

RESTRICTED

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TECHNICAL ORDER NO. 01-25C-2

# ARMAMENT, HYDRAULIC AND FUSELAGE TANK SERVICE INSTRUCTIONS

## P-40 Series AIRPLANES



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## INTRODUCTION

The information contained in this Handbook is applicable to all P-40 series airplanes; therefore, it is recommended that no parts be ordered by the call-out numbers in this Handbook. Order all parts from the parts catalog for that particular model. This will greatly facilitate the filling of orders and eliminate costly delays and errors in handling.

## SECTION I

### WING GUNS

#### 1. Installation of the Wing Guns.

a. General. - First identify all guns by marking, with chalk or paint, their respective location in the airplane to eliminate confusion when preparing the guns for installation. The guns should be marked as left 1, left 2, and left 3, and right 1, right 2, and right 3 with No. 1 the inboard gun, No. 2 the center gun, and No. 3 the outboard gun.

b. Setting Up the Guns. - Set up each gun to feed from the proper side as follows:

##### (1) Left Wing Guns.

Gun No. 1 (inboard) - Right-hand feed.  
Gun No. 2 (center) - Left-hand feed.  
Gun No. 3 (outboard) - Left-hand feed.

##### (2) Right Wing Guns.

Gun No. 1 (inboard) - Left-hand feed.  
Gun No. 2 (center) - Right-hand feed.  
Gun No. 3 (outboard) - Right-hand feed.

(3) Sear Slide. - The sear slide on the gun should operate from the inboard side of all guns (left side for the right wing guns and right side for the left wing guns) to coincide with the installation of the solenoids.

(4) Special Bolt Studs. - The special bolt studs, supplied with the hydraulic charger cylinders and stowed in the parts bag attached to the charger cylinder as loose equipment, should be installed on the outboard side of all guns (right side for right wing guns and left side for left wing guns).

(5) Safety Catch. - The safety catch on the gun backplate should be assembled with the overhang on the inboard side of each gun (left side for right wing guns and right side for left wing guns), to prevent the safety catch overhang from fouling the charging cylinder clamp when the backplate is removed from the gun. (See figure 1.)

(6) Feed Chute Attaching Blocks. - These blocks should be assembled to the gun feedway as follows:

#### Left Wing Guns.

Gun No. 1 (inboard) - Right side of gun.  
Gun No. 2 (center) - Left side of gun.  
Gun No. 3 (outboard) - Blocks not used.

#### Right Wing Guns.

Gun No. 1 (inboard) - Left side of gun.  
Gun No. 2 (center) - Right side of gun.  
Gun No. 3 (outboard) - Blocks not used.

**NOTE:** Three of the feed chute blocks are attached to the gun by the belt holding pawl pin and an additional pin is provided to connect the feed chutes to these blocks. The blocks always remain with the gun and the chutes may be disconnected by pulling the auxiliary pins.

c. To Install the Charger Cylinder Brackets on the Gun. - The special charger cylinder bolt studs are installed as outlined in section I, 1.b.(4). Install the charger cylinder mounting brackets on the outboard side of all guns with the wing nuts in the downward position as shown in figure 1. This may require reversing the strap type clamp of the mounting bracket. Install a locking wire around the three clevis pins of each bracket so that the pins will not foul the charger cylinder when it is being installed on the gun.

d. Lock Wire. - Install a lock wire of approximately .025 on all fillister-head screws and stake counter-sunk head screws.

#### e. To Install the Rear Adapters on the Guns.

(1) General. - Place one block under the gun barrel, place another block just forward of the adapter fitting on the bottom plate at the rear of the gun. These blocks should raise the gun off the bench or platform about 3 inches and consequently, will be of assistance while installing the adapter.

(2) To Install the Rear Adapters. - Assemble the rear adapter as illustrated in figure 2. The saddle over the gun for the tie-down arrangement should be installed with the largest overhang on the outboard side for all guns. Adjust the tie-down rods for prop-

er tension with the toggle in the locked position. Do not tighten excessively, or damage may result. Adjust the lower nut on the tie-down rod so that it will be approximately 1/16 inch below the saddle as illustrated in figure 4. The purpose of this lower nut on the one tie-down rod is to keep the tie-down mechanism intact when it is released by the toggle and swung out of position as illustrated in figure 19.

f. To Install the Blast Tube Retainers. - 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 inches  
Center guns - 15-1/2 inches  
Outboard guns - 15-1/2 inches

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

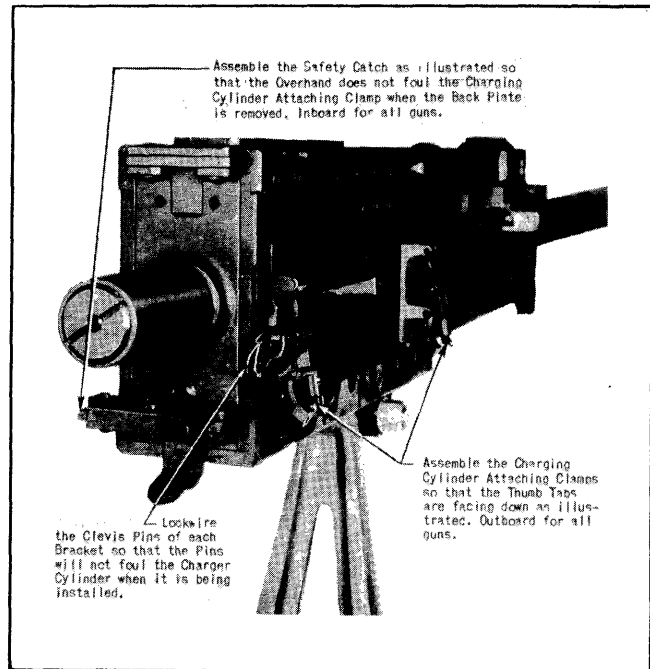


Figure 1 - Safety Catch and Charging Cylinder Clamps Installed

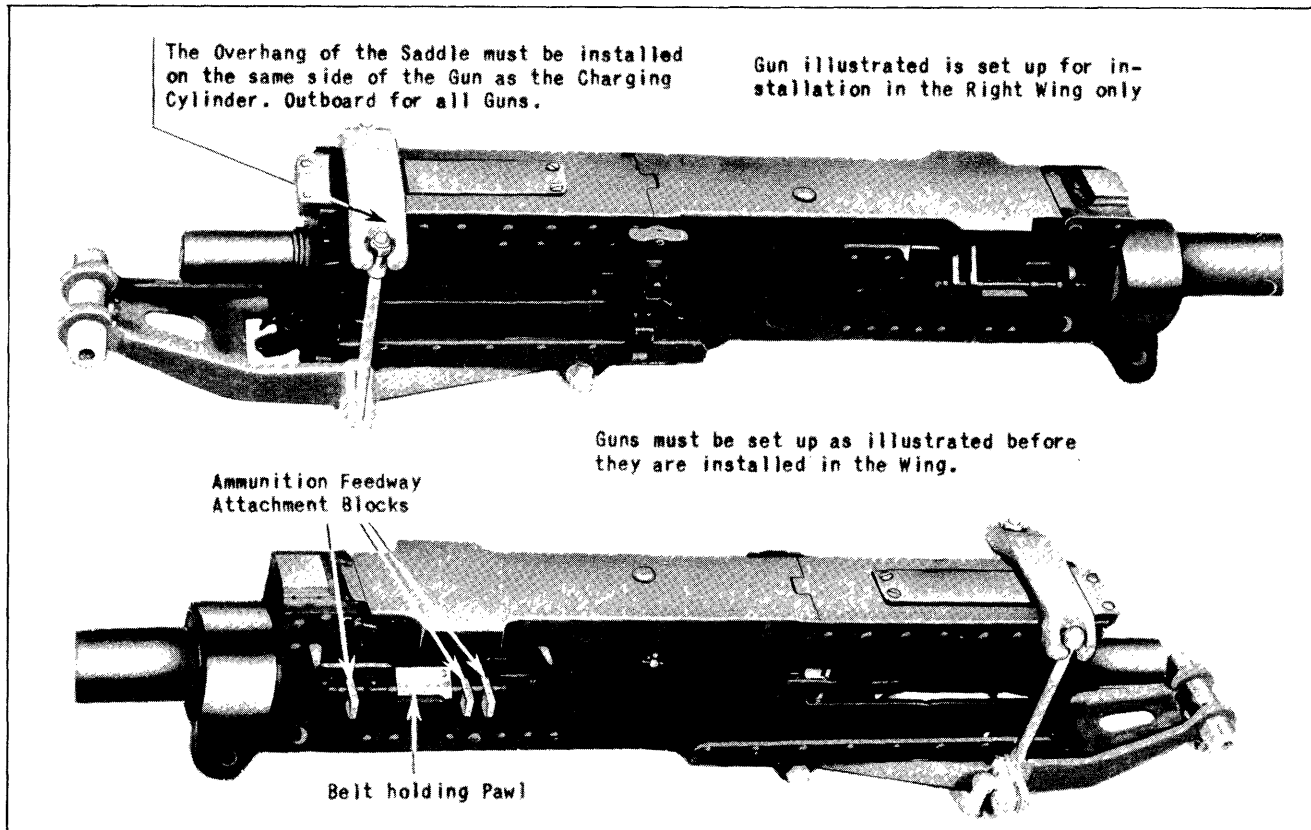
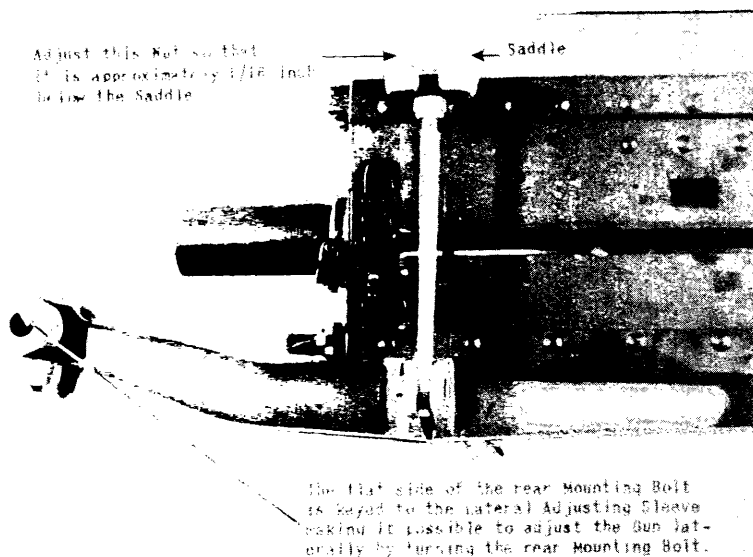


Figure 2 - Rear Adapter Installed on Gun



Figure 3 - Saddle Adjustment on Rear Adapter



Tighten the Nuts on the Saddle of the Rear Adapter with the Toggle in the closed position. Do not tighten Nuts excessively

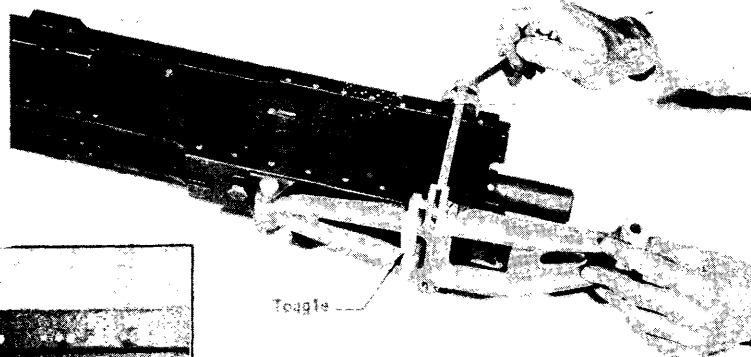


Figure 4 - Rear Adapter and Saddle Installed on Gun

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 lock-wired around the barrel as illustrated in figure 5. When the installation is complete the retainer should be slightly loose on the barrel jacket, but must be secure.

g. To Prepare the Gun Compartment in the Wing Prior to Installing the Guns. - Unbutton the Dzus fasteners on the gun access door and allow the door to swing down. Unlatch the door brace on the outboard side and swing the brace until it contacts the wing. Button the Dzus fastener on the brace to the correct spring retainer on the wing. This will keep the door from swinging when the guns are being installed in the open. If stowage brackets and clips are provided for the solenoids and charger cylinders, detach the solenoids and allow them to hang below the compartment on the electric cables. Detach the charger cylinders from the stowage clips and allow them to hang below the compartment, suspended from their hose connection. Do not disturb the connectors. If

