 87-61-651





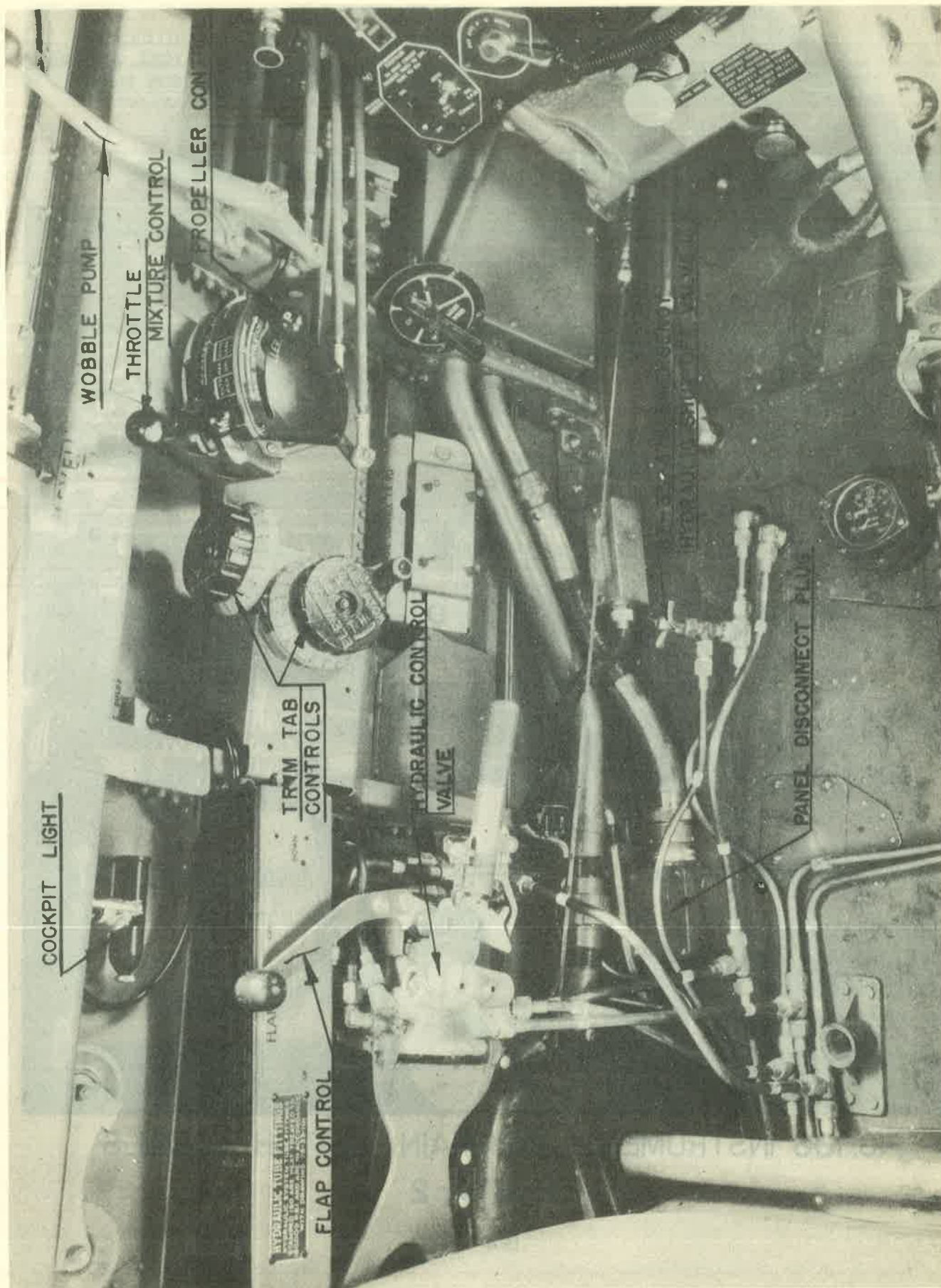


FIG. 105 COCKPIT L. H. SIDE H-87A-2 & H-87A-3



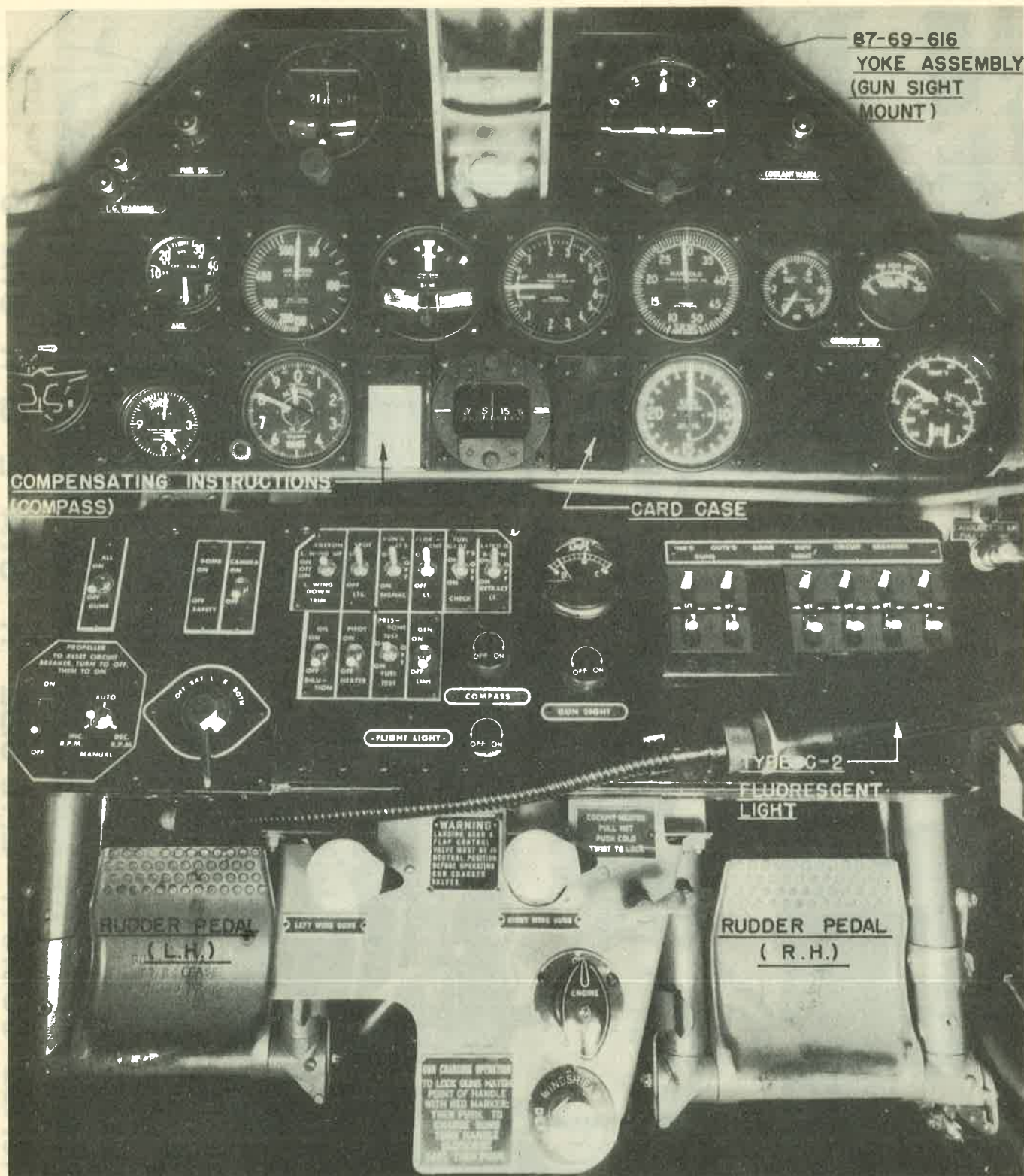


FIG. 106 INSTRUMENT AND MAIN SWITCH PANELS  
H-87A-2

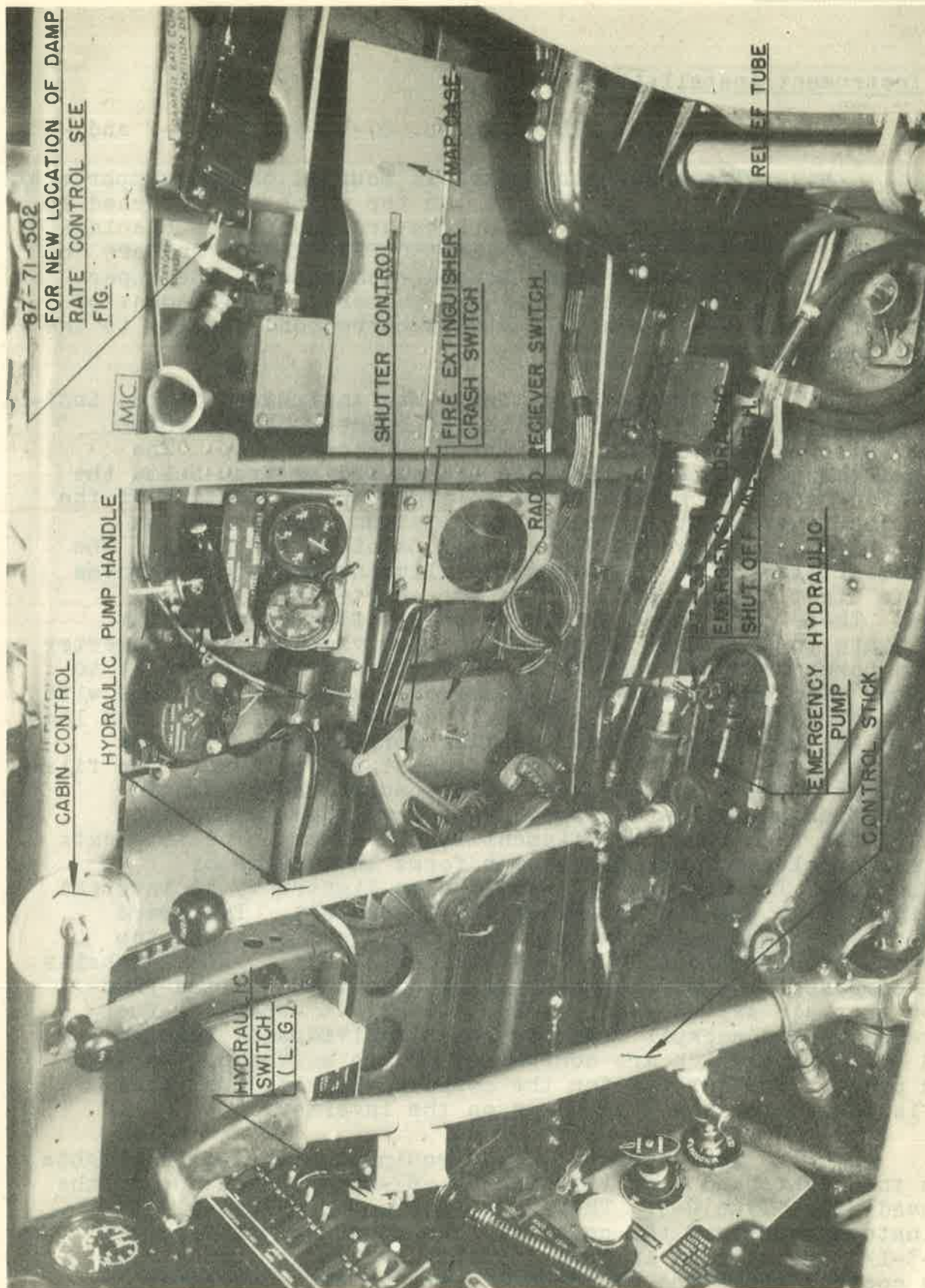


FIG.107 COCKPIT - R. H. SIDE H-87A-2 & H-87A-3



P. Instrument Installation

## 1. Instrument Panel (Drawing No. 87-61-651 H-87A-2 and -3)

a. The instrument panel is mounted on two supports at the bottom and braced by two rods at the top which are attached to the armor plate. The supports and braces are mounted on bushings and washers. The support bushings are 150 P20 (Monel) and are installed with the load rated sides toward each other. The upper mountings are installed with EX34115-56 washers. Replacement of these bushings and washers should always correspond exactly to the original installation.

b. Instrument lighting: The instrument dials, indicators and controls are painted with fluorescent paint; which becomes luminous under light from the fluorescent lamp. The lamp is attached to a semi-flexible arm extending from below the main switch panel and may be moved to light up any portion of the panel. The fluorescent lighting installation consists of an inverter, lamp assembly and fluorescent paint on the dials. The adjustable filter, when it covers the illuminating slot, removes the white light emitted and permits the shorter rays to pass through. These rays cause the salts in the fluorescent paint on the dials to fluoresce, thus making them visible. The inverter receives power from the battery at 24 volts and transforms it to 110 volts. The lamp assembly consists of a vapor filled tube with filaments at each end and an automatic switch. Closure of the lamp switch on the main switch panel permits current flow from the battery, thru the inverter, to the filament of the lamp. The filament rapidly becomes incandescent which causes the automatic switch to open and allow a large surge of voltage to arc the length of the tube from one filament to the other. The filaments then become poles for the arc, which forms the source of illumination. The compass is individually lighted by an inverted screw-in bulb at the top center of the instrument. Two spare bulbs for the compass are carried in dummy sockets on the top center of the Directional Gyro and Horizontal Gyro. The intensity of the compass light may be governed by adjustment of the rheostat on the main switch panel marked "COMPASS." The wing fuel tank gages on the cockpit floor are both individually lighted with 3 volt bulbs which are controlled by the switch on the main switch panel. The current for the compass and wing fuel tank gages is taken from the 3 volt tap on the inverter.

c. The cockpit is also equipped with two spotlights, one on the right hand side (Drawing No. 87-66-681) and one on the left hand side, Type C-3. These spotlights are adjustable to illuminate any part of the cockpit. Two spare bulbs, Type G-6 and T-3-1/4 are carried in dummy sockets on the left hand wall of the cockpit above the rudder and elevator trim tab control mechanism. The gyro instruments are operated by an engine driven vacuum pump.

At engine speeds of 1000 R.P.M. to maximum, adjust vacuum relief valve to give a suction gage reading of 4.00  $\pm$  .25 inches of mercury, adjust vacuum regulating valve to give a reading through the Turn and Bank indicator of 1.9  $\pm$  .15 inches of mercury. - .10

## 2. Inspection and Maintenance of Instrument Panel and Instruments.

a. The following is a list of maintenance checks which may be accomplished at stations where qualified personnel and adequate equipment are available:

1. Instrument Board
  - (a) Replace defective support brackets
  - (b) Replace defective shock absorber units
  - (c) Vibration test
  - (d) Maintenance of lighting equipment
  - (e) Replace defective connection tubing
  - (f) Replace instrument panels where necessary
2. Altimeter (Type 1546-2G, Pioneer)
  - (a) Correct zero error in reference marker
  - (b) Scale error test
  - (c) Position error test
  - (d) Friction test
  - (e) Case leak test
  - (f) Check static line and connections
  - (g) Replace defective instruments
3. Compass Magnetic (Type 1818-3, Pioneer)
  - (a) Friction test
  - (b) Balance test
  - (c) Period test
  - (d) Card error test
  - (e) Leak test
  - (f) Heeling test
  - (g) Leveling test
  - (h) Overswing test
  - (i) Damping tests (room temperature)
  - (j) Replace defective lights
  - (k) Replace or repair lighting system
  - (l) Tighten bezel screws
  - (m) Refill with liquid
  - (n) Compensation on airplane
  - (o) Test for magnetic interference
  - (p) Replace defective instruments
  - (q) Check electrical connections
4. Clocks (Type 3315-2B, Pioneer)
  - (a) Replace defective cover glass
  - (b) Regulate
  - (c) Rate test
  - (d) Wind and set
  - (e) Replace defective instruments



5. Gages, Oil Pressure, Fuel Pressure, Manifold Pressure, Suction.

- (a) Replace broken cover glasses
- (b) Clean and oil mechanism
- (c) Reset loose pointers
- (d) Scale error test
- (e) Leak test
- (f) Friction test
- (g) Adjust zero position of pointers
- (h) Adjust damping screws
- (i) Check calibration with master instrument
- (j) Reseal cases
- (k) Replace defective connection tubing
- (l) Check tubing for proper anchorage
- (m) Check connections and lines for leaks
- (n) Check calibration of fuel gage
- (o) Replace defective instruments

6. Airspeed Indicator (Type 1402-4P, Pioneer)  
(Airspeed Head Type 1079S, Pioneer)

- (a) Scale error test
- (b) Reseal cases
- (c) Case and diaphragm leak tests
- (d) Check calibration with master instrument
- (e) Check lines and connections
- (f) Replace defective heating element
- (g) Check electrical connections
- (h) Replace defective pitot-static head
- (i) Replace defective instrument

7. Rate of Climb Instrument (Type 1634-6C, Pioneer)

- (a) Adjust zero position of pointer
- (b) Scale error test
- (c) Position error test
- (d) Test thermos tanks for leaks
- (e) Inspect lines and connections
- (f) Replace defective instrument and tanks

8. Bank and Turn Indicator (Type 1700-2R, Pioneer)

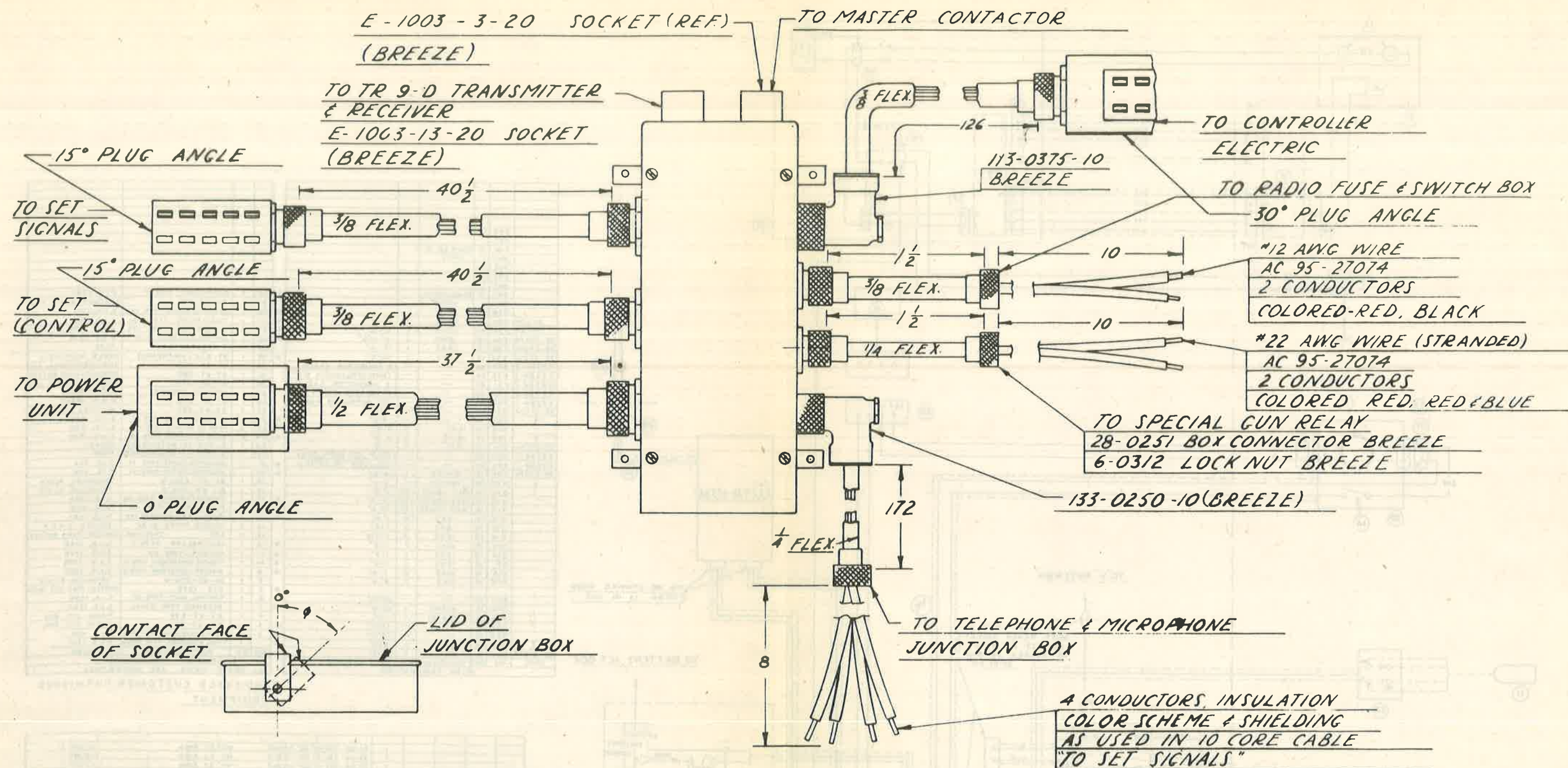
- (a) Lubricate gyro
- (b) Remove and clean screens
- (c) Zeroing test
- (d) Damping test
- (e) Adjust for damping
- (f) Sensitivity test
- (g) Adjust for sensitivity
- (h) Static and running friction test
- (i) Test installed instrument
- (j) Test lines and tubes
- (k) Replace defective lines and tubes
- (l) Replace defective instruments

9. Turn Indicator (Directional gyro) (Type 643715, Sperry)
- (a) Remove and clean screen
  - (b) Drift test
  - (c) Tilt test
  - (d) Inclinator test
  - (e) Coast test
  - (f) Inspect lines and venturi tubes
  - (g) Repair controller
  - (h) Repair control shaft
  - (i) Replace defective instruments
  - (j) Replace defective lines and tubes
  - (k) Replace defective controller and shaft
  - (l) Test installed instrument
10. Flight Indicator (Horizontal) (Type 643710, Sperry)
- (a) Remove and replace screen
  - (b) Remove and replace shipping lock
  - (c) Starting test
  - (d) Alignment test
  - (e) Static and friction test
  - (f) Erection test
  - (g) Upset test
  - (h) Coast test
  - (i) Inspect lines and venturi tubes
  - (j) Replace defective instruments
  - (k) Replace defective lines and tubes
  - (l) Test installed instrument
11. Tachometer (Chronometric) (Type 2000-ZQ, Pioneer)
- (a) Replace broken cover glass
  - (b) Scale error test
  - (c) Repair broken drive shafts
  - (d) Adjust pointer
  - (e) Check shaft for proper anchorage
  - (f) Lubricate shaft and adapters
  - (g) Check calibration with master instrument
  - (h) Replace defective instrument
12. Thermometer, Coolant (Coolant Type A-23-27947)
- (a) Replace broken cover glasses
  - (b) Clean and oil mechanism
  - (c) Reset loose pointers
  - (d) Scale error test
  - (e) Adjust progressive restrainers
  - (f) Reseal cases
  - (g) Adjust zero position of pointer
  - (h) Check capillary tubing for proper anchorage
  - (i) Replace defective instruments
  - (j) Check calibration with master instrument



13. Flap and Wheel Indicator (Type 8DJ4PXAB - General Electric)
- (a) Check position indicators in landing gear and tail wheel
  - (b) Adjust according to paragraph E., 4, Sec. V.
14. Suction Gage (Type 2601-1J, Pioneer or equivalent)
- (a) Replace broken cover glass
  - (b) Inspect lines for leaks, breaks and mountings
  - (c) Reset loose pointers
  - (d) Replace defective instruments
15. Fuel Indicator (Type 8DJ111LAE - General Electric)
- (a) Replace broken cover glass
  - (b) Reset loose pointers
  - (c) Check electrical connections at transmitter and indicator
  - (d) Adjust zero position of pointer
  - (e) Check transmitter and float assembly for free and maximum travel
  - (f) Replace defective instruments
16. Fuel Pressure Warning Light (Type C-3)
- (a) Replace broken cover glass
  - (b) Replace defective bulb
  - (c) Replace defective assembly
17. Engine Gage (Type 27943, Pioneer)
- (a) Replace broken cover glass
  - (b) Clean and oil mechanism
  - (c) Reset loose pointers
  - (d) Adjust zero position of pointers
  - (e) Adjust damping screws
  - (f) Adjust progressive restrainers
  - (g) Scale error test
  - (h) Friction test
  - (i) Reseal cases
  - (j) Replace connecting tubing
  - (k) Inspect lines for proper anchorage
  - (l) Inspect connections and lines for leaks
  - (m) Replace defective instruments
  - (n) Check calibration with master instrument

18. Any instrument reported as functioning improperly or otherwise defective should be first tested with the portable equipment where ever practicable to determine whether the defect is in the instrument or the installation. If the instrument is found to be defective it should be removed from the airplane and replaced, the defective instrument being turned in to the proper station for service repairs.



**FIG. 108 JUNCTION BOX  
ASSEMBLY 87-67-591**







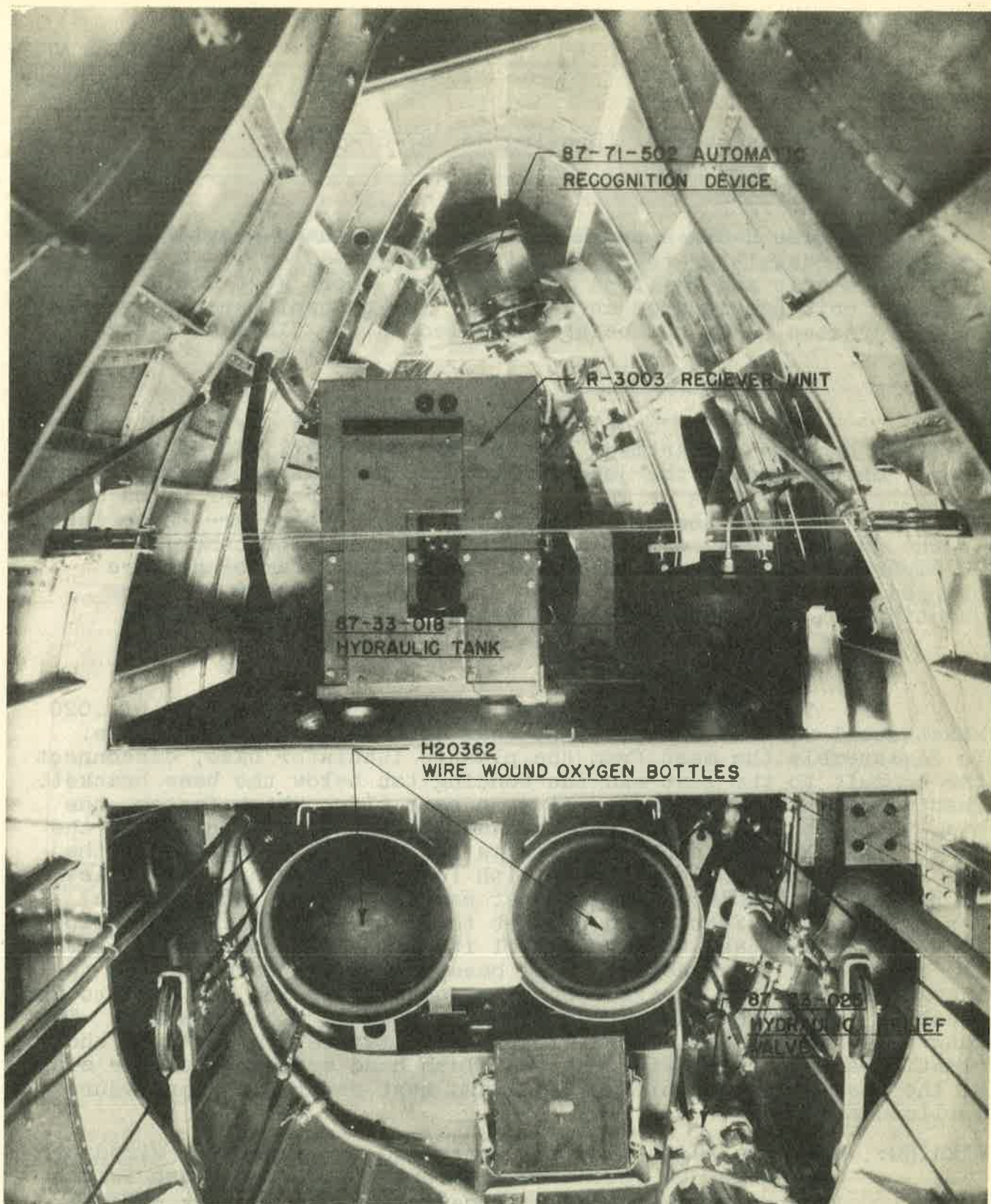


FIG.IIO RADIO AND OXYGEN INSTALLED H-87A-2 & 3



Q. Radio Installation (Drawing No. 87-67-551)

1. General

The H-87A-2 and H-87A-3 airplanes have provision for two principle transmitter-receiver units (designated as TR-9D for the Short Wave unit and TR-1133A for the Ultra-Short Wave unit) and one receiver unit (designated as R-3003). The transmitter-receiver units are alternates, only one being installed in the plane at a time.

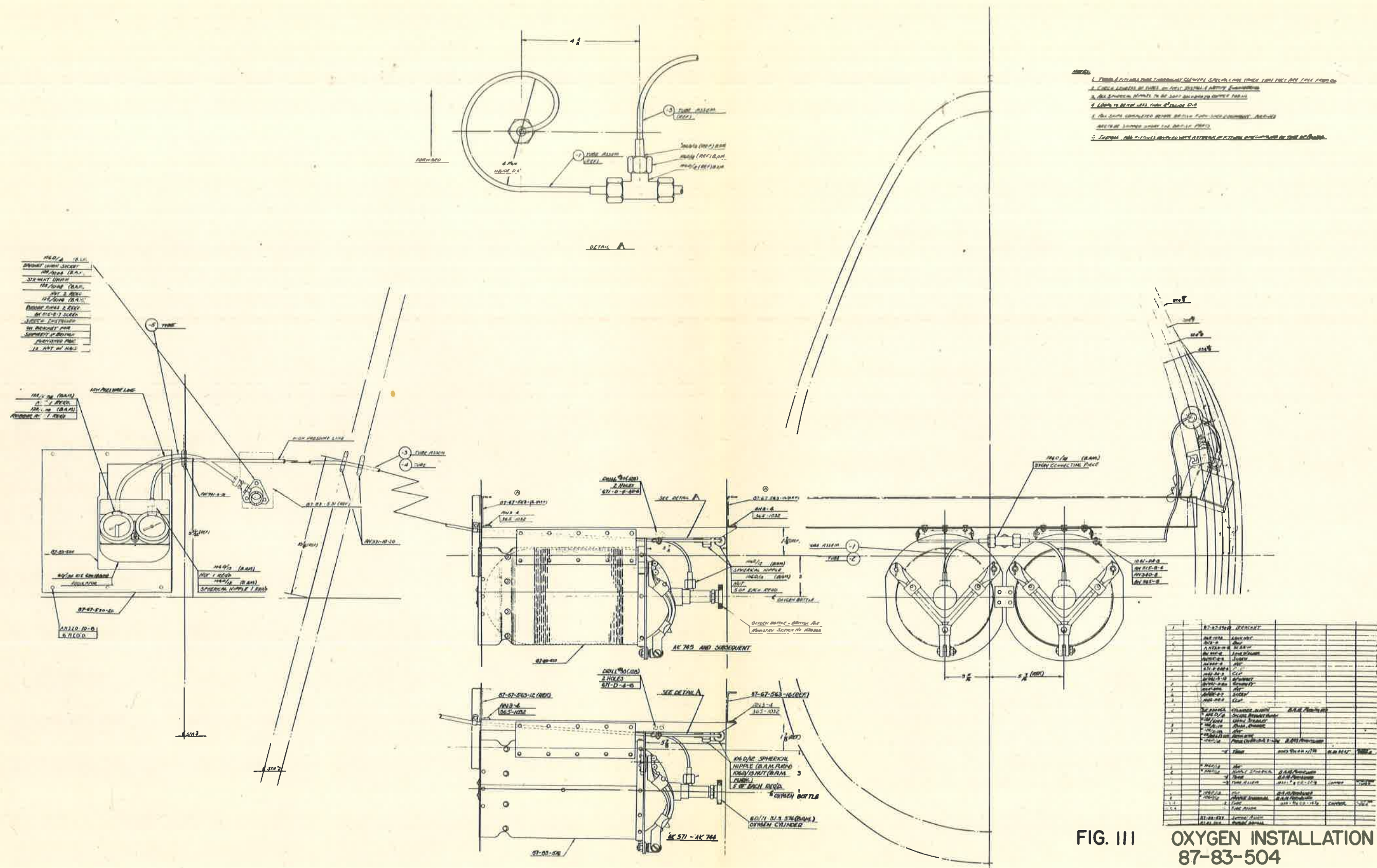
2. Radio Junction Box

The radio junction box (87-67-578) is installed in the fuselage baggage compartment on the left hand wall aft of the access door. On the end of the junction box are two master switches. One controls the TR-1133A or TR-9D transmitter and receiver units and the other controls the R-3003 receiver unit. There are three fuses in the junction box, one is a 5 ampere fuse and the other two are 20 amperes. Three spare fuses, of corresponding amperage, are carried in the junction box cover. In the opposite end of the junction box from the contactor switches is a relay assembly.

3. Radio Antenna Mast

The radio antenna mast assembly is constructed of .020 sheet steel with an intermittent seam weld on the trailing edge. To disassemble the mast from the plastic insulator base, disconnect the conduit to the mast and the bonding tab below the base bracket. Then unscrew the ten screws, five on each side, which fasten the mast to the base and pull the mast upward until it is clear of the base. The plastic insulator base is fastened to a bracket on the aft side of Station #8 bulkhead with four bolt and nut assemblies. To remove the insulator base, first remove the six bolt and nut assemblies which fasten the bracket to Station #8 bulkhead. Allow the bracket and base to lower until it clears the opening on the top surface of the fuselage. The base may now be removed from the bracket by removing the four bolt and nuts fastening the base to the bracket. The base and bracket are separated by a cork gasket. The gang plate which anchors the elastic nuts may be removed from the plastic base by unscrewing the two flush head screws on either side of the base. To assemble the base and mast reverse the procedure outlined above.

WARNING: When the radio sets are installed or completely wired, or hooked up, to touch the push buttons on the crash switch located in the cockpit is dangerous and may set off the detonator. When airplanes are parked on the ground or in storage, the plugs connected to the detonator control circuit should be disconnected as a safety measure.

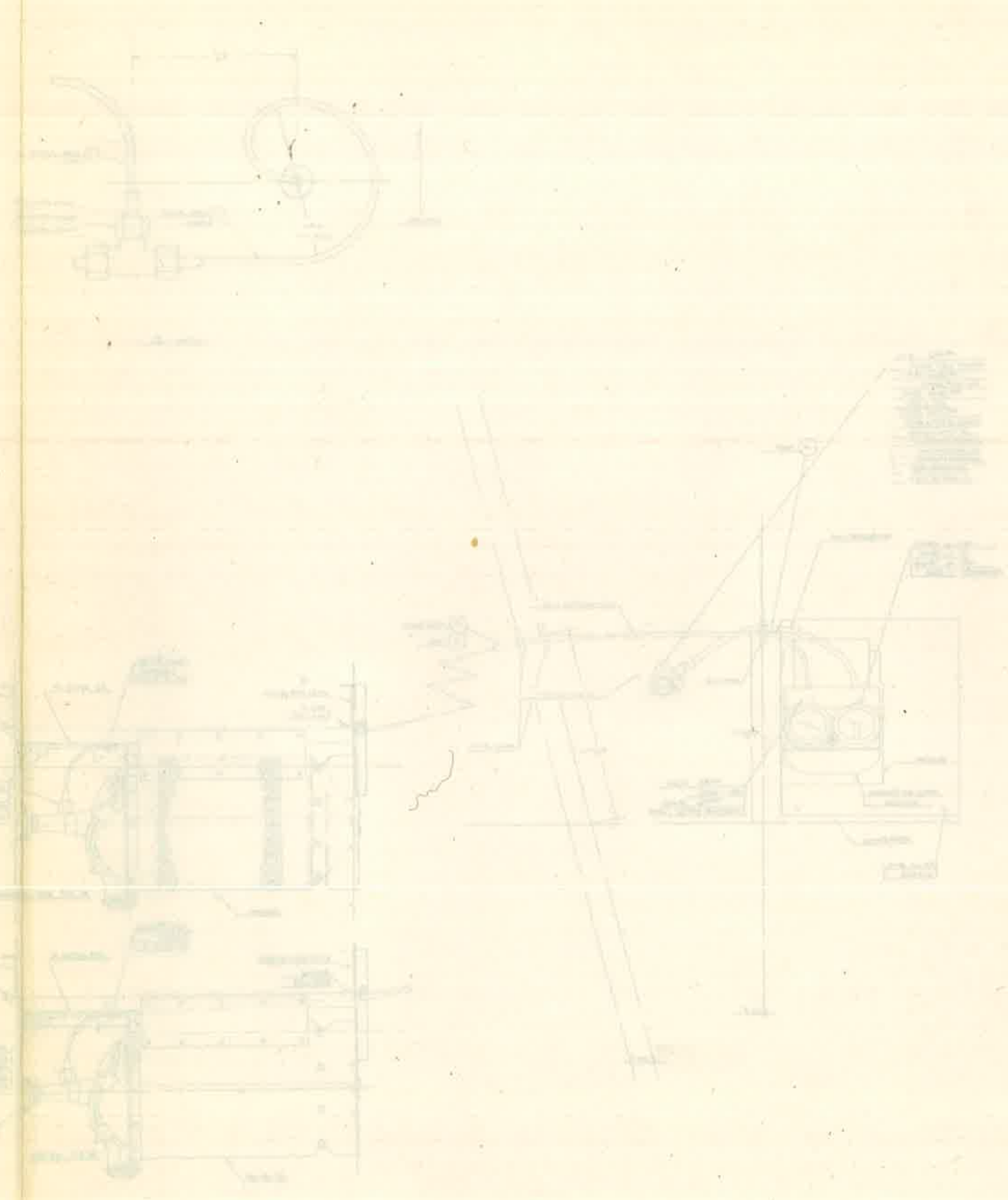
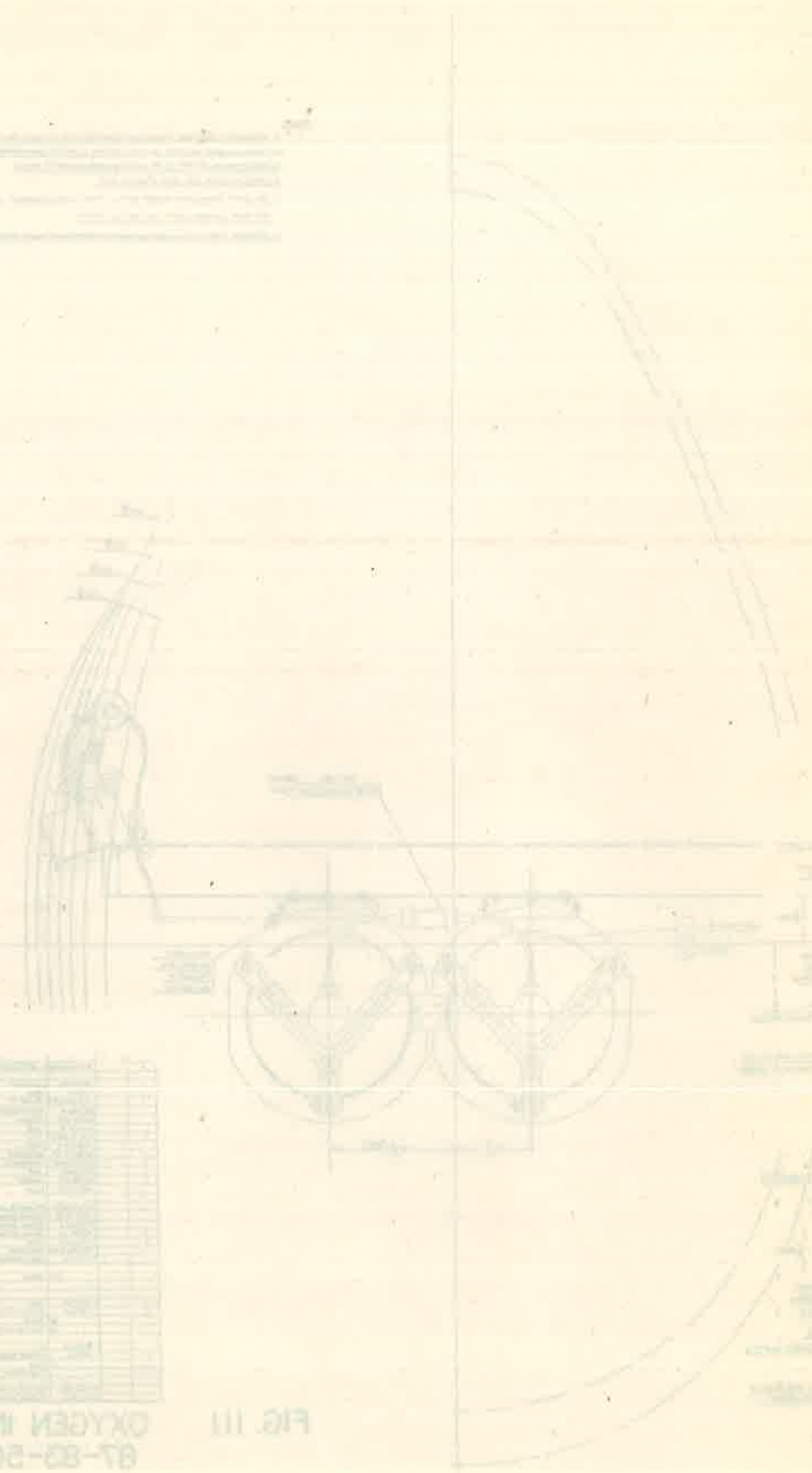




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FIG. III  
OXYGEN INSTALLATION  
87-82-204

1. Oxygen cylinder  
2. Oxygen regulator  
3. Oxygen flowmeter  
4. Oxygen line  
5. Oxygen line  
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99. Oxygen line  
100. Oxygen line



R. Oxygen Installation

1. Oxygen (Drawing No. 87-83-503 - Airplanes AK571 - AK744)  
(Drawing No. 87-83-504 - Airplanes AK745 and subsequent)

Provision is made for two British unwound type oxygen bottles (Mk. V ) on airplanes AK571 through AK744 and wire wound oxygen bottles on airplanes AK745 and subsequent. These oxygen bottles are mounted in the aft part of the fuselage between Sta. #8 and #9 and are accessible through fuselage access door. Provision is made for the oxygen regulator (Mk. VIIIA ) and oxygen bayonet union 106 D/4 in the cockpit on the right hand side. Copper tube lines are provided except the low pressure line from the regulator to the bayonet union, this line is a 5/16 O.D. aluminum alloy 24ST tube. Special care should be taken that tubes, lines, and fittings are free from oil.

2. General Safety Precautions:

a. Oxygen or other high pressure cylinders shall not be left near heaters, stoves, radiators, furnaces, or other sources of heat and shall not be exposed to the direct rays of the sun, because an increase in the temperature of the gas will cause an increase in the pressure in the cylinder.

b. Care must be taken to prevent oil, grease, white lead, or any other easily oxidized material from coming in contact with oxygen equipment, as the contact of such materials with oxygen under pressure will cause the oxygen to become highly explosive. Oxygen equipment must never be handled on the same platform or bench as is used for handling equipment in which oil is used, or placed in a position where oil from any source is likely to drop on it.

c. Oily hands and greasy gloves must not be used in handling oxygen cylinders.

d. Oxygen cylinders must not be tested with compressed air or other gases because of the possibility of these gases having been compressed by oil-lubricated compressor unless suitable means for removing the oil, such as an oil filter, is also employed.



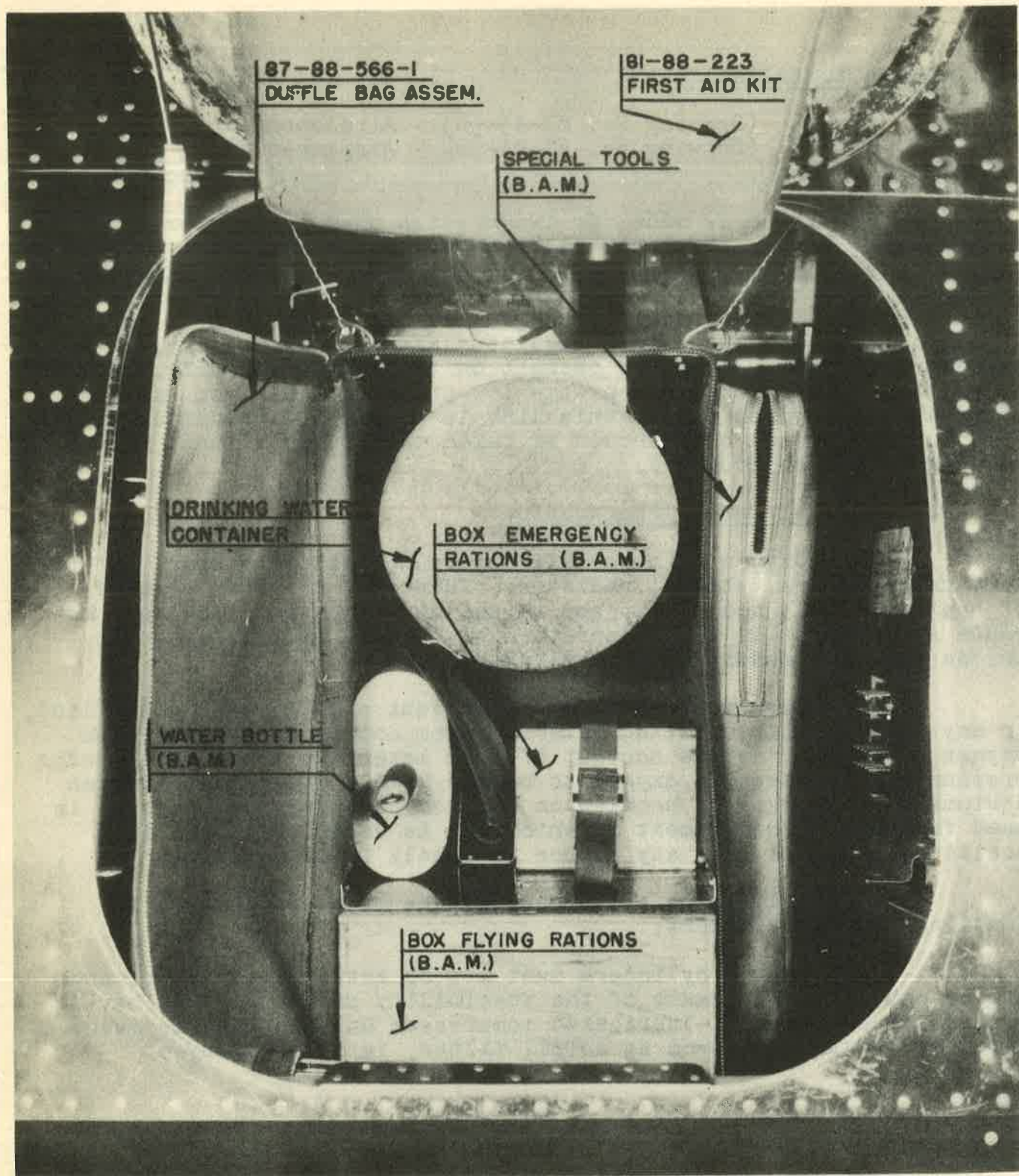
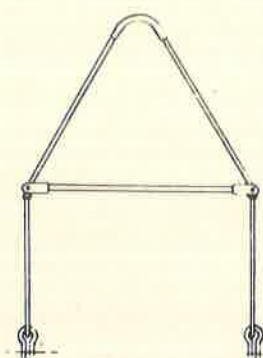
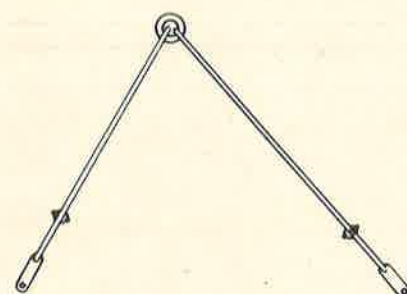


FIG.II2 DUFFLE BAG INSTALLATION  
H-87A-2 & H-87A-3

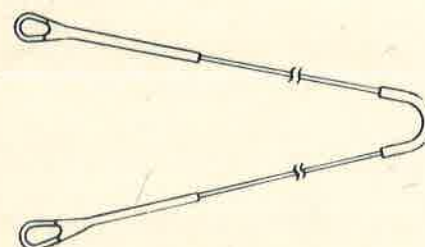
REFERENCE DRAWINGS NOTED



87-88-020  
FRONT HOISTING SLING



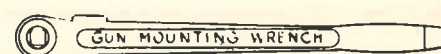
87-88-509  
WING HOIST SLING



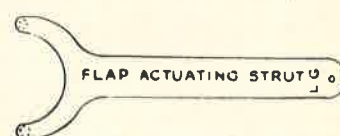
87-88-019  
TAIL HOISTING SLING



87-64-570  
PARKING HARNESS



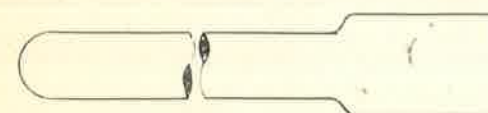
87-69-737  
GUN MOUNTING RATCHET WRENCH



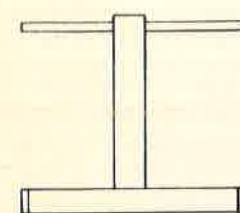
87-88-030  
WRENCH - ACTUATING STRUT - FLAP & L.G.



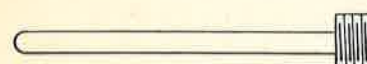
87-88-032  
WRENCH-HAND PUMP



87-88-594 LOCATING TOOL  
FILLER OPENING-WING FUEL CELLS



87-88-596  
WRENCH-FILLER CAP-WING FUEL CELLS



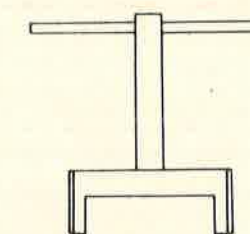
87-88-595  
LOCATING TOOL-GAGE OPENING-WING FUEL CELLS



87-88-031  
WRENCH-METERING PIN - L.G. & TAIL WHEEL



87-88-587  
PULLER ASSEMBLY-ENGINE MOUNT BOLTS



87-88-597  
WRENCH - GAGE MOUNT - WING FUEL CELLS

ONE EACH OF THE FOLLOWING IS FURNISHED WITH EVERY AIRPLANE: 87-69-737, 87-88-030, 87-88-031, 87-88-032, 87-64-570. THE PARKING HARNESS (87-64-570) IS STOWED BELOW THE PILOTS HEADREST, THE GUN MOUNTING WRENCH IS STOWED IN A SPECIAL CASE ON THE L.H. GUN ACCESS DOOR. THE OTHERS ARE CARRIED IN THE TOOL KIT ON DUFFLE BAG. ONE EACH OF THE FOLLOWING IS FURNISHED WITH EVERY NINTH AIRPLANE: 87-88-594, 87-88-595, 87-88-596, 87-88-597, 87-88-587, 87-88-020, 87-88-509, 87-88-019

FIG. 113 SERVICE TOOLS  
H-87A-2 & H-87A-3





## SECTION VI

### A. Service Inspection and Maintenance

#### 1. General

The following instructions outline the minimum inspection and maintenance program, excluding the engine, which is covered in the manufacturer's "Operator's Handbook". It is intended for use only until such time as the Official Maintenance Schedule (Vol. II, Part 2) has been drawn up and distributed.

It is extremely important to keep airplanes clean at all times, and wherever possible, a definite time should be set aside for cleaning those airplanes that are not in service. This periodic cleaning of airplanes and equipment will greatly reduce fire hazards and facilitate inspection and maintenance of this equipment. During the cleaning operations, the personnel should be instructed to note carefully and report all cases where there is evidence of faulty maintenance or an apparent need for inspection, adjustment or repair of any part or parts.

NOTE: Aqueous cleaners should be used whenever possible. When it is deemed necessary to use a volatile fluid for cleaning, every precaution should be exercised to guard against fire hazard, as these fluids are highly inflammable. CAUTION: When using volatile cleaning fluids, avoid breathing of their vapors, do not place bare hands in the solution, avoid smoking, open flames, operation of electrical equipment, wearing of shoes having exposed nail heads or iron cleats, which may cause sparking on hard surfaces, also have adequate fire fighting equipment available while cleaning. Inflammable cleaning solvents should be used and stored in small, safety type containers, and kept covered when not in use.

The following is a list of special airplane tools furnished by the contractor for use in connection with work prescribed in this Section.

#### Drawing No.

|           |                                               |            |
|-----------|-----------------------------------------------|------------|
| 87-88-020 | Hoisting Sling (Front)                        |            |
| 87-88-019 | Hoisting Sling (Tail)                         |            |
| 87-88-509 | Hoisting Sling (Wing)                         |            |
| 87-88-587 | Engine Mount Bolt Puller                      | One of     |
| 87-88-595 | Locating Tool - Gage Opening - Wing Fuel Cell | each with  |
| 87-88-594 | Locating Tool - Filler Cap - Wing Fuel Cell   | every      |
|           |                                               | nine       |
| 87-88-597 | Wrench - Nut, Gage Mount - Wing Fuel Cell     | airplanes. |
| 87-88-596 | Wrench - Filler Cap - Wing Fuel Cell          |            |



|               |                                              |
|---------------|----------------------------------------------|
| 87-88-030     | Flap Actuating Strut Wrench                  |
| 87-88-031     | Wrench Metering Pin (Tail Oleo Metering Pin) |
| 87-88-032     | Hand Pump Wrench                             |
| 87-88-525 L/R | Walkover Pad (Wing)                          |
| 87-88-524     | Pad Panel Throw Over Gun Servicing           |
| 87-64-570     | Parking Harness                              |
| 87-69-737     | Ratchet Wrench - Gun Mounting                |

## 2. Inspection and Maintenance

### a. General: Routine inspection periods are as follows:

- (1) Pre-flight
- (2) Daily
- (3) 25 Hour
- (4) 50 Hour
- (5) Special Inspection
- (6) Engine Change

### b. Pre-flight Inspection

- (1) Check quantities of fuel and oil in tanks
- (2) See that the fuel and oil tank caps are properly secured.
- (3) See that all cowlings are properly fastened.
- (4) See that there is nothing in the cockpit to interfere with the controls.
- (5) Set the altimeter.
- (6) Set the horizontal stabilizer trim tabs for correct take-off position.
- (7) See that clock is wound and set.
- (8) See that windshield is clean.
- (9) Turn the fuel valve one complete revolution to determine that it turns freely.
- (10) Check operation of the flight controls.
- (11) Check data case, map case, first aid kit, and duffle bag for security of fastening.
- (12) Check safety belt.
- (13) Check all doors for security of fastening as they are a primary part of the structure.
- (14) Check all engine instruments and switches.
- (15) Turn the propeller over by hand two or three revolutions before using starter - see "Operator's Handbook", issued by the engine manufacturer.
- (16) Inspect oxygen equipment for proper installation and operation whenever flying is to be done at altitudes requiring oxygen.
- (17) Inspect gunnery equipment.

(18) Check ignition switch as follows: With the engine running at about one third open throttle, turn the ignition switch momentarily to the "OFF" position. If the engine does not entirely cease firing, defective functioning of the switches or connections, likely the ground connection, is indicated. For this test the engine must not be excessively hot and the period during which the switch is in the "OFF" position must be brief so that the engine does not slow down too much to start again when the switch is thrown to the "ON" position.

**WARNING:** If the engine does not cease firing when the switch is placed in the "OFF" position it will be necessary to stop the engine by "turning off the fuel supply." AFTER THE ENGINE STOPS, DO NOT TOUCH THE PROPELLER UNTIL THE DIFFICULTY HAS BEEN FOUND AND CORRECTED, AS THE ENGINE MAY START OR "KICK OVER" CAUSING DEATH OR INJURY.

### c. Daily Inspection

(1) Engine Controls: Inspect operation, proper functioning and general condition of the following control assemblies.

- (a) Throttle
- (b) Mixture
- (c) Propeller
- (d) Carburetor Air

### (2) Fuel System

Drain all fuel sumps of any water that may have collected by means of the drain cocks. Safety drain cocks.

Check operation of wobble pump, electric auxiliary pump on airplane AK721 and subsequent, and the fuel pressure gage by turning fuel valve to the "ON" position and operating the wobble pump or electric pump until normal operating pressure is obtained.

Inspect for evidence of leaks in the fuel system. Note that the primer does not leak when in the "OFF" position.

### (3) Oil System

Inspect for evidence of the engine throwing oil.

Inspect all lines for leaks.

Inspect all drain plugs and drain cocks for proper safetying.

Inspect the oil cooler for possible leaks and security of its mounting assembly.



Remove and clean oil screens and strainers at the end of the first five flying hours after each oil change, or after installing a new or overhauled engine.

(4) Cooling System:

Inspect radiators, expansion tank and hose connections for:

Leaks, particularly in radiator cores and at drain plugs. Drain plugs safetied. Security of radiator and expansion tank mounting assemblies.

Inspect operation, proper functioning and general condition of the radiator cowl flaps. See that the cowl flaps operate to extreme positions. (Fully opened and fully closed) See Sec. V, C., 5.

(5) Engine Units

Check manifolds for security of attachment and blown out gaskets.

Check security of mounting carburetor heater and scoops.

(6) Propeller and Accessories

Inspect the propeller for:

Bullet holes  
Bent or damaged blades  
Looseness on crankshaft  
Looseness of detachable blades in hub  
Proper safetying of all exposed retaining lock and clamp nuts.

Clean the blades and hub with kerosene or gasoline and coat with light engine oil.

(7) Power Plants - General

Inspect the engine cowl and mounting brackets for security of attachment, cracks, deformation and general condition of fasteners.

Check the engine cowl spinner for cracks and deformation.

Inspect the exposed portions of the engine mount and mounting brackets for general condition and security of attachment.

(8) Cabin

Inspect the condition and function of sliding enclosures.

(9) Navigation Instruments

Inspect all navigation instruments for:

- Broken or loose crystals.
- Loose dials and dial pointers.
- Security of mounting.
- See that pointer of the rate of climb indicator rests at zero. If not, adjust to zero by turning the adjusting screw on the rear of the case.

(10) Flight Control Mechanism:

Inspect for freedom of operation and absence of interference with installed equipment.

(11) Flight Control Surfaces

Inspect all surfaces for holes and general condition.

(12) Wings

Inspect general condition of the metal covering.

Inspect surfaces of wing fillets for bullet holes; if any appear check thru for internal damage.

(13) Fuel Tanks

Each time fuel is serviced to a fuel tank, drain off the water through the drain cock.

Safety drain cocks.

(14) Empennage

Inspect horizontal stabilizer, vertical stabilizer and control surfaces for general condition of fabric and metal covering.

(15) Tail Gear

Check tail wheel for freedom from mud, grass, etc.

Inspect condition of shock unit, i.e. supporting tail in upper position.

Check tire for proper inflation



(16) Landing Gear

Inspect for general condition of:

Struts, braces and fittings  
Shock units as indicated by bottoming of strut.  
Landing gear fairing - keep free of mud.  
Evidence of leakage in hydraulic or similar units.

(17) Wheels and Brakes

Inspect for:

Bent or distorted rims  
Security of retaining nuts, or bolts and cotters.  
Inspect tire's for proper inflation.

(18) Fuselage

Inspect for:

General condition  
Tears or cuts in metal covering  
Broken structural members as evidenced by distortion of covering.

(19) Night Flying Equipment

Inspect functioning and condition of:

Identification lights  
Cockpit lights  
Lamp rheostats  
Landing light  
Formation lights  
Fluorescent lamp assembly

(20) Armor Plate

Check security of fastening of all armor plates.

Check for cracks or breaks in armor plates.

(21) Gunnery Equipment

Pre-flight: Check link and case chutes for security and obstructions after each flight.

(22) Airplane - General

Inspect fire extinguisher - see that it is full and ready for use.

Inspect oxygen equipment.

Check bottle pressure.

Check proper function of oxygen regulator.

Make sure that there is no grease or oil on or near any of the oxygen equipment.

d. 25 Hour Inspection(1) Engine Controls

Inspect the entire control assemblies, from the levers in the cockpits through all rods and cables, their linkage, supporting brackets, guides, pulleys, etc.

Inspect for:

Free and full movement - controls should operate with uniform tension throughout their full range.

Lost motion. See that linkage is properly adjusted.

Bent rods.

Frayed cables.

Loose, broken, or mis-aligned pulleys.

Loose or missing bolts, nuts, screws, cotter pins, etc.

Inspect and adjust ball and socket joints.

See that all adjustment or position locking devices function properly, and that all levers are adjusted to prevent creeping.

Clean and oil all working parts where necessary. Where ball bearings in bellcranks are sealed at factory, no further lubrication is necessary.

Lubricate the throttle shafts and throttle shaft bearings with light oil.



(2) Ignition and Electrical

For magnetos and spark plugs see engine manufacturer's "Operator's Handbook":

Generator and Generator control unit.

Inspect for:

Security of mounting.

Condition of leads, connections, and terminals.

Inspect generator control unit for general cleanliness and condition of contact points.

When inspecting contact points, the generator line switch should be open.

Dirt generally can be removed by inserting a piece of clean paper between the contacts, pressing the contacts together and pulling out the paper.

Contact points should be dressed with a fine file and cleaned with paper. Do not use sandpaper or emery cloth.

(3) Fuel System

With fuel on, pressure up, inspect fuel lines for:

Leaks, particularly at connections. (Note: This inspection should be made with the engine cowling removed and the wobble pump or electric auxiliary pump in operation.)

Cracks, particularly at sharp bends.

Security of link anchorage.

Wear due to vibration or chafing.

Inspect connections for:

Leaks

Condition particularly of rubber or synthetic rubber hose connections.

Chafing or cutting into lines by clamps, screws, bolts, etc.

Inspect by-pass valve assembly for leaks.

Lubricate carburetor throttle shaft bearings and pump operating parts.

Inspect all fuel overflow or drain lines for:

Security of anchorage.

Kinks, breaks, or "plugging".

Note that the overflow or drain lines extend beyond the cowling to avoid gasoline or gasoline vapors collecting inside the cowling.

Remove and clean all fuel strainers, excepting those screens and strainers permanently installed in the fuel tanks.

Clean the strainer bodies and inspect for breaks or tears.

Drain all fuel strainers which are not drained daily.

#### (4) Oil System

Inspect all oil lines for:

Leaks, particularly at connections and at passages through the firewall.

Security of anchorage.

Wear due to chafing or vibration.

Dents or cracks.

Inspect connections for:

Security of clamps.

Loose nuts.

Proper location of clamps.

Inspect oil cooler for:

Clogging of cores, dents, leaks.

Security of mounting.

#### (5) Cooling System

Inspection: Make thorough inspection of the radiator and expansion tanks.

Inspect the radiator mounting, supports and mounting brackets for breakage and security. Condition of "Lord" mountings.

Carefully inspect the cowl flaps for:

Bent or loose flaps and proper operation. (open wide and shut)



Inspect the coolant tubes for:

Evidence of leaks, particularly at connections and thermometer wells.

Security of anchorage.

Wear due to vibration or chafing.

Condition of the hose connections.

Tightness, condition and location of the clamps at the air duct seals.

Inspect the entire cowl flap control assembly from the lever in the cockpit, through all rods, support brackets, guides, etc.

Inspect for:

Free and full movement.

See that the cowl flaps open wide and shut tightly.

Lost motion.

See that the linkage is properly adjusted.

Loose or missing bolts, nuts, screws, cotter pins, etc.

#### (6) Lubrication

Lubricate the cowl flaps and controls.

#### (7) Valves, Manifolds.

See the engine manufacturer's "Operator's Handbook".

#### (8) Propellers and Accessories

Remove the propeller spinner assembly.

Inspect the propeller blades and hub thoroughly for:

Bends, nicks, and other damages.

Inspect the entire leading edge, trailing edge and tip portion of the blades for development of cracks. Use a magnifying glass.

Check the retaining, lock, and clamp ring nuts for looseness. See that they are properly safetied.

See the Handbook of Instructions issued by the propeller manufacturer for further information.

Completely fill the hub with grease through the three nipples.

(9) Power Plant - General

Check the engine cowl spinner bulkhead mounting bolts and engine mounting lugs for tightness of bolts and condition of rubber "Lord" bushings.

Inspect stud nuts, cylinder head-to-coolant jacket, and crank-case to coolant jacket for looseness.

The nuts should be uniformly tightened.

Inspect all engine accessories for security of mountings and proper functioning.

(10) Cockpits and Cabins:

Inspect the pilot's seat for:

Security of attachment, including supports and brackets.

The condition and functioning of adjusting mechanism.

Breaks or cracks, in the seat or back, which might foul the parachute harness or clothing.

Oil the seat adjusting mechanism.

Inspect safety belts for:

Security of fastening to the seat.

Date last tested; if over six months, replace with properly tested belt.

Inspect the windshield and sliding hood for:

Condition of frame and security of attachment.

Breaks or cracks in Plexiglas.

Breaks or chips in gunfire protection glass.

Condition and operation of sliding mechanism.

Cleanliness of windshield and hood.



Note: Check emergency release to insure that it is in proper working order. Inspect the cockpit heating and ventilating system for leaks and proper operation of control mechanism.