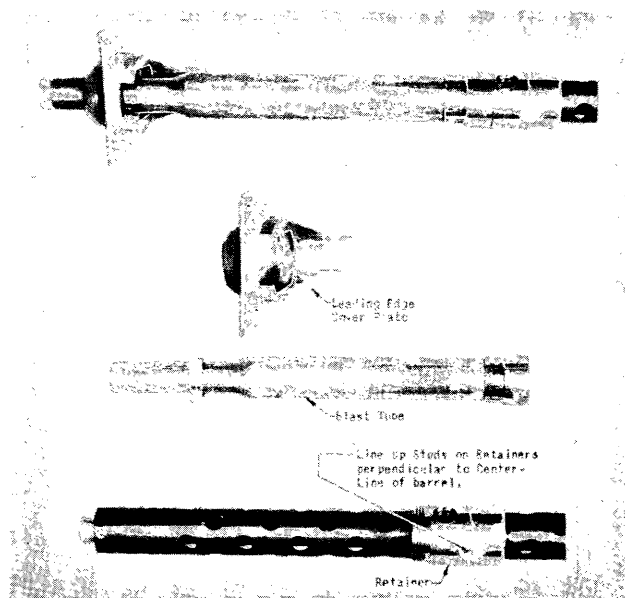


Figure 5 - Blast Tube and Cover Plate Assembled and Disassembled



Figure 6 - Gun Compartment Prior to Gun Installation

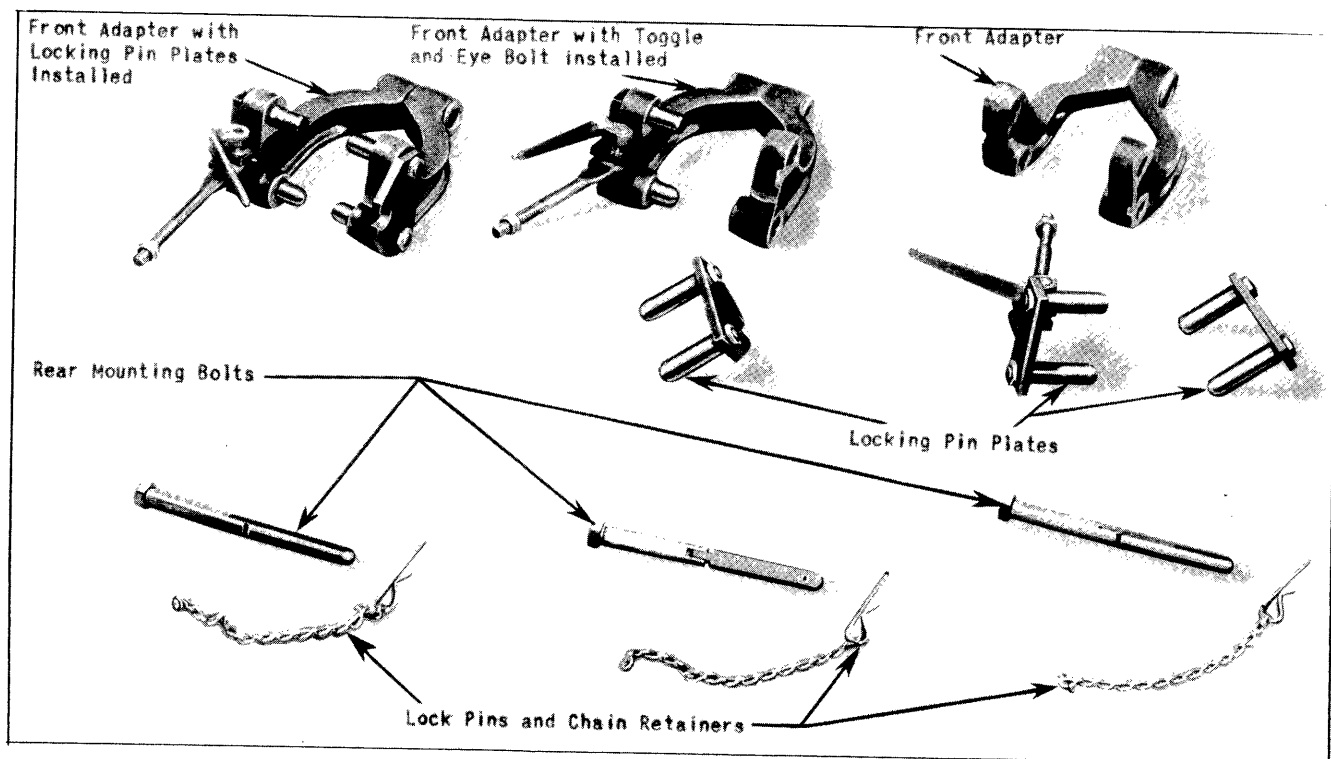


Figure 7 - Front Adapter Assemblies and Rear Mounting Bolts

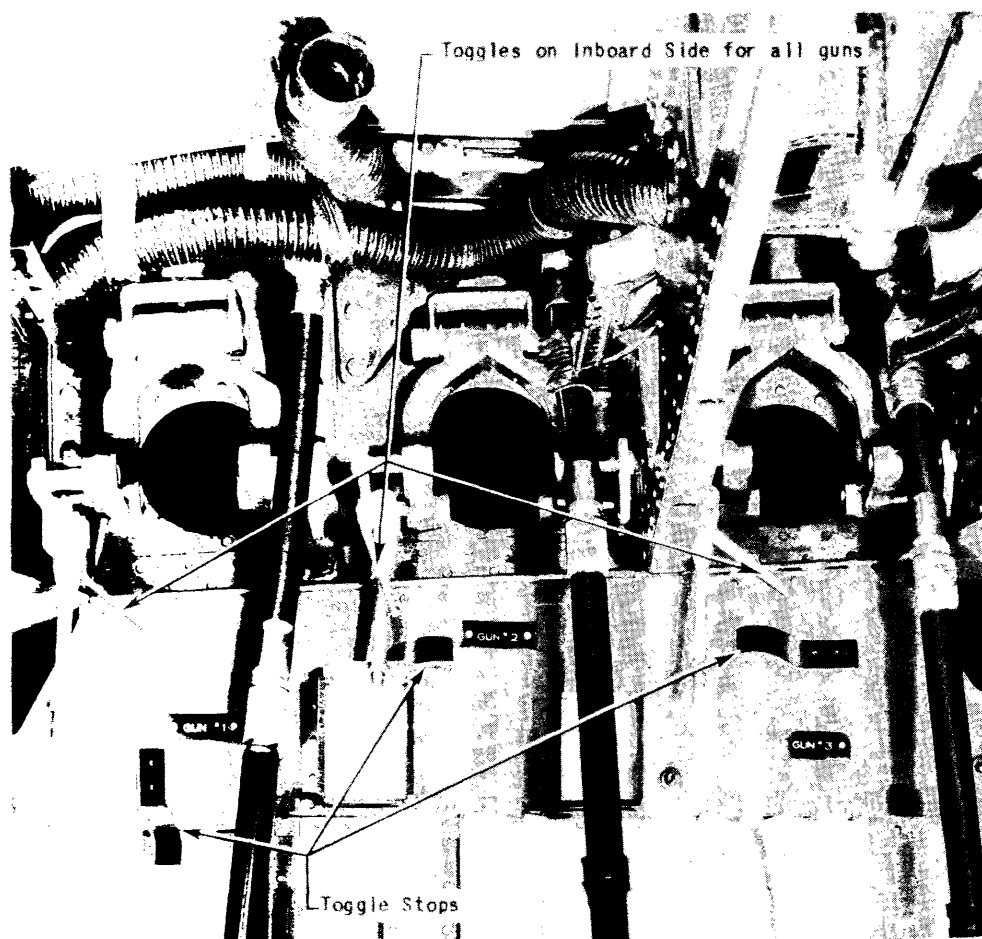


Figure 8 - Front Adapters and Toggles Installed

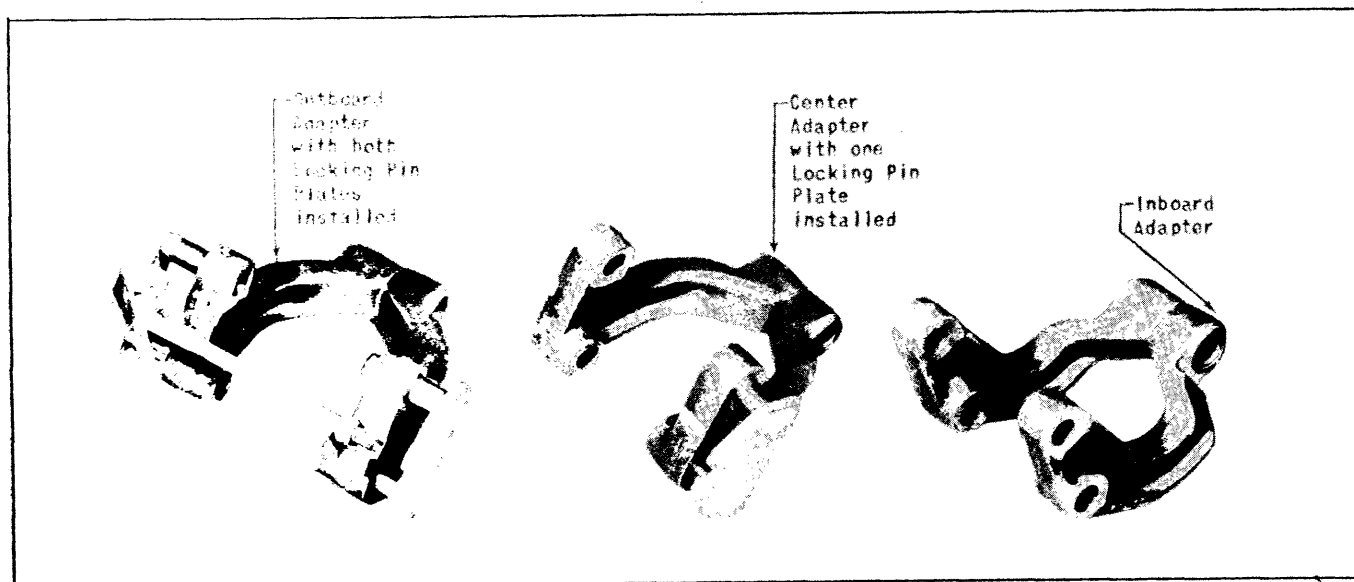


Figure 9 - Front Adapters

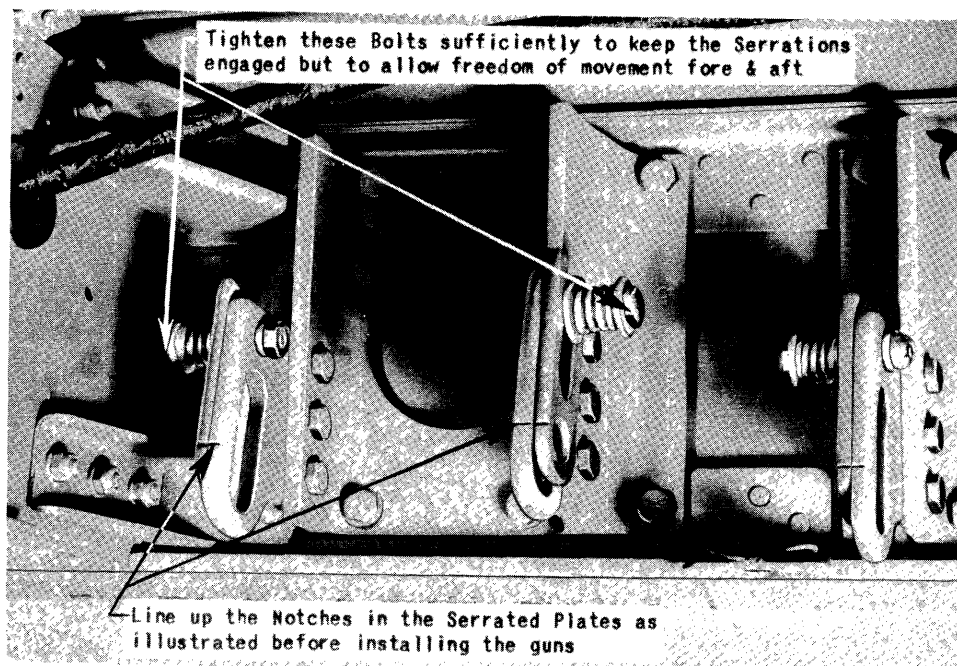


Figure 10 - Adjustment of Rear Gun Mount  
Prior to Gun Installation

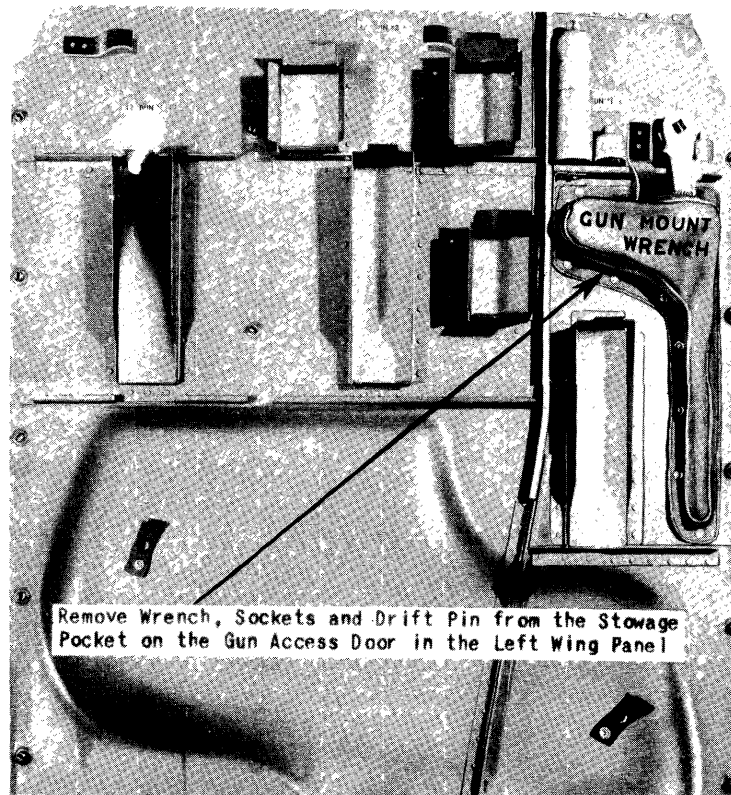


Figure 11 - Gun Access Door - Left Wing Panel

stowage brackets and clips are not in the compartment and the solenoids and charger cylinders have been temporarily supported by wire or tape, release the solenoids and charger cylinders and allow them to be suspended below the wing as outlined above. (See figure 6.)

(1) Install the yoke with the front adapter attached to the yoke mount in the forward end of the gun compartment as illustrated in figure 8. It will be noted that the inboard adapter is slightly different in contour than the center and outboard adapters. Refer to figure 9 for the correct location of the adapters. Turn up the yoke nut and front mounting bolt but do not tighten so that the adapter may be lined up correctly with the gun. This operation will only be necessary on the initial installation or on service installations when it has been necessary to remove the yoke from its mounting.

(2) Be sure the lockpins for the rear mounting bolts are installed with their retaining chains properly secured inside the aft compartment skin. Allow the lockpins to hang below the wing as illustrated in figure 21.

(3) It is very important that the charger cylinders are set in proper rotational position so that they will line up with their respective brackets on the guns when they are mounted. If readjustment is necessary, loos-

en the hose fitting aft of the wing web and rotate the charger cylinder to its proper position. This adjustment cannot be made after the gun is mounted. It is imperative that all hose fittings are tightened so that leaks in the hydraulic system will not occur.

(4) Check the feed chutes for proper installation and security. The piano hinge pull pins should be bowed for tension set-up when installed.

(5) If the leading edge cover plates are installed on the leading edge of the wing, remove them.

(6) Set the rear serrated plates approximately 1/2 inch from their lowest position with the bolt holes in line and the notches in the serrated plates lined up as illustrated in figure 10. Tighten the locking bolts sufficiently to positively engage the serrated plates but to allow freedom of movement fore and aft.

(7) Remove the wrench, sockets, and drift pin from the stowage pocket on the inboard side of the gun access door in the left wing. (See figure 11.)

(8) Insert the locking pin plates in the front adapters so that they do not protrude beyond the inner surface of the adapter as illustrated in figure 8. Be sure that all toggles are installed on the inboard side of the adapters.

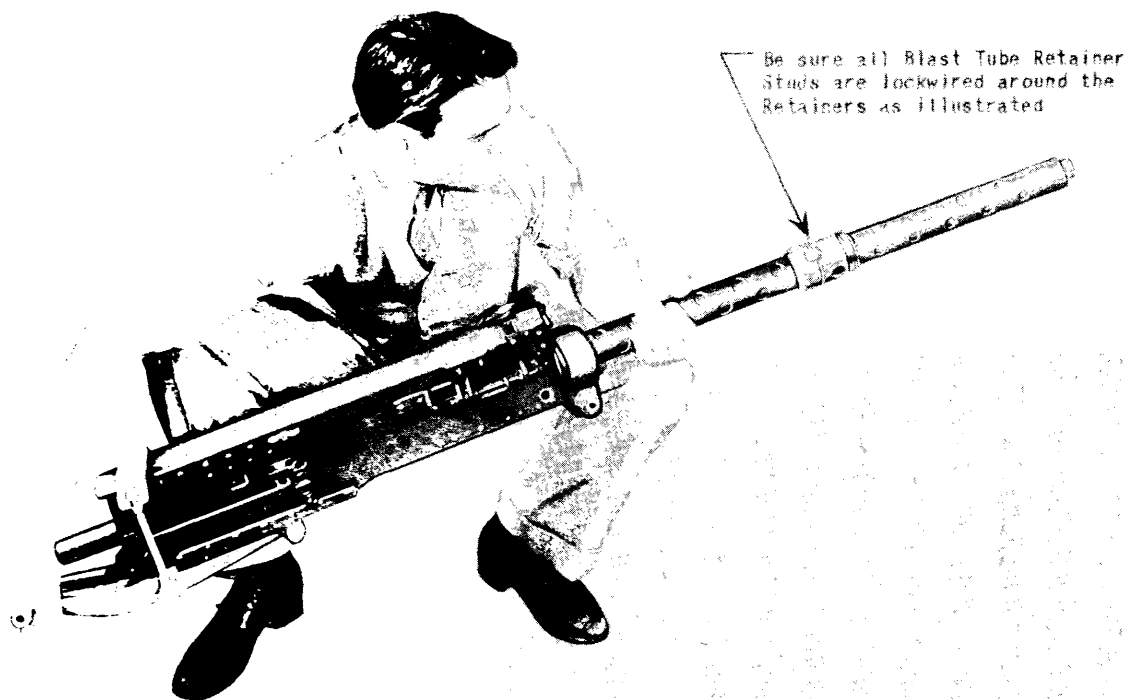


Figure 12 - Proper Method for Lifting Gun Prior to Installation in the Wing

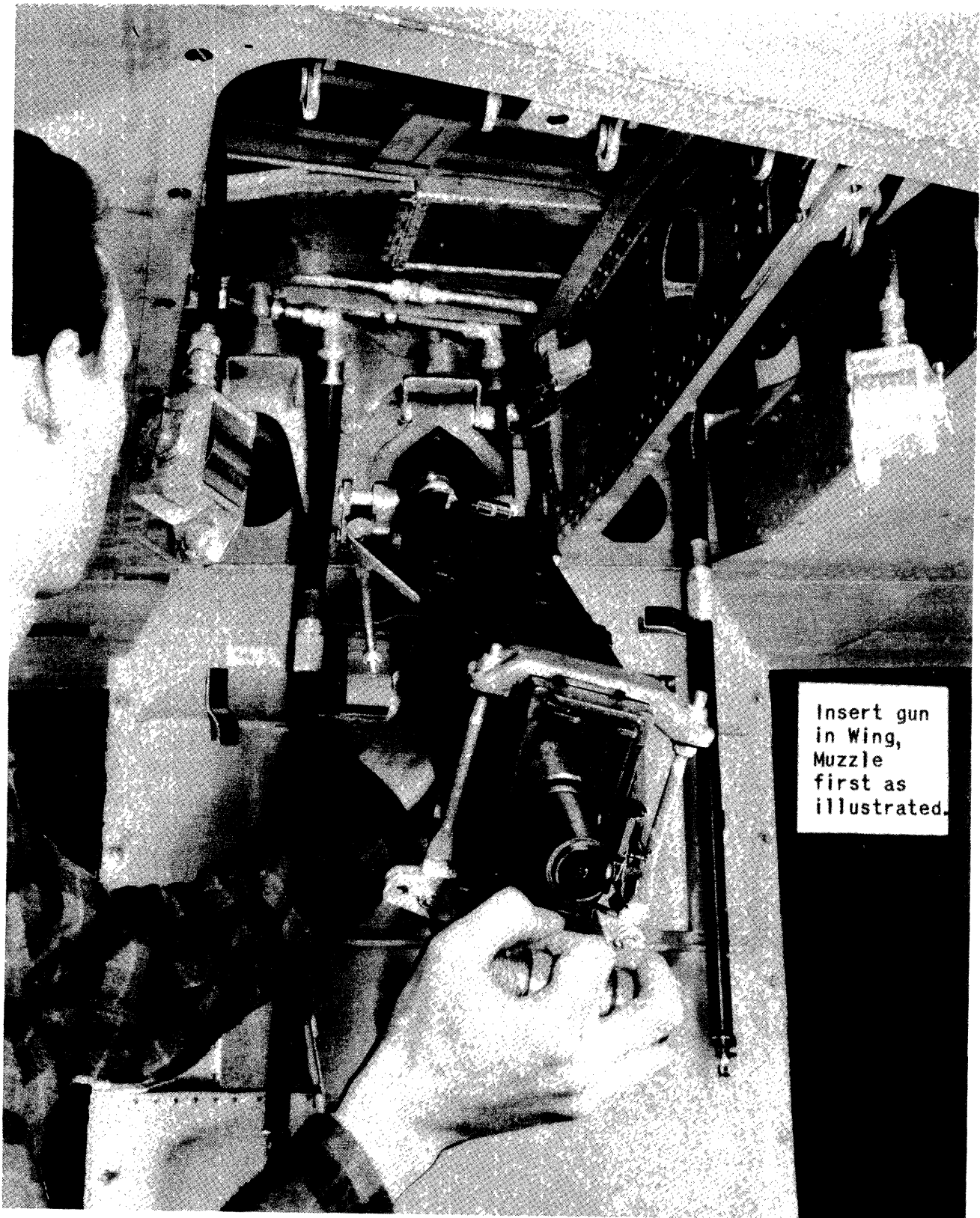


Figure 13 - Installing Center Gun in Wing



#### h. To Install the Gun in the Wing.

(1) General. - The most desirable position to grasp the gun for insertion into the wing compartment is illustrated in figure 12.

(2) To Insert the Gun in the Wing. - It is most important that the charger hose is placed over the front adapter so it will not be pinched between the gun and wing web No. 3. (See figure 8.) Insert the gun in the wing compartment muzzle first as illustrated in figure 13, and guide the muzzle through the round cut-outs in webs No. 3, No. 2, and No. 1. Engage the front adapter (figure 14) and temporarily support the rear of the gun by inserting the driftpin through the rear mount adapter as illustrated in figure 15.

(3) To Install the Gun in the Front Adapters. - Raise the forward part of the gun until the holes align with the pins on the locking pin plates. This step may be facilitated by inserting the socket wrench handle under the front gun lug and forcing the gun up until the holes on the gun and pins are aligned. Push the locking pins into the mount holes in the gun, swing the eyebolt up to engage the outboard lockpin plate and throw the toggle up to lock the gun in the adapter. (See figure 16.) Remove the driftpin and allow the rear of the gun to hang free as illustrated in figure 17.

(4) To Install the Solenoid on the Gun. - Install the solenoid on the inboard side of the gun, tighten the attaching nut and insert a safety pin to lock the nut. (See figure 18.) If it is necessary, adjust the sear plunger protrusion on the solenoid with the adjustment pin on the face of the solenoid. The end of the adjustment pin which is painted red should match the red mark on the face of the solenoid. Clockwise rotation decreases the protrusion and counterclockwise rotation increases the protrusion. Check the tightness of the electric cable ferrule.

(5) To Install the Charger Cylinder on the Gun. - Release the toggle on the under side of the rear adapter to free the saddle over the gun and swing the adapter downward. (See figure 31.) Install the charger cylinder in the mounting brackets on the gun and secure the front end first. (See figure 19.)