Inspect the windshield defrosting mechanism for proper operation.

(11) Flight Control Mechanism

(a) Inspect the rudder pedals for:

Proper condition and functioning of parts.

Cleanliness and condition of the post bearings and pedal bearings.

(b) Inspect the entire rudder control assembly for:

Lost motion and condition of the pedal adjusting mechanism.

With the pedals in the neutral position note the position of the rudder.

If lost motion exists, or if correct motion of the rudder cannot be secured without binding, thoroughly check the entire system to locate and correct the trouble.

The correct angular movement of the rudder is  $28^{\circ}$   $+2^{\circ}$  each side.  
 $-0^{\circ}$

Proper safetying at all joints and connections.

Frayed cables.

Misaligned, bent, loose, or broken pulley or brackets.

Freedom of interference between rudder and elevator in their extreme positions.

During inspection clean all linkage and working parts.

(c) Control Stick Assembly (aileron and elevator controls).

Inspect entire assembly for:

Proper condition and functioning of parts.

If lost motion or binding is present or if correct movement of the ailerons and elevator cannot be secured, rigidly inspect the entire system to locate and correct the trouble.

The correct aileron movement is  $18-3/4^{\circ} \pm 2^{\circ}$  up and  $10-3/4^{\circ} \pm 2^{\circ}$  down.

The correct elevator movement is  $30^{\circ} \pm 1^{\circ}$  up and  $20^{\circ} \pm 1^{\circ}$  down.

See that the control stick is secure in its socket.

Inspect all the rods, bearings, pulleys and cables for:

Lost motion

Proper safetying of all joints and attachments.

Frayed cables.

Misaligned, bent, loose or broken pulleys or brackets.

With the stick in the neutral position, see that the elevator is in its neutral position.

During inspection clean all working parts.

#### (d) Trim Tab Adjustment Mechanism

While the rudder and elevator tab controls are being operated from the cockpit, inspect for:

Freedom of operation.

Full adjustment of the tabs when control is fully extended.

The security and proper safetying of all cables, chains, rods and attachment fittings.

The condition of chains, cables, pulleys and fairleads.

The correct elevator tab setting is  $3^{\circ} \pm 1^{\circ}$  up and  $26^{\circ} \pm 1^{\circ}$  down from the  $\emptyset$  of the elevator.

The correct rudder tab setting is  $15^{\circ} \pm 5^{\circ}$  either side the  $\emptyset$  of the rudder.

Lubricate as required.



(e) Flap Control Mechanism

Test for proper functioning. Note that cockpit indicator is functioning and correctly shows the position of flaps.

Inspect for:

Security and proper safetying of control rods and attachment fittings.

Signs of interference with other parts or assemblies.

Inspect hydraulic operating mechanism for:

Leaks

Bent, kinked or damaged pipes or connections.

Functioning of the valves and pumps.

Refill the hydraulic control mechanism reservoirs as required.

(f) Flight Control Linkage

Inspect all the cables and rods constituting the flight control linkage; i.e., the ailerons, elevator and rudder. Also the tail wheel control linkage

Inspection will include cables, rods, pulleys, guides and their connecting linkage and attachment fittings.

Inspect for:

Frayed cables or bent rods.

Proper tension of cables.

Loose fittings, turnbuckles, bolts or nuts.

Elongated holes.

Loose brackets.

Broken, or misaligned pulleys or fairing.

Proper alignment of all moving parts, particularly noting that cables are not chafing structural members and are passing freely through the holes or slots in fuselage or wing covering provided therefore.

All accessible parts will be wiped clean and lubricated as required.

(12) Flight Control Surfaces

Ailerons, elevators and rudder:

Inspect for:

Free and full movement.

Warping.

Broken ribs, or ribs loose on spar.  
Condition of covering.

Inspect the horns and hinges for:

Bends and cracks.  
Security of attachments.  
Worn or loose hinge pins.  
Safetying.

Inspect all the braces or wires for:

Proper tension.  
Condition.  
Security of attachments and safetying.

Flaps and Trim Tabs:

Free and full movement of flaps and tabs.  
Warping.  
Condition of covering.  
Security of tabs.

Inspect horns, hinges, braces and wires as prescribed under "Ailerons, Elevators and Rudders".

(13) Fuel Tanks:

Drain all fuel tank sumps.  
Resafety all drain cocks.

Inspect self-sealing tanks and their aluminum shells for leaks or damage and security of the retaining straps. Proper anchorage of all fuel lines leading from the tanks.

(14) Tail Gear:

Inspect entire assembly for:

Cracks, breaks or bends, particularly at sharp angles and at welds.

Weak or broken shock absorber springs on steering cables.  
Fluid level of hydraulic shock absorber strut.

Broken or bent bearing post.

Cracked, bent or broken attachment fittings and brace members.

Proper operation of swivel release mechanism.  
Lubricate as required.



(15) Landing Gear:

Note that cockpit indicator is functioning and correctly shows position of landing gear.

Check Klaxon (See Fig. )

Inspect the struts, braces and fittings for:

Cracks

Bends

Security and condition of attachment fittings.

Elongated bolt holes.

Loose, missing or unsafetied bolts, nuts and cotter pins.

Security and condition of fairing.

Lubricate according to lubrication chart, Fig.

Inspect the oleo strut for:

Evidence of leakage.

Proper fluid level and air pressure.

(16) Wheels and Brakes:

Make inspection of the brakes and brake control assembly, from the operating pedals to the brake drums.

It should not be necessary to remove the wheels as they are equipped with roller type bearings.

With the weight of the airplane on the wheels adjust brakes. Brakes should be adjusted with equal tension, so as to hold the airplane at full throttle, and so as to be entirely free of dragging when released. Brake pedals should be adjusted so that, with pedals fully extended and rudder full on, the brake pedal will be unhindered in operation.

**CAUTION:** The brake pedals should be adjusted so as to allow some small movement of the pedals toward the "ON" or braking position before the brakes actually "TAKE HOLD" in order to avoid accidental application of brakes by the pilot.

Check fluid level in the reservoir of hydraulic brake system.

Inspect the hydraulic lines and connections for:

Leaks

Kinks

Twisted or damaged piping or connections.

(17) Night Flying Equipment

Inspect the landing light for:

Security of fastening.

Clean and lubricate. See Section V J., 6.

(18) Gunnery:

Proper functioning.

(19) Radio:

Carefully inspect the condition of the antenna and all its supports and connections.

See that the electric lines are not being rubbed anywhere by control cables.

e. 50 Hour Inspection (In addition to all 25-hour inspection items):

(1) Fuel System:

Inspect all safeties, controls, connections, etc. of the carburetor for proper insulation operation and leakage.

Fuel cock control -

Rotate the control handle and note whether there is excessive "drag" or back lash. Back lash will be evidenced by failure of control handle pointer to register the cock position at the points where the "clicks" occur. Replace worn parts.

Note that fuel cock control turns freely without stiffness or binding.

Clean the carburetor fuel strainer.

Inspect the condition of hose and hose clamps.

(2) Oil System:

Inspect the oil tank for:

Security of mounting.

Signs of leakage, tears or abrasions in covering.

Remove the oil strainer and wash with gasoline.

Proper tension of tie down bolts.

Proper anchorage of oil lines leading from the tank.

Inspect the oil lines for proper bonding.

Drain and refill with oil.



(3) Cooling System:

Remove the ball check valve from filler unit on expansion tank and inspect ball for freedom of motion. Inspect the armor cover plate for signs of damage.

Servicing: Drain and flush the coolant system.

The coolant will be drained into containers, strained and returned to the engine.

See that all drain plugs are properly safetied.

(4) Valves, Manifolds

See the engine manufacturer "Operator's Handbook."

(5) Power Plants - General

Inspect the engine mount for:

Cracks, particularly at welds.  
Proper protective coating.  
Tightness of the mounting clamps and bolts.  
Condition of the rudder shock absorbing units.

Inspect all bonding and shielding in the engine compartment for:

General condition.  
Tightness of contacts.

(6) Navigation Instruments:

Check the compass and compensate for variation.  
Special: Turn and bank indicator.

100 Hours: Remove and clean the jet cover.

300 Hours: Lubricate every 300 hours of operation.

(7) Wings:

Inspect the wings for:

Cracks, torn or loose metal covering.  
Loose rivets or rivets pulling through metal.  
For broken ribs by noting distortion of covering.

See that grommet drains are open.

Inspect the wing tips for:

Security of attachment.  
Cracks.  
Elongated bolt holes.

(8) Fuel Tanks:

Inspect fuel tanks for:

Condition of cover shells and retaining straps.  
Inspect self-sealing fuel cells for tears, or  
signs of rubbing.  
Proper seating of the cells in their shells.  
Proper tension of the supporting straps.  
Proper anchorage of the fuel lines leading from  
the fuel cells.

(9) Empennage:

Inspect the horizontal and vertical stabilizer for:

Cracks, torn or loose metal covering.  
Loose rivets, or rivets pulled through metal.  
Check for broken ribs by looking for distortion  
of metal covering.

Inspect the attachment fittings for:

Security of attachment and safetying.  
Cracks in fittings.  
Elongated bolt holes.

(10) Tail Gear:

Clean and inspect for condition of the wheel roller  
bearings then repack with a soft grease or high pressure gun grease.

(11) Landing Gear:

Thoroughly inspect all landing gear attachment  
fittings, bolts, ball and socket joints, etc.

Test functioning of the landing gear retracting and  
lowering mechanism with manually and electrically operated units.

Inspect landing gear retracting and lowering mechanism for:

Condition and functioning of valves, pumps,  
and other control mechanism.



Check cams and followers in the hydraulic control valve for wear and clearance. Working surfaces must be smooth and bright. Clearances range from .005 to .015 inches, between the cams and follower. This clearance is controlled by brass laminated shims under the cam followers.

Each poppet valve should have a minimum travel of .040 inch.

Condition of all pressure tubing, flexible connections couplings, etc.

Proper fluid level and air pressure in oleo struts.

The condition and functioning of latches, stops and limit switches, etc.

See that the landing gear position indicator conveys correctly the position of the landing gear.

Check the functioning and general condition of the Klaxon warning horn.

#### (12) Wheels and Brakes:

Inspect for:

Excessive wear between wheel bushing and axle. (clearance)  
Excessive side play.

Remove the wheels and inspect brake drums for:

Scoring  
Undue wear  
Loose screws, etc.

Inspect the entire assembly for:

Corrosion.  
Condition of protective coating.  
Dents in rims and discs.  
Snugness of fit of valve stem washers.

Clean, inspect, and lubricate roller bearings.

Inspect the brake mechanism for:

Distorted shoes.  
Distorted backing plates.  
Worn brake lining.  
Loose rivets.  
Freedom from grease  
Security and safetying of nuts, bolts, etc.

**(13) Fuselage:**

Inspect all accessible parts of the exterior and interior of the fuselage for:

Bent longerons and braces.  
Cracks in tubing, particularly at sharp bends and at welds.  
Loose members, bolts or rivets.  
Proper attachment of inspection doors.  
Condition of metal covering and of protective coating.

**(14) Gunnery Equipment:**

Check wear on feed chutes.

Inspect the gun mount for cracks and general condition.

**(15) Airplane - General:**

Bonding and shielding:

Inspect for:

Installation and condition.  
Security of contacts.  
Broken wires or leads.



f. Special Inspection:

Weekly: Once every seven days.

Battery:

Inspect terminals for security of connections and for corrosion. If dirty, or showing signs of corrosion, disconnect, scrape clean and reconnect, then smear vaseline lightly over metal surfaces. Take hydrometer reading of each cell. Voltage should be taken only when battery is charging or discharging as open circuit voltage readings are not conclusive. Add distilled water to the cells if the electrolyte is below the limit specified by the manufacturer. Never add electrolyte or acid. Warning: When using gasoline to clean the airplane or engine the battery should always be removed.

If any cell is low, or if any cell is too high, the battery is developing trouble and will be turned into the battery depot for complete inspection and repair.

Never add acid to the battery except after positively determining that the battery is fully charged. After the initial adjustment of the electrolyte, it should not be necessary to add acid during the life of the battery except in case of spillage.

In addition to reading the battery, inspect as follows:

Battery leads for:  
Condition of insulation  
Security of attachment

Battery, for leakage of electrolyte, and corrosion. In case leakage is found, examine airplane structure carefully for damage. Replace a leaking battery.

Battery box drain for cleanliness, security of attachment, freedom from corrosion, etc.

Check battery vent system to insure that vent lines are unobstructed and securely anchored.

Keep battery clean and dry.

Keep terminals tight and coated with a thin coat of vaseline.

Do not use an open flame around battery, especially during charge.

When installing battery be sure the terminal box and cover are in position and tight, and that the battery is securely held in place.

Normal charging: It is important that the batteries, following a discharge, should not be allowed to remain in a discharged condition. The standard method of recharging by the two step method is as follows:

Begin the charge at the starting rate of 5 and charge at this rate until the cells begin to gas or until the individual cell voltage reaches 2.35 volts. At this point cut the rate of charge to 2 and charge until specific gravity and voltage ceases to rise for 2 consecutive readings taken at 30 minute intervals. The fully discharged specific gravity is between 1.130 and 1.150 and the charge on a fully discharged battery will require approximately 6 1/2 hours at the high rate and 2 hours at the low or finishing rate. Each charge should be carefully checked, however, to prevent overcharge.

The recommended current and voltage values must be adhered to as deviation from this routine will materially decrease the life of the batteries. It is particularly important to reduce the charging rate when a cell voltage of 2.35 volts is reached.

Do not exceed a temperature of 110°F (44°C) during charge.

Preceding each charge add enough distilled water to bring the electrolyte level to the bottom of the tube extending down from the cover opening. This will replace that lost by evaporation.

Following each charge, clean the tops of the cells with a cloth dampened with weak ammonia, then dry the battery.

The battery should not stand longer than one week after charging before placing in service. If it is necessary for the battery to stand longer than one week, it should be charged at the finishing rate, until the specific gravity ceases to rise, before placing in service.

Charges should be conducted with the vents off the battery. It is advisable to occasionally wash out the vents with clean water and allow them to dry.



In addition to the foregoing, the following inspection will be accomplished:

**Propeller:**

See Propeller Handbook.

**G. Engine Change:**

When an engine is changed, accomplish all special inspection and maintenance work prescribed in this inspection section pertaining to engine change.

See engine manufacturer's "Operator's Handbook", and "Service and Maintenance Manual".

G- GREASE- MOBILGREASE "ZERO"  
 O- OIL-GUN OIL  
 HO- HYDRAULIC OIL LOCKHEED #5 OR EQUIVALENT  
 25- 25 HOURS  
 50- 50 HOURS  
 100-100 HOURS  
 D- DAILY  
 25S-25 SERVICE HOURS  
 50S-50 SERVICE HOURS

USE BEACON M-285 GREASE  
 FOR CONTROL SYSTEM BEARINGS

ALL SEALED BEARINGS TO BE LUBRICATED AT  
 OVERHAUL PERIODS.

CHECK BATTERY WEEKLY FOR CHARGE AND  
 PROPER ELECTROLYTE LEVEL

| NO. | PART                    | LUBR. | NO. | PART                               | LUBR. | NO. | PART                                | LUBR.  |
|-----|-------------------------|-------|-----|------------------------------------|-------|-----|-------------------------------------|--------|
| 1   | "FEATHER"- COAT SURFACE | O- D  | 13  | TAB CONTROL CHAIN- COATING         | G- 25 | 24  | HINGES- FLAP, LANDING GEAR DOOR,    |        |
| 2   | "A" FRAME CONNECTIONS   | G- 25 | 14  | TRIM TAB MOTOR DRIVE               | G-100 |     | TAIL WHEEL DOOR, AMMUNITION AND GUN |        |
| 3   | COWL FLAP HINGE         | O-25  | 15  | AILERON DRUM - CABLE ATTACHMENTS   | G- 25 |     | ACCESS DOORS, FUSELAGE ACCESS DOOR  | O- 50  |
| 4   | JACKSHAFT BEARINGS      | G-100 | 16  | TRIM TAB ROD ATTACHMENTS           | G-25  | 25  | BELLY TANK SHACKLE                  | O-25 S |
| 5   | BELLCRANK               | G-50  | 17  | LINK - (ELEV. HORN TO JACKSHAFT)   | G-50  | 26  | BELLY TANK RELEASE CONTROL          | O-25 S |
| 6   | ALL CONTROL CABLE ENDS  | O-25  | 18  | ELEV. CONTROL PUSH ROD BEARING     | G-100 | 27  | SWAY BRACES                         | G-50S  |
| 7   | TRIM TAB CONTROL UNIT   | G-25  | 19  | TRIM TAB DRIVE SHAFT CONNECTIONS   | O-50  | 28  | MASTER BRAKE CYLINDER               | HO-25  |
| 8   | FLAP PUSH ROD ROLLERS   | O-25  | 20  | BRAKE PEDAL BEARINGS               | O-25  | 29  | HYDRAULIC RESERVE TANK              | HO     |
| 9   | PUSH ROD - COAT SURFACE | O-25  | 21  | COCKPIT HEAT SYSTEM VALVE BEARINGS | O-25  |     |                                     |        |
| 10  | ALL TURNBUCKLE ENDS     | O-25  | 22  | PILOT'S SEAT GUIDE                 | O-25  |     |                                     |        |
| 11  | CONTROL STICK STOP      | O-25  | 23  | EMERGENCY CABIN RELEASE-HINGE AND  |       |     |                                     |        |
| 12  | TRIM TAB ACTUATORS      | G-25  |     | MECHANISM                          | O- D  |     |                                     |        |

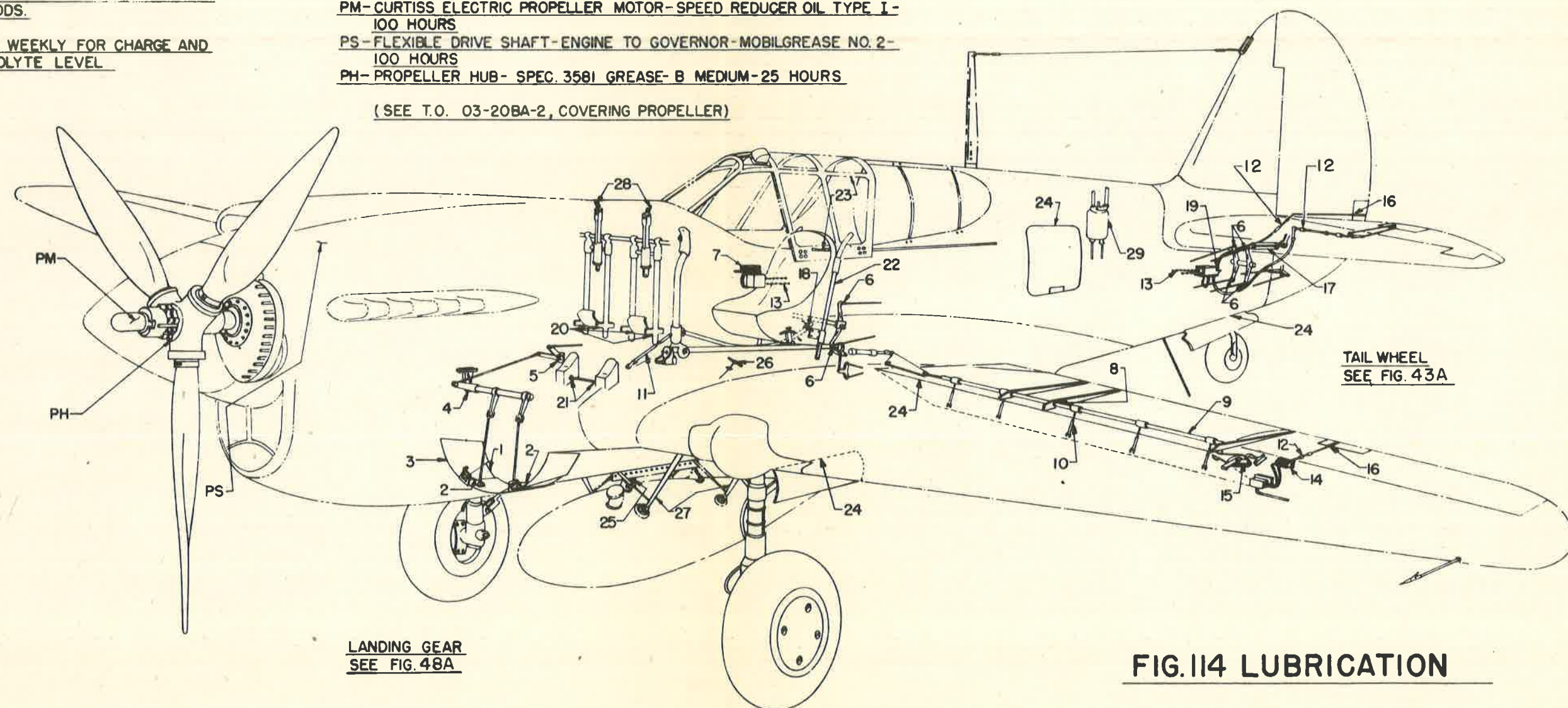
GREASE ALL CONTROL RODS FULL LENGTH  
 OF TRAVEL THRU FIREWALL

PM-CURTISS ELECTRIC PROPELLER MOTOR-SPEED REDUCER OIL TYPE 1-  
 100 HOURS

PS-FLEXIBLE DRIVE SHAFT-ENGINE TO GOVERNOR-MOBILGREASE NO. 2-  
 100 HOURS

PH- PROPELLER HUB- SPEC. 3581 GREASE- B MEDIUM-25 HOURS

(SEE T.O. 03-20BA-2, COVERING PROPELLER)



TAIL WHEEL  
 SEE FIG. 43A

LANDING GEAR  
 SEE FIG. 48A

FIG. 114 LUBRICATION





## SECTION VII

### LUBRICATION

A lubrication chart is provided as a guide for lubricating all important points on the airplane, excluding the engine, which is covered in the Operator's Handbook issued by the engine manufacturer.

Zerk fittings are provided at all pressure lubrication points on the airplane.

All ball bearing joints are packed with grease at assembly and require no attention. Oil will dissolve the grease. Do not lubricate surfaces on which rollers run.

If the landing light is used every day lubricate the landing light gear box with 10 to 15 drops of Pyroil every day and a small amount of cup grease in the arm slide twice a year.

All control cables should be wiped clean with an oily cloth as a precaution against corrosion.

Lubricate the electric trim tab motor by first removing the cover plate on the top leading edge of the aileron and then removing the screw in the base of the motor. Lubricate every 100 hours with low temperature Keystone #78 medium grease or equivalent.



## LUBRICATION

A lubrication chart is provided as a guide for lubricating all important points on the engine and the aircraft. This is covered in the Operator's Handbook issued by the engine manufacturer.

For reference see paragraph 4.1.1. Lubrication points on the engine.

All fuel tanking points are marked with green as necessary and green as applicable. Oil will dilute the grease. Do not lubricate sections on which to land.

If the landing lights are used every day lubricate the landing light gear box with 10 cc of grease at 1000 ft every day and a small amount of oil grease in the air side twice a year.

All control cables should be waxed twice with an oily cloth as a protection against corrosion.

Lubricate the electric trim and cover by first removing the cover plate on the top section of the airframe and then removing the cover in the rear of the motor. Lubricate every 100 hours with low temperature Kerosene RVS medium grease or equivalent.

## SECTION VIII

### STRUCTURAL REPAIR

NOTE: This section is provided as an interim measure until such time as a full repair scheme has been compiled and issued as Volume II, Part 3 (Instructions for Repair) of this publication.

#### A. REPAIRING MONOCOQUE STRUCTURE

##### 1. General Procedure

The following examples illustrate the general procedure in repairing monocoque structure. They do not, of course, cover all problems. A few general rules for splicing or reinforcing members follow:

a. Use replacing or reinforcing member of same general shape and at least the same cross sectional area as the one it replaces.

b. Space rivets not closer than four diameters apart and not closer than two diameters to edge of sheet.

c. Never depend upon any part of the structure that has permanently buckled under a compression load to carry its load again, no matter how well it may have been straightened. Either replace it or reinforce it with a member of equal strength.

d. In drilling out old rivets the following precautions should be observed:

(1) Use #30 drill for 1/8 rivets and 3/16 in. drill for 3/16 rivets.

(2) Drill to a depth equal to the thickness of the head only, after which the head can be driven off very easily with a chisel and the rivet driven out with a punch.

e. All rivets referred to in the notes on repairs are Al7ST modified brazier head rivets unless otherwise specified.



## 2. Material Strength

With the exception of the stainless steel firewall at Sta. 1, the major portion of the material in the monocoque structure is 24ST aluminum alloy. Patches and reinforcements must be of the same material if possible or at least equivalent in strength. If it is necessary to use 17ST aluminum alloy, use the proper gauge to give equivalent strength.

### Properties of 24ST Aluminum Alloy

|                  | Lbs. per<br>sq.in. |
|------------------|--------------------|
| Tensile strength | 62,000             |
| Yield Point      | 40,000             |
| Shear strength   | 37,000             |
| Bearing strength | 90,000             |

Practically all the rivets used in the airplane are Al7ST aluminum alloy so that they can be driven in the heat treated state. They have the following properties and strengths:

### Strength of Al7ST Rivets

| Rivet                   | Diam.<br>In. | Allow. Shear<br>lbs. | Allow Bearing |        | lbs./in <sup>2</sup> |             |
|-------------------------|--------------|----------------------|---------------|--------|----------------------|-------------|
|                         |              |                      | 24ST          | Alclad | 17ST                 | 17ST Alclad |
| Mod.<br>Braxler<br>Head | 1/8<br>3/16  | 306                  | 74000         |        | 67500                | 81000       |
| Button<br>Head          | 1/8<br>3/16  | 306<br>690           | 82000         |        | 75000                | 68000       |
| Flat<br>Head            | 1/8<br>3/16  | 306<br>690           | 74000         |        | 87500                | 61000       |

REF. DWG. 87-21-701

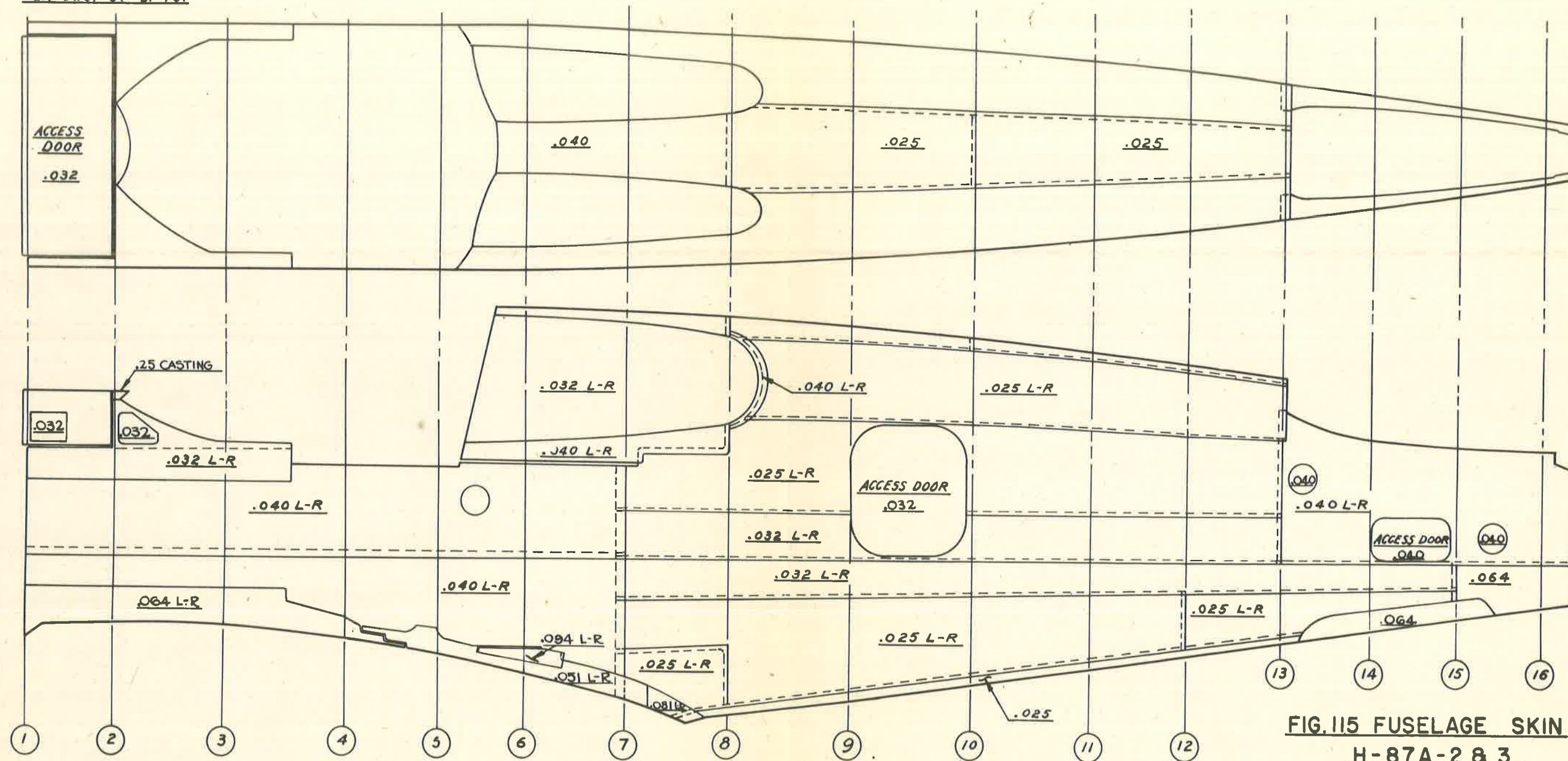


FIG. 115 FUSELAGE SKIN  
H-87A-2 & 3





# FUSELAGE SKIN PATCH

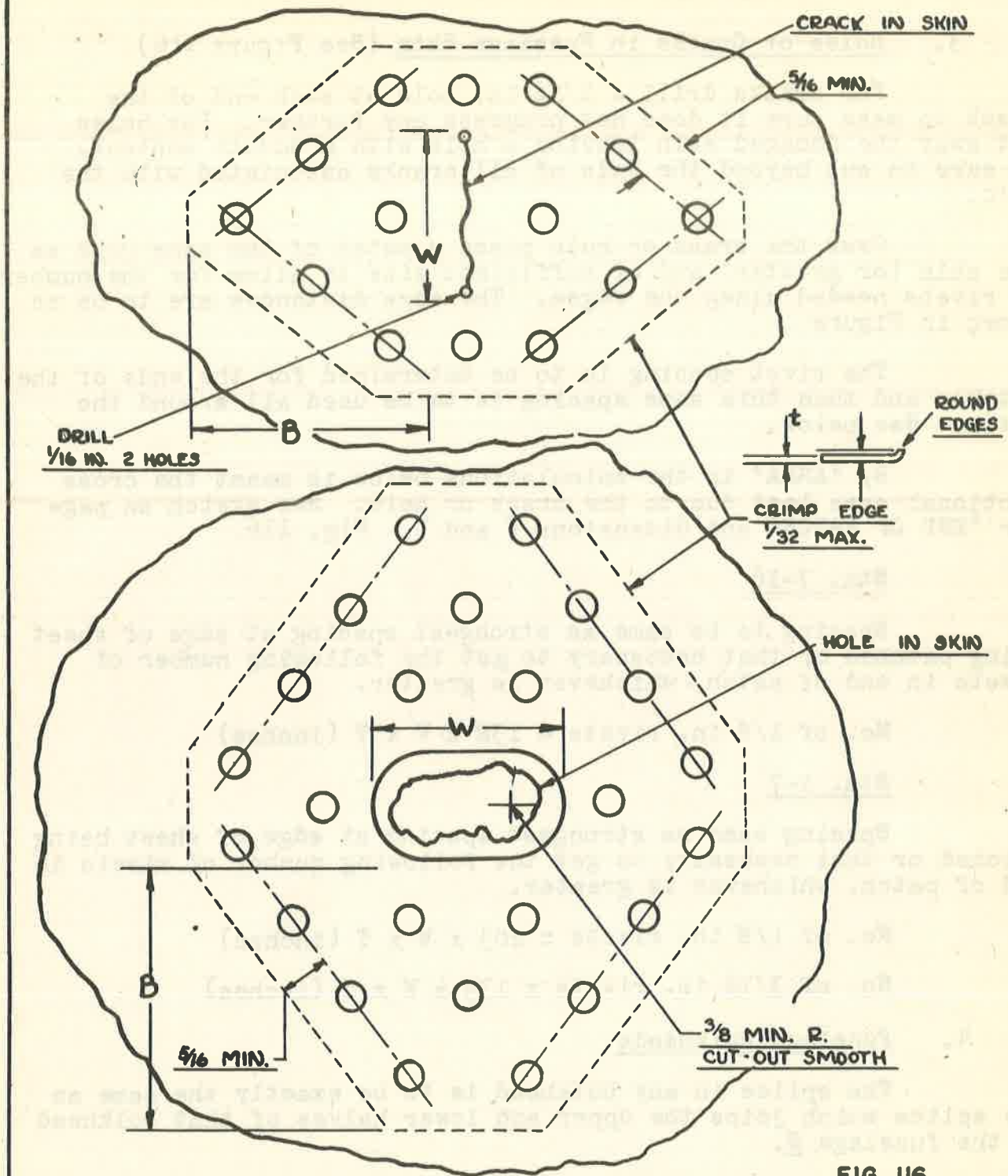


FIG. 116

| PORTION of FUSELAGE | RIVETS   | NO. OF RIVETS<br>IN AREA "B" |
|---------------------|----------|------------------------------|
|                     |          | W & T IN INCHES              |
| STA. 7-16 - REAR    | 1/8 IN.  | 138 • W • T                  |
| STA. 1-7 - FRONT    | 1/8 IN.  | 203 • W • T                  |
|                     | 3/16 IN. | 135 • W • T                  |



### 3. Holes or Cracks in Fuselage Skin (See Figure 116)

For cracks drill a 1/16 in. hole at each end of the crack to make sure it does not progress any further. For holes cut away the damaged skin leaving a hole with a smooth contour. Be sure to cut beyond the ends of all cracks associated with the hole.

Over the crack or hole place a patch of the same gage as the skin (or greater) and of sufficient size to allow for the number of rivets needed along the edges. The edge distances are to be as shown in Figure

The rivet spacing is to be determined for the ends of the patches and then this same spacing is to be used all around the patch. See below.

By "AREA" in the calculations below is meant the cross sectional area lost due to the crack or hole. See sketch on page for "END OF PATCH" and dimensions W and T. Fig. 116.

#### Sta. 7-16

Spacing to be same as strongest spacing at edge of sheet being patched or that necessary to get the following number of rivets in end of patch, whichever is greater.

$$\text{No. of } 1/8 \text{ in. rivets} = 138 \times W \times T \text{ (inches)}$$

#### Sta. 1-7

Spacing same as strongest spacing at edge of sheet being patched or that necessary to get the following number of rivets in end of patch, whichever is greater.

$$\text{No. of } 1/8 \text{ in. rivets} = 203 \times W \times T \text{ (inches)}$$

$$\text{No. of } 3/16 \text{ in. rivets} = 135 \times W \times T \text{ (inches)}$$

### 4. Fuselage Bulkheads.

The splice in any bulkhead is to be exactly the same as the splice which joins the upper and lower halves of that bulkhead at the fuselage  $\emptyset$ .

REF. DWG. 87-21-702

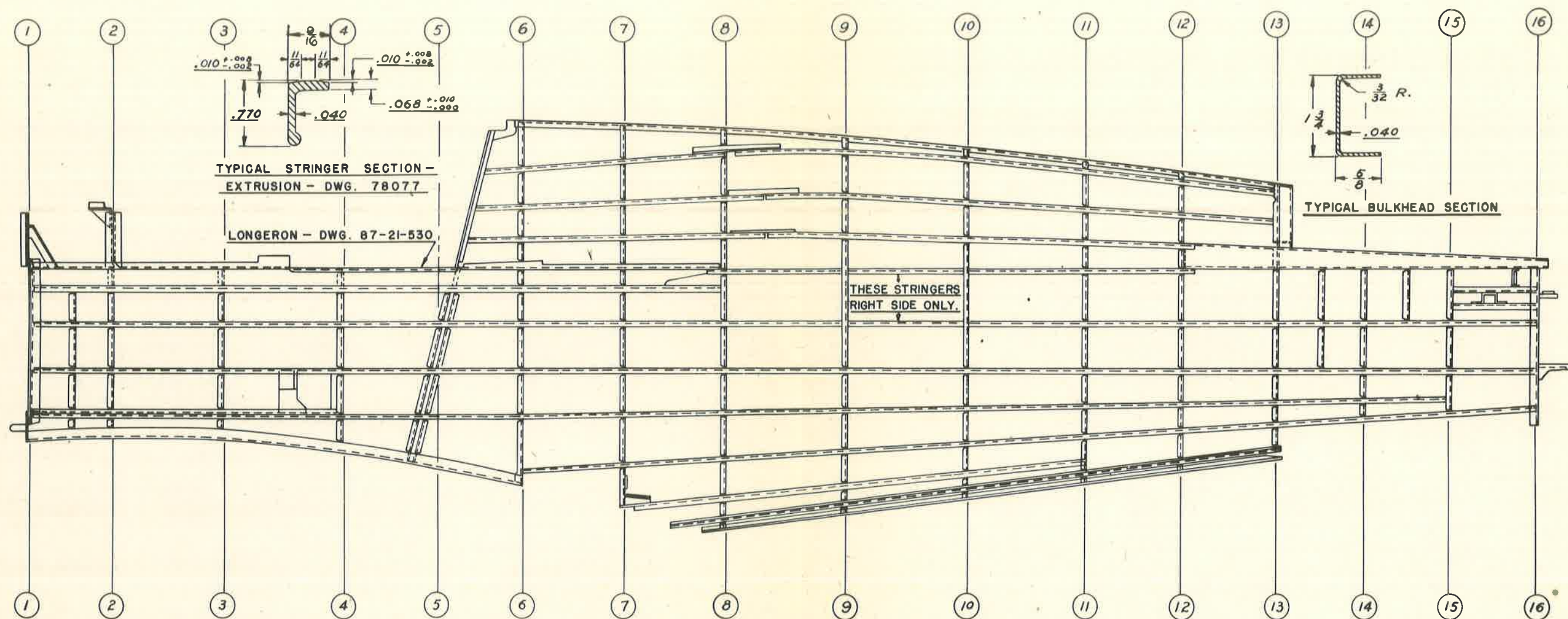


FIG. II7 FUSELAGE  
SKELETON H-87A-2 & 3



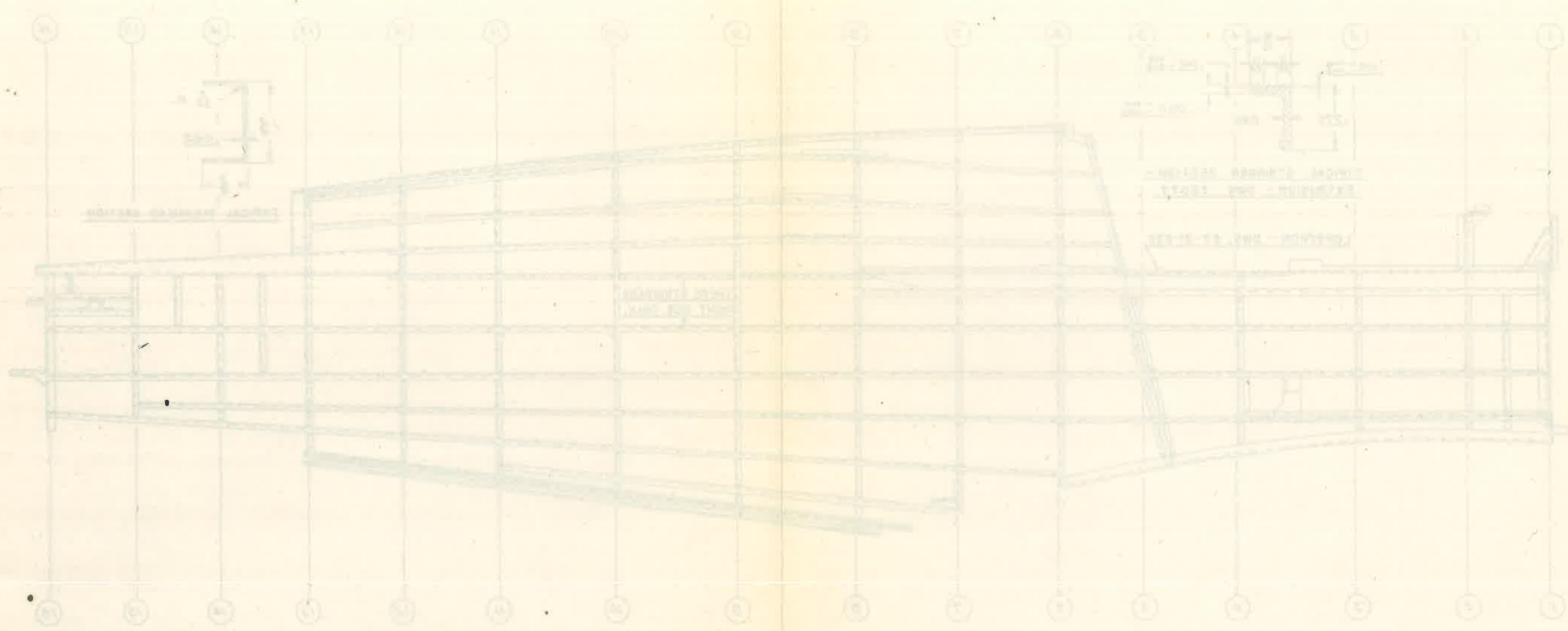
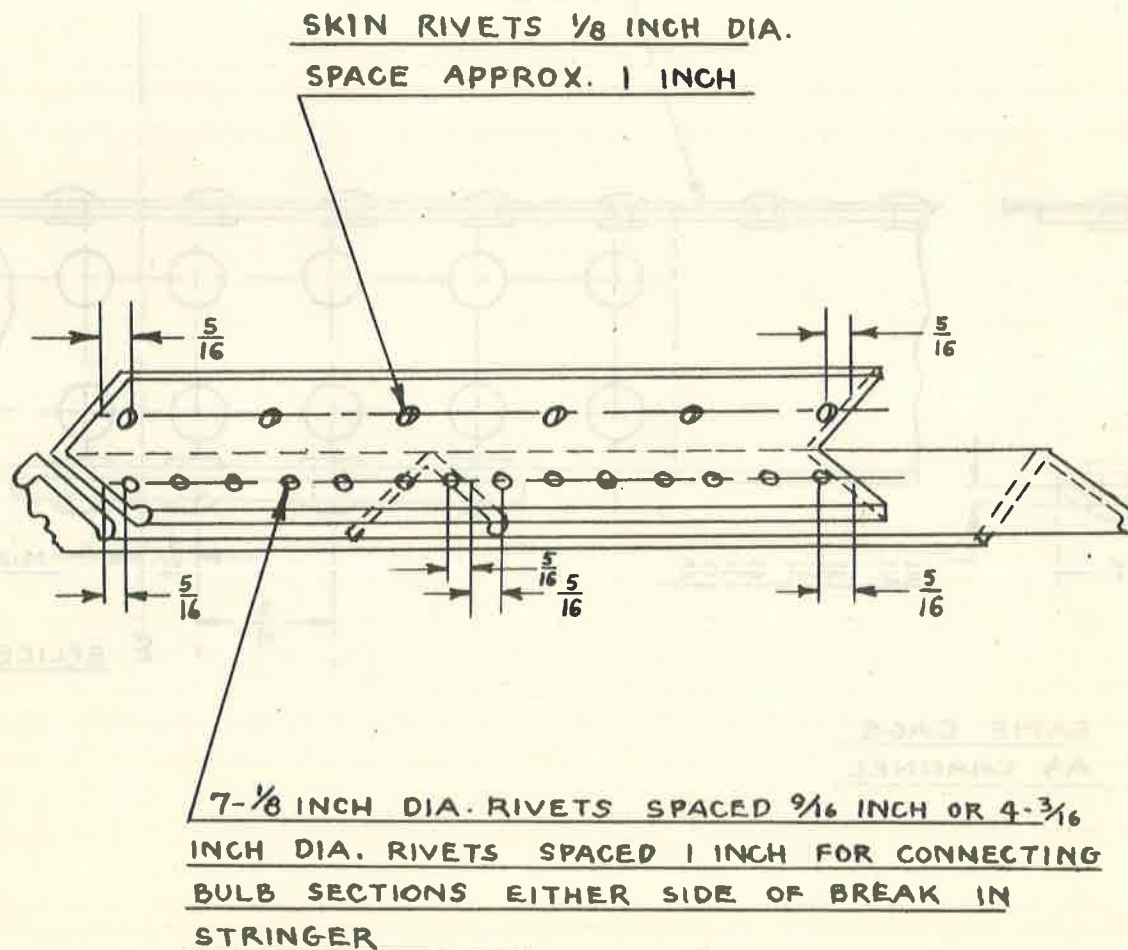


FIG. 113 FUSELAGE  
SKELETON H-BTA-2 B.3

5. Stringers in Fuselage.

( $\frac{9}{16} \times .770 \times .040$  in. Cross sectional area = .067 sq.in.)

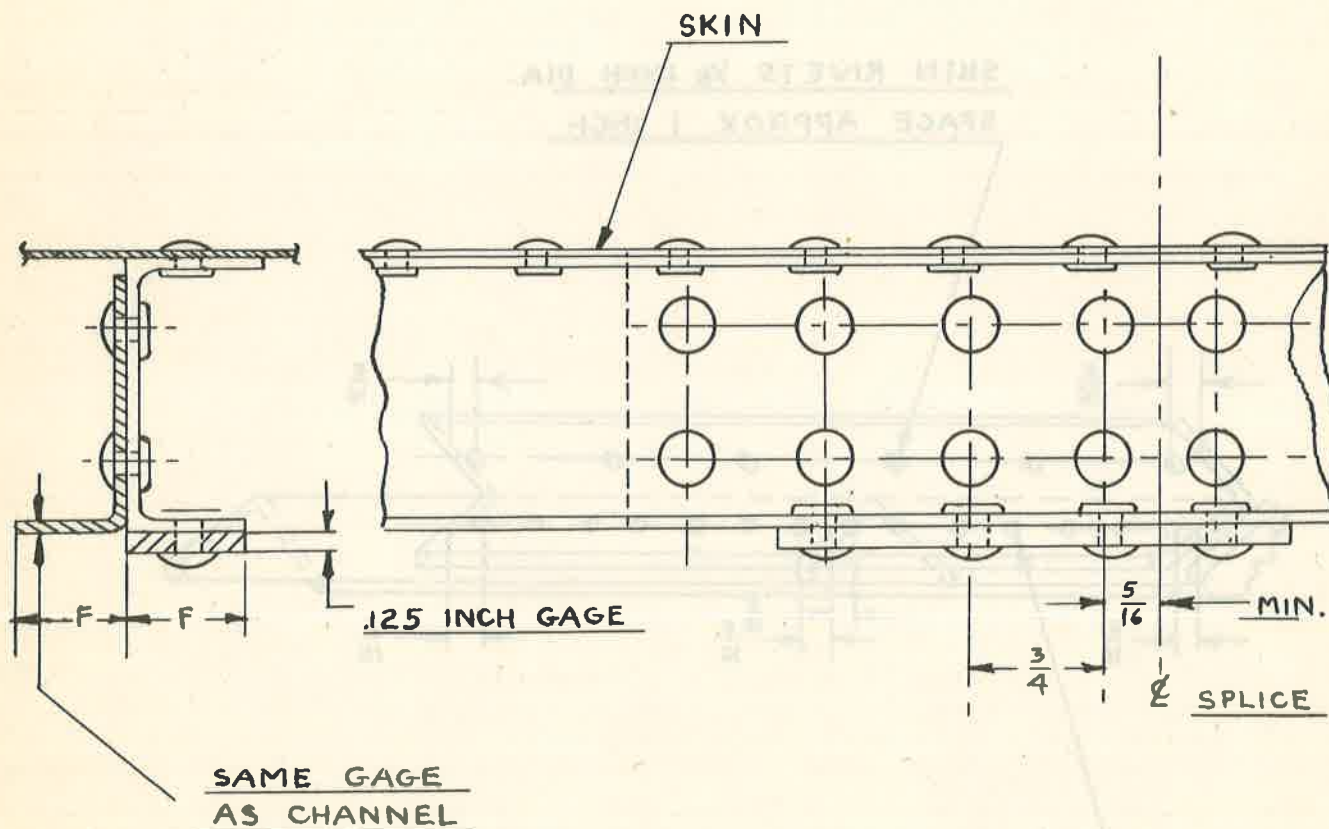
If it is necessary to replace a section of a stringer, splice the ends with a butt joint as shown. If a section of bulb angle can not be obtained, an angle of the same cross sectional area (.067 sq.in.) may be used, but must be at least  $\frac{3}{4}$ " high. Gage of splice angle must be the same as the stringer (.040 in.)





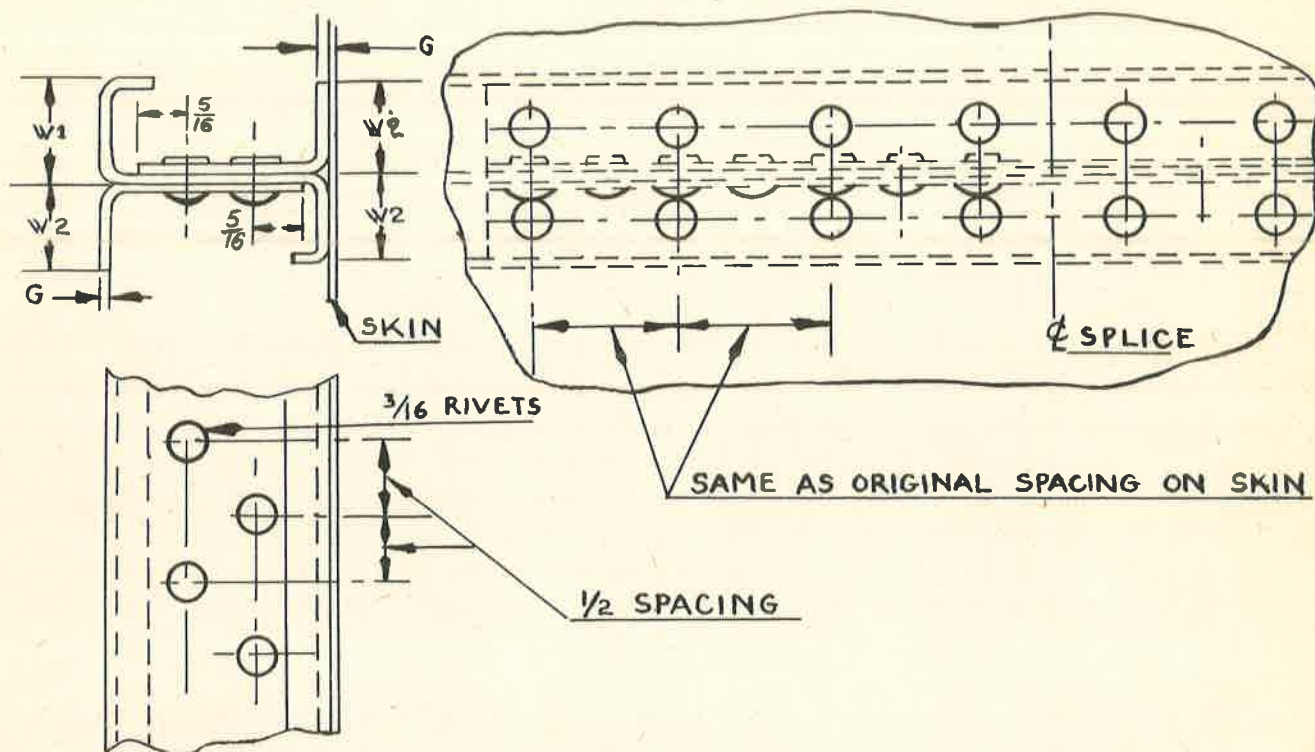
6. Stringers, - Heavy Channel Section in Panel ( $1\frac{1}{2} \times \frac{5}{8}$  in.) (Cross sectional area = .19 sq.in.)

These stringers may be spliced as indicated in the following sketch, using a total of eleven (11)  $\frac{3}{16}$ " rivets on either side of the break.



7. Stringers - Bulb Section in Wing ( $1\frac{1}{4} \times 21/32 \times .083$  in. cross sectional area = .19 sq.in.)

( Use the same type of splice (but with above stringer) as for fuselage but use 10 -  $3/16$  in. rivets either side of break in stringer.



### STRINGERS - ZEE SECTION

Splice with two angles of same gauge as stringer, as shown above.

The  $1-3/16 \times 5/8 \times .040$  in. stringer has a cross sectional area of .10 sq. in. Use 8- $3/16$  rivets in stringer web each side of break. Where this stringer is less than  $1-3/16$  in. high, one  $3/16$ " rivets may be omitted for each .25 in. decrease in height.

The stringer which is .051 in. thick varies in height and area. Compute the cross sectional area at the splice and use in each side of the break a number of  $3/16$ " rivets.

$$= 61 \times \text{area in sq. in.}$$





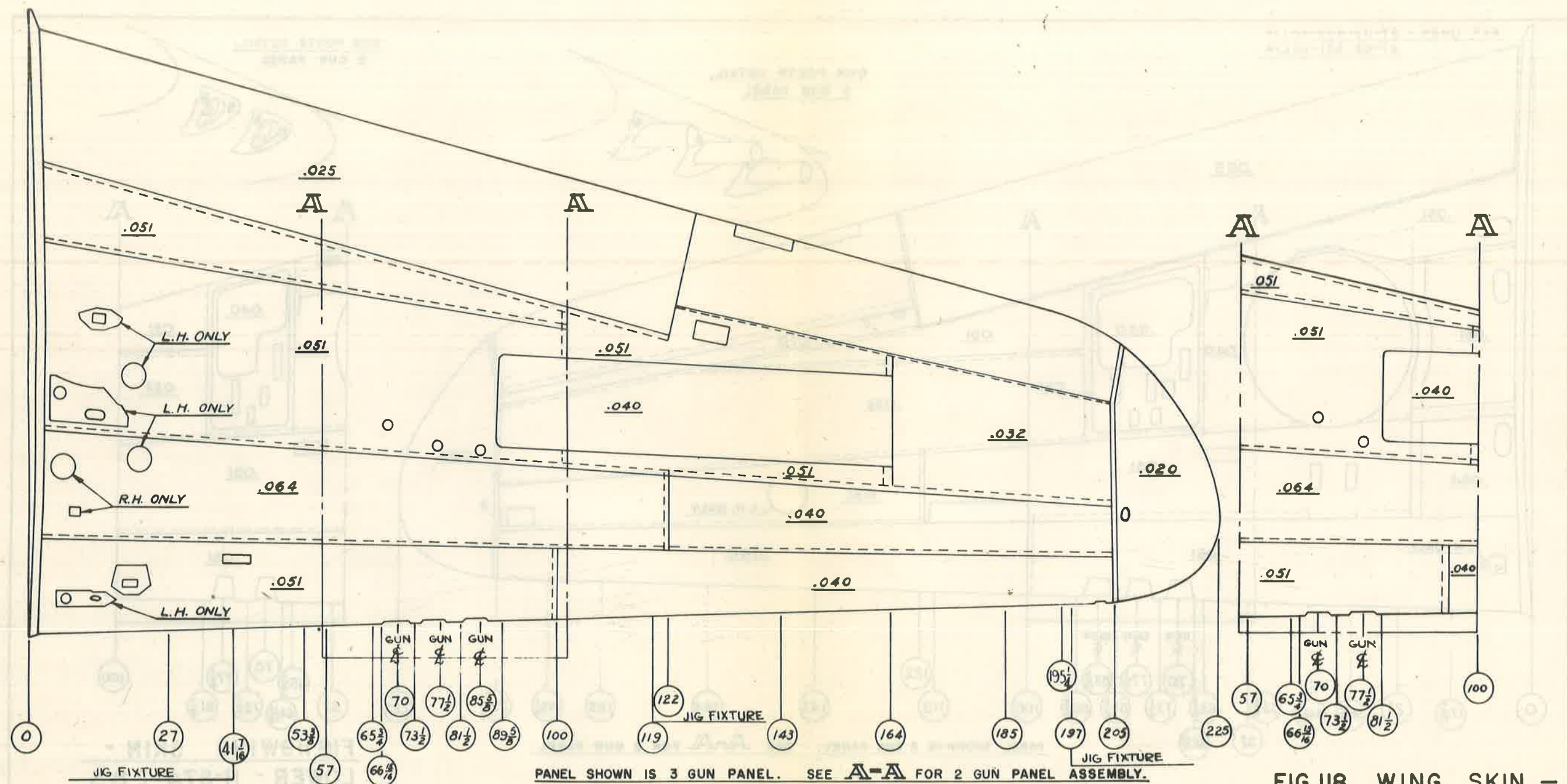


FIG.118 WING SKIN -  
UPPER H-87A-2 & 3



REF. DWGS: - 87-03-809-50 L/R  
87-03-501-50 L/R

GUN PORTS DETAIL,  
3 GUN PANEL

GUN PORTS DETAIL,  
2 GUN PANEL

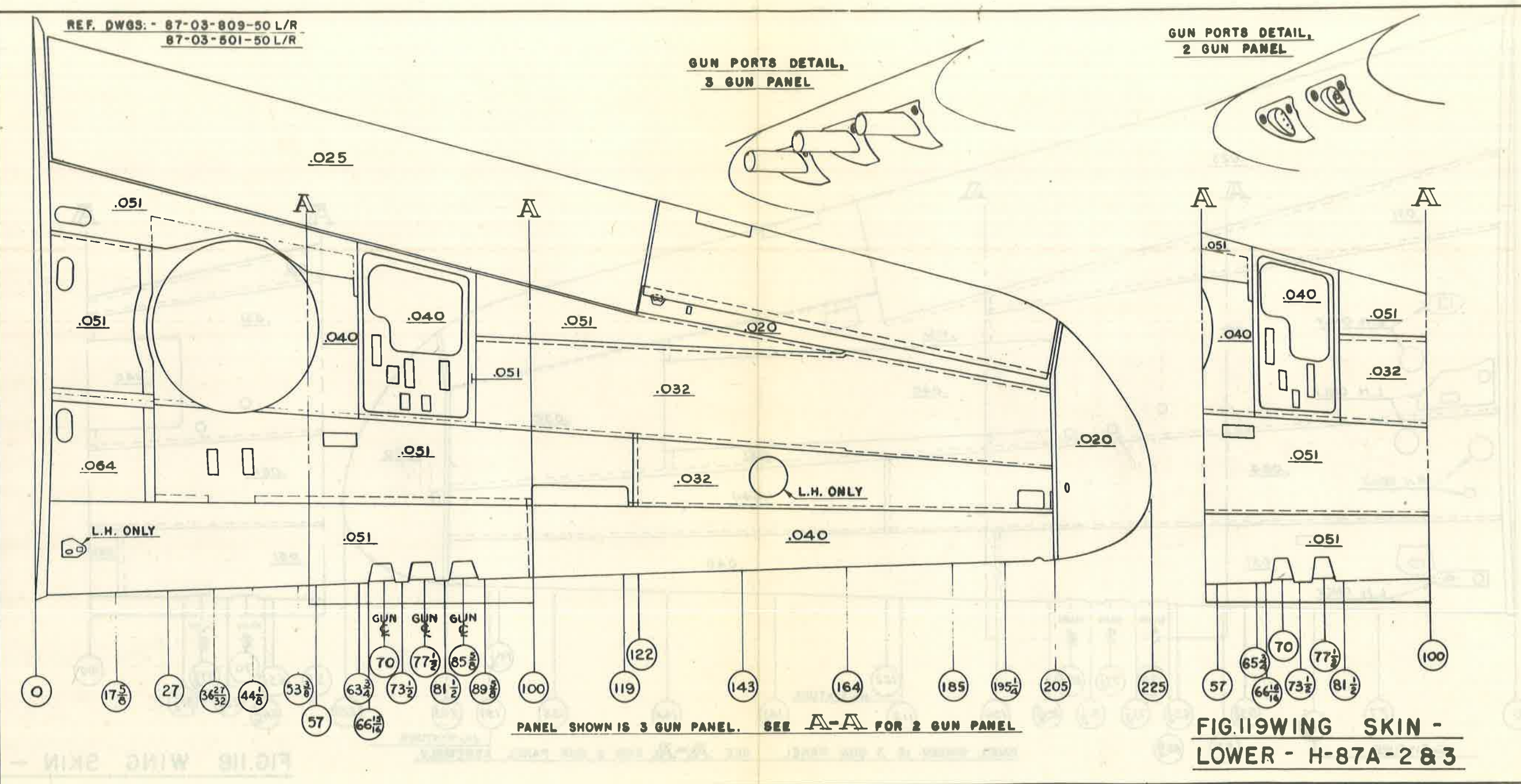


FIG.119 WING SKIN -  
LOWER - H-87A-2 & 3

# TYPICAL WING SKIN PATCH

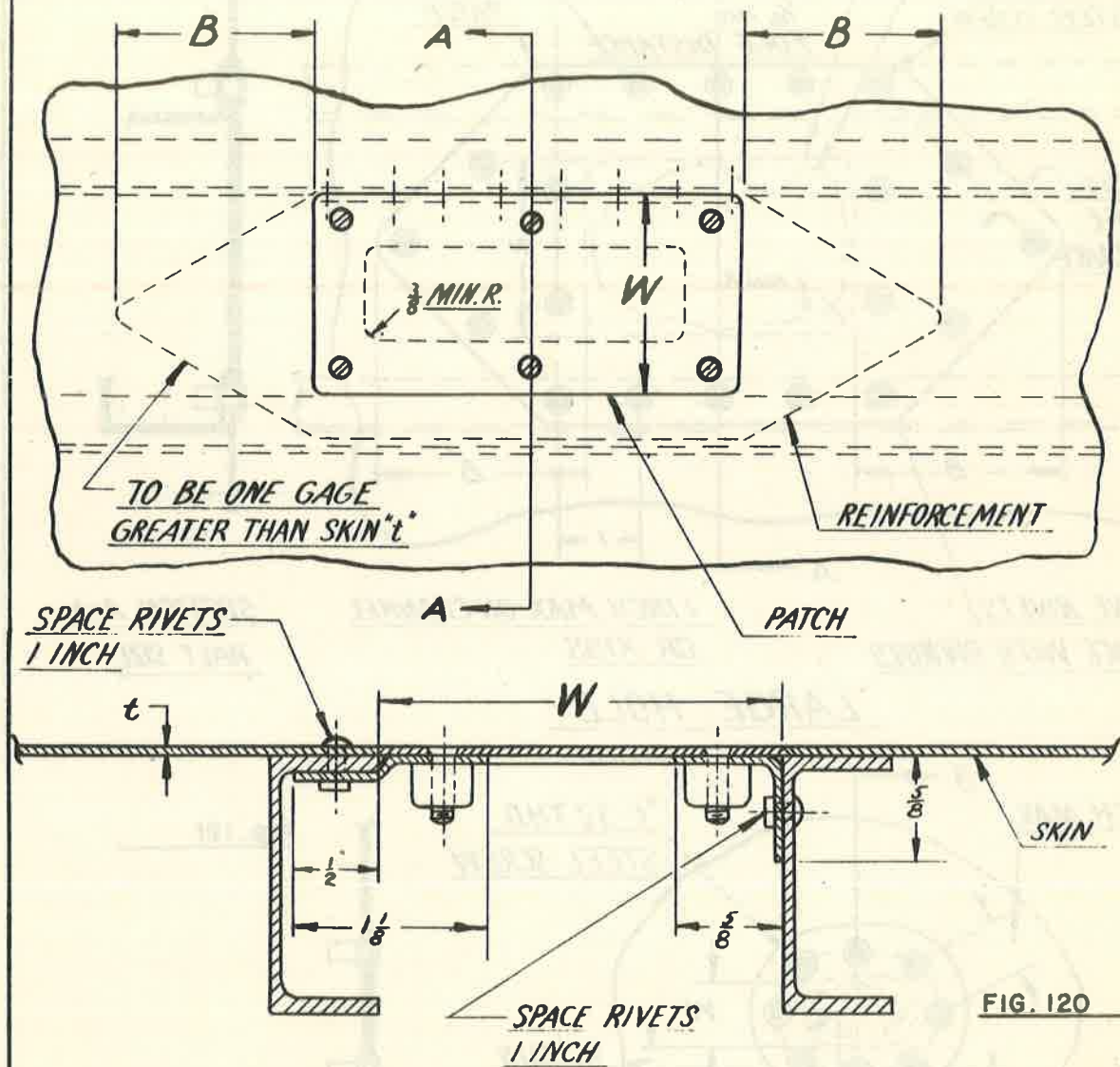


FIG. 120

## SECTION A-A FULL SIZE

| PORTION OF WING      | RIVETS             | NO. OF RIVETS IN AREA "B"<br>$W \times t$ IN INCHES |
|----------------------|--------------------|-----------------------------------------------------|
| INBOARD OF STA. 100  | $\frac{3}{16}$ IN. | $100 \times W \times t$                             |
|                      | $\frac{1}{8}$ IN.  | $177 \times W \times t$                             |
| OUTBOARD OF STA. 100 | $\frac{3}{16}$ IN. | $103 \times W \times t$                             |
|                      | $\frac{1}{8}$ IN.  | $154 \times W \times t$                             |