(6) To Install the Rear Mounting Bolt. - Swing the adapter upward and engage the saddle tie rod and tighten the saddle by locking the toggle on the under side of the adapter. Raise the rear end of the gun and install the rear mounting bolt. For the installation of the rear mounting bolt on the outboard guns see figure 21. Install the mounting bolt lockpin on the outboard side of the gun. (See figure 22.) Secure the feed chutes

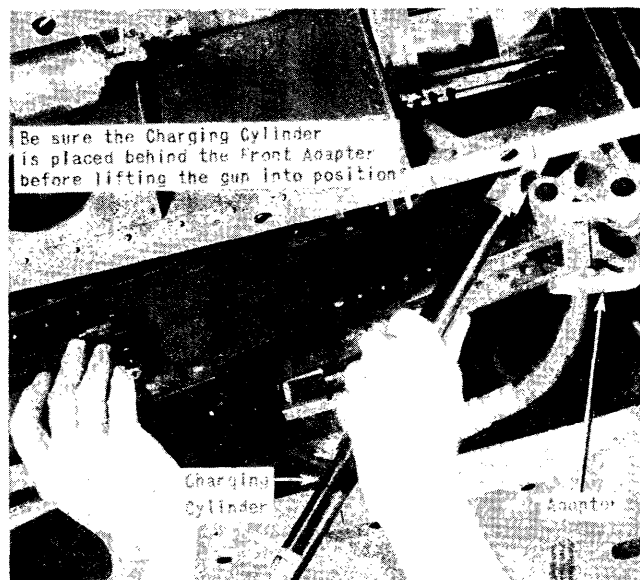


Figure 14 - Proper Position of Charging Cylinder when Installing Gun

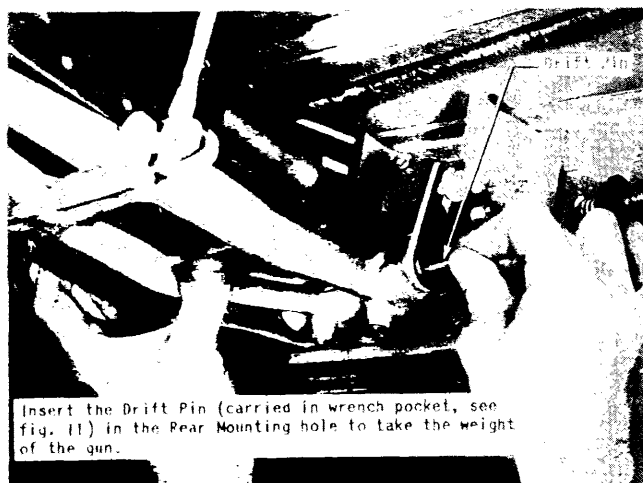


Figure 15 - Installation of Driftpin in Rear Mounting Hole

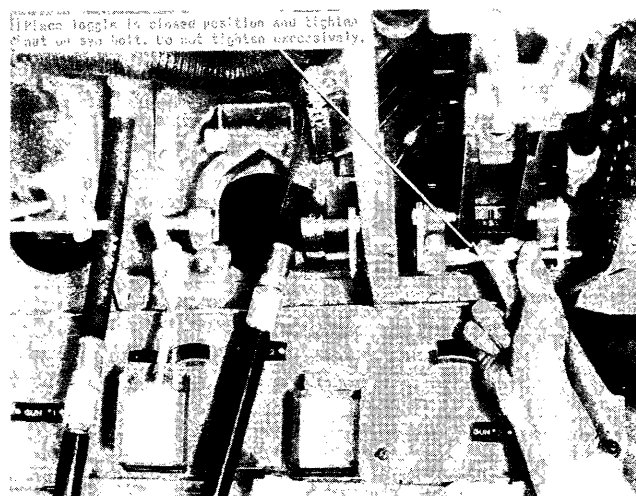


Figure 16 - Front Adapter Locked on Gun

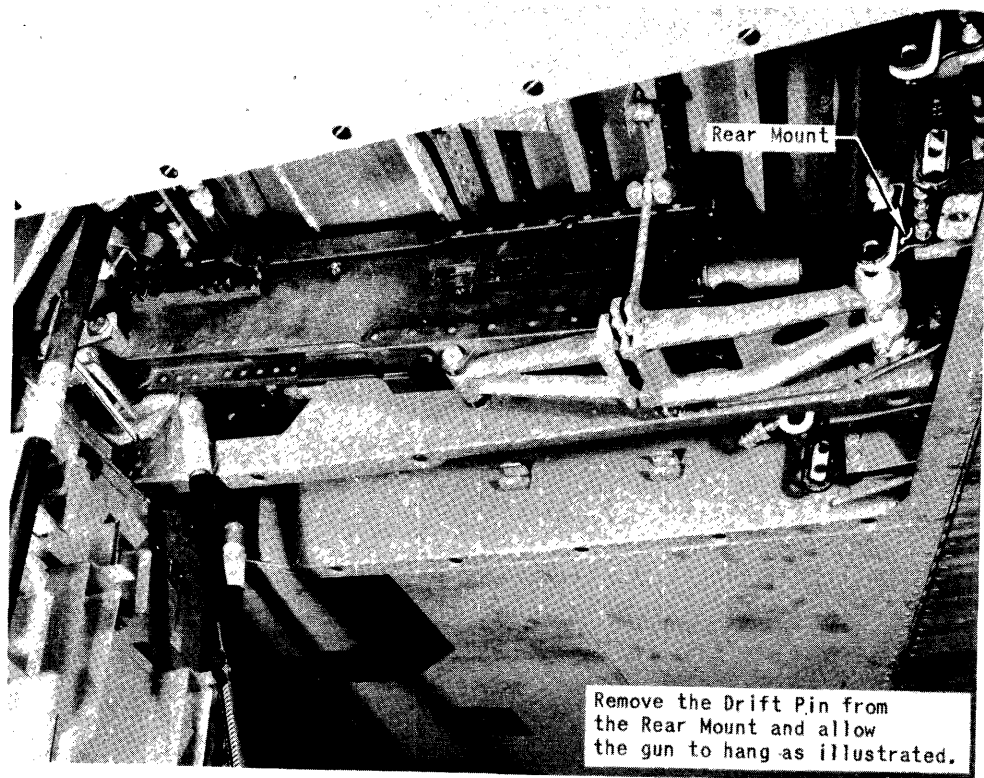


Figure 17 - Rear Mount -  
Driftpin Removed

Install the Solenoid on the Inboard Side of the gun, insert the Nut Plate in the gun and tighten the nut as illustrated. Safety pin the nut.

The red end of the sear plunger adjusting pin should coincide with the red mark on the face of the solenoid. Clockwise rotation of the adjusting pin decreases the sear plunger protrusion and counterclockwise rotation increases the protrusion.

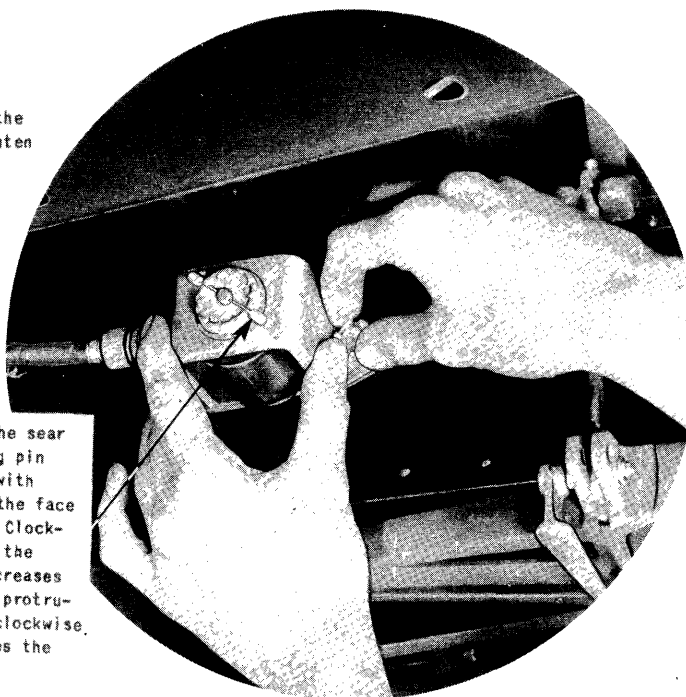


Figure 18 - Installing Solenoid



Close Front Mounting  
Bracket first and  
tighten Wing Bolt. Fol-  
low same procedure on  
Rear Bracket.

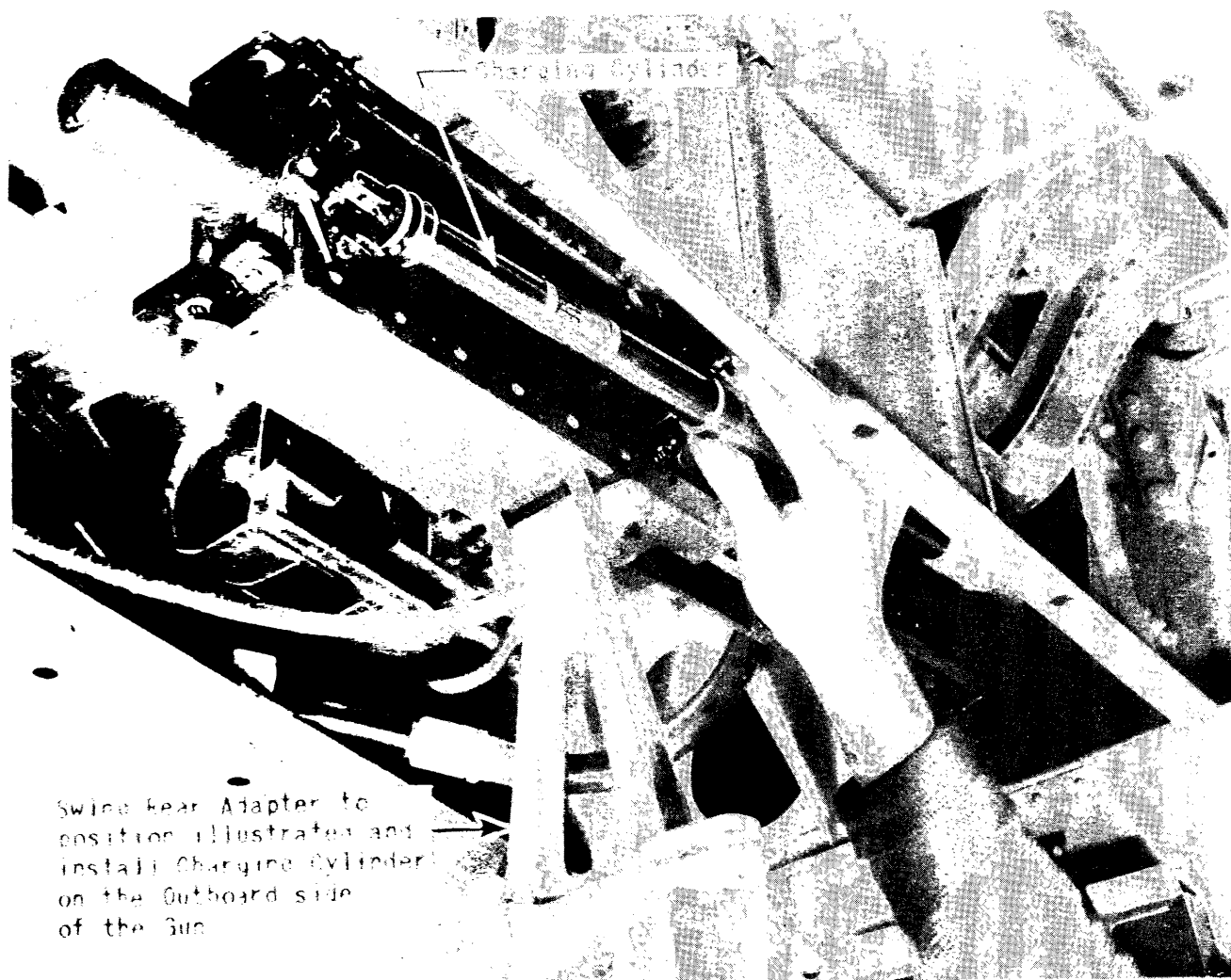


Figure 19 - Installing Charging Cylinder on Gun

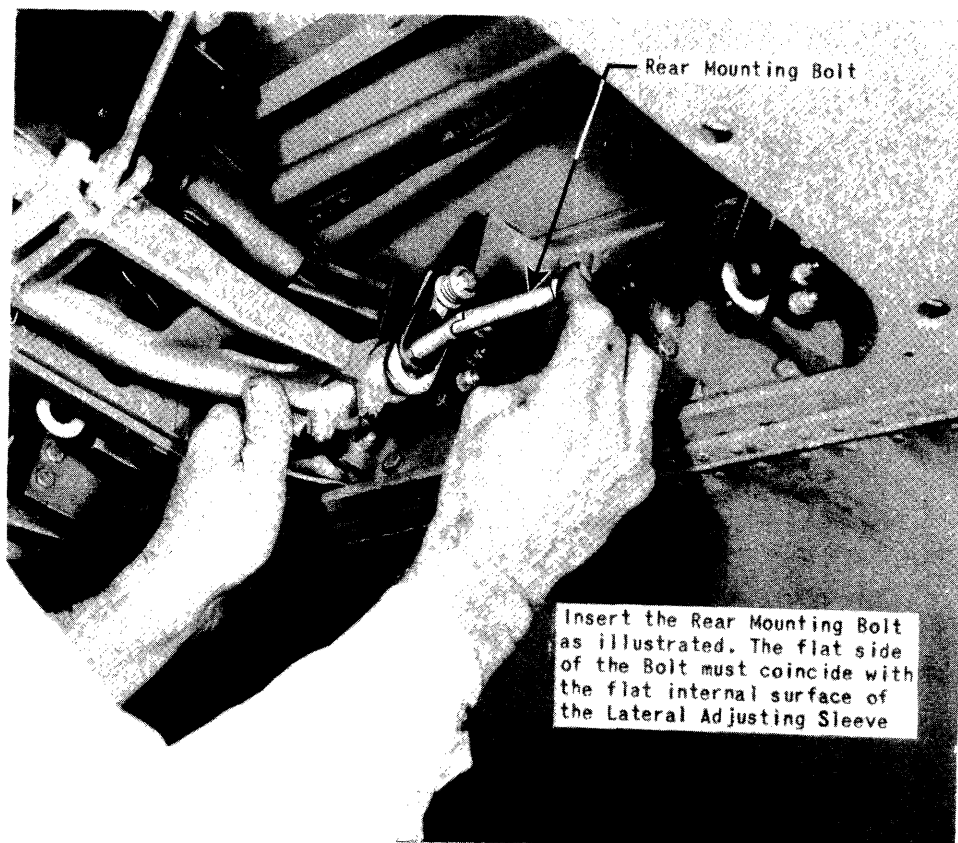


Figure 20 - Installation of Rear Mounting Bolt

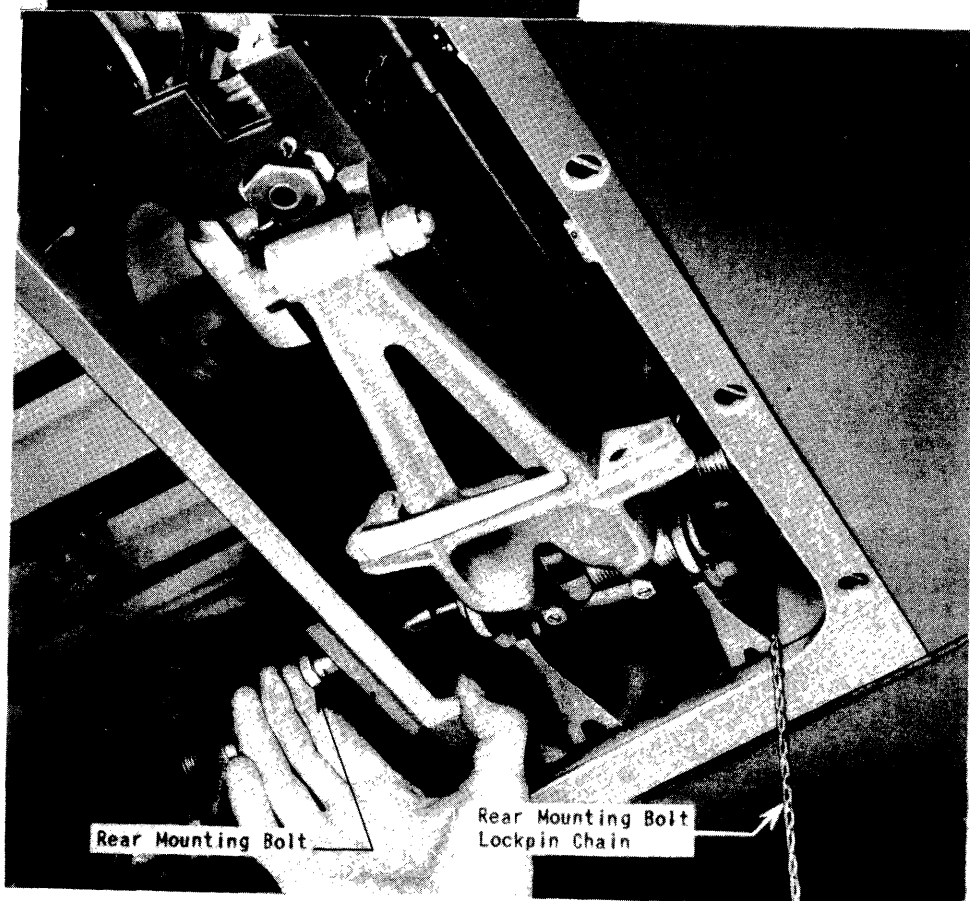


Figure 21 - Installing Rear Mounting Bolt in Outboard Gun



Figure 22 - Installing Lockpin  
in Rear Mounting Bolt

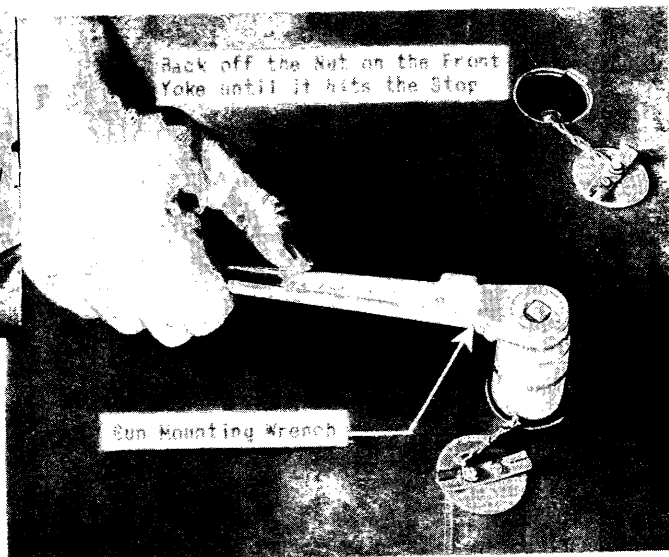


Figure 23 - Yoke Nut Adjustment

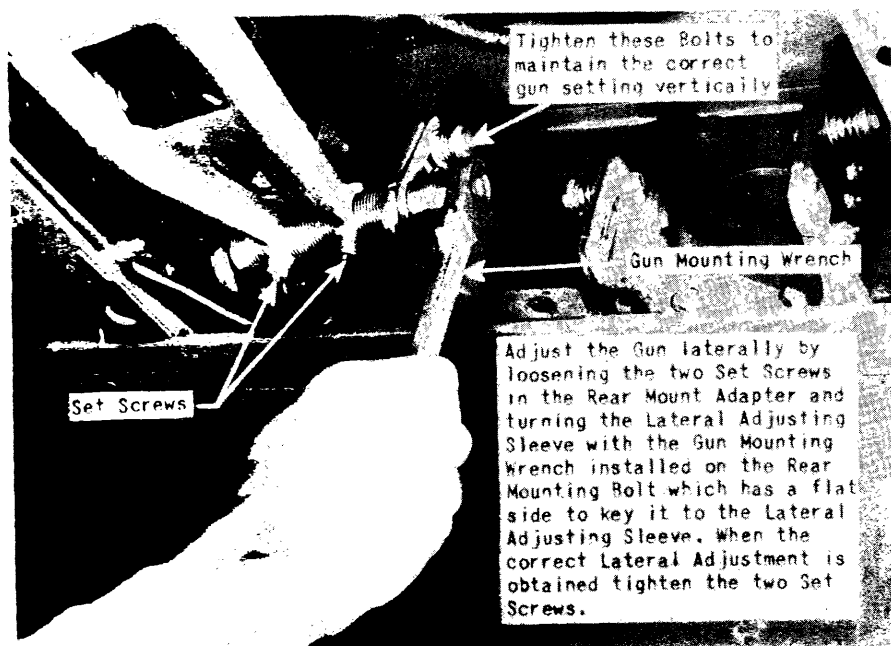


Figure 24 - Adjusting Gun Laterally

to the left and right No. 1 and No. 2 guns by inserting the attaching pins and locking with safety pins. The feed chutes on No. 3 guns, right and left, are not attached to the gun until after the guns are bore-sighted. Next tighten the front yoke nut by means of the special socket wrench inserted through the nut port in the top surface of the wing. (See figure 23.) Screw the three retainer washer screws into the yoke bolts so that the yoke nuts can never be turned entirely off the bolt allowing the gun to drop out of the wing compartment. Bore-sight the gun. Bore-sighting the gun may be accomplished by loosening the locking elements at the serrated plates so that the gun can be moved in a vertical direction. Loosen the setscrews in the adapter securing the lateral adjusting threaded sleeve. Then by moving the gun up or down, grasping it with the hands, vertical adjustments may be attained. Lateral adjustment may be made by turning the rear mounting bolt which has a flat side to key it to the lateral adjusting sleeve. After these adjustments are made the locking elements should be properly secured. (See figure 24.) The front mounting bolt should then be tightened using the special socket wrench (87-69-737) provided for gun mounting. Refer to section IV, 2.(a) through (i) for complete information on sight adjustment.

(7) To Install the Blast Tube. - 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. (See figure 28.) If the Dzus fasteners appear to be loose in their securing springs, 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.

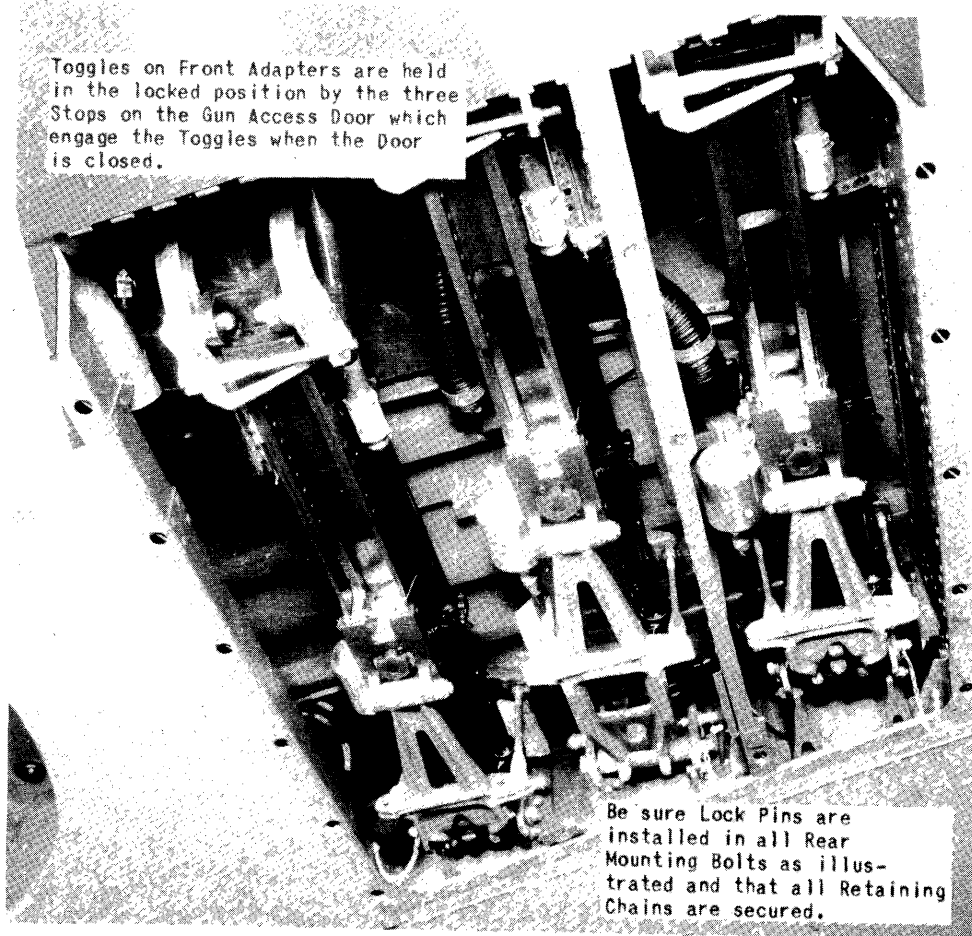


Figure 25 - Guns Installed in Left Wing Panel - Looking Aft

(8) To Install the Link Ejection Chutes. - Attach the link ejection chutes to the gun feedway pin.

After checking the charger cylinder and solenoids for satisfactory operation, the gun access door can be buttoned up. Be sure all Dzus fasteners have the proper tension grip.

i. To Remove the Action from the Installed Gun.

(1) Unbutton the gun access door and allow the door to swing down. Unlatch the door brace on the outboard side and swing the brace up. Engage the Dzus fastener on the brace in the correct hole on the wing. This brace will keep the door from swinging if the guns are being serviced in the open.

(2) Unbutton and remove the leading edge cover plate on the leading edge of the wing. Unscrew the blast tube from the retainer and remove the blast tube from the muzzle of the gun. (See figure 27.)

(3) Detach the feed chutes from No. 1 and No. 2 guns and the link chute from No. 3 gun.

(4) Working through the yoke nut port on the top surface of the wing unscrew the yoke nut with the special socket wrench to lower the front of the gun as far as it will go. (See figure 23.)

(5) Loosen the front mounting bolt slightly with the special gun mounting wrench to allow the front adapter to pivot on the yoke.

(6) Pull the lockpin and remove the rear mounting bolt and lower the rear end of the gun without disturbing the adjustment. (See figure 30.)

(7) Release the toggle on the rear mount adapter and free the saddle over the gun as illustrated in figure 31. Rotate the adapter downward. (See figure 32.)

(8) Release the charger cylinder from the gun and remove the special charger cylinder bolt studs.

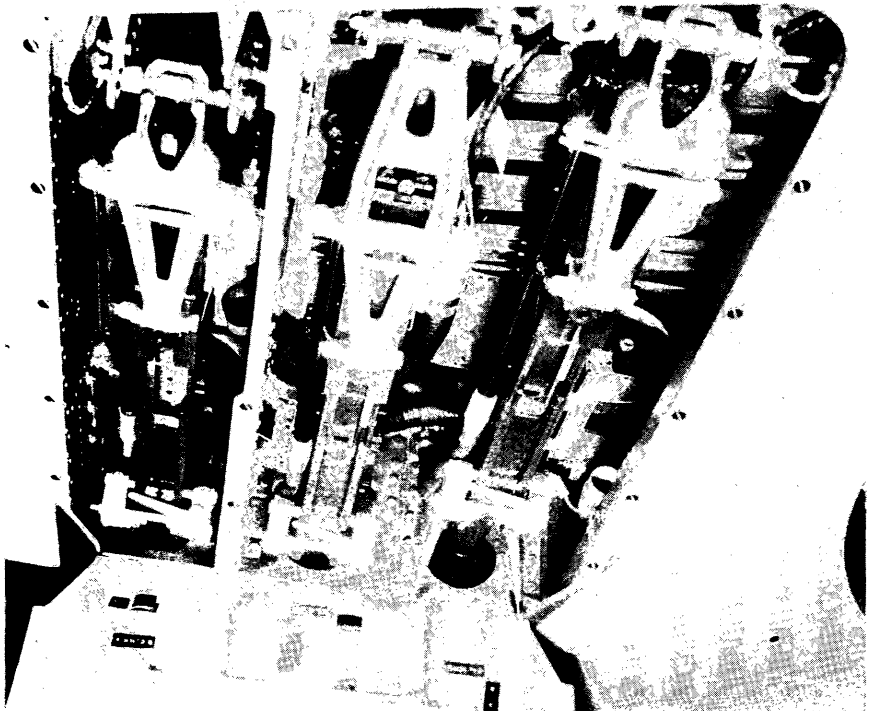
(9) Pull out the safety catch on the backplate, push up on the latch and slide the backplate up until it is free of the gun. (See figure 32.)

(10) Remove the bolt and driving pin through the backplate opening as illustrated in figure 33.

(11) Release the gun barrel lock spring with the flat end of the driftpin to depress the spring as illustrated in figure 34.

(12) Remove the gun barrel with the barrel extension and lock frame as illustrated in figure 35.

Figure 26 - Guns Installed in  
Left Wing Panel Looking  
Forward



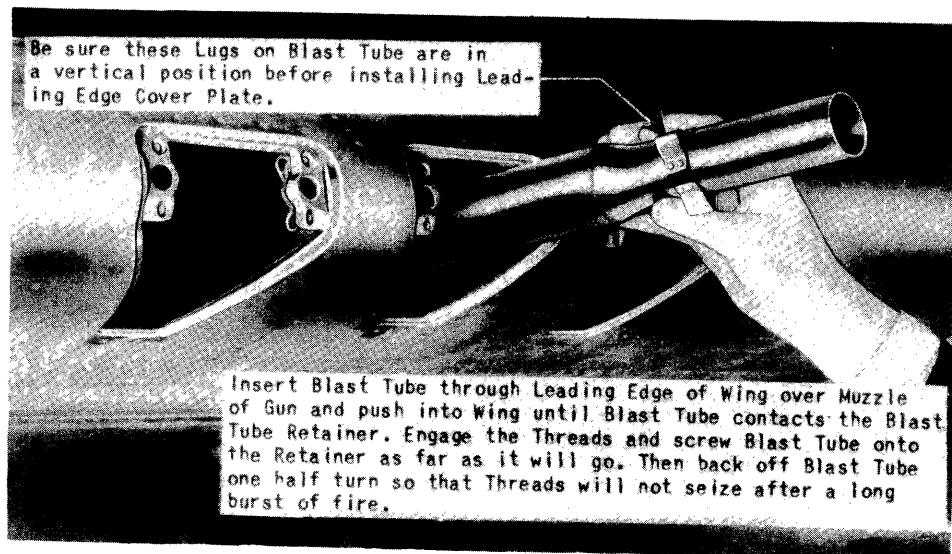


Figure 27 - Installing Blast Tube on Gun

Figure 28 - Installing Leading Edge Cover Plate

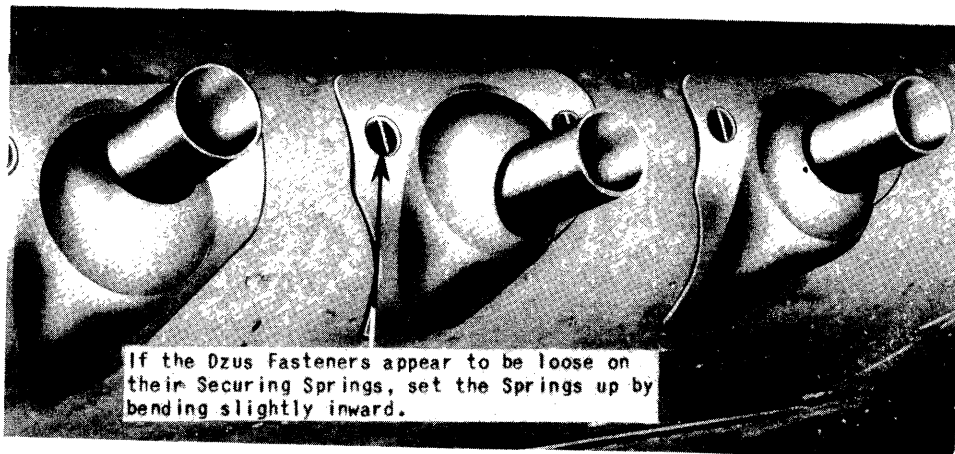
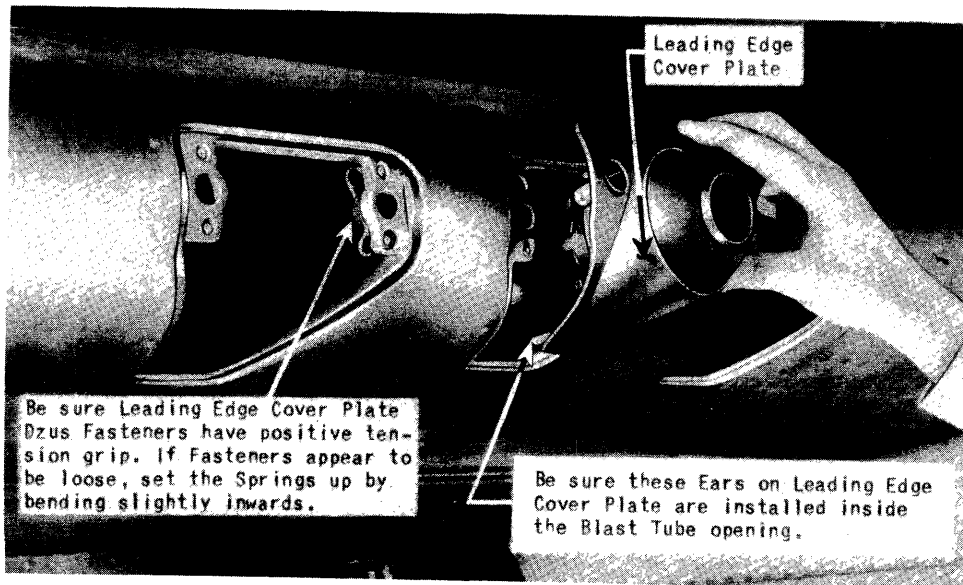


Figure 29 - Blast Tubes and Leading Edge Cover Plates Installed

Figure 30 - Removing Rear Mounting Bolt

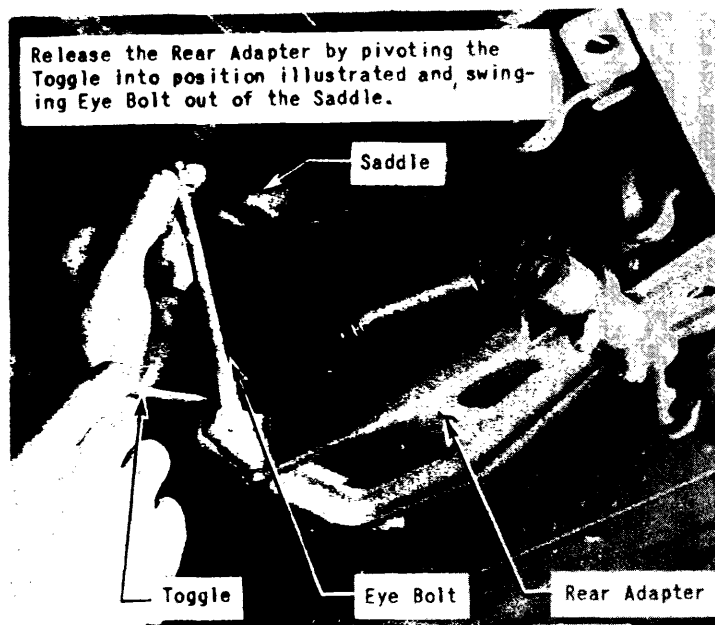
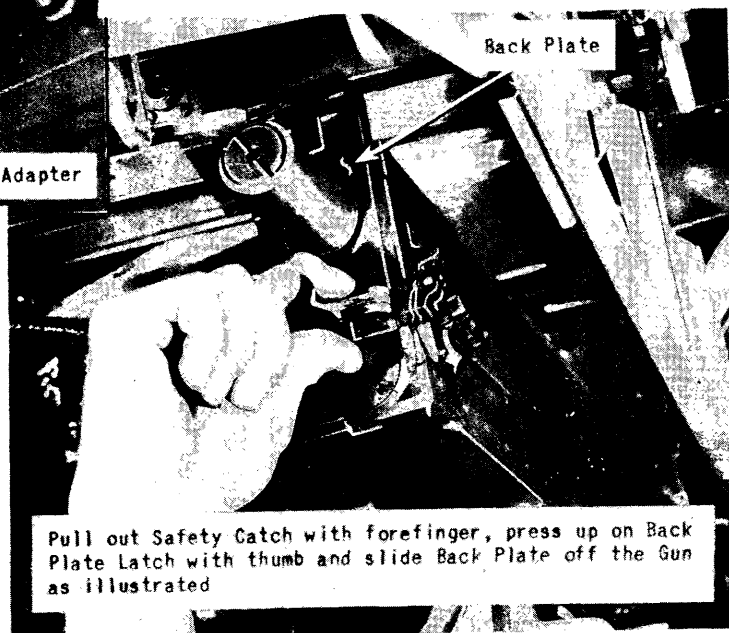


Figure 31 - Use of Toggle to Release Rear Adapter

Figure 32 - Removing the Back-plate from the Gun





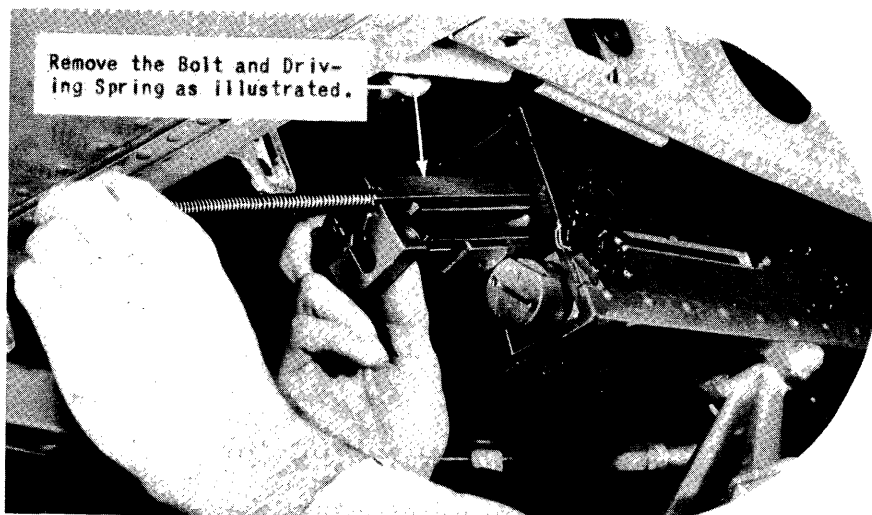


Figure 33 - Removal of Bolt from Gun

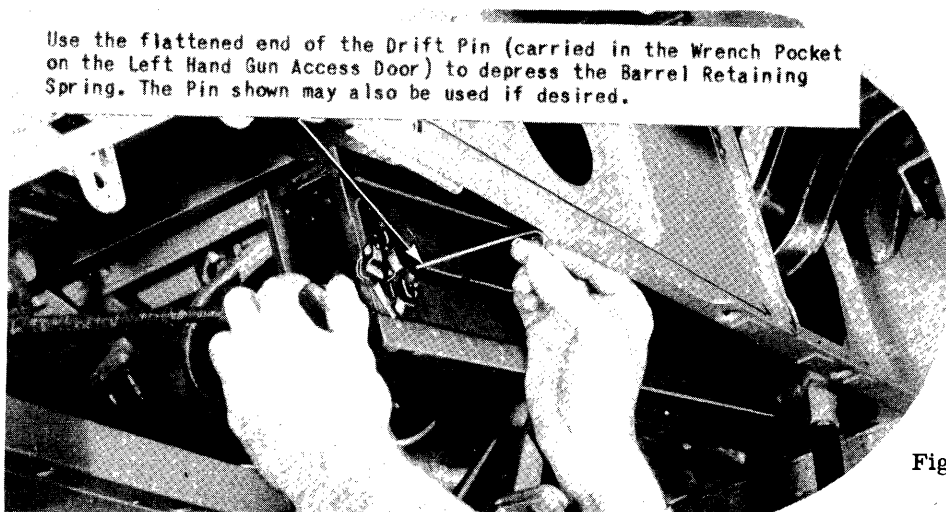


Figure 34 - Depressing Retaining Spring on Gun Barrel



Figure 35 - Removal of Barrel from Gun



j. To Install the Action in the Gun. - After thoroughly inspecting, cleaning, and lubricating the gun action, reinstall the action by reversing the procedure outlined in paragraph g.(1) through (11), this section.

k. To Remove the Gun from the Wing.