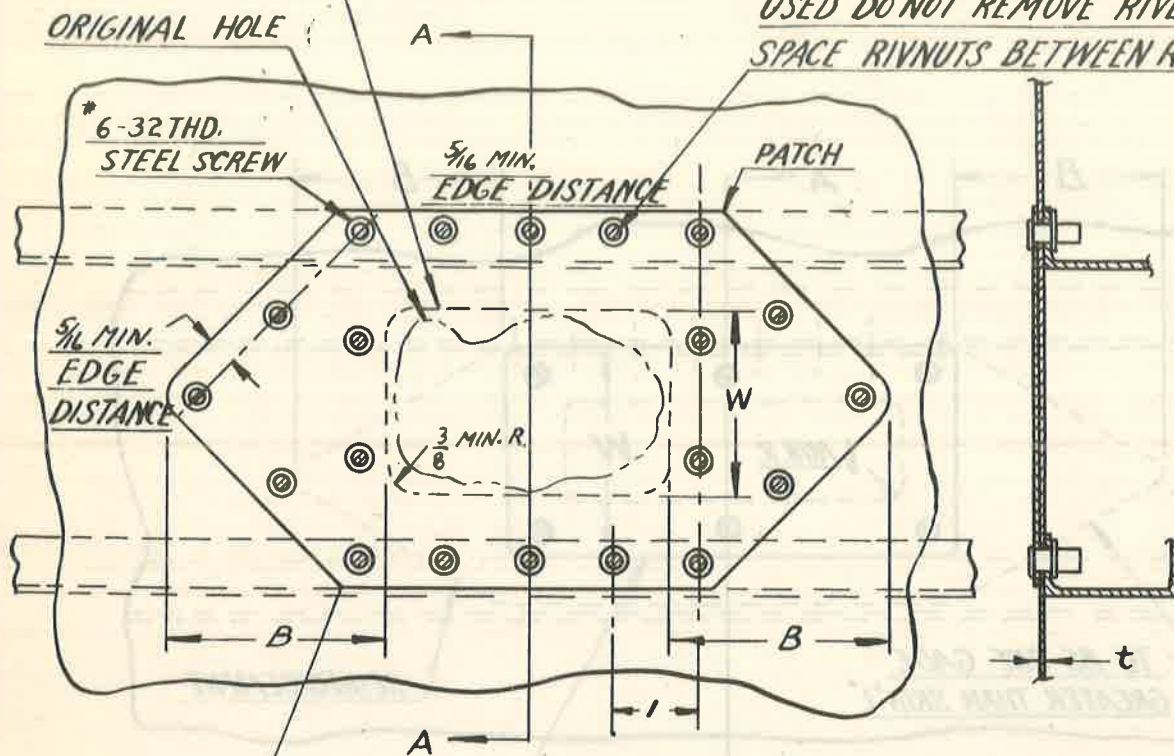


# TYPICAL WING SKIN PATCHES

## USING RIVNUTS

CUTOUT TO NEW SHAPE SMOOTH

NOTE: WHERE FLUSH RIVETS ARE USED DO NOT REMOVE RIVETS  
SPACE RIVNUTS BETWEEN RIVETS



REMOVE RIVETS  
REPLACE WITH RIVNUTS

1 INCH MAX. ON CHANNEL  
OR RIBS

SECTION A-A  
HALF SIZE

## LARGE HOLE

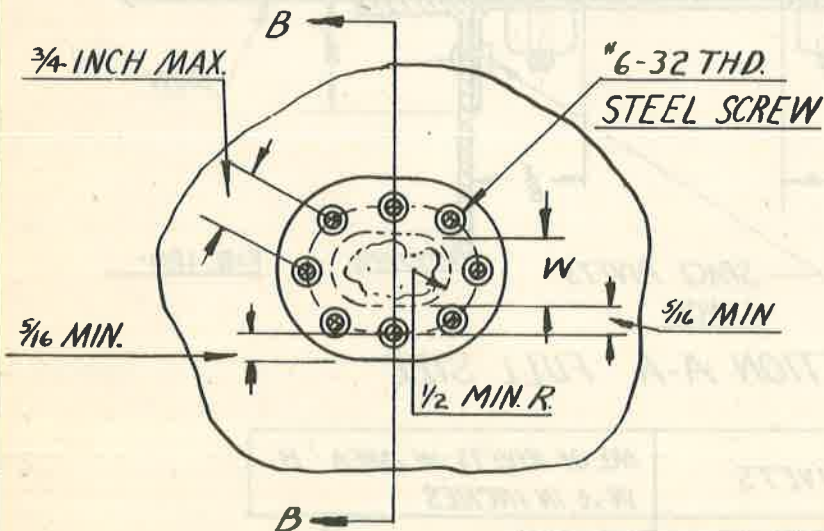


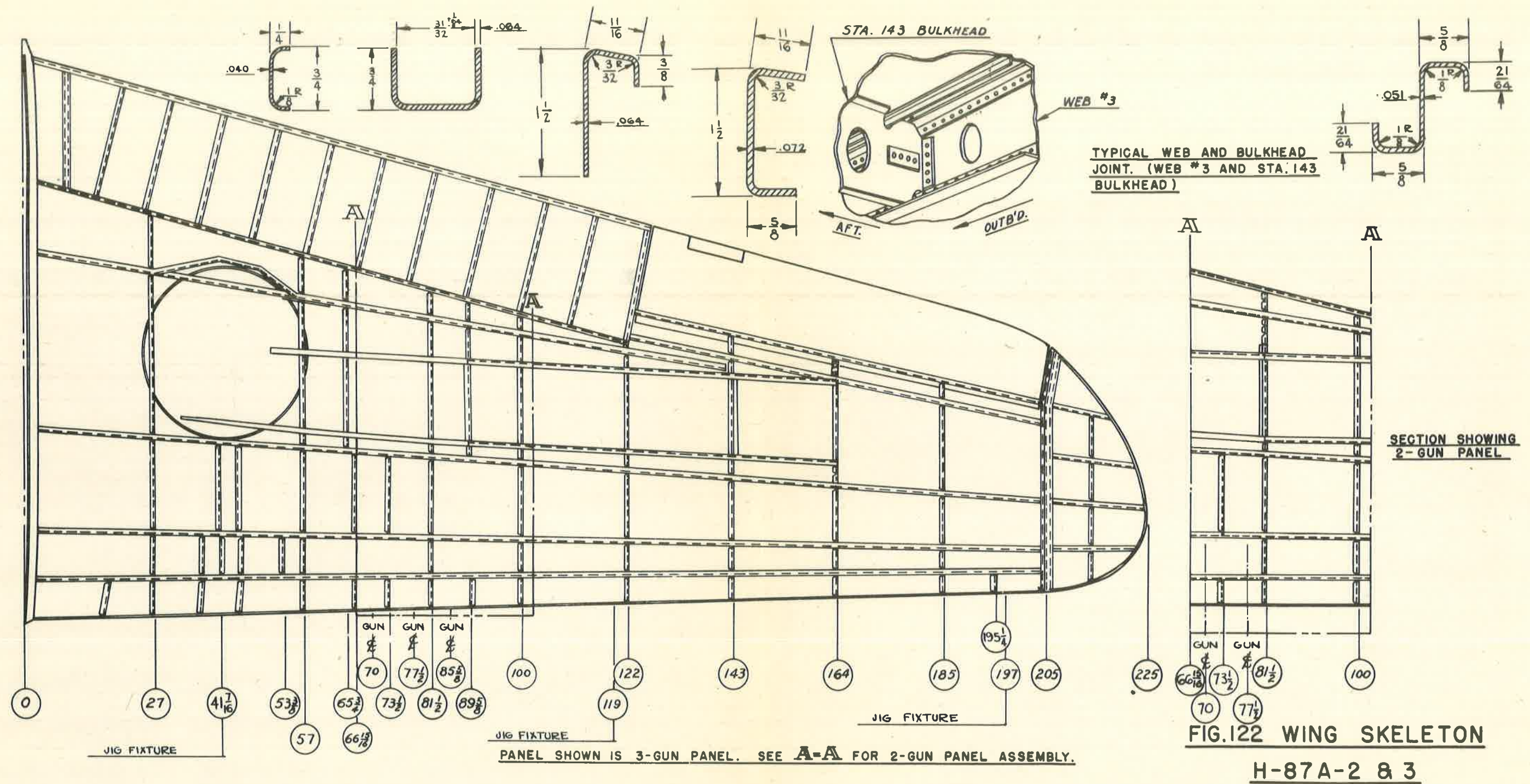
FIG. 121

SECTION B-B

## SMALL HOLE

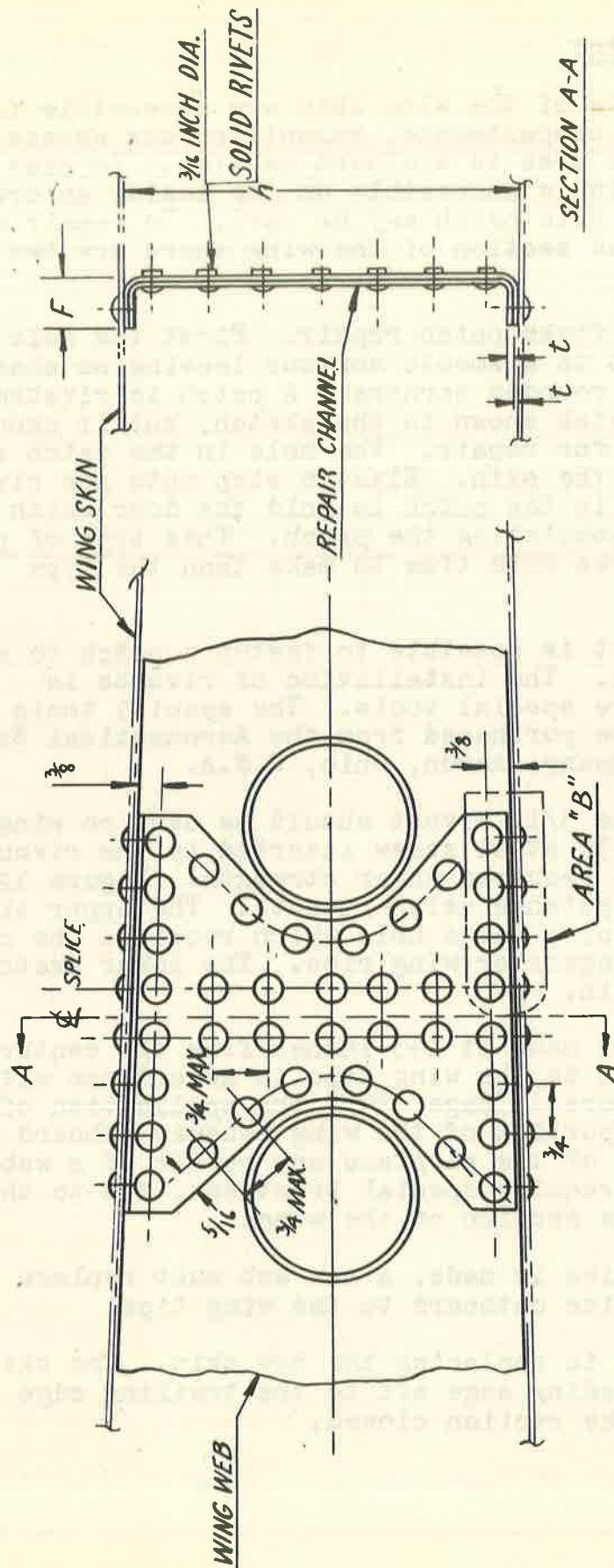
| PORTION OF WING    | NUMBER OF RIVETS IN AREA "B" W & t IN INCHES |
|--------------------|----------------------------------------------|
| INB'D OF STA. 100  | 136 x W x t                                  |
| OUTB'D OF STA. 100 | 103 x W x t                                  |











NUMBER OF RIVETS  
IN AREA "B"

$$= \frac{[(F \times T) + (2h \times t)]}{9 \times 462} = 1.25 \times 36,000 \frac{1}{in^2}$$

$$= 102 \frac{[(F \times t) \times (2h \times t)]}{9 \times 462}$$

EXAMPLE:

$$h = 5 \text{ IN.}$$

$$F = .625$$

$$t = .040$$

$$102 [ (.625 \times .040) \times (2 \times 5 \times .040) ]$$

$$120 \times 421 = 6.6 \text{ RIVETS}$$

$$8 \text{ RIVETS USED IN AREA "B"}$$

FIG. 123  
GENERAL WEB SPLICE  
FROM 143 INCHES OUTBOARD  
HALF SIZE



## 8. Repair of Wing Skin:

Although some parts of the wing skin are accessible for repair through the gas tank compartments, ammunition box access doors and the wheel wells, a large area is a closed section. In case of repair where the surface skin is accessible on the inside an ordinary patch similar to a fuselage skin patch may be used. To repair small holes in the skin of a closed section of the wing there are two methods commonly applied.

Figure 120 shows a flush patch repair. First the hole or crack in the skin is cut out to a smooth contour leaving no sharp edges and having generously rounded corners. A patch is riveted to the inside similar to the patch shown in the sketch, but it should suit the specific condition for repair. The hole in the patch should be smaller than the hole in the skin. Elastic stop nuts are riveted around the edge of the hole in the patch to hold the door which is fastened with screws, thus completing the patch. This type of patch is more difficult and requires more time to make than the type employing rivnuts.

By using rivnuts it is possible to fasten a patch to a closed section from one side. The installation of rivnuts is quite simple but they require special tools. The special tools along with the rivnuts may be purchased from the Aeronautical Sales Division, B. F. Goodrich Company, Akron, Ohio, U.S.A.

The closed end type 3/16 rivnut should be used on wing skin patches and a number 6-32 steel screw inserted in the rivnut after assembly to insure the required shear strength. Figure 121 shows two typical wing skin patches using rivnuts. The upper sketch of the figure shows a patch of a large hole which requires the patch to tie into the channel stringers or wing ribs. The lower sketch is for small holes in the skin.

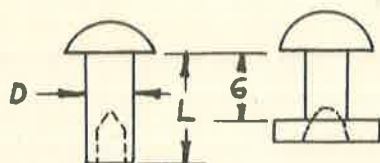
A web splice may be made at 143 inches from the centerline of the airplane outboard to the wing tips in accordance with the "General Web Splice" Figure 123 page 249. The application of this splice is limited to a portion of the wing because inboard of 143 inches to the centerline of the airplane any repair of a web would be a special case and require special treatment, due to the complicated structure in this section of the wing.

Wherever a web splice is made, a new web must replace the damaged web from the splice outboard to the wing tips.

Care must be taken in replacing the new skin. The skin should be worked from the leading edge aft to the trailing edge of the wing in order to rivet the section closed.

## B. THOMSON RIVETS - Methods of Using and Replacing

Thomson rivets are characterized by a depression in the shank. The depression is still visible after the head is formed, but then it is only a shallow dimple. In driving a Thomson rivet the working of the metal is confined largely to the region of the depression. Hence the shank does not expand as much as in a solid rivet. As a result the Thomson rivet should fill the hole closely before driving. If not, a solid rivet is better. Thomson rivets should not be used in holes from which rivets have been previously removed unless the hole is redrilled for the next size larger rivet.



$D$  = diameter

$L$  = length

$G$  = grip

There are three methods of installing and setting Thomson rivets; namely, by machine, by squeezers and by hand tools.

The Thomson rivet machine consists of a hopper; a gravity feed chute with a device allowing only one rivet to fall at a time, a set with receding pin for locating work and guiding rivet through hole; and a mechanically actuated plunger which heads the rivets. The use of the machines is limited to riveting small assemblies and such parts as may be easily maneuvered by hand.

In squeezing Thomson rivets either hand or pneumatic squeezers are used. The jaws of each type are equipped with removable sets of size and shape to suit the different rivet sizes. In each case one set is shaped to fit the manufactured head and one to fit the formed head. Squeezers are used for riveting large assemblies such as monocoques, panels, and parts which may not readily be riveted on a machine.

Where rivets are so inaccessible that they cannot be set with machine or squeezer, hand tools and a hammer are used.

This method is probably the most common in replacing rivets. Rivets may be driven from either side depending upon which is more convenient. The driving tool is usually a straight bar six or eight inches in length, while the buck-up tool may be straight or bent to various shapes depending on the accessibility of the rivet. These tools also have the removable sets as in the case of the squeezer.



In replacing a rivet which has been removed, drill the hole out and use the next larger size Thomson rivet, except in cases where the net section is critical. In such cases the same size Thomson rivet may be used if the hole is not oversize. If the hole is oversize, it will be found better to use the same size solid rivet. For 1/8 dia. rivet drill #30 dia. hole; and for 3/16" dia., drill 3/16" dia. hole. When a rivet is formed, the bottom of the hole in the end can be below the outermost surface of the material on the side of the formed head, not over .032 on 1/8 rivet and not over .040 on 3/16 rivet.

Only steel Thomson rivets may be used.



1/8 DIA.

| <u>STOCK THICKNESS</u> | <u>LENGTH</u> | <u>DASH NUMBER</u> |
|------------------------|---------------|--------------------|
| .015 - .027            | 3/32          | -4-3               |
| .028 - .059            | 1/8           | -4-4               |
| .060 - .090            | 5/32          | -4-5               |
| .091 - .121            | 3/16          | -4-6               |
| .122 - .152            | 7/32          | -4-7               |
| .153 - .184            | 1/4           | -4-8               |
| .185 - .215            | 9/32          | -4-9               |
| .216 - .247            | 5/16          | -4-10              |
| .248 - .278            | 11/32         | -4-11              |
| .279 - .309            | 3/8           | -4-12              |
| .310 - .340            | 13/32         | -4-13              |
| .341 - .372            | 7/16          | -4-14              |
| .373 - .403            | 15/32         | -4-15              |
| .404 - .434            | 1/2           | -4-16              |

3/16 DIA.

|             |       |       |
|-------------|-------|-------|
| .063 - .095 | 3/16  | -6-6  |
| .096 - .125 | 7/32  | -6-7  |
| .126 - .156 | 1/4   | -6-8  |
| .157 - .188 | 9/32  | -6-9  |
| .189 - .218 | 5/16  | -6-10 |
| .219 - .250 | 11/32 | -6-11 |
| .251 - .281 | 3/8   | -6-12 |
| .282 - .313 | 13/32 | -6-13 |
| .314 - .344 | 7/16  | -6-14 |
| .345 - .375 | 15/32 | -6-15 |
| .376 - .408 | 1/2   | -6-16 |
| .409 - .438 | 17/32 | -6-17 |
| .439 - .469 | 9/16  | -6-18 |
| .470 - .500 | 19/32 | -6-19 |
| .501 - .531 | 5/8   | -6-20 |
| .532 - .562 | 21/32 | -6-21 |
| .563 - .594 | 11/16 | -6-22 |
| .595 - .625 | 23/32 | -6-23 |
| .626 - .656 | 3/4   | -6-24 |



### C. TREATMENT OF STEEL FOR WELDING

All finishing materials should be thoroughly removed from metal surfaces which are to be welded. It is also desirable, but not absolutely necessary to remove cadmium plating from steel. If the above materials are not removed before welding greater difficulty will be experienced in producing a satisfactory weld and unpleasant gases will be formed that may make the welder ill.

Enamels and varnishes can be removed from all metal parts with a good commercial paint-and-varnish remover. If the part is small it can be immersed in the remover and after the finishing coats are softened they may be removed by brushing or scrubbing with a rag saturated with the remover. If the part is large and it is only desired to remove the finishing coats around the area to be welded the paint remover can be applied on the desired locations with a small brush or rag. After the paint is softened it may be scraped off with a dull edged putty knife. Care should also be taken to clean the part far enough from the area to be welded to prevent burning of the paint as it will then be more difficult to remove and may cause difficulty in satisfactorily refinishing the part. The paint remover should then be thoroughly washed off with hot water. Cadmium plating on steel parts can then be removed by rubbing with very fine steel wool or emery cloth. Excessive rubbing will reduce the thickness of the part and may produce scratches detrimental to the part.

After cleaning as described above the parts are ready for welding. The welded areas of steel parts should be cleaned by sand blasting or wire brushing. Steel parts should be cadmium (or zinc) plated if equipment is available and provided entire finish of part was removed. Closed tubular or hollow steel parts should be filled with hot raw linseed oil and drained and the drain holes plugged with self tapping or drive screws to prevent corrosion on the interior of such parts. The parts should then be refinished as originally with one coat of metal primer and two coats of enamel.

### D. ENGINE MOUNT

The upper truss and lower tube assemblies which consist of welded-up structure are not to be repaired or braced under any circumstances. The welded-up assemblies must be replaced as a complete unit as must the other parts which comprise the complete engine mount.

**E. TREATMENT OF ALUMINUM AND ALUMINUM ALLOY FOR WELDING**

All finishing materials should be thoroughly removed from metal surfaces which are to be welded. It is also desirable but not absolutely necessary to remove film from aluminum or aluminum alloys. If the above materials are not removed before welding greater difficulty will be experienced in producing a satisfactory weld and unpleasant gases will be formed that may make the welder ill.

Enamels and varnishes can be removed from all metal parts with a good commercial paint-and-varnish remover. If the part is small it can be immersed in the remover and after the finishing coats are softened they may be removed by brushing or scrubbing with a rag saturated with the remover. If the part is large and it is only desired to remove the finishing coats around the area to be welded the paint remover can be applied on the desired locations with a small brush or rag. After the paint is softened it may be scraped off with a dull edged putty knife or preferably a piece of wood. Extreme care should be taken when working on aluminum or aluminum alloy parts, not to scratch or gouge the material as this may cause a failure after the part is returned to service. Care should also be taken to clean the part far enough from the area to be welded to prevent burning of the paint as it will then be more difficult to remove and may cause difficulty in satisfactory refinishing the part. The paint remover should then be thoroughly washed off with hot water. The anodic film on aluminum or aluminum alloy parts can then be removed by rubbing with very fine steel wool or emery cloth. Extreme caution should be exercised on aluminum alloy parts to rub only enough to remove the anodic film which is extremely thin and very easily removed. Excessive rubbing will reduce the thickness of the part and may produce scratches detrimental to the part.

After cleaning as described above, the parts are ready for welding. After welding the aluminum or aluminum alloy parts shall be treated in accordance with the instructions entitled "Treating Aluminum or Aluminum Alloy Parts after Welding." Aluminum or aluminum alloy parts should be anodized if equipment is available and provided entire finish of part was removed. The parts should then be refinished as originally with one coat of metal primer and two coats of enamel.

**F. ANNEALING AND HEAT TREATMENT OF ALUMINUM AND ALUMINUM ALLOYS**

All of the aluminum and aluminum alloy parts in an airplane are in a definite physical condition which will be adversely affected by the application of excessive heat. In the repair of any parts it should be definitely ascertained what alloy it is made of before any heat is applied.



The simple alloys 2S (Aluminum) 3S (Aluminum-manganese) and 4S (Aluminum-manganese-magnesium) are not susceptible to heat treatment and are usually used in either the annealed or half hard condition. The half hard material can be annealed as indicated in Table #1 but the annealed material cannot be hardened except by cold working.

The high strength alloys 17S (Aluminum-manganese-magnesium-copper) and 24S (Aluminum-manganese-1.5% magnesium-copper) obtain their physical properties from heat treatment which consists of heating to the temperature indicated in Table 1 and then quenching in cold water. Heating may be done in gas or electric furnace or in a nitrate salt bath. They can be annealed so that forming operations can be performed and then reheat treated. They are always used in the heat treated condition in airplane structures in which condition they are not very ductile and any repairs requiring forming operations necessitates annealing and then re-heat treatment. If the forming can be done in one hour or less after quenching the annealing operation can be dispensed with.

Rivets made of 17S aluminum alloy are used in aluminum alloy structural parts and are to be heat treated the same as other 17S parts. They should only be used for 1/2 hour after quenching. If considerable quantities of rivets are to be used it will facilitate matters to keep the rivets in an ice box at a temperature of 0° F. or lower, which will delay the hardening until they are exposed to atmospheric temperatures. Such an ice box can be kept cold by dry ice (solid carbon-dioxide).

Aluminum Alloy 17S and 24S parts (sheet, bar, tubing, forgings, and castings) should never be repaired by welding as the physical properties are destroyed and cannot be restored in the welded area. Aluminum alloy 4S can be welded but becomes quite brittle and therefore it is recommended repairs be made by riveting on reinforcements. Aluminum 2S and aluminum alloy 3S can be readily welded and repairs made in this way are entirely satisfactory, but it must be kept in mind that the metal adjacent to the weld will be in the annealed condition.

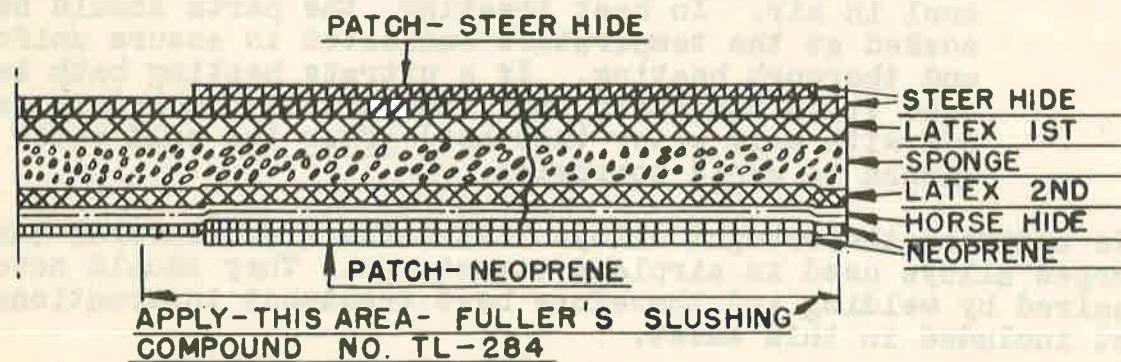
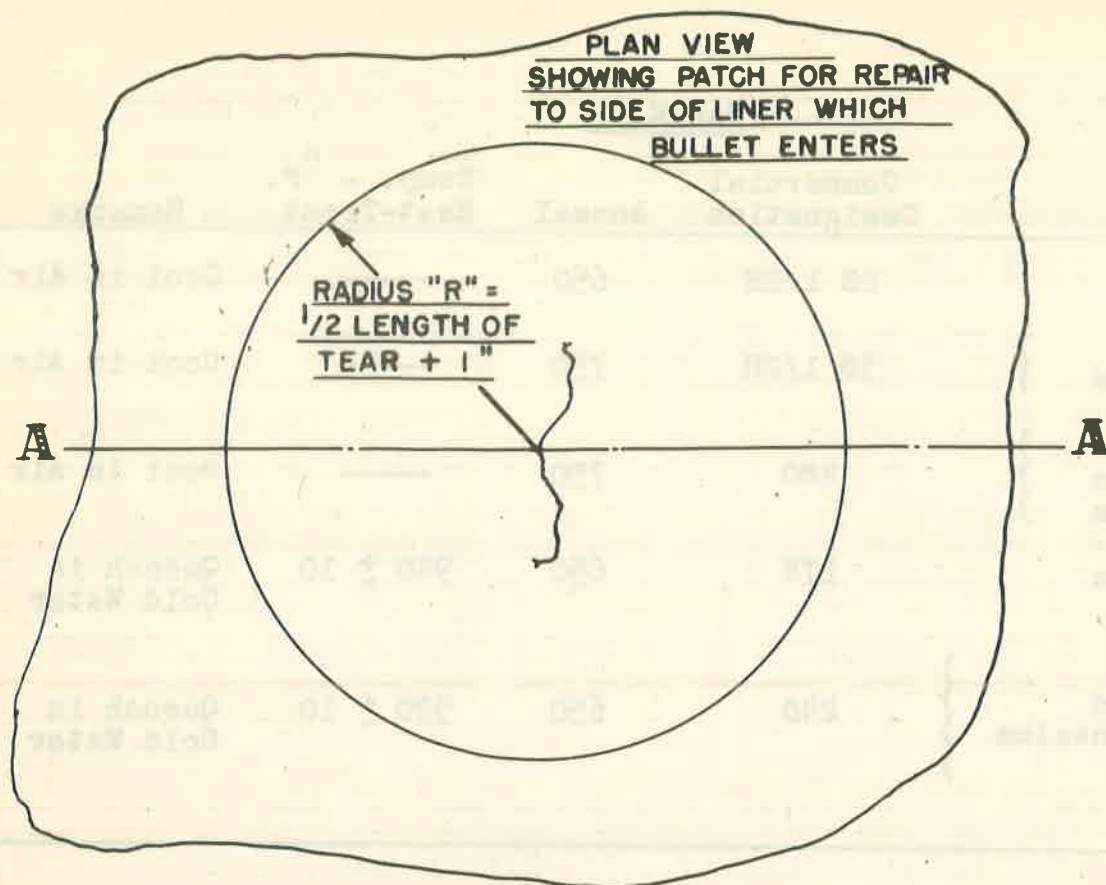
TABLE #1

| Material                                            | Commercial Designation | Anneal | Temp. - °F.<br>Heat-Treat | Remarks                 |
|-----------------------------------------------------|------------------------|--------|---------------------------|-------------------------|
| Aluminum                                            | 2S 1/2H                | 650    | -----                     | Cool in Air             |
| Aluminum<br>Manganese }                             | 3S 1/2H                | 750    | -----                     | Cool in Air             |
| Aluminum<br>Manganese<br>Magnesium }                | 4S0                    | 750    | -----                     | Cool in Air             |
| Duralumin                                           | 17S                    | 650    | 940 ± 10                  | Quench in<br>Cold Water |
| Aluminum<br>Manganese<br>1.5% Magnesium<br>Copper } | 24S                    | 650    | 920 ± 10                  | Quench in<br>Cold Water |

NOTE: Annealing only requires parts to be raised to designated temperatures, removed from furnace and allowed to cool in air. In heat treating, the parts should be soaked at the temperature indicated to assure uniform and thorough heating. If a nitrate heating bath is used it is necessary that the part be completely washed off with warm water (not hot) after the cold water quench to avoid corrosion.

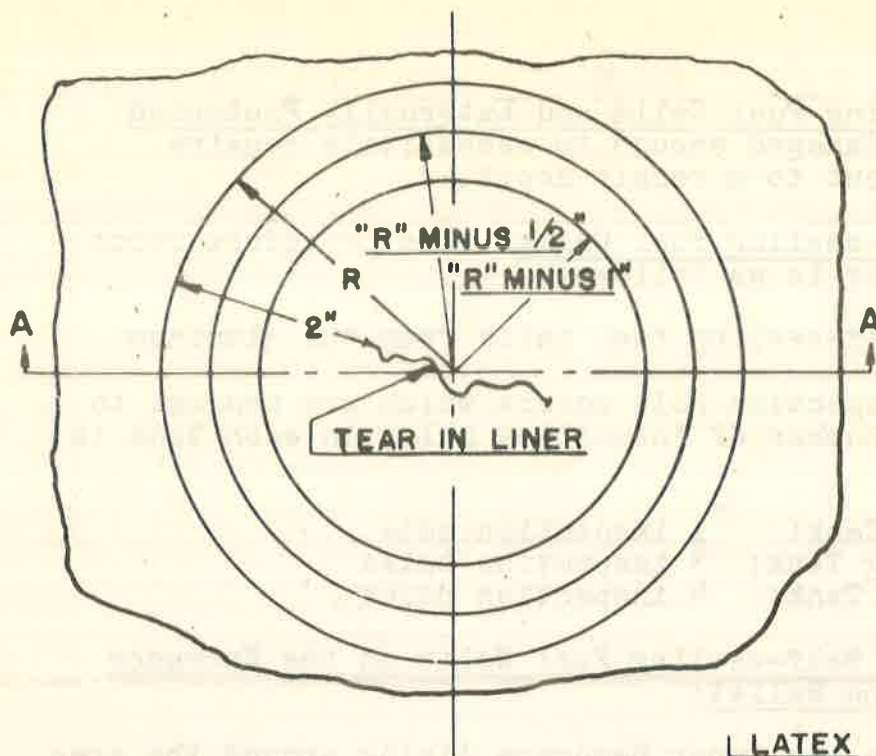
In addition, the wrought alloys listed there are several case and forged alloys used in airplane structures. They should never be repaired by welding and therefore heat treatment instructions are not included in this sheet.