(1) Unbutton the gun access door and lower the door from the gun compartment. Swing the door brace up and button it to the wing with the Dzus fastener.

(2) Remove the leading edge cover plate from the leading edge of the wing by unbuttoning the two Dzus fasteners. Unscrew the blast tube from the retainer and remove the tube from the muzzle of the gun.

(3) Detach the feed and link ejection chutes from the gun.

(4) Remove the rear mounting bolt without disturbing the adjustment. (See figure 30.)

(5) Pull the toggle down on the rear mount adapter and release the saddle over the gun. Rotate the saddle to clear the gun and allow the adapter to swing downward as illustrated in figure 31.

(6) Release the wing nuts on the special charger cylinder bolts and remove the cylinder. Allow the cylinder to swing downward, suspended by the hydraulic hose connection. (See figure 6.)

(7) Remove the solenoid attaching nut and allow the solenoid to swing downward, suspended from the electric cable. (See figure 6.)

(8) Swing the saddle over the gun and lock with the toggle. Raise the rear end of the gun and support the mount adapter with the driftpin. (See figure 15.)

(9) Release the toggle on the front adapter. Swing the eyebolt down and pull out the lockpin plates on either side of the gun. This will release the gun from the adapter without disturbing the adjustment. (See figure 16.)

(10) Withdraw the driftpin from the rear mount adapter and remove the gun from the wing without disturbing the adjustment. (See figure 13.)

(11) After the initial installation and adjustment of the guns by bore-sighting, it will be possible to remove the guns whenever necessary without disturbing the adjustments as long as the yoke nuts on the front adapters and the locking nuts on the serrated plates on the aft mounts are not tampered with.

2. Ammunition Boxes.

a. General. (See figures 36, 37, and 38.) - The ammunition box installation consists of two single and two double stainless steel 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.

b. To Load the Ammunition Boxes.

(1) Withdraw the continuous hinge pins in the ammunition compartment doors on the top surface of the wings. Remove the boxes and feed chutes. Withdraw the two center hinge pins on the double outboard box and open the covers. Start laying the ammunition into the boxes from the outboard compartment. Lay a row of ammunition from the outboard to the inboard end of the compartment and fold the ammunition back and lay another row to the outboard end. Continue laying the ammunition in even rows back and forth to correspond to the instruction plate on the box top. When the outboard compartment is filled in the double boxes, lay the ammunition over the roller between the compartments and load the inboard compartment in accordance with the instruction plate on the box cover. (See figure 39.) When the inboard compartments of the double boxes are filled run the ammunition over the roller on the inboard end of the box and close the box allowing two links and cartridges to extend from the box. Turn the two links and cartridges up over the box cover so that the links may be attached between boxes upon installation in the wings. Exercise extreme care when loading so that the ammunition lays evenly in the boxes. Do not dump the ammunition into the boxes in uneven piles. Careless loading of boxes will cause undue strain on the links and feed pawl in the gun causing the gun to cease firing. All personnel in armories should be cautioned against careless loading of ammunition boxes because such carelessness will greatly decrease the efficiency of the gunnery equipment even to the point where the guns cannot function due to jammed ammunition in the boxes.

(2) Where armory loading of ammunition boxes is available, loaded boxes can be substituted for empty boxes and the empties returned to the armory for loading. After the loaded boxes are installed open the cover on the inboard box and connect the links between the boxes. Start the links and cartridges through their respective chutes, install the chutes for the inboard and center guns and install their attaching pins. Install the hinge pins on the box covers.

(3) Pull the ammunition towards the guns through the cut-outs on the top of the inboard and center gun chutes until the first cartridge contacts the gun.

c. To Load the Guns.

(1) To load the gun use a screw driver inserted from the under side between the gun and feed chute and boost the first round over the belt holding pawl. Then 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.

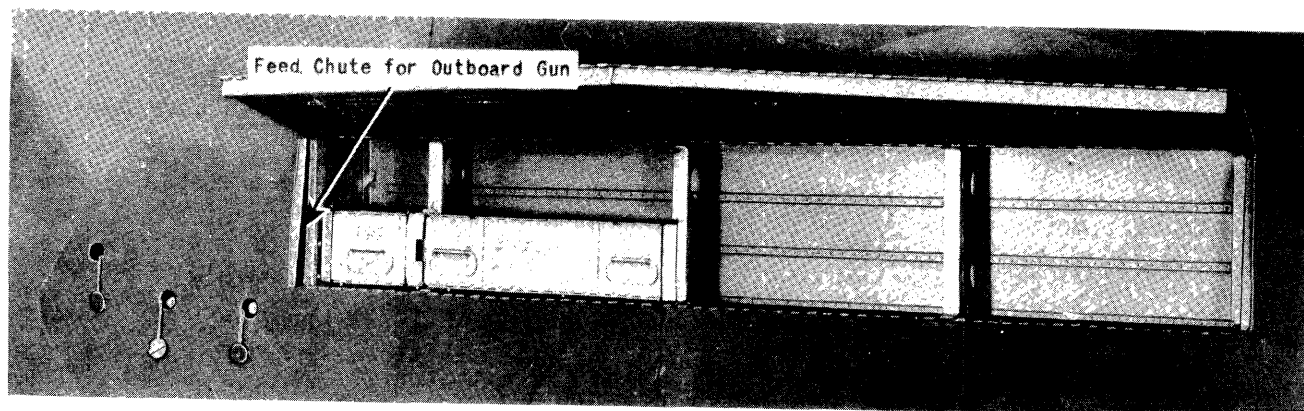


Figure 36 - Plan View - Two Inboard Ammunition Boxes Installed

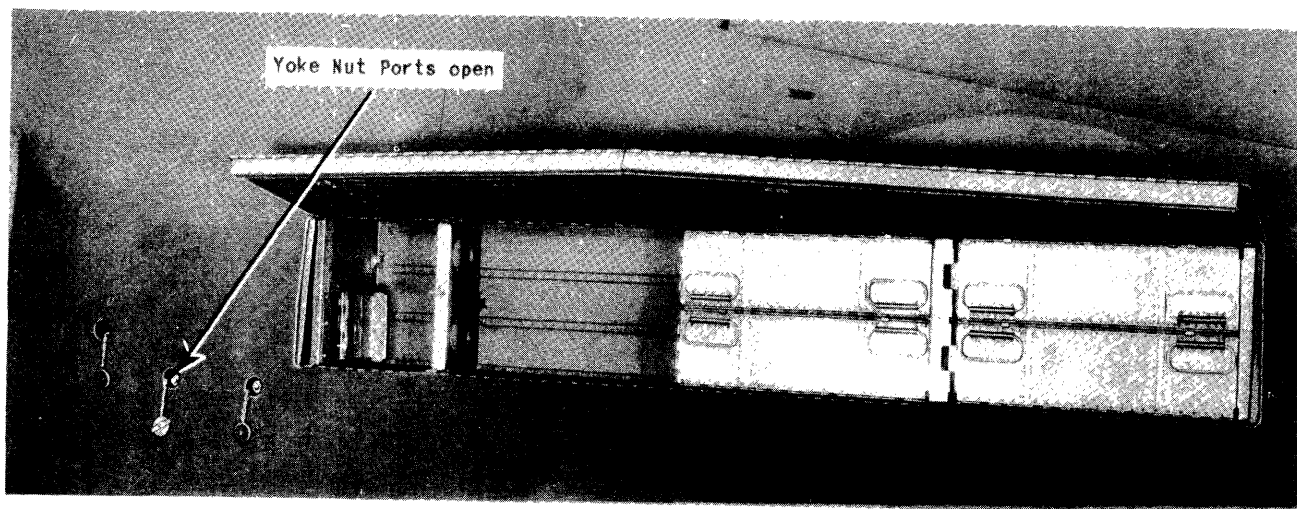


Figure 37 - Plan View - Two Outboard Ammunition Boxes Installed

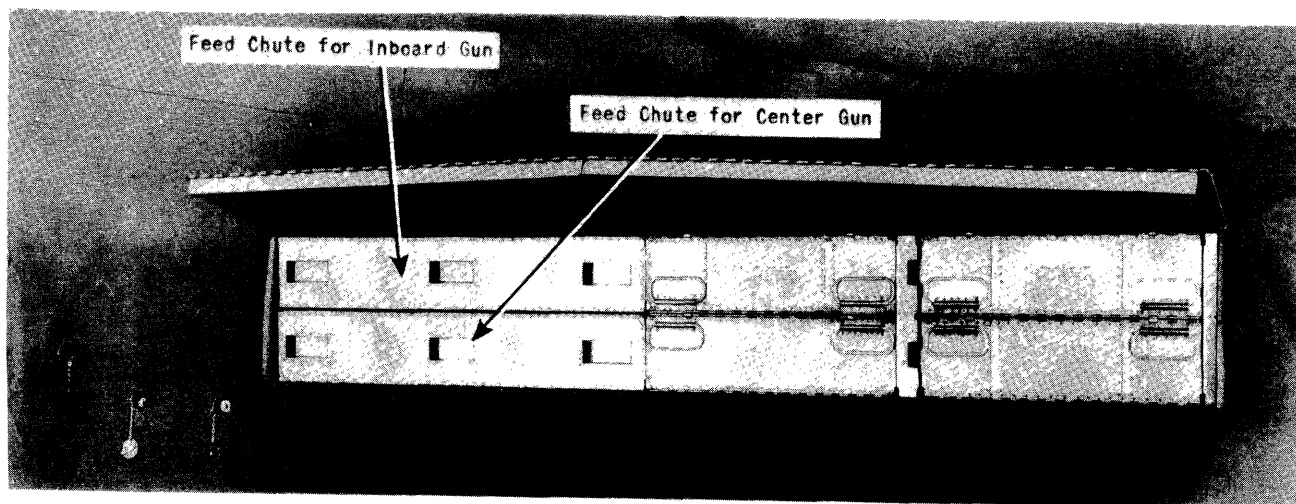
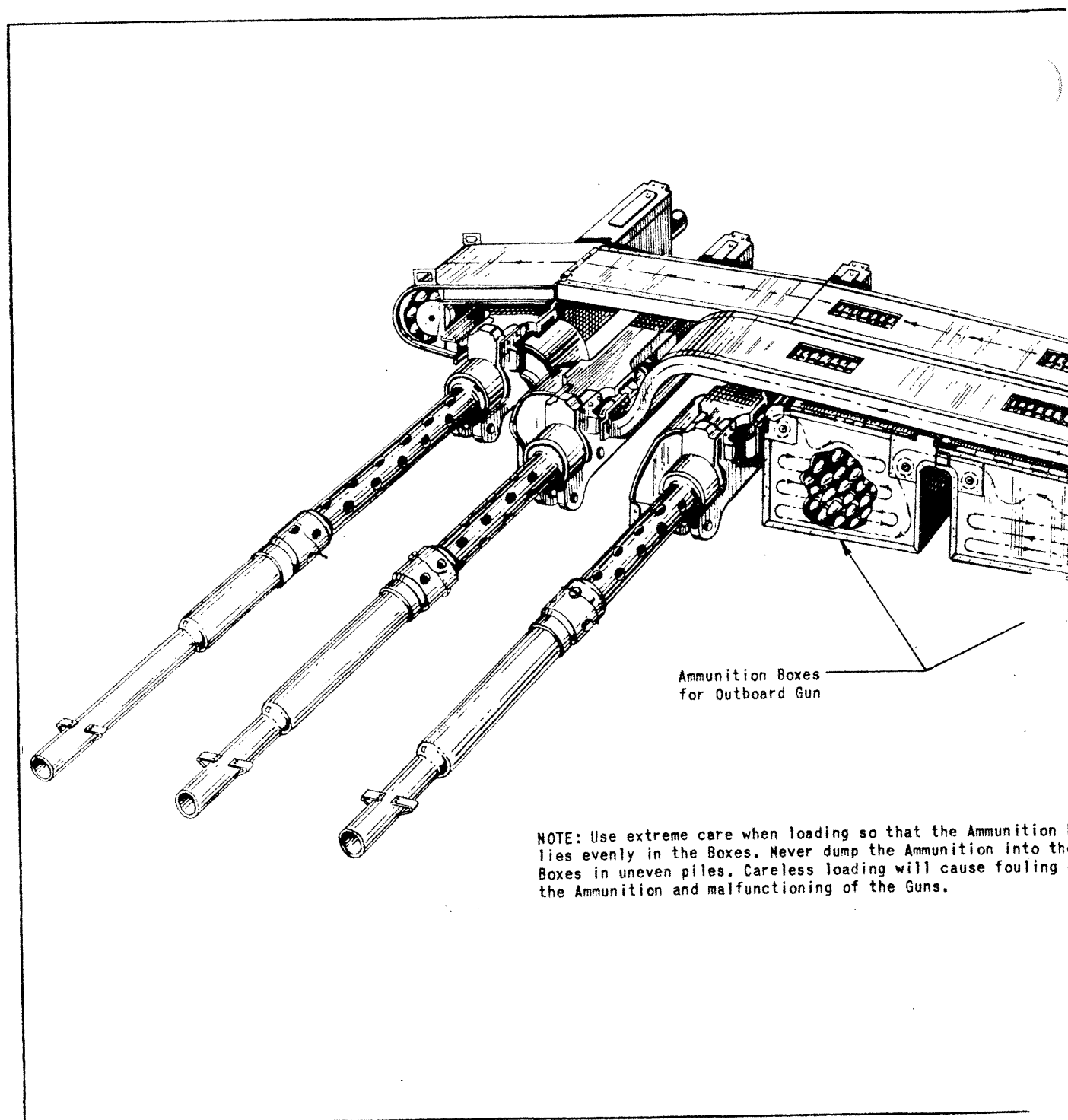


Figure 38 - Plan View - Ammunition Boxes and Chutes Installed



NOTE: Use extreme care when loading so that the Ammunition lies evenly in the Boxes. Never dump the Ammunition into the Boxes in uneven piles. Careless loading will cause fouling of the Ammunition and malfunctioning of the Guns.

Figure 39 - Loading .50-Caliber  
Ammunition Boxes

Be sure ammunition is fed over  
all Rollers between Compartments  
and Boxes and that all Links are  
properly connected after loaded.  
Boxes are installed in the Wing.