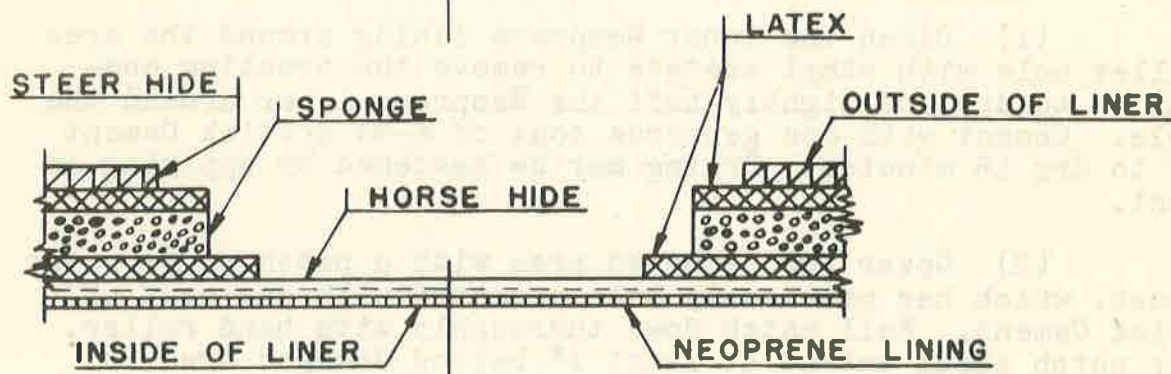
SECTION A-A SHOWING PATCH LAYERS IN PLACE

FIG.124 REPAIR TO FUEL CELL LINER

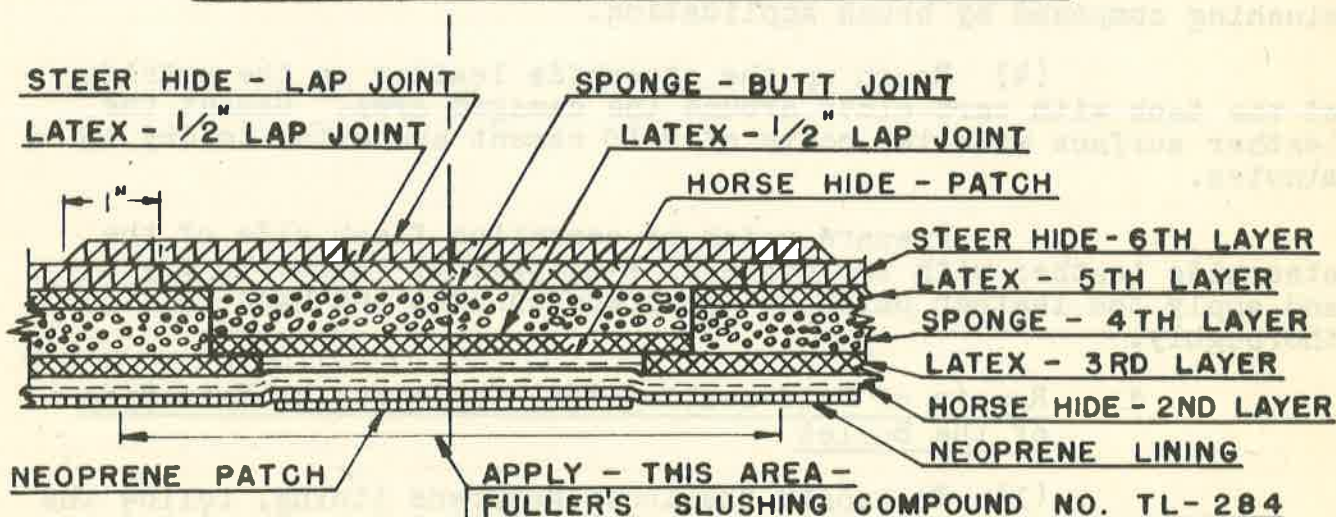


PLAN VIEW SHOWING  
CIRCULAR CUT-OUTS  
OF LAYERS FOR  
REPAIRING TEAR ON  
SIDE OF LINER FROM  
WHICH BULLET  
EMERGES.

NOTE - RADIUS "R"  
EQUALS 1/2 LENGTH  
OF TEAR PLUS 2".



SECTION A-A SHOWING LAYERS REMOVED



SECTION A-A SHOWING PATCH LAYERS IN PLACE

FIG.125 REPAIR TO FUEL CELL LINER



G. Repair of Self-sealing Fuel Cells and Externally Protected Oil Tanks: A tank damaged enough to necessitate repairs should be replaced and sent to a repair depot.

1. Repair of Self-sealing Fuel Cells: The procedure recommended by the manufacturer is as follows:

- a. Remove self-sealing fuel cells from the aluminum shells.
- b. Remove inspection hole covers which are nearest to the damaged areas. The number of inspection holes in each tank is as follows:

|                  |                    |
|------------------|--------------------|
| Fuselage Tank:   | 1 inspection hole  |
| Front Wing Tank: | 3 inspection holes |
| Rear Wing Tank:  | 4 inspection holes |

- c. Repair of Self-sealing Fuel Cells on the Entrance Side of the Bullet:

(1) Clean the inner Neoprene lining around the area of the bullet hole with ethyl acetate to remove the treating compound. Allow to dry and lightly buff the Neoprene layer around the bullet hole. Cement with one generous coat of M-40 Bostick Cement and allow to dry 15 minutes. Drying may be hastened by applying an air current.

(2) Cover the cemented area with a patch of Neoprene repair stock, which has previously been cemented with one coat of M-40 Bostick Cement. Roll patch down thoroughly with hand roller. The repair patch shall extend at least 1" beyond damaged area in all directions.

(3) Treat repaired Neoprene liner with TL-284 slushing compound by brush application.

(4) Rough up the steerhide leather on the outside of the tank with card-cloth around the damaged area. Cement the leather surface with two coats of M-40 cement and allow to dry 15 minutes.

Prepare patch by cementing flesh side of the steerhide leather with two coats of M-40 cement. Allow to dry and apply the leather patch to the prepared area and hand-roll thoroughly.

- d. Repair of Self-sealing Fuel Cells on the Exit Side of the Bullet

(1) To repair the inner Neoprene lining, follow the same procedure as outlined above in (1) (a), (1) (b), and (1) (c).

(2) On the outside leather surface draw a circle around the damaged area so that no part of the circle will fall closer than .2" to any part of the damaged area. Remove this section of leather with the aid of benzene ( $C_6H_6$ ) and a sharp knife.

(3) Remove the outer layer of the latex and sponge from a concentric circle having a  $1/2$ " smaller radius than the previously removed steerhide leather. Please note that the outer layer of latex and sponge are removed simultaneously over an equal area. If necessary, use benzene sparingly to aid removal.

(4) Remove the inner layer of latex sheet gum from a concentric circle having a 1" smaller radius than the previously removed steerhide leather.

(5) Remove any loose particles of horsehide leather which is now exposed around the damaged area.

(6) Rough up the outer surface of steerhide leather of tank liner for a distance of 1" beyond the cut out portion. Cement this surface with two coats of M-40 cement and allow to dry 15 minutes.

(7) Cut patches from the repair materials (steerhide leather, latex sheet, sponge and horsehide leather). These patches should be large enough to make a lap joint on each step of the repair (Fig. 125). Cement the patching materials with two coats of cement each and allow to dry. In the case of the sponge patch use a butt joint instead of an overlap. Each lap is to be  $\frac{1}{2}$ " except for the outer layer of steerhide leather which should lap 1". Hand-roll thoroughly each individual layer while being applied over the repaired area.

2. Test of Fuel Cells after Repairs: All repaired fuel cells should be given the following leak test before installation. Plug all openings and inflate to 1 P.S.I. pressure. Submerge all molded connections and repaired areas, either consecutively or concurrently, in a container of commercial alcohol. Inspect the entire surface of the fuel cell in this manner. The repaired fuel cells must show no leakage or porosity under this pressure test.

### 3. Repair of Covered Oil Tanks

a. Strip the covering from the tank and repair tank as described in paragraph 4.

b. Install new covering when tank repairs are complete.

### 4. Repair of Tank Shells

a. Cleaning Procedure: To eliminate danger from possible ignition of explosive gases when repairing aircraft fuel shells or oil tanks, the following precautions should be taken:



(1) No repairs requiring the application of heat will be accomplished on fuel shells or oil tanks while installed in aircraft.

(2) A fuel tank shell requiring repairs by welding or by use of an open flame will, before such repairs are attempted, be thoroughly cleaned with a scrub brush using concentrated soap chips and hot water. Flush thoroughly with hot water after the soap application.

(a) The oil tank will be flushed for 15 minutes with hot water entering at the bottom of the tank and overflowing at the top. This should remove all deposits of oil adhering to the sides of the tank.

(b) After flushing with hot water, the tank will be cleaned with live steam, the steam being passed through the tank for a minimum period of one hour. The oil tank will be mounted so that there is an opening at the top, and one at the bottom at the lowest point of the tank. The live steam will be fed in at the top opening and allowed to escape through the bottom opening. All other openings will be closed.

(c) If facilities for steam cleaning are not available, the flushing with hot water, as specified in paragraph 2 (a) will be continued for a minimum period of one hour, following which the interior of the tank will be thoroughly dried with compressed air. This is not as positive a method of removing combustible material and fumes as the steam cleaning; therefore, it should not be used unless absolutely necessary.

(d) When the exterior of the oil tank or fuel shell is to be cleaned with paint remover, or any other combustible solvents, this cleaning will be done prior to flushing or steaming of the interior of the tank.

(e) The repair work should be done as soon as possible after the tank has been cleaned and dried. Under no circumstances will a tank that has been flushed or steam cleaned and dried be allowed to stand more than 30 minutes before being repaired. Tanks that are allowed to stand in excess of this period will be re-cleaned before applying any heat.

b. When oil tank and fuel shell repairs can be accomplished by soldering, it will not be necessary to steam-clean the tank provided all oil has been completely drained from the tank and caution is used in heating the soldering irons so that they will not be heated to the point where they will cause particles of dust to become incandescent, as this is sufficient to ignite an explosive mixture in the tank.

c. Welding of oil tanks that have contained oil will not be accomplished near any combustible materials or in any building containing such materials.

#### H. Repair of Welded Aluminum - Fuel Shells and Oil Tanks

Failures in fuel tank shells can usually be repaired by simply welding up the crack. The paint coatings should first be removed for a distance of at least 3" all around the crack. This can be done by the application of paint remover which should then be thoroughly washed off with hot water. The gasoline fumes should then be thoroughly removed, following procedure outlined in Repair of Tank Shells.

A small hole ( $3/64$ " or  $1/16$ " diameter) should then be drilled at each end of the crack to prevent its progression under the welding heat or after the tank is again in service. The welding can then be accomplished using an oxy-hydrogen flame. The flame should be adjusted to a neutral condition with the hydrogen gage set about 5 lbs. above the oxygen gage. A filler rod of the same material as the tank shell can be used although 5% silicon rod, if available, is generally easier to handle and gives better results in complicated welds. United States Aluminum Company Flux #22, or equivalent, should be used. It is mixed to a paste condition with water and the part to be welded is coated with it and the rod dipped in it. Enough heat should be applied to form a bead on the inside of the joint being welded but care should be exercised to prevent melting holes in the material. A good practice to follow is to weld from each end of a crack toward the center to prevent the crack progressing ahead of the flame.

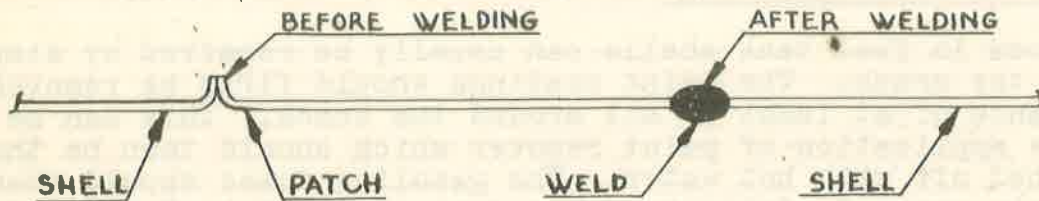
Cracks in the shell around rivets can be repaired in the manner described above. It is more desirable in this case to use silicon rod if available.

1. Testing Tanks After Repairs: Before installing coolant or oil tanks in the airplane, they must be tested under water to the following air pressures:

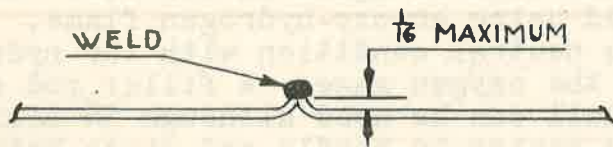
- a. Oil Tank - 5 p.s.i.
- b. Coolant Tank - 20 p.s.i.



The patch can then be tacked and welded in place in accordance with welding instructions in paragraph two and the following sketch:



The seam can be left standing as shown below if desired but the better practice is as described above:



An easier method of closing these openings which is satisfactory if they are not too large and if the thickness of the metal is .050 or more is to simply lap weld a patch on as shown below. However, care must be used to avoid burning the metal:

## I. Armament

### Aircraft Machine Guns and Their Accessories

1. The head space which governs the proper seating of the cartridge in the chamber of the barrel is of great importance and must be properly set in accordance with the gun manual instructions to avoid splitting the cases.

2. The guns should be inspected frequently, particularly prior to installation and prior to firing missions. Inspect for faulty parts and to guard against excessive oiling. Inspect to assure smooth operation of action, cleanness of bore and proper adjustments.

3. Alignment of ammunition boxes, chutes, and blast tubes is necessary to prevent gun mal-functioning.

4. The ammunition should be inspected for split necks, deep primers, thick rims, bulged or distorted cases and to assure proper seating in chamber of barrel. Ammunition should not be belted in the links for any considerable length of time since a chemical reaction between the metals of the link and cartridge will cause corrosion and consequently greatly increase the extraction pull.



## J. Salvaging Equipment Submerged in Salt Water

The salvaging operation should start as soon as possible.

It will usually be necessary to completely disassemble the various parts of the airplane.

After disassembly, the parts should be thoroughly cleaned and inspected and unuseable or questionable parts should be replaced.

It is desirable that the parts be immersed in hot water using soft water if available and changing the water frequently. After washing all parts completely, they should be drained and thoroughly dried, using an air blast if available.

All engine parts should be thoroughly rinsed, as above outlined, in water and then all engine parts except electric equipment should be immersed for a short time in hot lubricating oil at about 180° F.

All fabric covering of airplane parts shall be completely removed and recovered if the parts are found salvageable. Thoroughly wash or flush all parts with fresh water.

All metal parts shall be thoroughly sprayed or dipped in hot mineral oil.

Remove oiling plugs from tubular members, flush with fresh water and then retreat with hot linseed oil. The holes should then be replugged.

The wheels should be thoroughly cleaned inside and out with water and sprayed with penetrating oil. The propeller hubs and blades should be treated with lubricating oil.

Screws, gears, bearings and working surfaces of mechanisms should be thoroughly oiled and greased after flushing with water.

Fuel and oil systems should be drained and flushed with hot water.

It may be possible to save generators, starter control box and other electrical units by thoroughly flushing with fresh water and drying, but these parts must be thoroughly overhauled after being completely dismantled and thoroughly inspected and tested. All other electrical equipment items, including ignition, coils, magneto wiring and flexible shielding, should be destroyed and replaced. All unsealed instruments must be thoroughly dismantled and treated with fresh water, after which they should be dipped in alcohol and then treated with penetrating oil. However, no alcohol should be used on electrical instruments.

Guns must be thoroughly flushed with fresh water and treated with hot lubricating oil. Similar treatment should be given to other armament items.

Leather parts, after submersion, should be rinsed in fresh water, dried and then treated with Neat's foot oil.

#### K. Application Of Dope To Fabric Surfaces

##### 1. Materials

Dope, Nitrocellulose Clear.  
Dope, Nitrocellulose Pigmented.  
Aluminum Powder - 325 Mesh or Finer.  
Thinner, Nitrocellulose Dopes.

All material should be of high quality. Because of the fire hazard involved, dope should be stored under conditions approved by the fire prevention and safety authorities concerned. Dope when stored for extended periods in a warm place, is subject to serious deterioration. Storage temperatures should not exceed 60°F. for long periods, and may approximate, but should not exceed 80°F. for short periods.

##### 2. Workshop Conditions

a. Room - The room in which doping is performed should be completely enclosed and should not be used for any purpose other than doping or painting. The room should be maintained in a neat and clean condition consistent with the best practice for obtaining dust free finishes. Doping performed in any place outside the doping room should constitute emergency work.

b. Temperature and Humidity - Every effort should be made to maintain the temperature and humidity of the doping room at the best relative adjustment. The most desirable condition is a temperature of 70°-80°F. with a relative humidity below 75%. At low temperatures the viscosity of dope increases to a point where it is impossible to apply without addition of excess thinner. This high viscosity also prevents proper penetration of the priming coats and produces a finish having defective adhesion. The relative humidity will vary directly as the temperature within the limits specified, that is, the lower the temperature the lower the relative humidity should be, and the higher the temperature the higher the relative humidity allowed. When no humidity control is available, the relative humidity may be lowered by raising the temperature. Doping may be permitted up to a dry bulb temperature of 90°F. with a wet bulb depression of not less than 4°F. but it is recommended that work be stopped if conditions become worse. Work on which blushing has developed shall be treated as detailed in paragraph on blushing. The wet and dry bulb temperatures in the doping room should be checked hourly.



c. Ventilation - The doping room should be ventilated by forced draft which is capable of effecting at least 15 complete air changes per hour. The air should be cleaned before entering the room by covering all inlet openings with cheese cloth or extra fine mesh screen.

d. Conditioning of Fabric Surfaces before Doping - It is most essential that fabric surfaces be as dry as possible at the time of doping. Fabric surfaces after being covered and before being doped shall be exposed to an atmosphere as described under "Temperature and Humidity" for a sufficient period, (approximately 4 hours), to achieve this condition.

### 3. Preparation of Materials

a. Thinning - Dopes should be thinned as specified by the manufacturer. When thinning directions are not supplied with the dope, it shall be thinned until suitable brushing and flowing properties are obtained. The thinning of dopes influence the drying time, tautening properties and the blushing tendency and it is highly essential that it be properly done.

b. Aluminum Pigmented Dope - Aluminum dope can be prepared by adding aluminum powder to clear dope. One pound per gallon is about the right proportion although this can be varied to suit the materials used. The mixture can then be thinned the same as clear dope.

c. Brushes - It is recommended that brushes used for applying dope be of the flat style, 5 or 6 inches wide, with the bristles set in rubber and bound in metal. Brushes shall be cleaned after each day's use.

d. Dope Dispensing Cans - Cans for applying dope should be of approximately one gallon capacity and shall be maintained in a clean condition.

e. Spray Guns - Spray guns shall be of a type which will provide the proper spray distribution for satisfactory coverage, and otherwise be suitable for the purpose intended.

### 4. Application of Dope

a. General - The finishing scheme consists of base coats of clear dope with protective coats of pigmented dope, and the outside surfaces of all fabric covered parts should be finished in accordance with the following method:

Four coats of clear nitrocellulose dope and two coats of pigmented nitrocellulose dope.

Under no circumstances should any airplane fabric surface be finished with clear dope only. The dope shall be applied in such a manner as to produce a uniform and smooth finish over the surface of the fabric. Finished surfaces shall be taut and shall ring with a drum-like effect when struck.

b. Position of Panels During Doping - Panels should be horizontal during application, if practicable. If a vertical position is necessary, care shall be taken to apply the dope in a continuous film and to prevent the dope from running along the bottom edge.

c. Tautening of Fabric Surfaces - The tautening property of dope is a function of both the volatiles and plasticizer. Insufficient thinning will cause a loss in tautness. The speed of tautening may be greatly increased by blowing air inside the confined spaces to remove the heavy solvent vapors which accumulate during the drying period.

d. Drying Time Between Successive Coats - Drying time will vary with temperature and humidity. Under good atmospheric conditions not less than 30 minutes should be allowed between coats, and under unfavorable conditions this time must be extended. Under all conditions sufficient time should elapse between coats to allow the surface to become dry to touch. Unless the dope is properly thinned, drying time will be unduly retarded.

e. First Coat - The first coat should be applied with a brush. It should be spread on the surface as uniformly as possible and thoroughly worked into the fabric. Care should be taken not to work the dope through the fabric to the extent that an excessive film is formed on the reverse side. In effect, the first coat should be nothing more than a thorough and uniform wetting of the fabric. This coat should be applied quickly but not hastily.

f. Surface Tape - Finishing tape shall be applied over all lacing, over all seams, both machine and hand sewn, and over corners, edges and covered structural members where hard wear occurs. Tape shall not be applied until the first coat of dope has dried. A second coat of dope shall be brushed locally over that portion of the fabric which is to be covered by the finishing tape and the tape laid in position over the freshly doped surface. A coat of dope shall be applied over the tape immediately.



g. Reinforcing Patches - All portions of fabric pierced by wires, bolts, or any projections shall be reinforced by ample patches, except that patches may be omitted where other means of reinforcing are specified. The patch shall be doped on after the first coat of dope has dried. Where fittings protrude through the cover, filler blocks shall be fitted about them so that the fabric can be tacked to the blocks. A reinforcing patch shall be doped on closely around the fitting for protection against the possible entrance of moisture.

h. Second Coat - The second coat shall be applied with a brush, and should be laid on smooth and worked only enough to secure an even spread.

i. Rubbing - If roughness appears after the second or any succeeding coats, the surface may be smoothed by very light rubbing with #0000000 sandpaper or with doped canvas rubbing pads. These pads are made by applying one coat of dope to clean canvas, allowing it to dry, and cutting fabric to proper size. No other rubbing materials should be used for this purpose.

j. Third and Fourth Coats - These coats may be applied by either brush or spray gun. When a gun is employed, the correct nozzle setting and spray consistency shall be obtained before starting the actual work.

k. Pigmented Dope - Pigmented dope of the proper color shall be applied to the various surfaces. The number of coats shall be not less than 2 and shall provide sufficient opacity to effectively shield the clear dope. Pigmented dope shall be applied with a spray gun.

l. Blushing - Blushing has the effect of reducing the tensile strength of the dope film and is caused by a precipitation of cellulose ester under certain favorable relationships of the rate of evaporation of the volatile portion of dope to the relative humidity of the surrounding atmosphere. High evaporation rates and high humidity promote blushing. The rate of evaporation is governed principally by the volatile composition, the atmospheric temperature, and the barometric pressure. High temperatures and low pressures produce high evaporation rates. When conditions produce too rapid drying, corrective measures are necessary to reduce the rate of evaporation and blush tendency. Work which has developed only a light blush may be treated by dampening the surface with a light spray of the applicable thinner.

5. Precautions

Dope should never be poured on the fabric.

Dope should not be allowed to stand in open containers exposed to the air for more than 1 hour. When not in use, dope dispensing cans or other containers should be carefully covered to prevent unnecessary evaporation.

6. Patching Torn Areas

Clean off all dirt, grease or wax around torn area. If tear is not more than 2 or 3 inches long, a sandwich patch should be used. Cut the cloth at right angles to the tear and for the same distance. Prepare a patch that extend at least one inch beyond the tear. Wet the patch thoroughly with clear dope and insert under the flap formed by the tear and cut. Stick the patch down well to the cloth and the flap to the patch. Prepare another patch that will extend over the first one at least an inch on all sides, wet it with dope and apply over the first patch. After dope is dry apply three more coats of clear dope and two coats of pigmented dope in the usual manner.

If the tear is more than four inches long, the edges should be sewn together with a baseball stitch. A patch that extends at least 1-1/2 inches beyond the tear in all directions should be prepared and doped over the tear as described above.



Preparation

Labels should never be poured on the fabric.

Labels should not be allowed to stand in open containers exposed to the air for more than 1 hour. When not in use, labels should be covered to prevent unnecessary evaporation.

Preparing Test Areas

Remove all dirt, grease or wax around test area. If test is not more than 2 or 3 inches long, a sandwich patch should be used. Cut the cloth at right angles to the tear and for the same distance. Prepare a patch that extends at least one inch beyond the tear. Wet the patch thoroughly with clear dope and insert under the flap formed by the tear and cut. Stick the patch down well on the cloth and the flap to the patch. Prepare another patch that will extend over the first one at least an inch on all sides. Wet it with dope and apply over the first patch. After dope is dry apply three more coats at right angles and two coats at diagonal dope in the usual manner.

If the tear is more than four inches long, the edges should be sewn together with a carefully stitched. A patch that extends at least 1-1/2 inches beyond the tear in all directions should be prepared and taped over the tear as described above.

APPENDIX I.

1. This appendix is a supplement to the Kittyhawk I Volume I and indicates the changes and additions which should be taken into account if that publication is being used with reference to Kittyhawk IA aircraft.

2. In general the Kittyhawk IA aircraft is very similar to the Kittyhawk I aircraft. Hence most of the information given in the main body of the handbook also applies to the Kittyhawk IA. However there are differences, and if a user of the handbook is utilising information given in the main body of the handbook with respect to the Kittyhawk IA aircraft, he should first consult this Appendix to ascertain whether the information is affected by differences between the two aircraft.

3. A number of illustrations are included in this Appendix. These illustrations apply directly to the Kittyhawk IA aircraft. Hence they should be used instead of the corresponding illustrations in the main body of the handbook if reference is being made with respect to the Kittyhawk IA aircraft only.



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|------|----------------------------------------------------------------|--------------------------------------|-------|---------|--------------------------------------|-------|---------|--------------------------------------|-------|---------|--------------------------------------|-------|---------|--------------------------------------|-------|---------|
|      |                                                                | Weight                               | Arm   | Moment  | Weight                               | Arm   | Moment  | Weight                               | Arm   | Moment  | Weight                               | Arm   | Moment  | Weight                               | Arm   | Moment  |
| Item | Aircraft At Take Weight                                        | 6220                                 |       | +98434  | 6220                                 |       | +98434  | 6220                                 |       | +98434  | 6220                                 |       | +98434  | 6220                                 |       | +98434  |
| No.  | Removable Items Of Military Load                               |                                      |       |         |                                      |       |         |                                      |       |         |                                      |       |         |                                      |       |         |
| 1    | Pilot and parachute                                            | 180                                  | +60   | +10800  | 180                                  | +60   | +10800  | 180                                  | +60   | +10800  | 180                                  | +60   | +10800  | 180                                  | +60   | +10800  |
| 2    | M2A gun/sight                                                  | 4                                    | +36   | +144    | 4                                    | +36   | +144    | 4                                    | +36   | +144    | 4                                    | +36   | +144    | 4                                    | +36   | +144    |
| 3    | 1.45 camera                                                    | 10                                   | +23   | +237    | 10                                   | +23   | +237    | 10                                   | +23   | +237    |                                      |       |         | 10                                   | +23   | +237    |
| 4    | Engine air cleaner                                             |                                      |       |         |                                      |       |         | 10                                   | +35   | +350    |                                      |       |         |                                      |       |         |
| 5    | First Aid outfit                                               | 3                                    | +142  | +426    | 3                                    | +142  | +426    | 3                                    | +142  | +426    | 3                                    | +142  | +426    | 3                                    | +142  | +426    |
| 6    | Storage bag for desert equipment                               |                                      |       |         |                                      |       |         | 4                                    | +140  | +560    |                                      |       |         |                                      |       |         |
| 7    | Desert equipment                                               |                                      |       |         |                                      |       |         | 23                                   | +140  | +3220   |                                      |       |         |                                      |       |         |
| 8    | 5 signal cartridges                                            | 3                                    | +147  | +441    | 3                                    | +147  | +441    | 3                                    | +147  | +441    | 3                                    | +147  | +441    | 3                                    | +147  | +441    |
| 9    | Shackles and away braces for belly fuel tank or 500 pound bomb |                                      |       |         |                                      |       |         |                                      |       |         | 14                                   | +25   | +350    | 14                                   | +25   | +350    |
| 10   | Belly fuel tank                                                |                                      |       |         |                                      |       |         |                                      |       |         | 40                                   | +21.6 | +864    |                                      |       |         |
| 11   | 500 pound demolition bomb                                      |                                      |       |         |                                      |       |         |                                      |       |         |                                      |       |         | 500                                  | +24   | +12000  |
| 12   | Ammunition Boxes                                               | 80                                   | +41.5 | +3320   | 80                                   | +41.5 | +3320   | 80                                   | +41.5 | +3320   | 80                                   | +41.5 | +3320   | 80                                   | +41.5 | +3320   |
| 13   | .50 cal. ammunition, 1686 rounds                               | 506                                  | +41.5 | +20999  | 506                                  | +41.5 | +20999  | 506                                  | +41.5 | +20999  | 506                                  | +41.5 | +20999  | 506                                  | +41.5 | +20999  |
| 14   | 6 - .50 cal. guns, and blast tubes, adapters                   | 463                                  | +41   | +18933  | 463                                  | +41   | +18933  | 463                                  | +41   | +18933  | 463                                  | +41   | +18933  | 463                                  | +41   | +18933  |
| 15   | TR1143 + SCR535 or R3090 radio                                 | 124                                  | +129  | +15996  |                                      |       |         |                                      |       |         |                                      |       |         |                                      |       |         |
| 16   | SCR522 + SCR515 radio                                          |                                      |       |         | 121                                  | +128  | +15488  |                                      |       |         |                                      |       |         |                                      |       |         |
| 17   | SCR274 + R3003 radio                                           |                                      |       |         |                                      |       |         | 119                                  | +126  | +14994  |                                      |       |         |                                      |       |         |
| 18   | SCR522 + R3003 radio                                           |                                      |       |         |                                      |       |         |                                      |       |         | 124                                  | +129  | +15996  |                                      |       |         |
| 19   | TR1143 + SCR515 radio                                          |                                      |       |         |                                      |       |         |                                      |       |         |                                      |       |         | 121                                  | +128  | +15988  |
| 20   | Tools                                                          |                                      |       |         |                                      |       |         | 20                                   | +140  | +2800   | 20                                   | +140  | +2800   |                                      |       |         |
|      | Total All Up Weight and Moments Of Removable Military Load     | 1373                                 |       | +71300  | 1370                                 |       | +70792  | 1425                                 |       | +76526  | 1437                                 |       | +75077  | 1684                                 |       | +83642  |
| 21   | Fuel at 7.2#/gal: Front wing tank (29.0 I.G.)                  | 210                                  | +27   | +5690   | 210                                  | +27   | +5690   | 210                                  | +27   | +5690   | 210                                  | +27   | +5690   | 210                                  | +27   | +5690   |
| 22   | Fuel at 7.2#/gal: Rear wing tank (42.0 I.G.)                   | 303                                  | +52   | +15745  | 303                                  | +52   | +15745  | 303                                  | +52   | +15745  | 303                                  | +52   | +15745  | 303                                  | +52   | +15745  |
| 23   | Fuel at 7.2#/gal: Fuselage tank (52.0 I.G.)                    | 375                                  | +95   | +35535  | 375                                  | +95   | +35535  | 375                                  | +95   | +35535  | 375                                  | +95   | +35535  | 375                                  | +95   | +35535  |
| 24   | Fuel at 7.2#/gal: Belly tank (43.0 I.G.)                       |                                      |       |         |                                      |       |         |                                      |       |         | 312                                  | +21.6 | +6740   |                                      |       |         |
| 25   | Oil at 9.0#/gal: (17.5 I.G.)                                   | 158                                  |       | +316    | 158                                  |       | +316    | 158                                  |       | +316    | 158                                  |       | +316    | 158                                  |       | +316    |
|      | Total Weight and Moment (wheels down)                          | 8639                                 |       | +227020 | 8636                                 |       | +226512 | 8691                                 |       | +232248 | 9015                                 |       | +237537 | 9150                                 |       | +239362 |
|      | Moment due to retracting wheels                                |                                      |       | +12086  |                                      |       | +12086  |                                      |       | +12086  |                                      |       | +12086  |                                      |       | +12086  |
|      | Total Weight and Moment (wheels up)                            | 8639                                 | +27.7 | +239106 | 8636                                 | +27.6 | +238598 | 8691                                 | +28.1 | +244334 | 9015                                 | +27.7 | +249623 | 9150                                 | +27.5 | +251448 |
|      | C. G. Wheels Up                                                | 27.7" aft C.G. origin (31.3% M.A.C.) |       |         | 27.6" aft C.G. origin (31.1% M.A.C.) |       |         | 28.1" aft C.G. origin (31.7% M.A.C.) |       |         | 27.7" aft C.G. origin (31.3% M.A.C.) |       |         | 27.5" aft C.G. origin (31.0% M.A.C.) |       |         |

Take Weight, 6220 lbs., includes Following:  
 Ring and bead sight  
 Gun firing mechanism  
 Battery and all electrical services  
 All instruments  
 Oxygen regulator, piping, and 1 low-pressure cylinder  
 Recognition device  
 Sutter harness and seat pad  
 Fixed parts of W/T equipment  
 Starter crank and extension  
 Coolant and hydraulic fluid  
 Fuel tank protection and bullet proof glass  
 Armor plate

P-40E-1  
 6 - Gun Aeroplane  
 Dual Propeller

Loading and C.G. Diagram  
 Kittyhawk 1A Aeroplane (Allison V-1710-39)

1. Maximum All-Up Weight at which the aircraft has been designed and flight tested - 8500 lbs.
2. Limits of Permissible C.G. Travel - 19.4" to 28.10" aft of axis of reference, measured parallel to the Thrust Line (this corresponds to 21.0% M.A.C. to 31.7% M.A.C.)
3. Length of Mean Chord = 31.6 inches
4. 1% of Mean Chord = .316 inches
5. Fuselage tank to be emptied first.