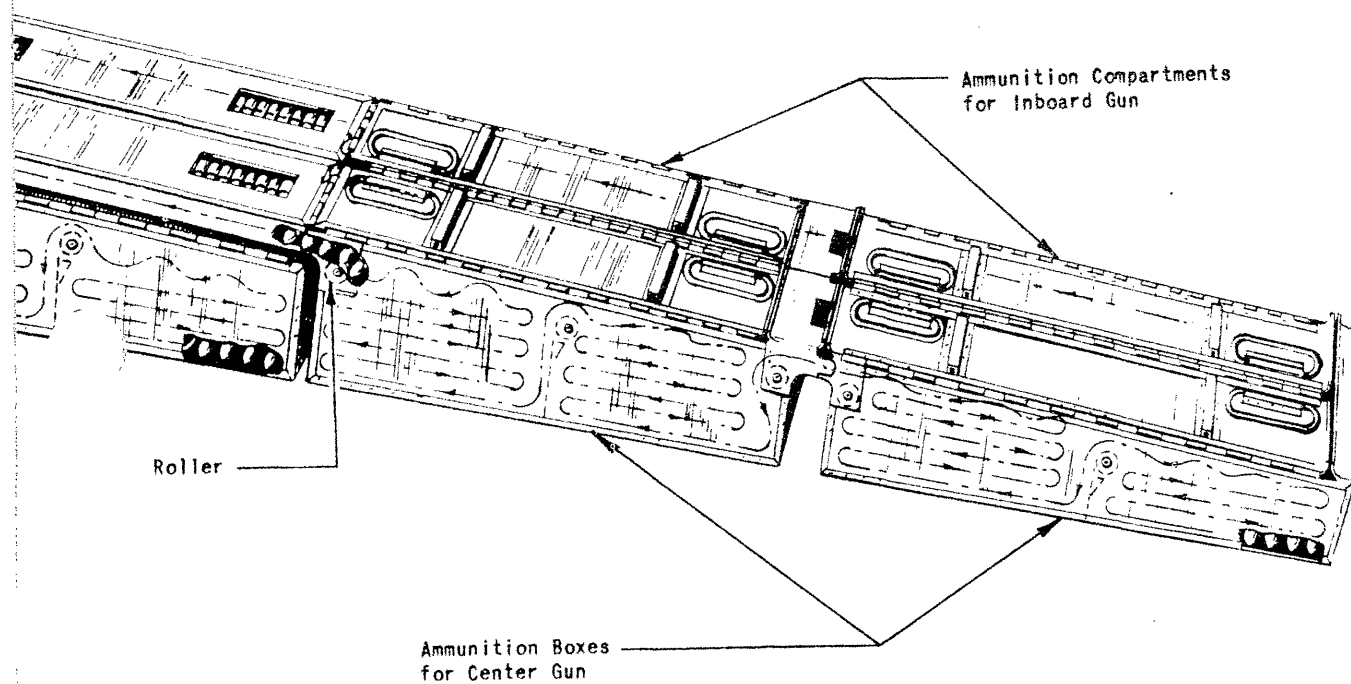


FIG.39 LOADING .50 CALIBER  
AMMUNITION IN BOXES

Figure 40 - Loading Out-  
board Ammunition Box



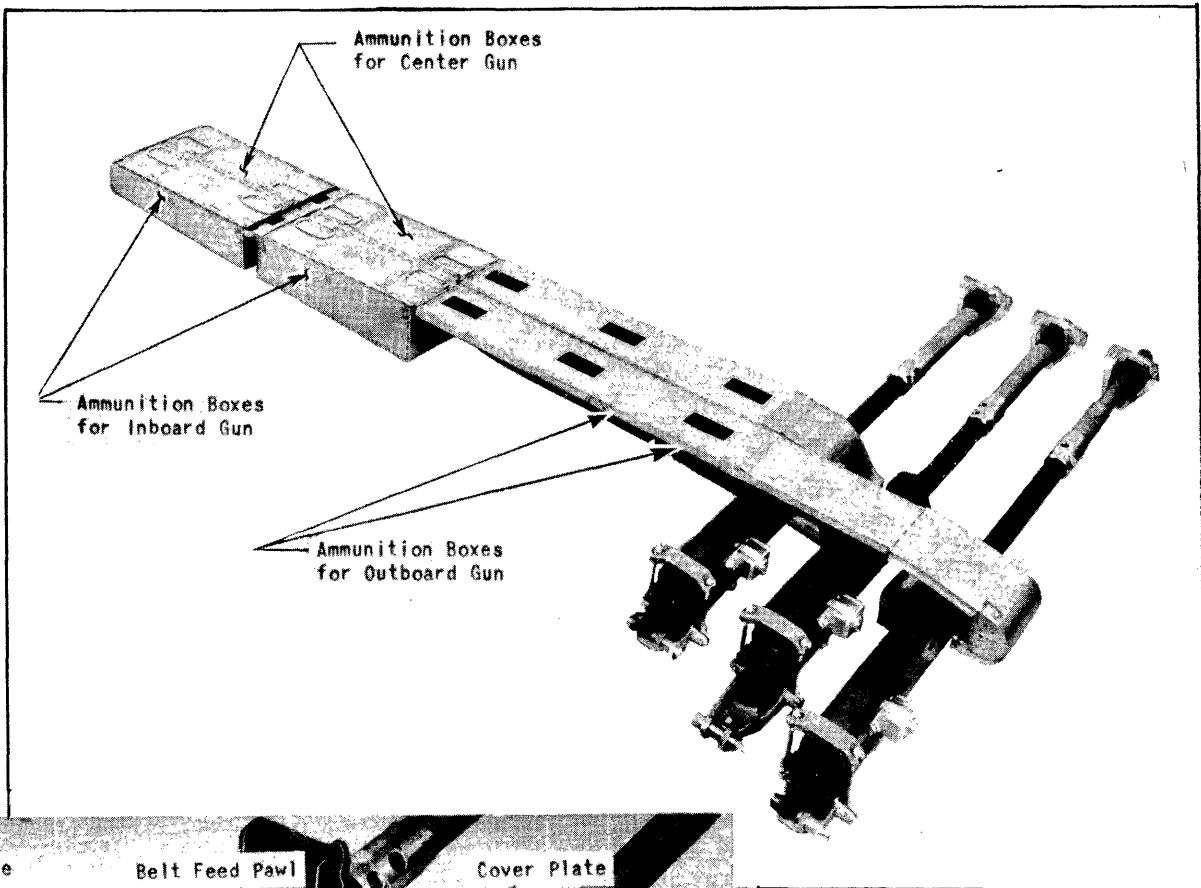


Figure 41 - Ammunition Boxes, Chutes, and Guns Looking Forward

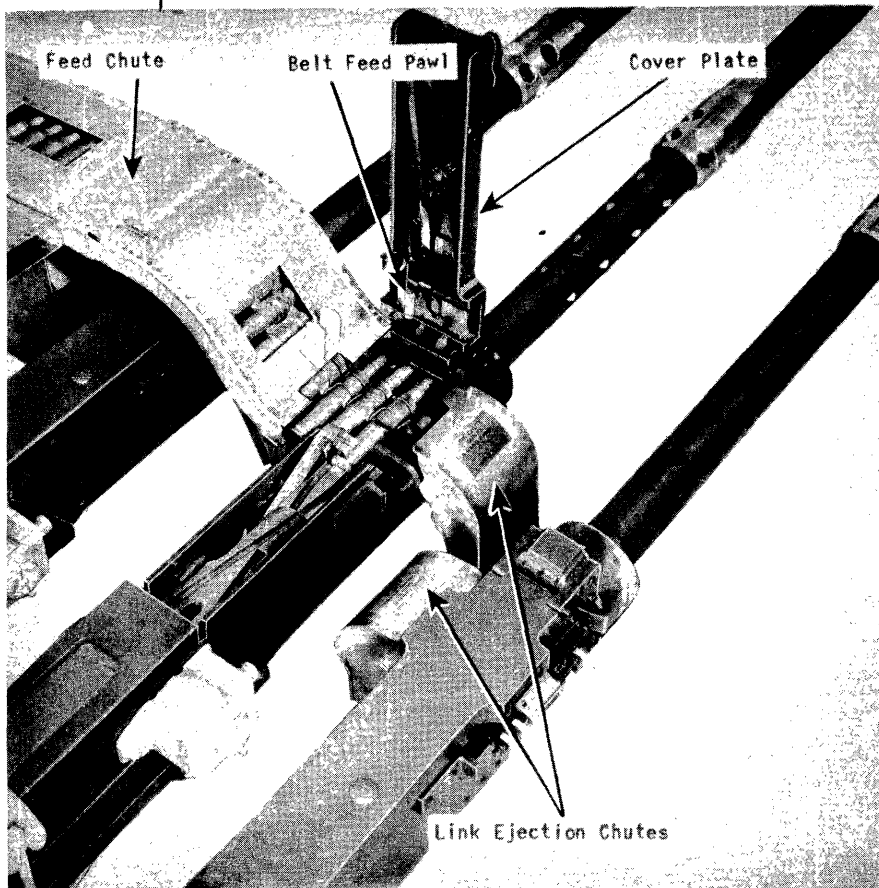
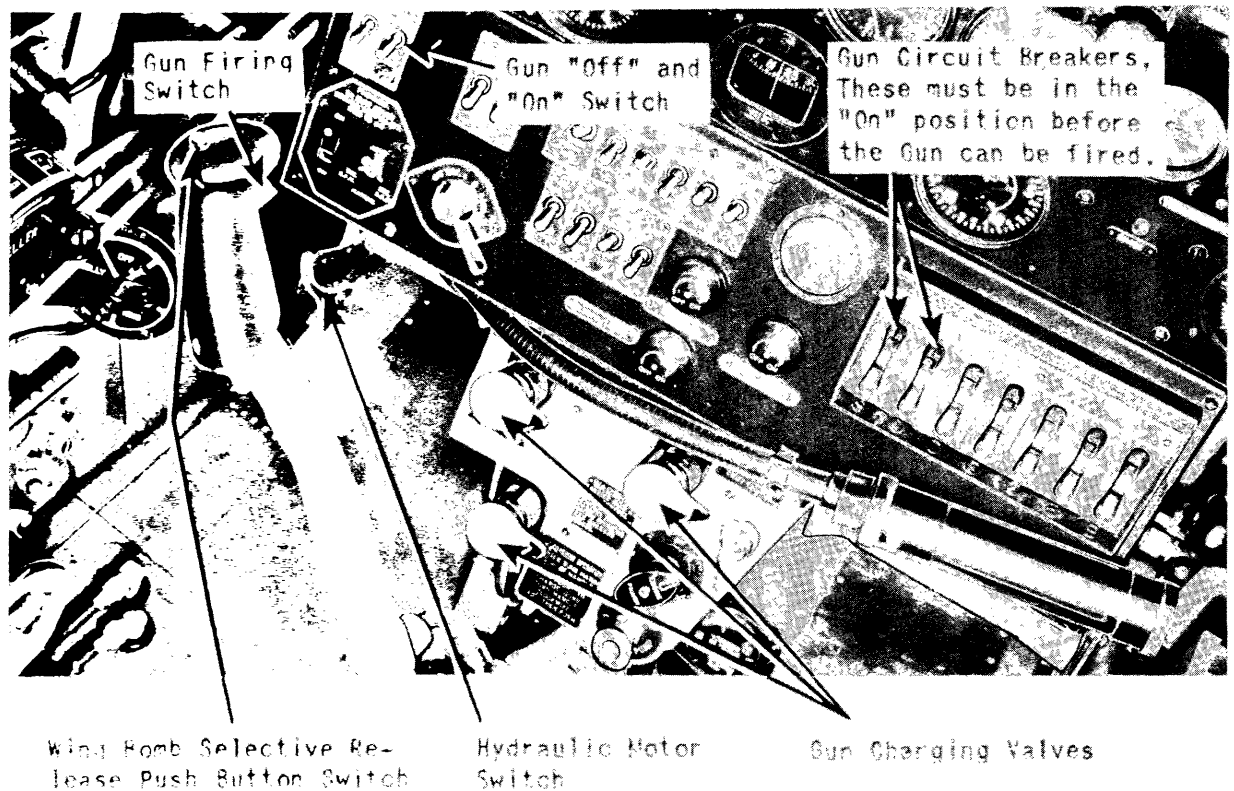


Figure 42 - Ammunition in Center Gun Ready for Charging



To fire the Guns charge the Guns with the Charger Valves as follows: turn the Valve Handles clockwise 140° away from the Red Markers on the Panel. Actuate one Charger Valve at a time. Push Charger Valve Handle all the way in and actuate the Hydraulic Motor Switch on the Control Stick until the Handle pops out. Repeat this procedure for the remaining Valves and the Guns are charged. Throw the Gun Circuit Breakers and the Gun Switch to the "On" position and depress the Trigger Switch on the Control Stick Hand Grip for the desired burst of Gun fire.

To lock all Guns, match the Red Point on the Charger Valve Handle with the Red Marker on the Panel and push Handle all the way in. Actuate the Hydraulic Electric Motor Switch until the Handle pops out. The Gun is now locked rearward. To lock Guns actuate one Charger Valve at a time. To charge Guns again after they are locked, turn the Charger Handle 140° clockwise from the Red Marker and the Guns are charged.

Figure 43 - Arrangement of Gun Controls

d. To Unload the Guns.

(1) Lift up the cover on the gun, move the belt of cartridges out of the feedway and close the cover. Pull the belt back into the box. Operate the hydraulic chargers to eject a possible cartridge remaining in the chamber. This operation must be accomplished with the gun charging handles in the cockpit.

(a) IMPORTANT. - It is recommended that the gun charging valves be operated one at a time to insure proper gun charging. To charge the guns proceed as follows:

1. Turn the charger valve handles 140 degrees clockwise away from the red markers on the panel. (See figure 43.)

2. Actuate one charger valve at a time.

3. Push the charger valve handle all the way in.

4. Actuate the hydraulic electric motor switch on the control stick, below the handgrip, until the valve handle pops out.

5. Follow this same procedure for the remaining two valves and the guns are charged.

(b) To lock the guns in the rearward position proceed as follows:

1. Turn the charger valves counterclockwise and match the red point of the valve handles with the red markers on the panel.

2. Actuate one charger valve at a time.

3. Push the charger valve handle all the way in.

4. Actuate the hydraulic electric motor switch until the valve handle pops out.

5. Follow this same procedure for the remaining two valves and the guns are locked in their rearward position.

(c) To charge the guns again turn the valve handles 140 degrees clockwise away from the red markers on the panel and the guns are charged.

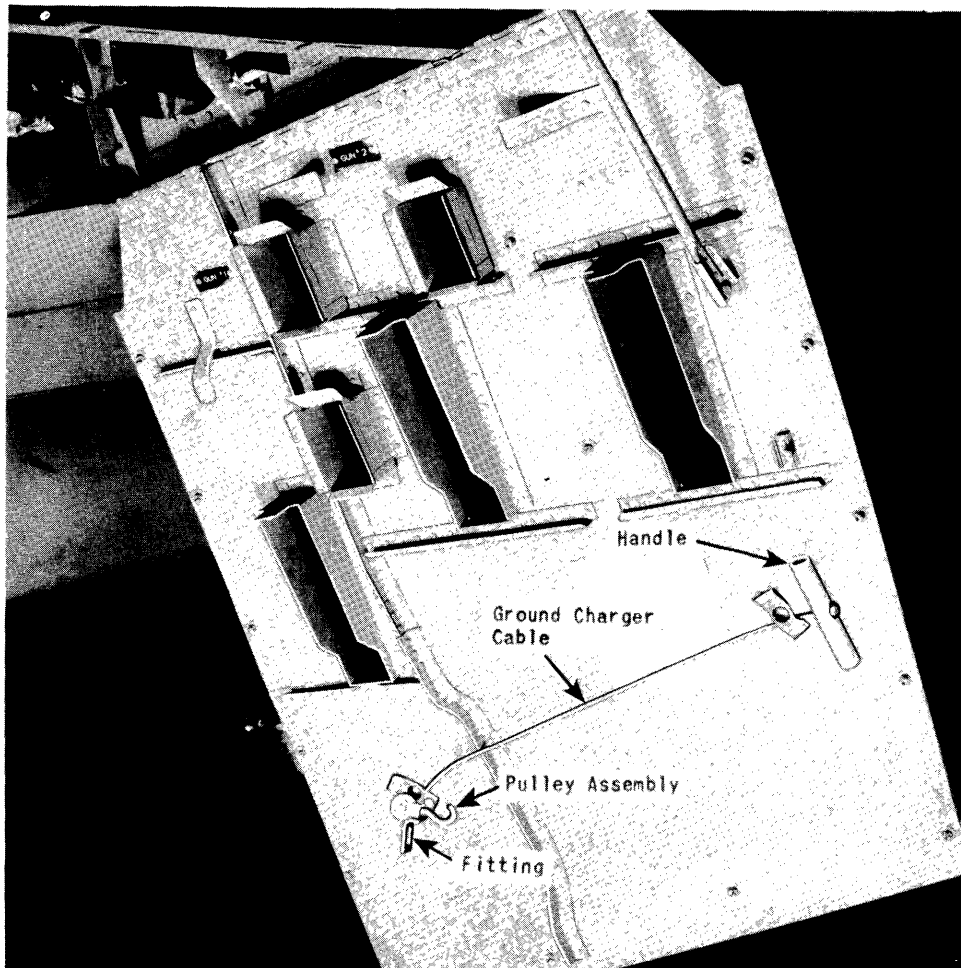


Figure 43A - Ground  
Charger - Stowed



NOTE: A 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.

e. To Charge the Guns Manually.

(1) General. - On late airplanes the hydraulic gun charging equipment has been removed and a ground charger assembly has been provided for each airplane. All airplanes, minus the hydraulic charging equipment must be charged on the ground before each flight. The guns cannot be charged while the airplane is in flight. The ground charger assembly consists of a pulley, a cable, a fitting, which has a tapered elongated hole to tightly engage the bolt stud on the gun, and a handle assembly. (See figure 43A.)

(2) To charge the guns on the ground proceed as follows:

(a) Unbutton both gun access doors and secure the doors with the door brace to keep the doors from swinging.

(b) Remove the ground charger from the stowed position on the access door and mount the charger on the outboard side of the gun as follows:

1. Slip the hook on the pulley bracket over the spring on the rear gun mount as illustrated in figure 43B.

2. Slide the slot in the fitting at the end of the charging cable over the bolt stud on the gun.

(c) Pull down on the handle of the charger cable until the gun action is locked in the rearward position.

(d) Repeat this procedure on each gun and all guns will be charged.

WARNING: When the guns are charged, a round of ammunition is placed in the firing chamber of the guns. Be sure that the gun safety switch, which is marked "ALL GUNS" and located on the left side of the main control switch panel, is "OFF" during all gun charging operations.

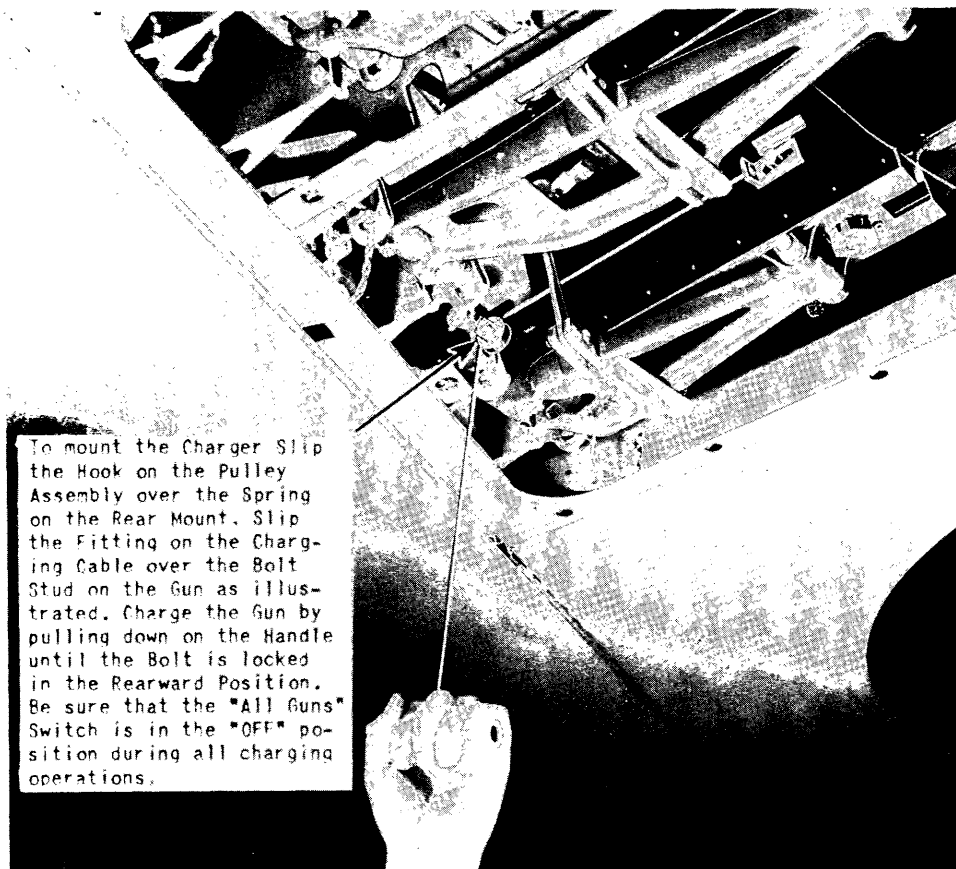
f. To Unload the Guns Manually.

(1) To unload the guns manually unbutton the gun access doors and secure in place with the side braces.

(2) Mount the charger cable as outlined in paragraph e.(1) through (2) preceding.

(3) Open the gun cover plate. (See figure 42.)

Figure 43B - Ground Charger Mounted on Gun



(4) Pull the gun action back with the charging cable and hold it there.

(5) Remove the ammunition belt from the feedway of the gun.

(6) Allow the gun action to come forward then

charge the action again to remove the last round from the chamber of the barrel.

**NOTE:** An instruction plate for ground charging the guns is mounted on the inside of the gun access door in each wing panel.

## SECTION II

### WING BOMBS

#### 1. Wing Bomb Installation.

**a. General.** - The wing bomb installation consists of a type L-21A control quadrant in the cockpit (figure 44), two type Q2 bomb racks and doors, twelve front sway braces and six rear sway braces. Each bomb rack will support three 20-pound type M42, or three 30-pound type M5, fragmentation bombs, or, three 20-pound type M45 practice bombs.

##### b. To Install the Type Q2 Bomb Rack.

(1) Assemble the attaching angles to the bomb rack operating bars with the bolts provided. Note that the bolt heads are on the inboard side of the assembly as illustrated in figure 47.

(2) Assemble the bomb rack to the bomb rack door with four bolts, two main attaching bolts as illustrated in figure 48, and one bolt at each end of the bomb rack. It is imperative that the heads of the two main attaching bolts are on the correct side of the bomb rack as illustrated in figure 48; otherwise they will foul the operating cams on the rack.

(3) Attach the two tension springs, one on either side of the bomb rack as shown in figure 48. Attach one end to the inboard hole on the attaching angle and the other end to the cocking lever support. Attach the third spring, which is shorter, to the hole in the cupped part of the cocking lever and to the small tab on the door assembly. (See figure 48.)

(4) Remove the bomb rack compartment cover plate from the under surface of the wing, outboard of the wing guns near the leading edge. (See figure 49.)

(5) Disconnect the control cables from the bell cranks on the inboard side of the wing gun compartment and pull the outboard clevis ends of the control cables through the wing bomb compartment opening far enough to lock the clevis ends into the remaining hole on the two attaching angles on the operating bars. (See figure 51.) Be sure that the cable clevis ends are attached to the proper attaching angle so that the cables do not cross.

(6) Remove the electrical disconnect plug from the stowage clip in the bomb rack compartment and make the connection to the plug on the bomb rack solenoid. (See figure 51.)

**NOTE:** Paragraphs (5) and (6) cannot be accomplished after the bomb rack is installed in the wing.

(7) As the bomb rack unit is lifted into position for attachment to the wing, push the control cables out of the bomb rack compartment to prevent any entanglement of the cables around the bomb rack as it is installed in the compartment. Align the holes in the bomb rack door with those in the wing and secure the door to the wing tentatively with six screws as illustrated in figure 52.

(8) Attach the control cables to the bell cranks in the gun compartment.

(9) Place the bomb control handle on the quadrant in the "LOCK" position, the arming control handle in the "SAFE" position and check for slack in the control cables. If slack is apparent in the cables, adjustments should be made with the turnbuckles at the bell cranks in the gun compartments. After adjustments have been made to the controls be sure that the turnbuckles on the rods in the wheel pocket and those in the gun compartment are secured by lock wires.