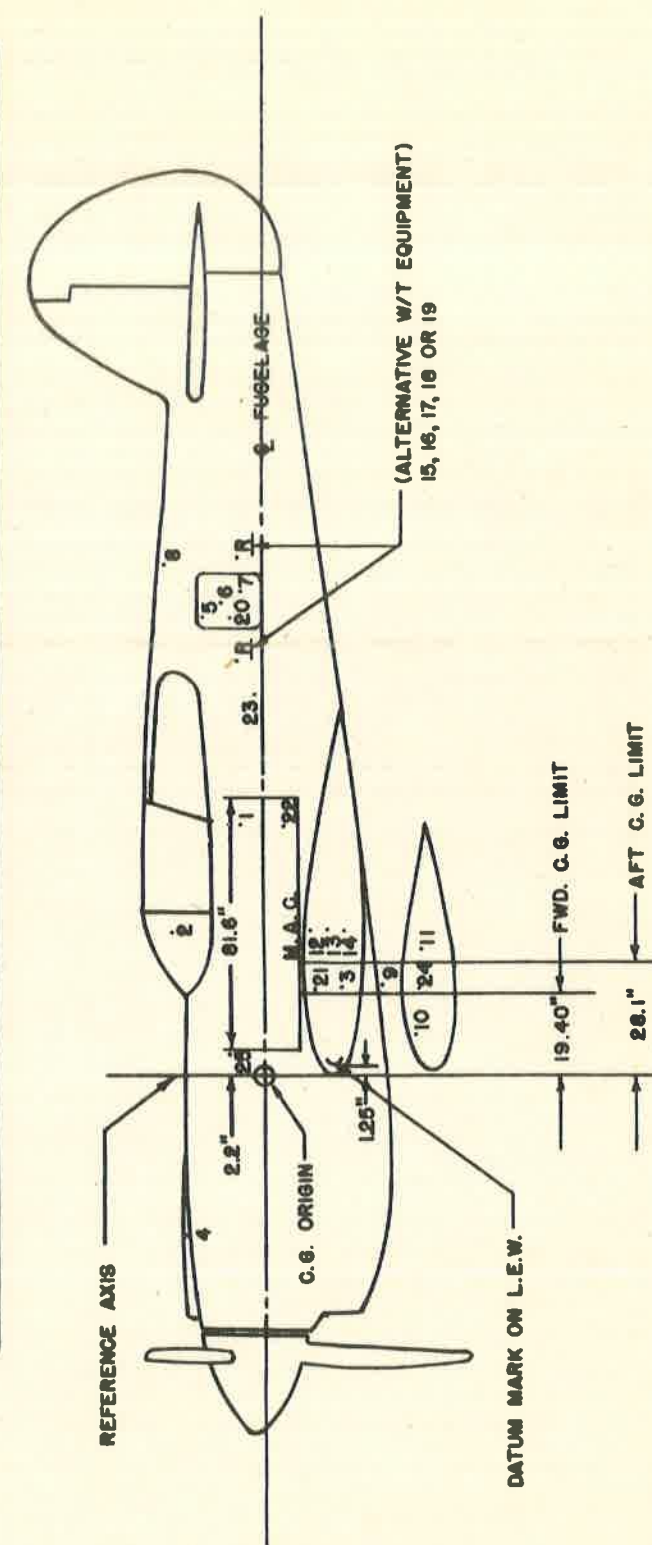


FIG. 125A LOADING & C.G. DIAGRAM





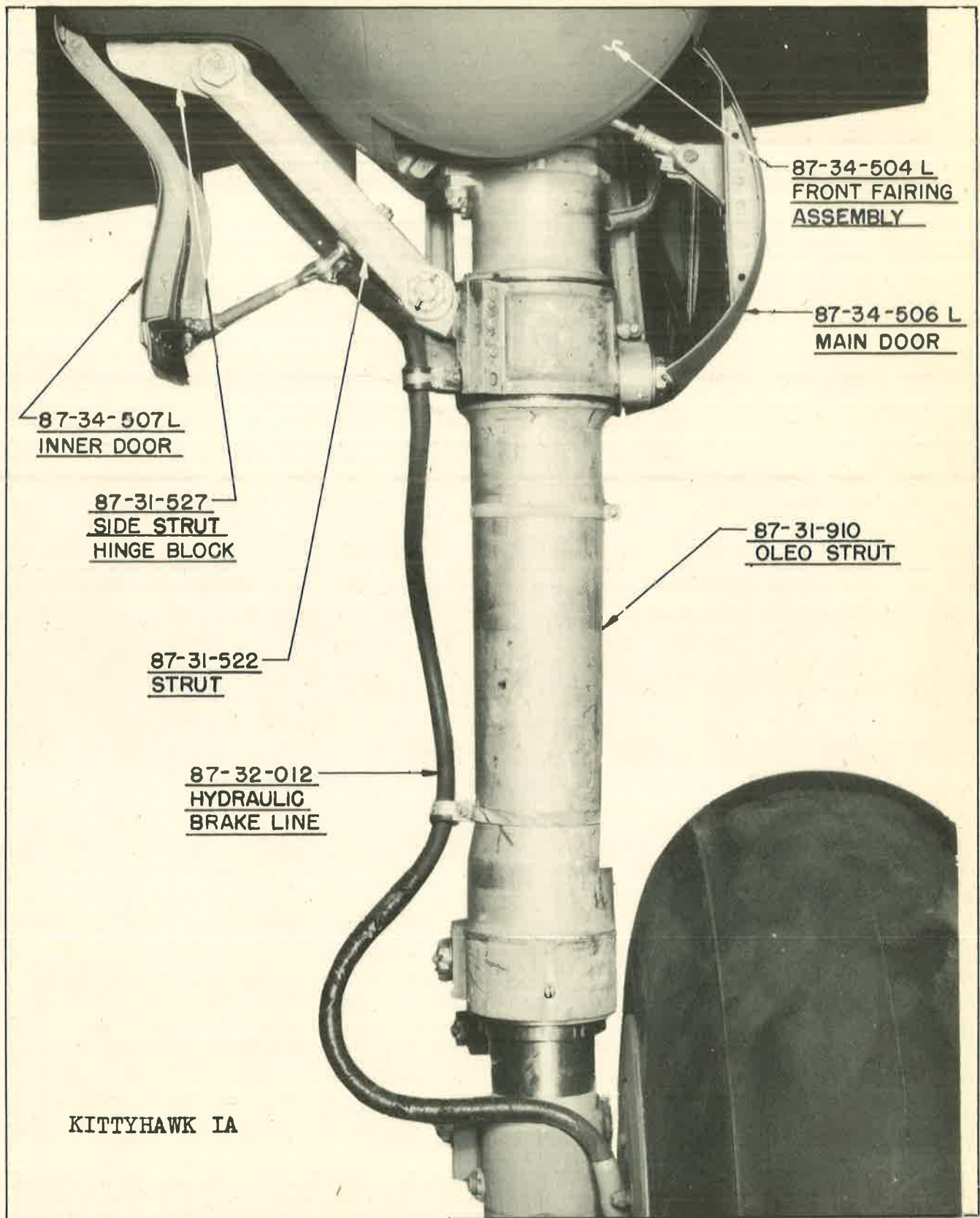


FIG. 126 LANDING GEAR INSTALLATION - LOOKING AFT





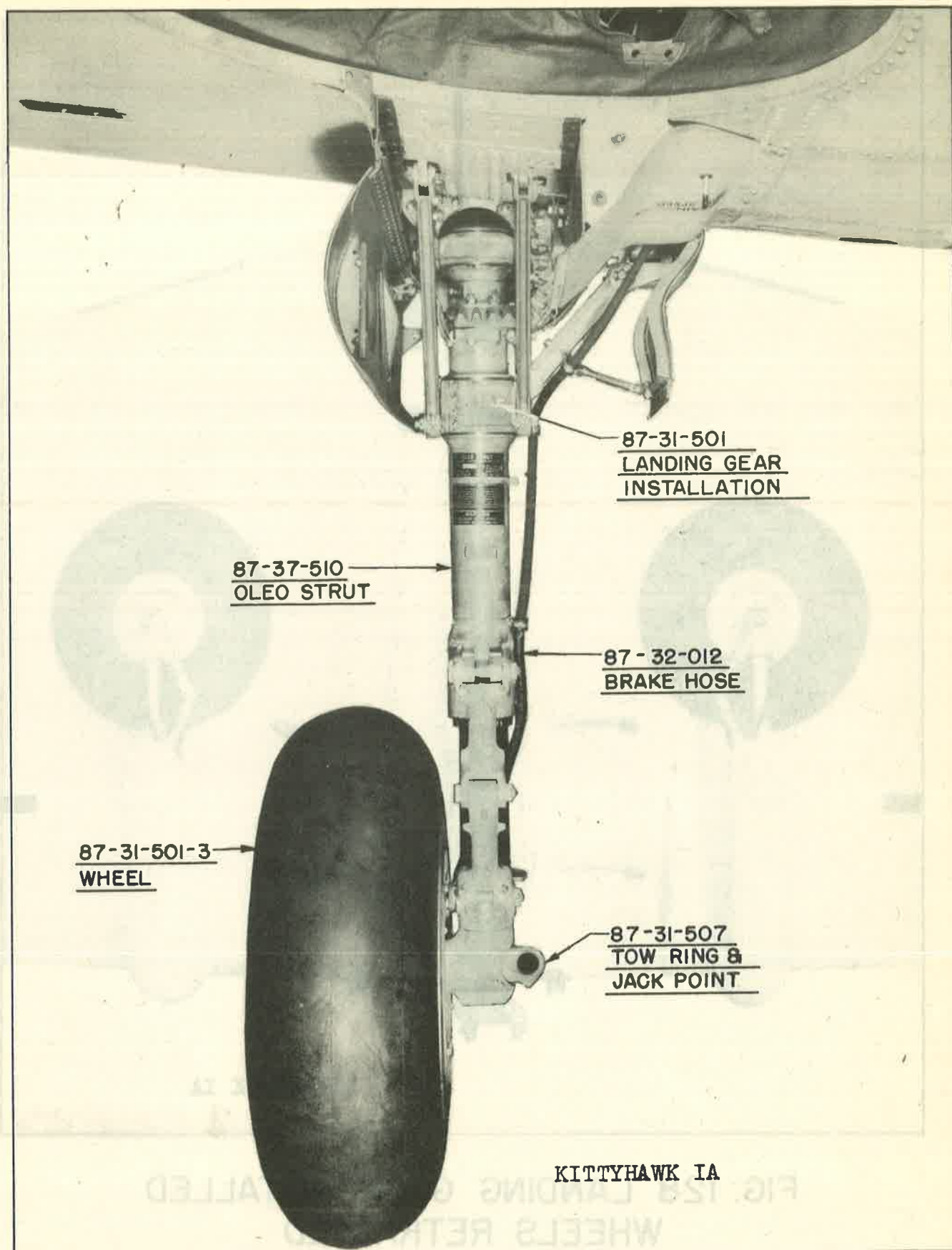
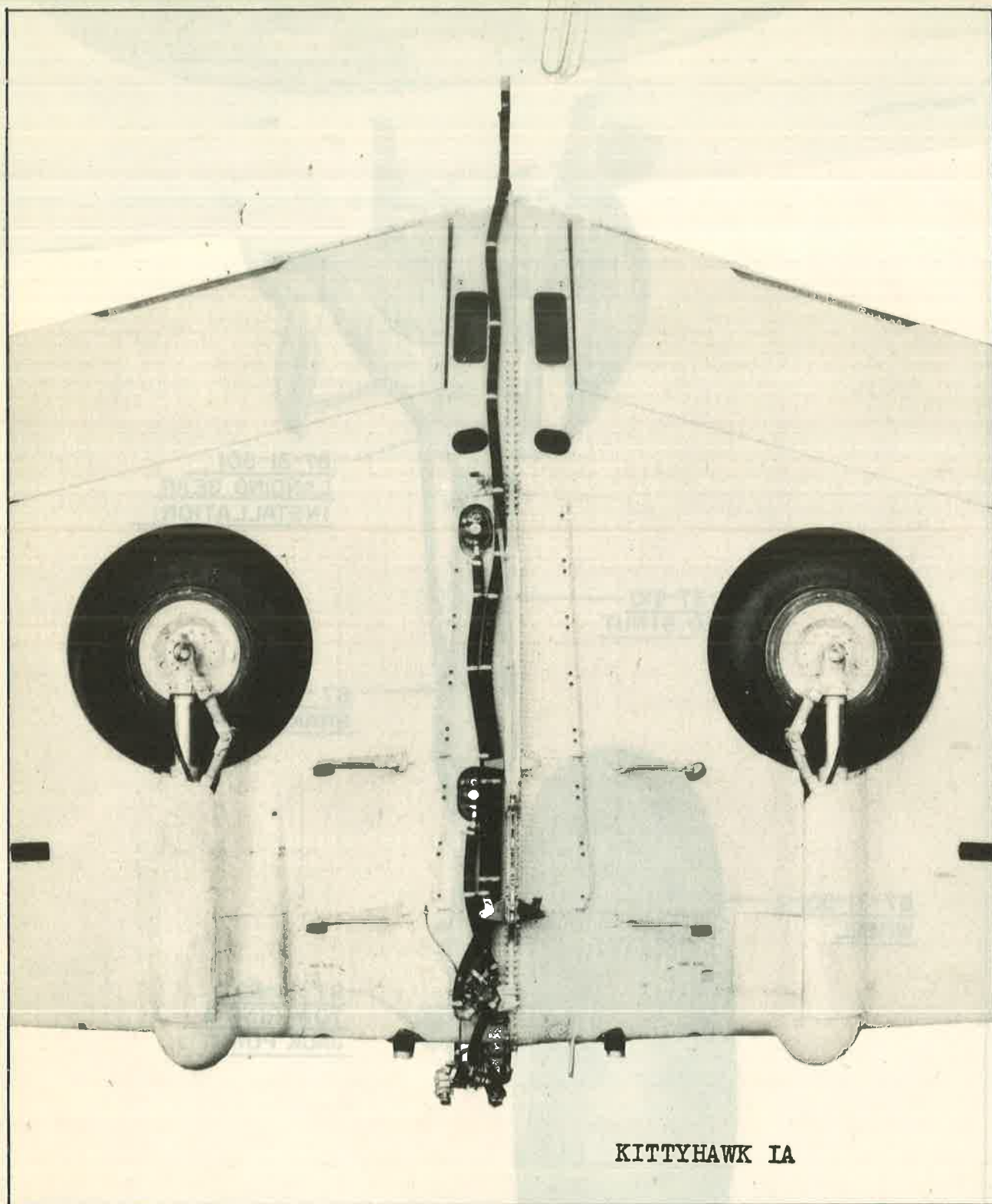


FIG. 127 LANDING GEAR INSTALLATION  
LOOKING FORWARD





KITTYHAWK 1A

FIG. 128 LANDING GEAR INSTALLED  
WHEELS RETRACTED



FIG. 129 WHEEL COVER INSTALLATION



SECTIONS I to IV

1. The information given in Sections I to IV inclusive in the main body of the handbook applies also to the Kittyhawk IA aircraft except the "Loading and C.G. Diagrams." A corresponding diagram, which applies to the Kittyhawk IA only is included in this Appendix at Fig.125A.

SECTION V

2. The text of the main body of the handbook applies to the Kittyhawk IA except where indicated in the following paragraphs.

Note. The page and item numbers refer to those in the main body of the handbook.

3. Wing Assembly.

(1) Page 33, item 2, d. Substitute the following:-

"d. Remove the keel fairing after removing the belly tank and sway braces."

(ii) Page 34, item t. The hydraulic system tank on the Kittyhawk IA is aft of the fuselage access door.

(iii) Page 35, item 3, a. On the Kittyhawk IA aircraft the bomb-tank shackle at the match angle must be removed before attempting to remove the landing gear fairing.

4. Landing Gear Wheel Covers.

Page 82. Special wheel covers (see Fig.129) are provided for Kittyhawk IA aircraft. When the aircraft is moored where an excess of dirt, sand, or other foreign matter is blowing through the atmosphere, the special wheel covers should be installed. These covers protect the oleo strut piston surface from being scratched and pitted. To install the cover, insert the seven hooks in the eyes provided on the screws in the landing gear fairing, and close the cover with ten snaps on the lap joint.

5. Removal of the Power Plant.

(1) Page 119, item (1). The instructions when applied to the Kittyhawk IA should have the following item included:-

"(e) The fuel air thermometer conduit at the junction to the engine."

(ii) Page 119, item 1, (7). This item for the Kittyhawk IA should read:-

"(7) Disconnect the hose from the left hand cockpit heating duct to the oil tank compartment and remove the heating duct at the junction to the valve housing assembly."

#### 6. Carburetor Air Intake System.

On Kittyhawk IA aircraft provision has been made for installing an ice guard at the carburetor air scoop forward end casting. It is inserted into the casting and held in place by four screws. (Airplanes AC-41-36494 to AC-41-36953 inclusive)

#### 7. Starting System.

Page 133, item 13, a. The Kittyhawk IA has a type B-11 starter switch. Otherwise the text applies.

#### 8. Fuel System.

Page 140. The following is additional information peculiar to the Kittyhawk IA:-

"There are three self sealing fuel cells and one belly tank with a total capacity of 160 Imperial gallons. The belly tank (42.8 Imperial gallons) is slung under the wing parallel to the airplane center line. It may be released in flight by a L-21 Bomb Release Handle actuated in the cockpit.

A vent line connects the carburetor fuel chamber and air vapor eliminator to the tee connection on the aft vent line of the fuselage fuel tank."

#### 9. Removal of Belly Tank.

The following are the instructions for this operation:-

a. Drain the belly tank by means of the stopcock at the bottom of the tank.

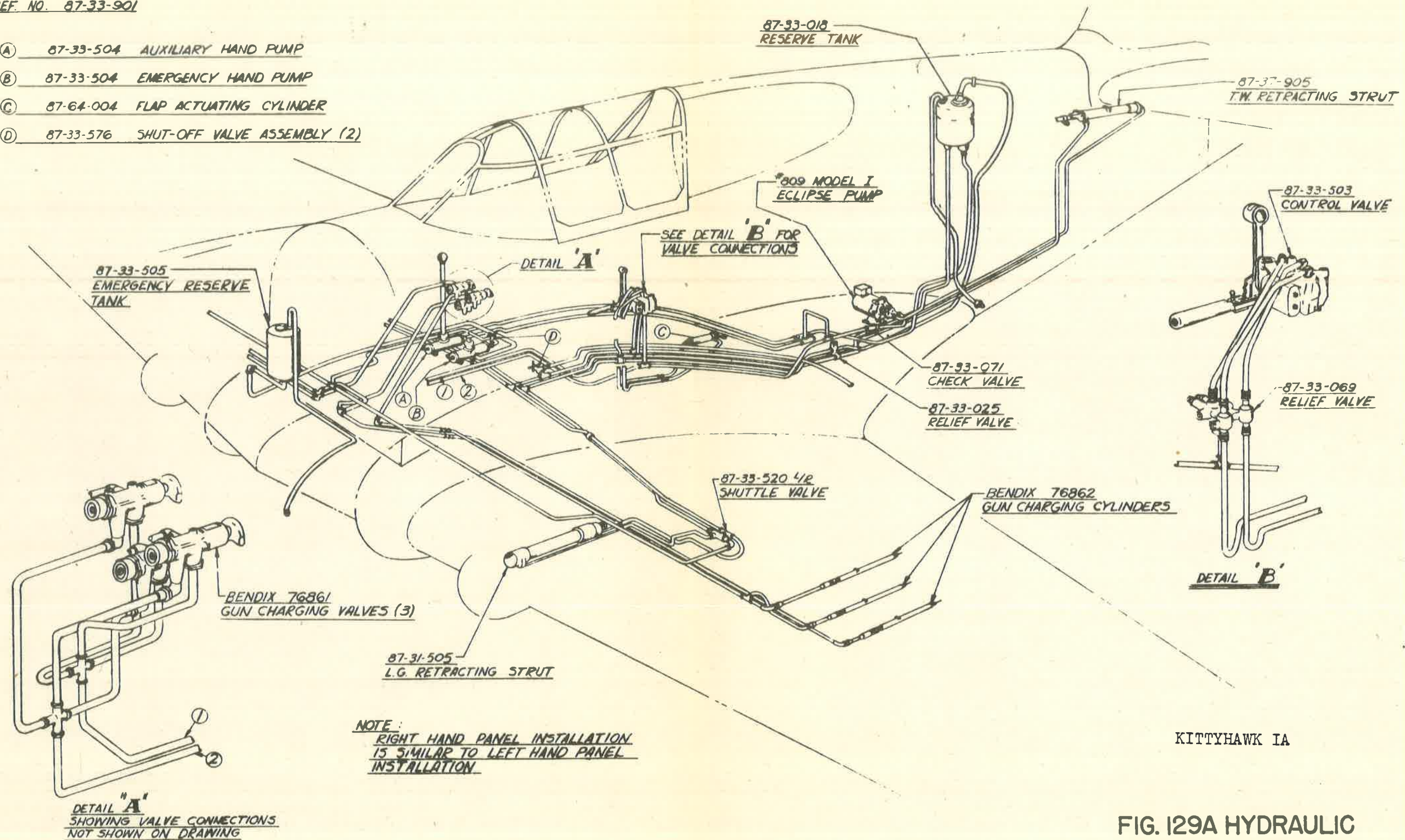
b. Break the fuel line at the belly tank connection to the fuel cock line.





REF. NO. 87-33-901

- (A) 87-33-504 AUXILIARY HAND PUMP
- (B) 87-33-504 EMERGENCY HAND PUMP
- (C) 87-64-004 FLAP ACTUATING CYLINDER
- (D) 87-33-576 SHUT-OFF VALVE ASSEMBLY (2)

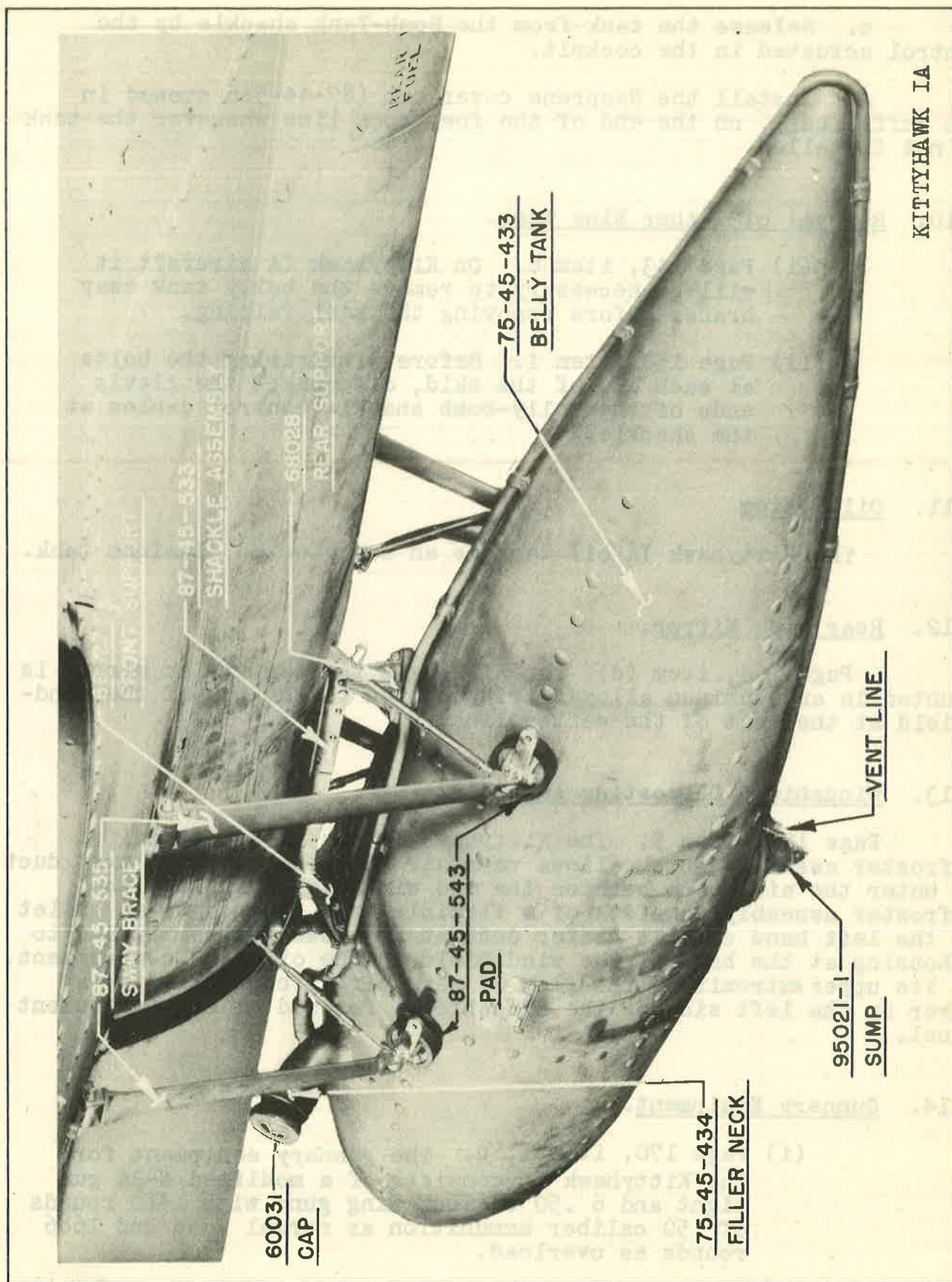


KITTYHAWK IA

FIG. 129A HYDRAULIC  
SYSTEM DIAGRAM







KITTYHAWK IA

FIG. 130 BELLY TANK INSTALLED



c. Release the tank from the Bomb-Tank shackle by the control actuated in the cockpit.

d. Install the Neoprene cover cap (87-44-566 stowed in the duffel bag), on the end of the fuel cock line whenever the tank is not installed.

#### 10. Removal of Either Wing Tank.

(i) Page 143, item 6. On Kittyhawk IA aircraft it will be necessary to remove the belly tank sway braces before removing the keel fairing.

(ii) Page 150, item i. Before withdrawing the bolts at each end of the skid, disconnect the clevis ends of the belly-bomb shackle control cables at the shackle.

#### 11. Oil System

The Kittyhawk IA oil tank is an unprotected aluminum tank.

#### 12. Rear View Mirror.

Page 164, item (d). The Kittyhawk IA rear vision mirror is mounted in an aluminum alloy fairing bolted to the top of the windshield at the left of the center line.

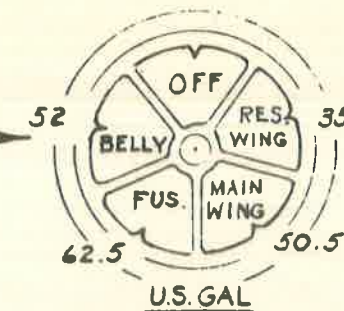
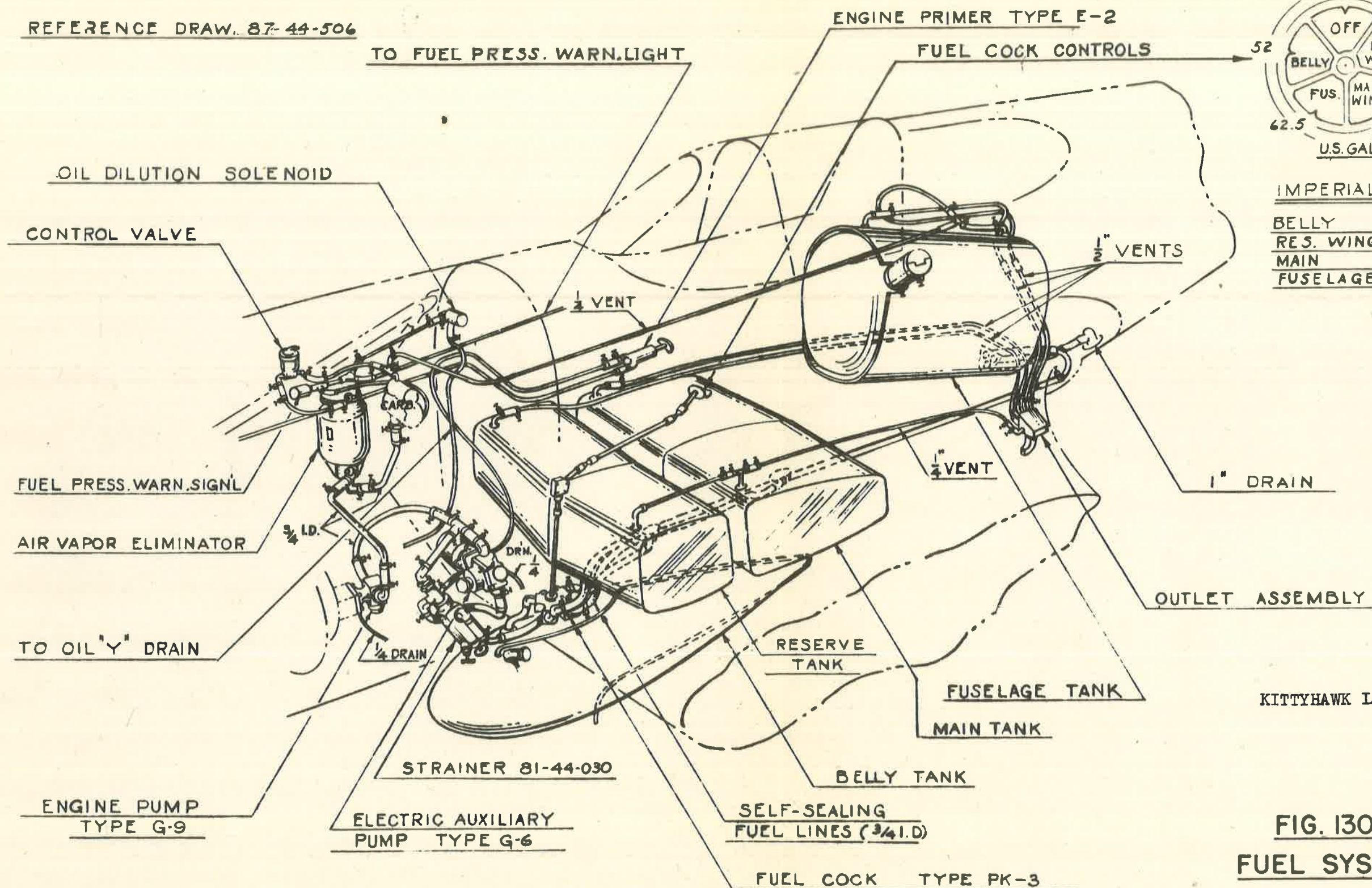
#### 13. Windshield Defrosting Assembly.

Page 170, item 5. The Kittyhawk IA has an additional defroster assembly which allows warm air from the radiator exit duct to enter the air space between the two windshield panels. The defroster assembly consists of a flexible tube clamped to an outlet on the left hand cockpit heater duct at its lower extremity and to a housing at the base of the windshield in the oil tank compartment, at its upper extremity. The flow of warm air is controlled by a lever on the left side of the windshield, forward of the instrument panel.

#### 14. Gunnery Equipment.

(i) Page 170, item 1, b. The gunnery equipment for the Kittyhawk IA consists of a modified N-3A gun sight and 6 .50 caliber wing guns with 1410 rounds of .50 caliber ammunition as normal load and 1686 rounds as overload.

REFERENCE DRAW. 87-44-506



IMPERIAL GAL.

|           |             |
|-----------|-------------|
| BELLY     | TANK - 43.3 |
| RES. WING | - 29.2      |
| MAIN      | - 42.1      |
| FUSELAGE  | - 51.5      |

KITTYHAWK IA

**FIG. 130A**  
**FUEL SYSTEM**





- (ii) Page 170, item 2, a. The gun sight for the Kittyhawk IA is a modified Type N-3A, supported by a casting mounted on the forward armor plating of the airplane. It may be removed without disturbing the setting by removing the nut attaching the yoke assembly to the base assembly.

### 15. Gun Camera.

Page 177, item d. The following is additional matter:-

"A Type N-2 gun camera may be mounted on the rear of the N-3A gun sight.

To Assemble the Type N-2 Gun Camera:- The Type N-2 gun camera is a gun sight aiming point camera, 24 volt unit designed for use as an aerial machine gun camera. It is equipped with an F4.5 3" 90° Erecting System Lens, an F4.5 3" Plain Lens and interchangeable Minus Blue Filters. It is designed for selective speeds of 16, 32 and 64 exposures per second. The camera combination employing the 90° Erecting System Lens is mounted on the gun sight with an adapter in such a position that it photographs the illuminated graticule in the gun sight simultaneously with the target.

The Overrun Control is a separate unit mounted on a bracket on the left side of the cockpit, outboard of the landing gear control handle. The function of the overrun control is to keep the camera running after the release of the trigger switch, for a period of time indicated by its dial. This dial may be set for any period between 0 and 3 seconds in 1/20 second increments. A small pin mounted on a magnet acts as an overrun indicator. The pin is magnetically retracted from the picture aperture when the trigger switch is closed and inserted into the aperture when the switch is released. Hence the indicator shows in the picture during the period the camera runs via the overrun device, and records the exact instant the gunner ceases firing. The camera accommodates the Eastman Kodak 16MM. Magazine. Any number of magazines may be carried and the change of magazines is very simple because no threading is required.

### To Install the Camera:-

(i) If the Camera Adapter is not installed on the gun sight, bolt the adapter in place at the rear of the sight with two bolts.

(ii) Be sure the 3" 90° Erecting System Lens is installed in the camera and attach the camera to the adapter by inserting the bolts on the back plate of the camera into the four holes in the adapter, and tighten the nuts. If the adapter ball and socket is not flexible loosen the two nuts at the joint on the adapter.





(iii) Adjust the lens in such a manner that the light from the gunsight graticule completely fills the lens. For this adjustment, employ the following procedure:- Switch on the gun sight reticle and bring the shutter into its open position. Insert the aligning indicator into the camera in the magazine holder, and move the camera by hand until a brilliant image of the gun sight graticule appears in the field of vision. When the cross hairs of the gunsight graticule exactly coincide with the fiducial marks in the aperture plate, lock the camera in this position by tightening the adjustment nuts on the adapter ball and socket joint.

(iv) Remove the electric disconnect plug from its stowage bracket and connect the plug to the socket on the lower right side of the camera.

(v) Install the overrun control box on the bracket on the left side of the cockpit, just forward of Sta. #4 bulkhead. Insert the four long bolts through the holes in the four corners of the control box and screw the bolts into the holes in the mounting bracket.

(vi) Attach the two electric cables by their disconnect plugs to the sockets on top of the control box. Before each flight check the camera installation to be sure that all cables are plugged into place. The control switch for the overrun unit is on the top center of the box.

(vii) Test the camera installation by operating the trigger switch for a few short bursts. Set the overrun control pointer at two or three different settings and note whether the camera continues to run after the switch is released for the length of time indicated on the dial setting.

(viii) Insert the magazine into the camera as follows:- Open the door at the end of the camera by pushing the eccentric knobs upward. Push the magazine latch pin out of the way which positively retracts the magazine driving spline. Insert the magazine into the chamber with the film opening towards the lens and the consumption indicator on the magazine towards the mount side of the camera. Move the latch pin over the magazine as far as it will go and close the door.

(ix) Select the desired speed with the shutter speed knob.  
**WARNING:** Never try to set the speed control knob when the camera is running and always have the speed numbers opposite the index.

(x) Set the film footage indicator by pushing in and turning the knurled knob. The footage indicator knob should be set to the number of feet of film loaded in the magazine. The indicator will then accurately account for the film footage remaining in the magazine.



(xi) Operate the trigger switch for a very short burst to insure that the camera is functioning and the film is feeding properly.

(xii) Set the ring on the lens to correspond to the speed on the shutter speed knob. Then set the diaphragm ring with index opposite the correct mark. ("B" for bright, "H" for hazy and "D" for dull days). Each speed setting on the lens has its separate group of diaphragm settings.

(xiii) Set the overrun control for the desired overrun. If no overrun is desired, the overrun control may be cut out by throwing the switch on top of the box to the "OFF" position.

(xiv) When a filming mission is concluded, turn off the switch on the control panel to prevent any drain on the power supply by the camera heater.

To remove the Gun Camera:-

(i) Remove the electric cable connection and stow the plug in the dummy socket.

(ii) Remove the two capscrews which attach the camera adapter to the sight body, and remove the camera and adapter without disturbing the setting.

To Remove the Overrun Control Box:-

(i) Remove the two electric cable plugs on top of the box.

(ii) Unscrew the four attaching bolts and remove the control box from the mounting bracket.

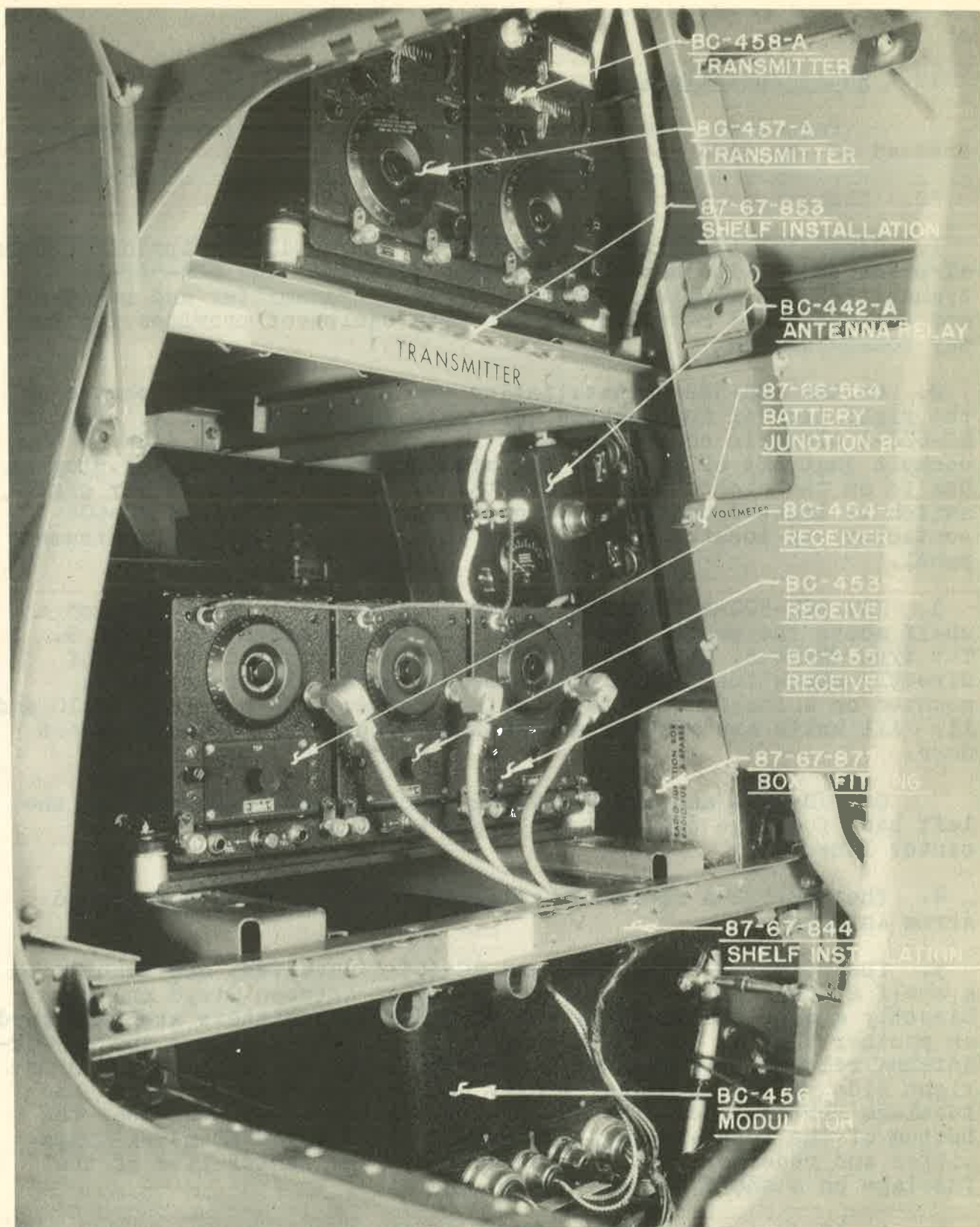
Lubrication of the Gun Camera:-

(i) Gun Camera: A thin film of grease should be applied to the gear teeth. A drop of oil should be applied to the pivots and bearings. Remove all excess oil to prevent its spread to the lens or film.

(ii) Overrun Control Box: A very small amount of grease may be applied to the gears, cam and ratchet teeth, and a drop of oil to the pivots."

**16. Battery.**

Page 191, item 8. On the Kittyhawk IA an Exide, 12 TAS-9 battery or equivalent with a capacity of 24 volts, 34 ampere hours, supplies the electrical power. It is accessible through the baggage compartment door. Provisions are made for the installation of either the British type battery ground plug, Type E-1, or the United States Army Air Corps type plug.



KITTYHAWK IA

FIG. 131 RADIO INSTALLATION



17. Radio Installation.

Page 204. The following should be read for the Kittyhawk IA instead of the information given on page 204:-

"Q. Communications Equipment (See Fig.131).

1. General: (Drawing No. 87-67-851) The radio equipment in this airplane is an alternate installation of either the SCR-522-A transmitter and receiver or the SCR-274-N transmitter and receiver and the SCR-515-A receiver units. This equipment provides for two-way communication.

2. On the SCR-522-A installation the control unit is located on the right side of the cockpit, directly forward of Sta. 3. The BC-602-A electric controller unit is also on the right side of the cockpit just aft of Sta. 3. The microphone and head phones plug-in box is on the right side aft of Sta. 4. A fire extinguisher crash switch is located below the electric controller unit. A BC-608 contactor is located on the upper left hand side of the instrument panel.

3. The SCR-522-A transmitter and receiver unit is mounted on a shelf above the center line of the fuselage between Sta.8 and 9. The type PE-94-A, H42D3114 dynamotor unit is mounted on a shelf directly above the transmitter receiver unit. The receiver is mounted on a shelf above the fuselage center line between Sta.10 and 11. All units are readily accessible through the fuselage access door.

One JB-29-A and one 87-67-882 junction box is mounted on the left hand fuselage wall between Sta.8 and 9 above the fuselage center line.

4. The SCR-522-A radio installation is equipped with a "Broad Arrow Antenna".

5. The BC-453-A, BC-454-A, and BC-455-A receivers are mounted on a shelf at the center line of the fuselage between Sta.8 and 9. Directly above, the BC-457-A and BC-458-A transmitters are installed on another shelf. On the top right side of the fuselage the BC-442-A antenna relay box is mounted. A BC-616 relay box is mounted on the right side of the fuselage, midway between Sta.8 and 9, above the fuselage center line. The PE-101-A Dynamotor is mounted near the bottom of the fuselage just forward of Sta.9. The BC-645-A transmitter and receiver unit is mounted above the center line of the fuselage on a shelf between Sta.10 and 11.

6. An AN-40-A receiver antenna is installed on the top of the fuselage just off the center line to the left, at Sta.9. An AN-40-A transmitter is installed in the same manner as the receiver antenna immediately forward of Sta.12. A "Broad Arrow Antenna" may also be employed with the SCR-274-N radio installation.

7. A Type T-30A microphone is installed for use with the SCR-274-N radio installation together with a Type JK-48 jack which is located on the right side of the fuselage at Sta.4.

8. To Install the SCR-274-N Radio:

This radio set consists basically of a group of three radio receivers, and two radio transmitters, each with its special rack and mounting. In addition there is a modulator unit with a high-voltage dynamotor, an antenna relay unit and separate radio control boxes for the group of receivers and transmitters.

a. To Install the Receivers and Transmitters: Slide each unit into its proper rack compartment as far as it will go, slip the locking lugs, located on the rack under each unit, over the conical shaped studs on each unit. The knurled nuts, which hold these lugs in place should now be hand-tightened and then safety-wired to insure good electrical and ground connections at all times. Always allow enough clearance around units so that under the maximum possible amplitude of vibration, the units will not strike anything. Allow plenty of slack in cords near the points of attachment to the units.

b. It will be necessary to change receivers and transmitters occasionally, and to tune them up.

c. To attach plugs, "feel" for the proper orientation before using any considerable pressure on the plugs. The locking rings should be hand-tightened.

d. Safety-wire the snapslides which lock the several units to their mounting. Safety-wire the snapslides holding the tube covers on the transmitters and modulator unit. (This makes accidental access to the high-voltage plate leads of Tube VT-136 on the modulator more difficult).

e. Set each receiver radio control box dial to correspond with the dial of the receiver connected thereto. Each radio control box dial may be adjusted to a predetermined position by first loosening the knurled screw in the center and then rotating the dial to the desired reading. Hand-tighten the knurled screw, do not use pliers or other tools for this operation.

Safety Notice: It is very important that the following safety precautions be rigidly observed before turning on the power for the radio equipment.

a. The dynamotor DM-33-A on the modulator unit of this set generates 600 volts, D.C. This is sufficient to cause severe shock, or death. Be sure that the dynamotor is not running before making any adjustments whatever, except tuning up the radio transmitters. Do not depend upon hearing the dynamotor or upon the position of the control switch, "FEEL" the dynamotor for running vibration.



b. In tuning up the antenna circuit of the transmitter, be careful to avoid touching the antenna when the power is on. Warn anyone who may be working near the antenna of your intentions when turning on the power.

c. Fire: If the radio compartment has been exposed to gasoline vapor, be sure it is aired well before turning on the power.

d. The dynamotor DM-32-A, on each radio receiver unit, generates 250 volts, D.C. Do not expose anyone to this voltage. Be sure that all dynamotors are "OFF" before adjusting any equipment other than the antenna alignment.

10. Antenna Circuit Alignment of the Receiver: Alignment of the circuit should be accomplished as follows:

a. Set the "CW-OFF-MCW" power switch controlling the first receiver to "CW".

b. Set the "A TEL-B TEL" switch of the same control box section to "A TEL."

c. Connect a headset to any "A TEL" jack.

d. Set the gain control knob to the maximum gain position.

e. Tune the receiver to the highest frequency.

f. Trim the antenna input circuit for maximum background noise using the "Align In-Put" knob on front of the receiver.

g. Switch this receiver "OFF".

h. Perform the same operation on the other two receivers in turn.

i. It is good practice to repeat the alignment operation on all receivers for maximum results, even though the improvement may seem slight.

11. Tuning Up the Transmitters: There are three controls on the front of each transmitter.

a. The frequency control knob in the lower right corner marked "Frequency."

b. The Antenna tuning inductance control in the upper right section marked "Ant. Inductance."

c. The Coupling control in the middle left section marked "Ant. Coupling."

All receivers and transmitters should be connected to the Antenna Relay Unit BC-442-A and the antenna connected thereto before the transmitters are tuned up. Transmitters must be tuned up with the emission switch of the Radio Control Box BC-451-A in the "CW" position and must not be retrimmed after switching to "TONE" or "VOICE." Such retrimming would result in greater antenna current, but the transmitter would be incapable of being modulated properly.

d. Tune up the transmitter as follows:

(1) Set the "Frequency" control dial to the desired transmitting frequency. If the calibration accuracy of this transmitter has not been checked, read paragraph (16) before continuing.

(2) Set the "Ant. Coupling" Control to about 3 on its scale.

(3) Throw the toggle switch on Antenna Relay Unit BC-442-A to "Local."

(4) Set Radio Control Box BC-451-A Emission switch to "CW".

(5) Set Radio Control Box BC-451-A transmitter selector switch to #1 or #2 depending on whether the left or right transmitter is being tuned.

(6) After making sure that neither the microphone button nor the key is closed, set "Trans Power" switch to "ON". The Dynamotor DM-33-A should start.

(7) Allow 15 seconds for the tubes to heat up.

(8) Lock the "Built-in" key on top of the radio control box BC-451-A by rotating it clockwise.

(9) Resonate the Antenna circuit by adjusting the "Ant. Inductance" for maximum antenna current.

(10) Vary the "Ant. Coupling" until the maximum antenna current is obtained. This setting must be accurately made.

(11) Retrim the "Ant. Inductance" tuning.

(12) Check the Antenna current on "VOICE" and "TONE." On "VOICE" it will be considerably less than for "CW" and for "TONE" it will be between the values of "CW" and "VOICE".

(13) The second transmitter should be tuned up following the same procedure. Then return to the first transmitter and retrim the "Ant. Inductance" control on "CW".

(14) Lock the controls of each transmitter by rotating the "LOCK" knob one half turn clockwise to a stop, in which position the engraving "LOCK" on the knob will read right side up.



(15) If desired, mark the frequency to which each transmitter has been tuned, in a soft pencil, in the blank spaces on the plate above the "TRANSMITTER SELECTION" switch. Record the transmitter tuning data on the "write-in" plate on the front of each transmitter.

(16) Each transmitter is supplied with a special frequency-checking circuit which includes a plug-in crystal resonator. This crystal circuit is used in checking the frequency at one point on the dial; it does not control the frequency. The frequencies of the crystals supplied with the different transmitters are as follows:

| Radio Transmitter  | Crystal Frequency |
|--------------------|-------------------|
| BC-457-A(4-5.3 MC) | 4.6 MC            |
| BC-458-A(5-7.3 MC) | 6.2 MC            |

Tube VT-138 in each transmitter is used as an indicator of resonance between the crystal and the transmitting frequency. When a transmitter is operated at or near the frequency of the crystal which is in that transmitter, a dark three-cornered shadow appears in the round spot of green light on the screen of Tube VT-138. This shadow "opens" as the transmitting frequency passes through the frequency of the crystal. Operation at exact resonance with the crystal frequency is indicated by a sharp maximum in the width of this shadow. When a transmitter is first put in service the frequency calibration should be checked as follows:

Open the hinged cover, at the top rear of the transmitter, to such an angle that the reflection of the entire resonance indicator screen of Tube VT-138 may be seen.

Tune the transmitter to the lowest frequency which will open the shadow on the resonance indicator. The indicated dial frequency should now correspond with that of the crystal. If it does not, set the dial exactly on the nominal frequency of the crystal and trim the master-oscillator capacitor to make it conform. This trimmer may be adjusted with a small metal screw driver inserted through the hole in the top of the transmitter which is covered by a metal slide. A clockwise rotation of this trimming control lowers the transmitter frequency. Adjust the "FREQUENCY" control again to make sure that the crystal is resonating at its lowest frequency and that no "opening" of the resonance indicator is observed for any indicated dial frequency below that corresponding to the value shown on the crystal holder. The calibration engraved on the frequency dial of the transmitter will then be correct at other parts of the dial.

Note: Always recheck the frequency calibration as described above after any tube is replaced in the transmitter; this is particularly important when a new master oscillation Tube VT-137 is installed.

(17) If a wing tip terminal breaks off repair the damage as follows:-

(a) Cut the extension wire at the end of the terminal.

(b) Drill out the piece of wire in the terminal with a #59 (0410) drill.

(c) Insert the end of the extension wire through the redrilled terminal or new terminal.

(d) Loop the end of the extension wire so that it will not pull out of the terminal. Make the I.D. of the loop large enough to allow solder to fill it.

(e) Solder the loop of wire in the cup of the terminal.

NOTE: Use resin core solder only.

## 18. Oxygen equipment

Page 206. The following should be read for the Kittyhawk IA instead of the information given on page 206:-

### "R. Oxygen Equipment. (87-83-505)

General: The oxygen installation is a low pressure system operating at approximately 425 lb. per sq. in. The installation consists of a type F-1 cylinder (Spec. 40330), with a cross connection on its forward end, an oxygen and filler line of 5/16 inch O.D. copper tube (Spec. WW-T-799) or aluminum alloy, soft temper (Spec. 57-187-3), a Type A-9 regulator (Spec. 40319), a British type economizer, a spring loaded relief valve, and a one way filler valve. See Figure 131C.

2. Oxygen Cylinder: The oxygen cylinder has a capacity of 1,000 cu. in. and will withstand approximately 750 lb. per sq. in. pressure. It rests on rubber padding in a cradle installation mounted on the centerline of bulkheads eleven and twelve at the bottom of the fuselage. The cylinder is anchored in the cradle by a rubber lined strap and may be removed through the fuselage access door by disconnecting the oxygen and filler lines at the cross forward of the cylinder and releasing the retaining strap by means of the turnbuckle.

3. Cross: The cross connection has a relief valve which will open at a pressure of 525 to 645 lb. per sq. in. One line goes to the oxygen regulator and the other to the filler valve.

4. Oxygen Regulator: The Type A-9 oxygen regulator is located near the floor of the cockpit on the right hand side of the airplane, adjacent to the pilot's seat.



REF. DWG. 87-83-505

TO OXYGEN MASK

OXYGEN REGULATOR  
TYPE A-9

FILLER TUBE ASSEMBLY  
87-83-545

OXYGEN CYLINDER  
TYPE F-1

FILLER VALVE  
87-83-533

RELIEF VALVE  
87-83-532

STOWAGE CLIP

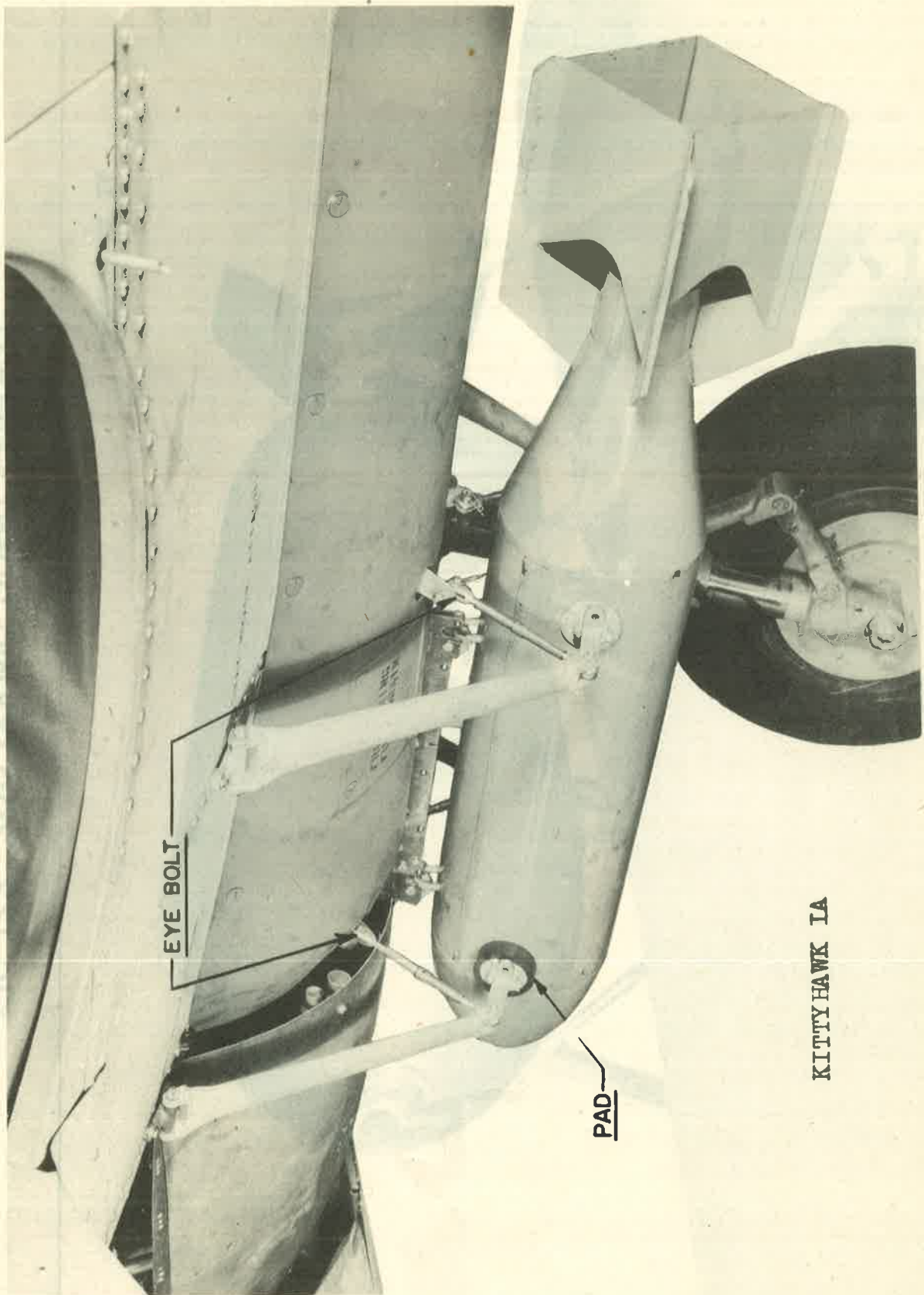
OXYGEN ECONOMIZER  
TYPE MARK II

.035 x 5/16 O.D.

.035 x 5/16 O.D.

KITTYHAWK TA

FIG. 131C OXYGEN SYSTEM



KITTYHAWK 1A

FIG. 132 100 POUND PRACTICE BOMB LOADED

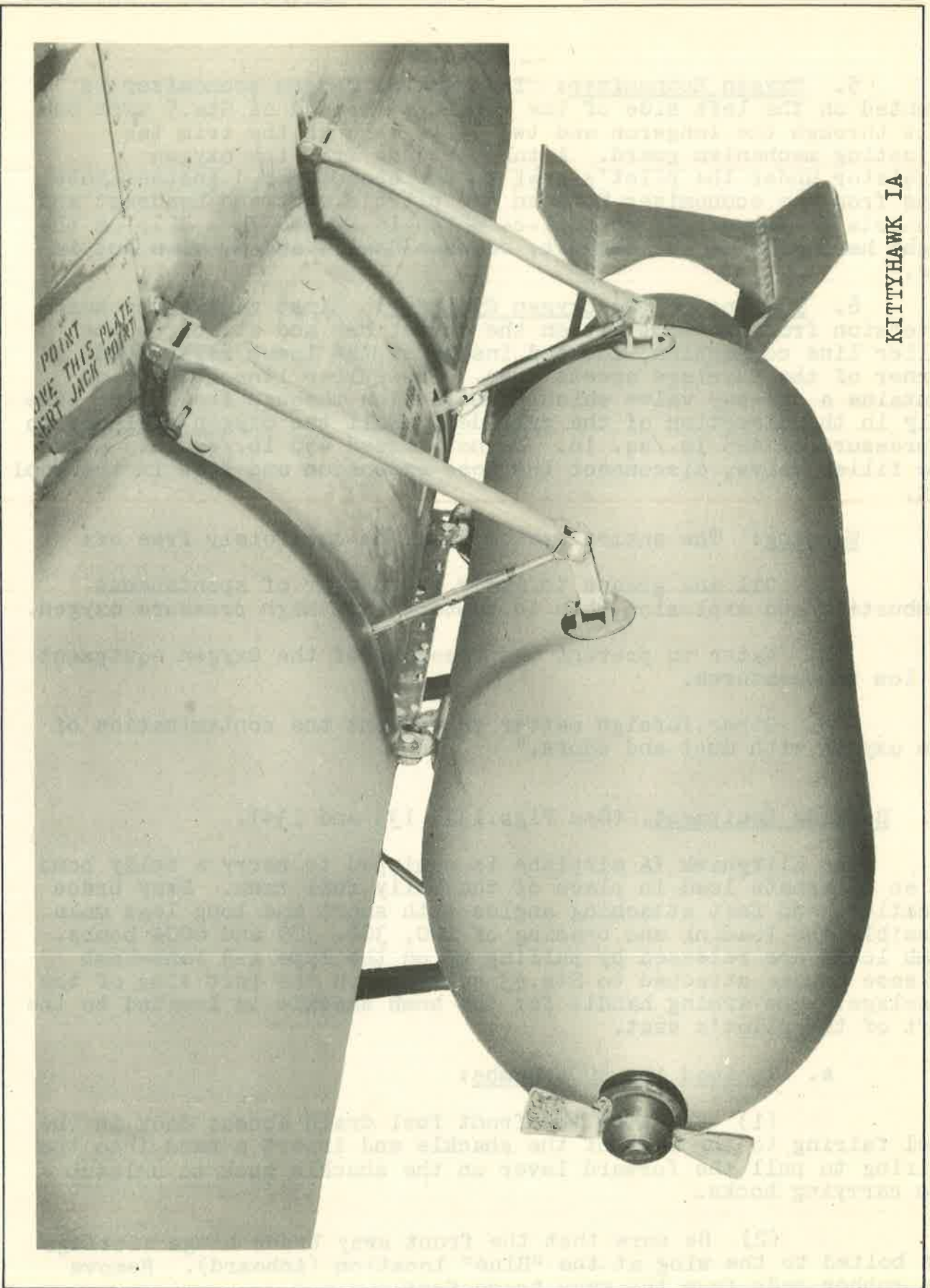


FIG. 133 100 POUND PRACTICE BOMB LOADED



KITTYHAWK 1A

FIG. 133 300 POUND BOMB LOADED



KITTYHAWK IA

FIG. 134 500 POUND BOMB LOADED



5. Oxygen Economizer: The Mark II Oxygen economizer is mounted on the left side of the fuselage forward of Sta.5 with one bolt through the longeron and two bolts through the trim tab adjusting mechanism guard. A tube extends from the oxygen regulator under the pilot's seat to the economizer. Another tube runs from the economizer between the pilot's seat and headrest and connects to the oxygen mouthpiece which is stowed in a clip on the right hand side of the cockpit, between Sta. 4 and 5, when not in use.

6. Filling of the Oxygen Cylinder: First remove the hose extension from the tool kit on the duffel bag and attach to the filler line connection, located inside at the lower right hand corner of the fuselage access door. The filler line connection contains a one-way valve which permits flow through the filler line only in the direction of the cylinder. Fill the oxygen cylinder to a pressure of 425 lb./sq. in. Do not exceed 450 lb./sq.in. Close the filler valve, disconnect the hose extension and stow in the tool kit.

Warning: The entire system shall be completely free of:

- a. Oil and grease to avoid the danger of spontaneous combustion and explosion when in contact with high pressure oxygen.
- b. Water to prevent the freezing of the Oxygen equipment at low temperatures.
- c. Other foreign matter to prevent the contamination of the oxygen with dust and odors."

19. Bombing Equipment. (See Figs.132, 133 and 134).

The Kittyhawk IA airplane is equipped to carry a belly bomb as an alternate load in place of the belly fuel tank. Sway brace locations and feet attaching angles with short and long legs make possible the loading and bracing of 100, 300, 500 and 600# bombs. Bomb loads are released by pulling up on the Type A-3 Tank-Bomb release handle attached to Sta.#3 bulkhead on the left side of the fuselage. The arming handle for the bomb shackle is located to the left of the pilot's seat.

a. To Load the 500# Bombs:

(1) Unbutton the front fuel drain access door in the keel fairing to the left of the shackle and insert a hand into the fairing to pull the forward lever on the shackle back to unlatch the carrying hooks.

(2) Be sure that the front sway brace hinge fittings are bolted to the wing at the "Blue" location (inboard). Remove the rubber pads from the sway brace feet.

(3) Attach the front sway brace feet at the long leg of the fitting and the back feet at the short leg. Be sure that the long barrels are installed on the front sway brace turnbuckles.

(4) Raise the bomb to the shackle and engage the bomb lugs in the carrying hooks. Raise the bomb until it has closed the carrying hooks and insert a hand through the fuel drain access door to pull the release lever back approximately one inch to lock the carrying hooks.

(5) Adjust the sway braces at the barrels to contact the bomb surface evenly and positively at all sway brace feet. Do not tighten sway bracing excessively or the shackle will not function. Lock wire the turnbuckle barrels.

(6) Arm the bomb by inserting a screw driver into the opening aft of the arming slot on the shackle and push the arming hook back. Slide the loop of the arming wire into the slot on the shackle and release the arming hook.

b. To Load the 300# Bomb:

(1) Move the front sway braces from the "Blue" location to the "Red" location (outboard) and be sure that all feet are attached at the long leg. Install rubber pads on all feet and be sure that the short barrels are installed on the front sway brace turnbuckles.

(2) Proceed with the loading as outlined for the 500# bomb.

c. To Load the 100# Bomb:

(1) Attach the front sway braces to the wing at the "Blue" location (inboard) and the rear sway braces to the wing at the "Red" location (outboard). See Fig.132.

(2) Install the special eye bolts on all turnbuckle attachment supports.

(3) Install short barrels on all four turnbuckles and attach the inboard clevis end of each turnbuckle to the special eye bolts.

(4) Attach all sway brace feet at the long leg and install the rubber pads on the front feet only.

(5) Unbutton the front fuel drain access door in the keel fairing, insert a hand and actuate the release lever on the shackle to unlatch the carrying hooks.

(6) Proceed with the bomb loading as outlined for the 500# bomb in a., (4) and (5).



d. To Unload the Bomb:

- (1) Place arming handle in the "SAFE" position and open the front fuel drain access door.
- (2) Attach bomb hoist to bomb and insert a hand through the access door to pull back on the release lever as far as possible to release the carrying hooks.