**c. To Install the Wing Bomb Sway Braces.** - Remove the sway braces from the tool kit in the duffle bag and screw the front braces into the holes provided in the under surface of the wing just forward of the bomb rack door. (See figure 52.) Install each aft sway brace with two bolts and washers in the holes provided in the wing aft of the bomb rack door. (See figure 53.) The bomb rack is now ready for a preliminary test.

##### d. Testing the Bomb Rack Installation.

(1) Place the release handle (marked "R") in the "SALVO" position and the arming handle (marked "A") in the "SAFE" position as illustrated in figure 54.

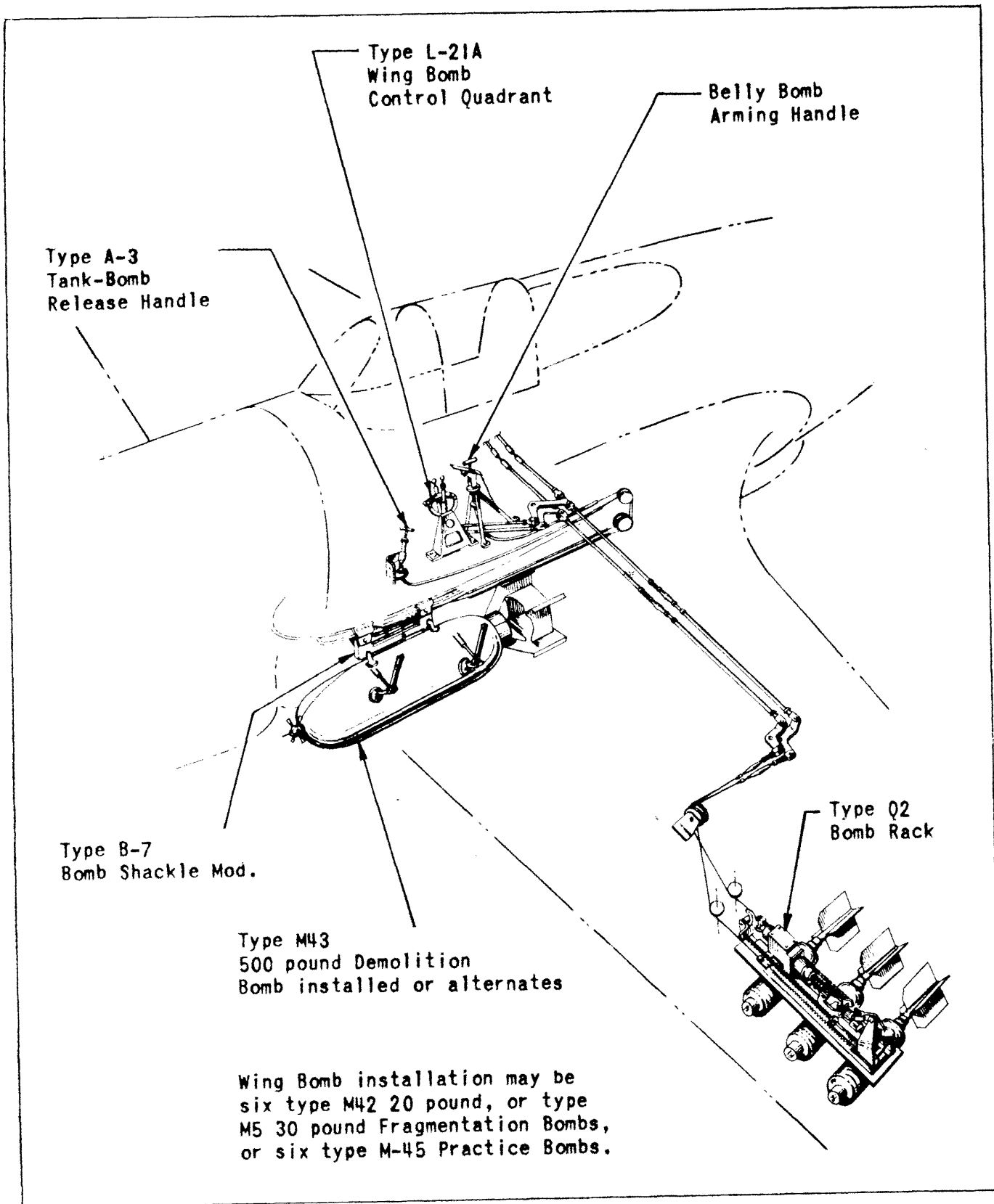


Figure 44 - Belly and Wing Bomb Controls

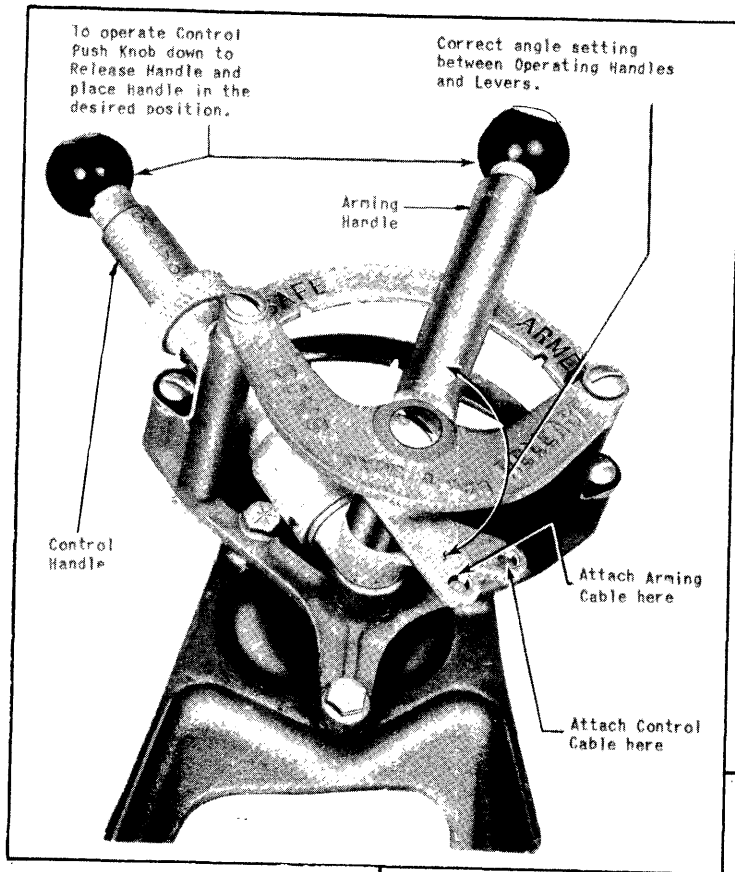


Figure 45 - Type L-21A Bomb Control Quadrant

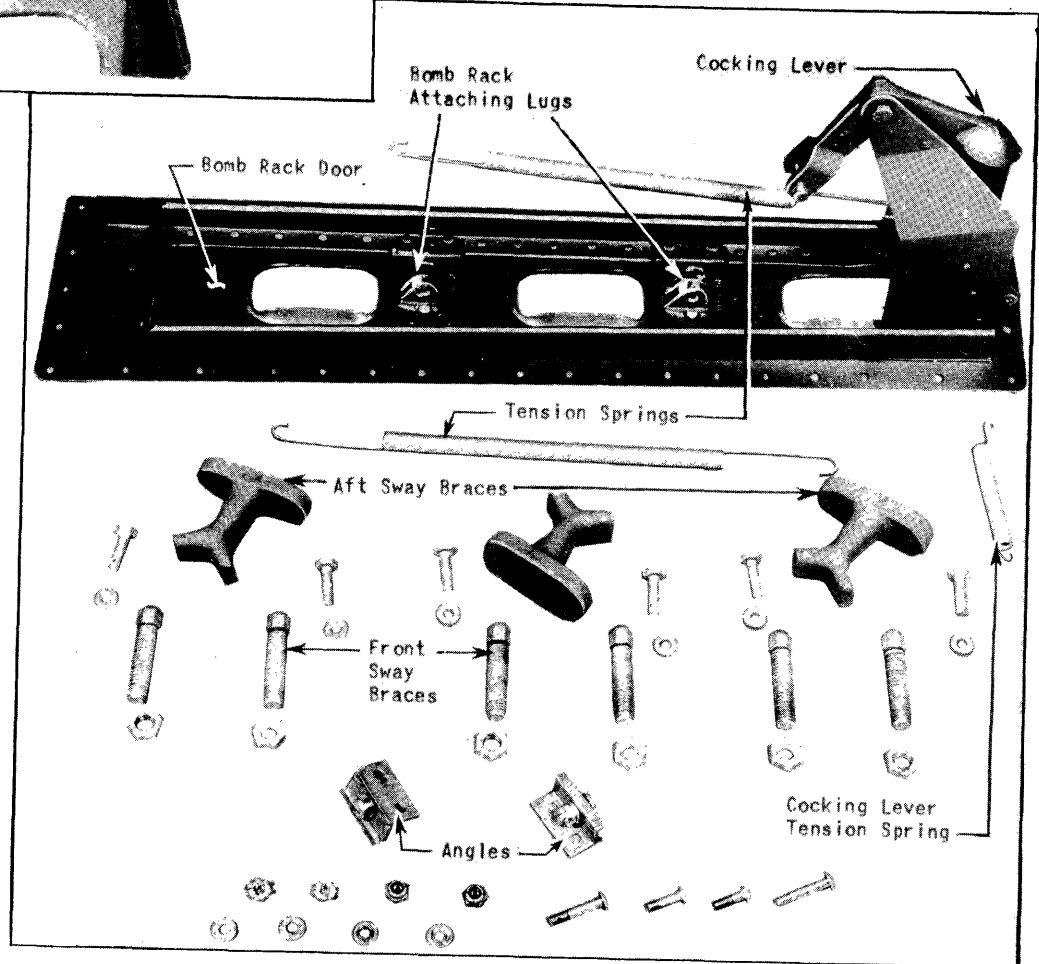


Figure 46 - Bomb Door, Sway Braces, and Accessories

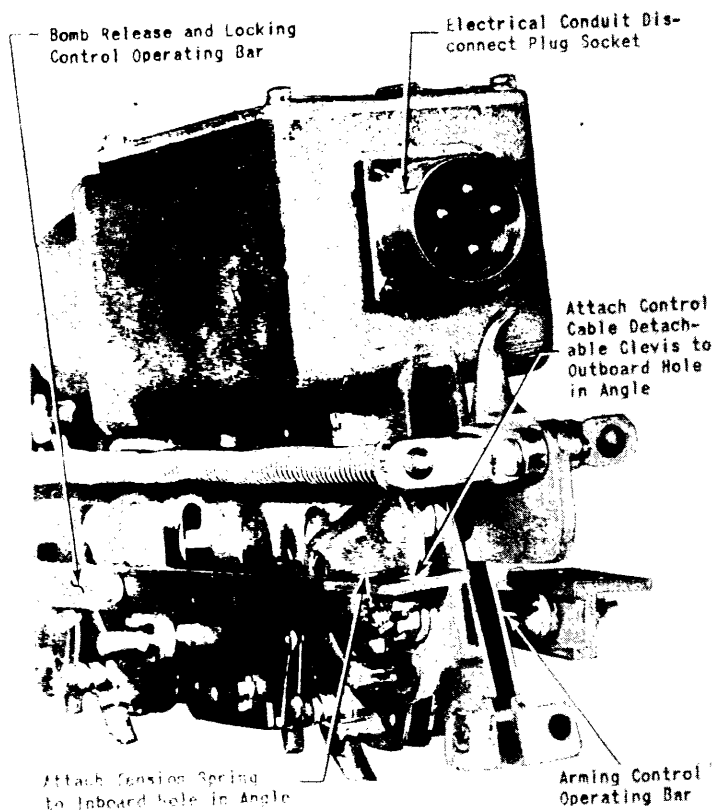


Figure 47 - Bomb Rack - Inboard End

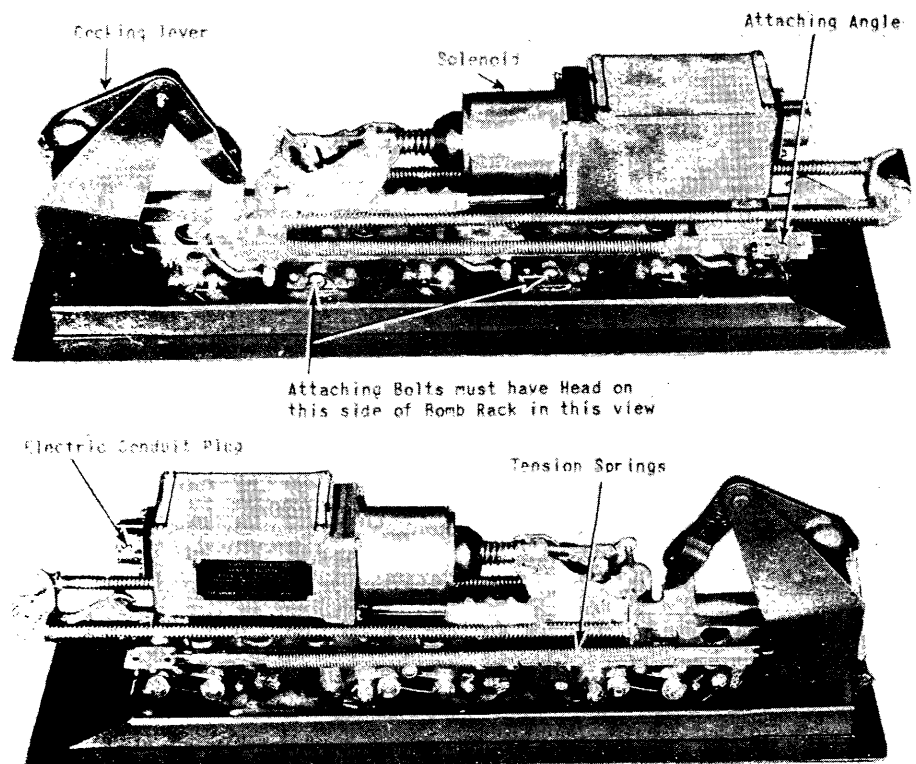


Figure 48 - Bomb Rack Assembly Ready for Installation

Figure 49 - Bomb Rack Compartment Access Door Removed

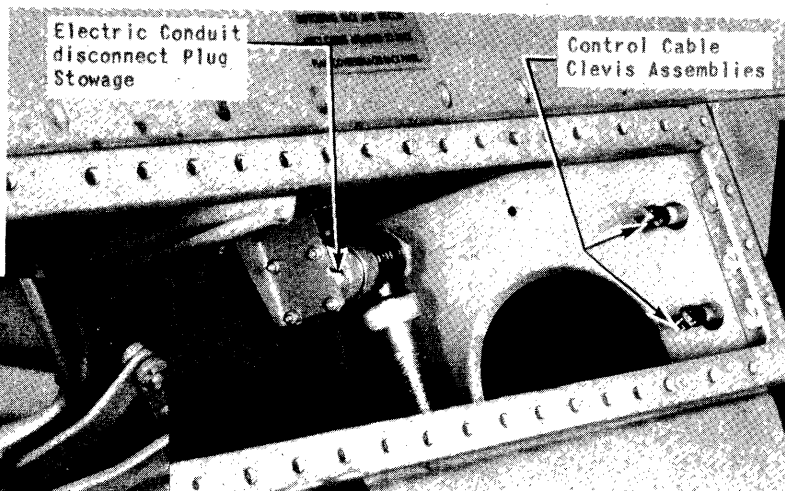
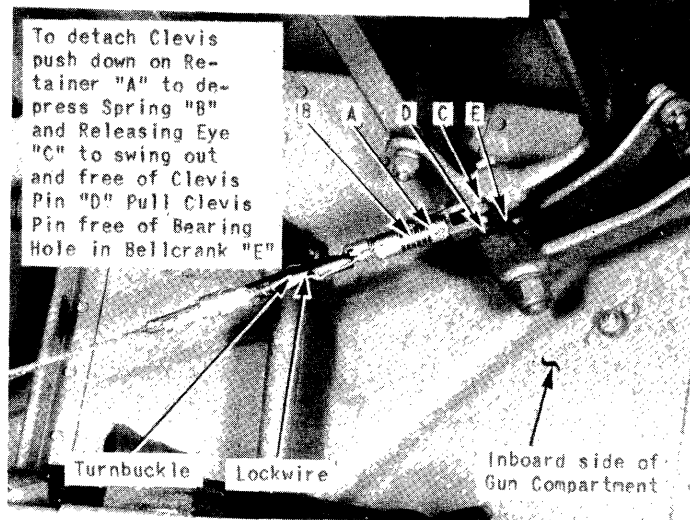


Figure 50 - Turnbuckle and Detachable Clevis - Wing Bomb Controls

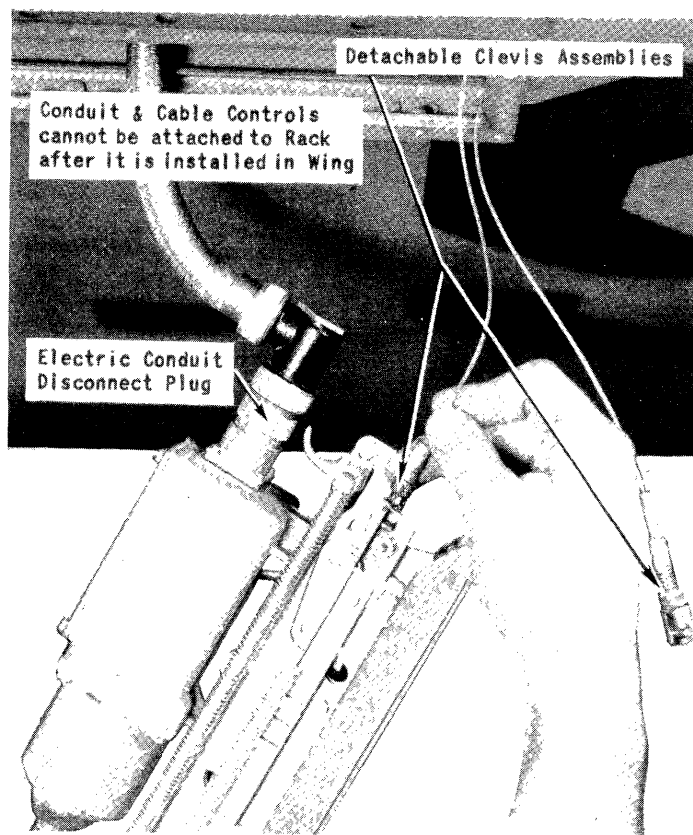


Figure 51 - Attaching Control Cable Clevis End to Bomb Rack

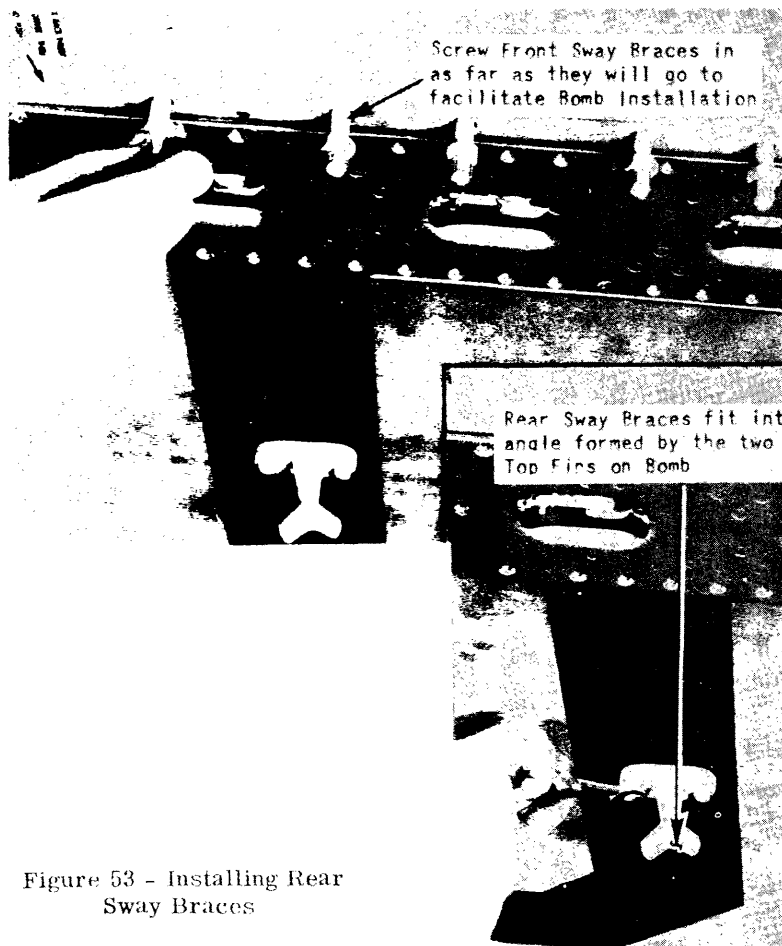


Figure 52 - Installing Front Sway Braces

Figure 53 - Installing Rear Sway Braces



Figure 54 - Bomb Control Quadrant - Salvo Position

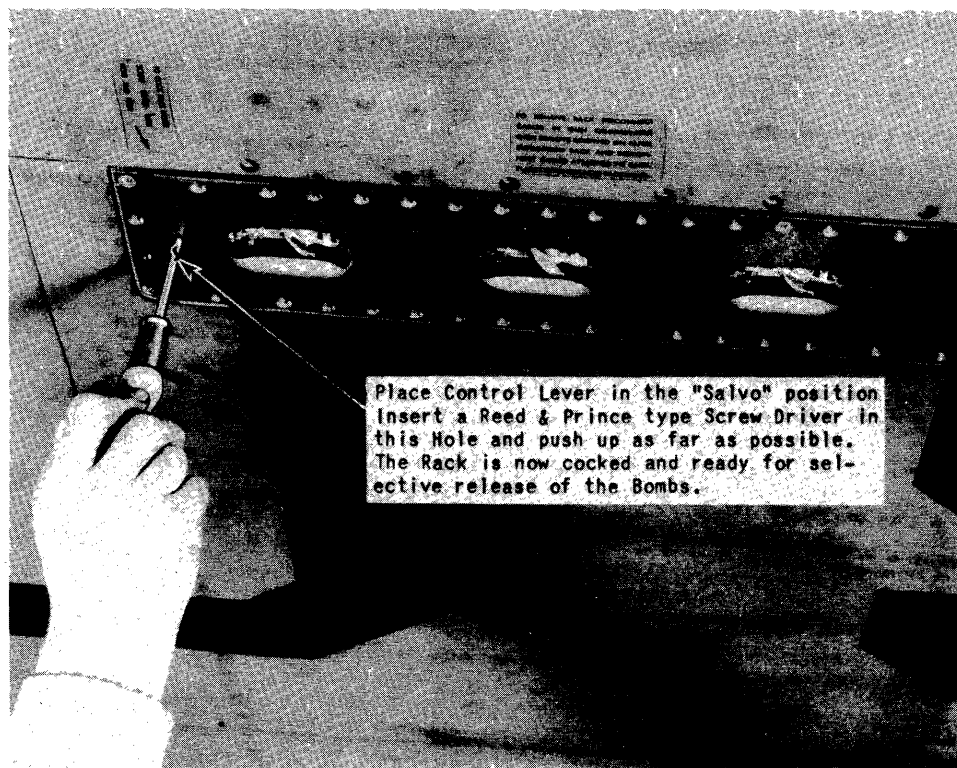
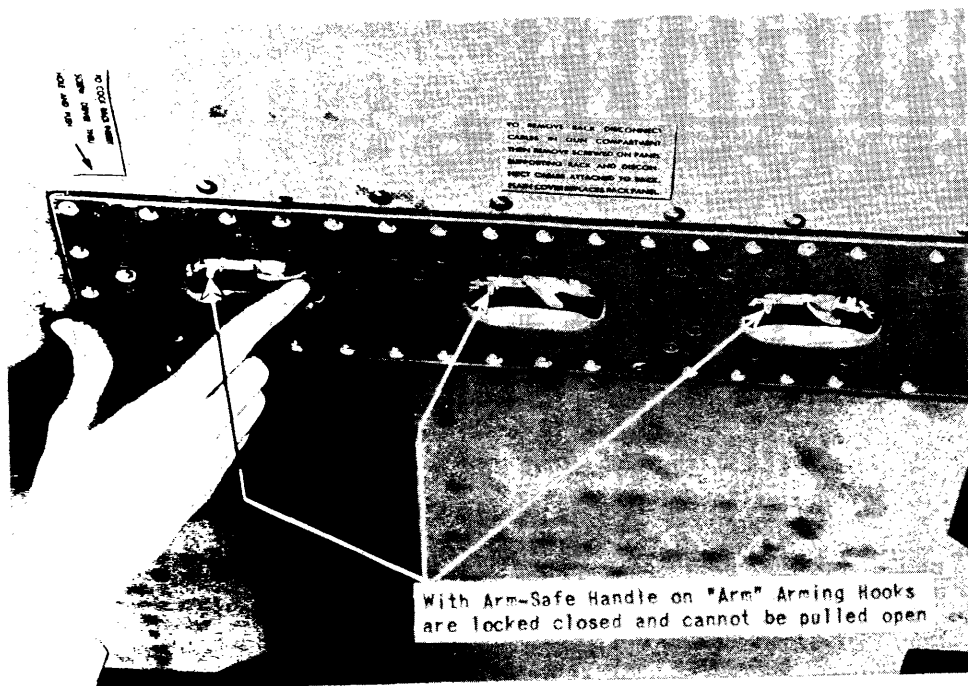


Figure 55 - Cocking Bomb Rack



Figure 56 - Bomb Control Quadrant - Selective Position





Place the Release Handle "R" in "Salvo" position and Arming Handle "A" in "Safe" position. Cock Bomb Rack with Phillips Screw Driver. Move Release Handle to "Selective" position and Latch Carrying Hook with forefinger as illustrated. Throw the Circuit Breakers and Bomb Switch to "On" position and turn battery switch to "Bat". Actuate Bomb Releasing Mechanism electrically by pressing Button on top of Hand Grip on Control Stick three times. Turn off Battery Switch. The Carrying Hooks on Bomb Rack should all be open.

Test Bomb Rack for Salvo Release as follows: Place Release Handle in "Salvo" position and Arming Handle in "Armed" position. Cock Bomb Rack with Phillips Screw Driver. Place Release Handle in "Selective" position. Latch Carrying Hooks with forefinger as shown. Place Release Handle in "Salvo" position. All Carrying Hooks on Bomb Rack should be open. Arming Hooks should be locked closed.

Figure 57 - Testing Bomb Rack Installation

(2) Cock the bomb rack with a Phillips or Reed and Prince type screw driver as illustrated in figure 55.

(3) Move the release handle to the "SELECTIVE" position as illustrated in figure 56.

(4) Latch the carrying hooks. (See figure 57.)

(5) Throw the circuit breakers and the bomb switch to the "ON" position and turn the battery switch to "BAT."

**WARNING:** Since the battery switch controls the engine ignition it is imperative that no one be in the vicinity of the propeller while the battery switch is on "BAT."

(6) Actuate the bomb rack releasing mechanism electrically by pressing the button on the top of the grip on the control stick three times. TURN OFF BATTERY SWITCH.

(7) After the operation outlined in paragraph (6) has been completed the carrying hooks on the bomb rack should all be open. The arming hooks should be in the unlocked condition and may be opened with the fingers.

(8) Test the bomb rack for Salvo release as follows:

(a) Place the release handle in the "SALVO" position and arming handle in the "ARM" position.

(b) Cock the bomb rack as illustrated in figure 55.

(c) Place the release handle in the "SELECTIVE" position. (See figure 56.)

(d) Latch the carrying hooks. (See figure 57.)

(e) Place the release handle in the "SALVO" position.

(f) All carrying hooks on the bomb rack should be open. Arming hooks should be locked closed.

(9) Test the bomb rack for the lock condition as follows: Place the release handle in the "LOCK" position and test the carrying hooks. All hooks should be locked either open or closed depending on their position prior to placing the release handle in the "LOCK" position. The bomb rack will not release electrically when the release handle is in the "LOCK" position as illustrated in figure 59.

(10) After this preliminary test has been made, install all remaining screws in the bomb rack door and tighten. The bomb rack is now ready for loading.

#### e. To Load the Wing Bomb Rack.

(1) Place the release handle on the quadrant in the "SALVO" position, then insert a screw driver of the Reed and Prince or Phillips type, in the hole at the outboard end of the bomb rack door and push up on the cocking lever as far as possible. This will cock the bomb rack for selective release of the bombs. After the rack has been cocked, pull the release control handle backward to "SELECTIVE" and place the arming control in the "SAFE" position.

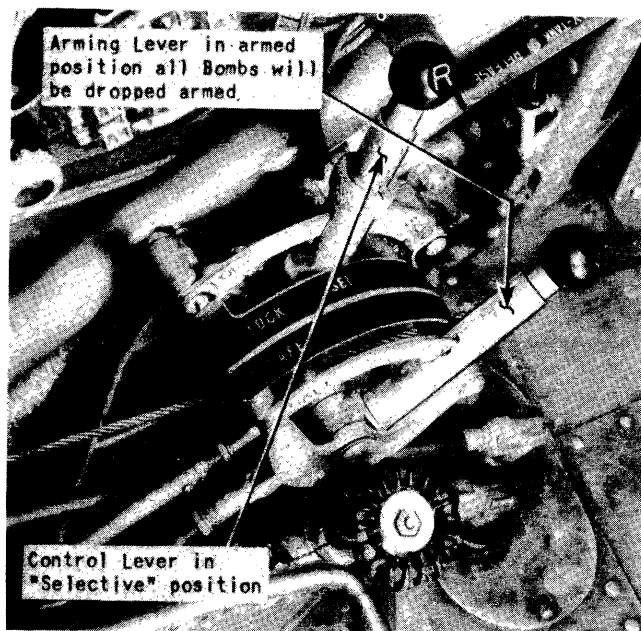


Figure 58 - Bomb Control Quadrant  
(Release Lever in "SELECTIVE" Position)



Figure 59 - Bomb Control Quadrant  
(Release Lever in "LOCKED" Position)

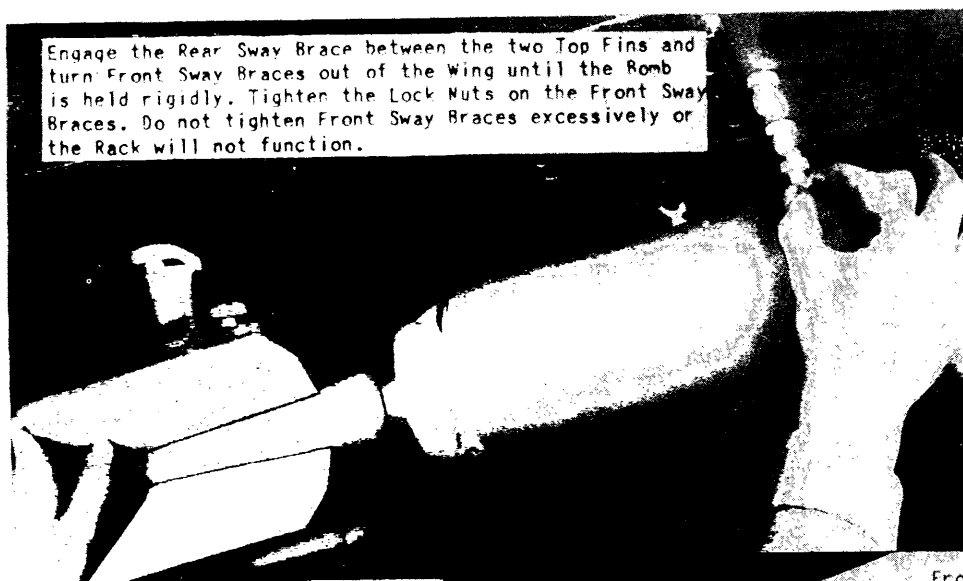


Figure 60 - Adjusting Front Sway Braces

Figure 61 - Three-Quarter Rear View Wing Bombs Installed

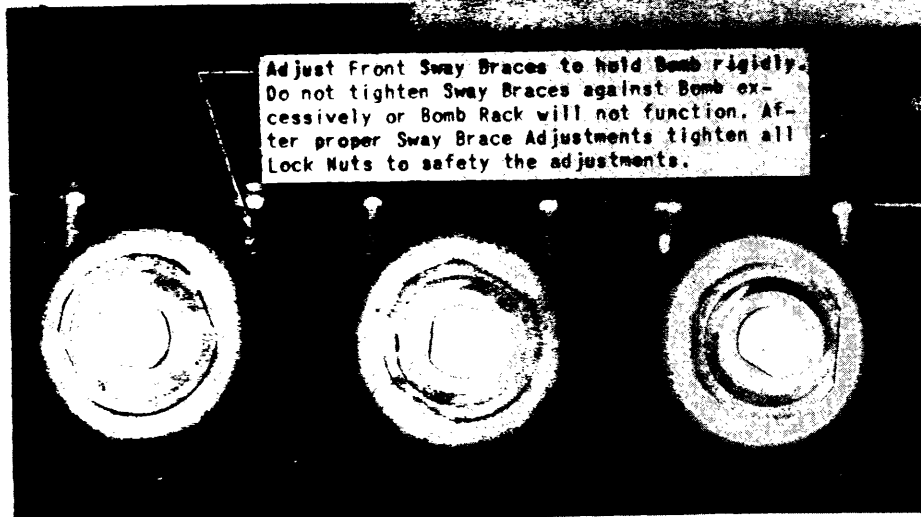


Figure 62 - Bombs Installed - Front Sway Braces Adjusted

(2) Screw the front sway braces in as far as possible.

(3) Raise the first bomb up to the rack and insert the carrying hook on the rack into the lug on the bomb. Then by pushing upward on the bomb the carrying hook will snap into the latched position securely holding the bomb. Be sure that the fins on the aft end of the bomb are properly engaged by the rear sway brace. (See figure 61.) A decided click will be heard when the latch is locked.

(4) Adjust the front sway braces until they hold the bomb rigidly. Do not tighten excessively or the rack will not function. Tighten the locking nuts on the sway braces. (See figure 60.)

(5) Follow this same procedure for the remainder of the bombs until all bombs are loaded.

(6) Pull the arming hook on the rack inboard to the open position and attach the looped end of the arming wire over the hook then release. The hook will snap to the closed position retaining the arming wire.

f. To Unload the Wing Bomb Racks.

(1) Be sure that the arming control lever is in the "SAFE" or fully aft position at all times when unloading.

(2) Place the release handle in the "SELECTIVE" position and one man can then unload the bombs.

(3) Grasp the bomb firmly in one hand and trip the carrying hook latch on the rack with a screw driver. Repeat this procedure until all bombs are unloaded.

(4) If the airplane is to be flown minus bombs under the wings, remove both the front and aft sway braces and stow them in the duffle bag. The bomb racks may be removed and the bomb rack compartment cover plates installed. When the airplane is flown minus a bomb load with the racks installed it is advisable to cover the rack opening with masking tape to safeguard the rack mechanism against grit, dirt, and other foreign matter which might impair the efficiency of the rack mechanism.

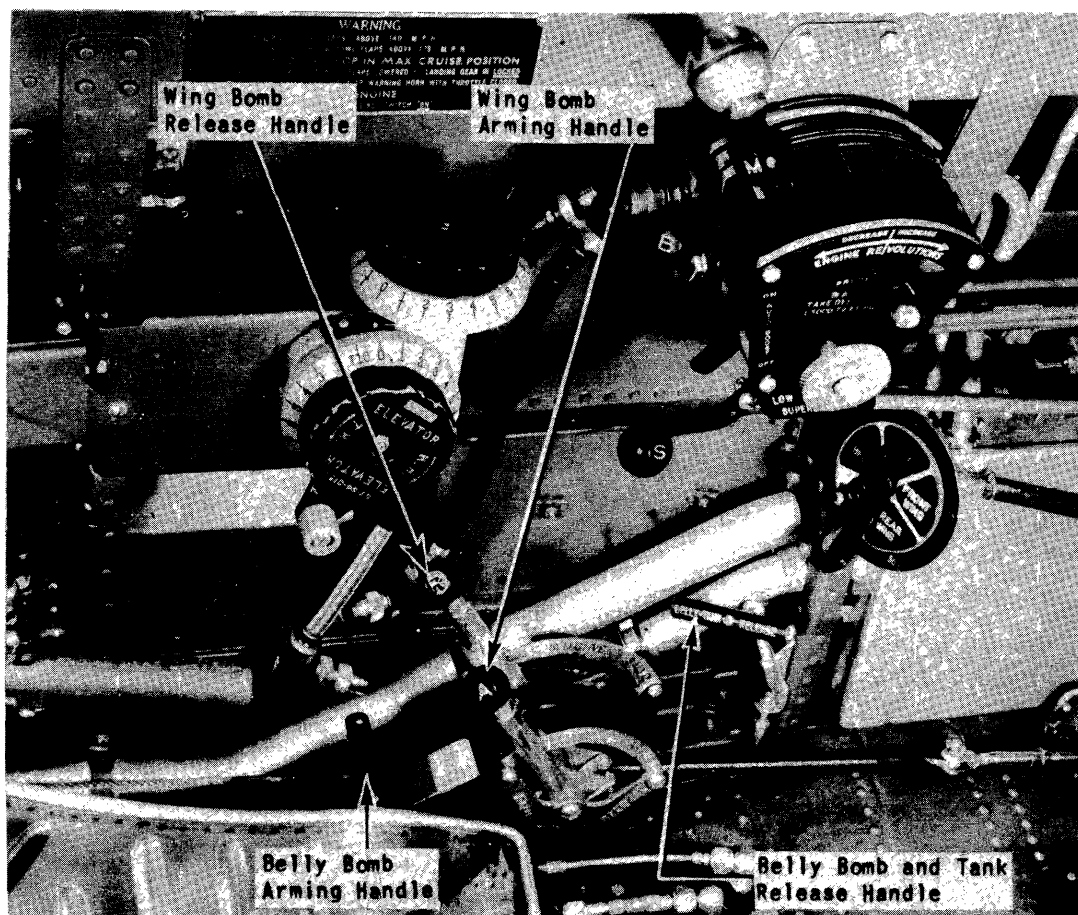


Figure 63 - Left Side of P-40F Cockpit Showing Bomb Control Handles

## SECTION III

BELLY BOMB AND BELLY FUEL TANK INSTALLATION

## 1. To Install the Belly Bomb.

a. General. - The 52- or 75-gallon belly tank and following bombs are alternate installations, only one being installed at a time:

500 lb Lake Erie Chemical	F-9350 A
600 lb Lake Erie Chemical	F-9000 A
300 lb Lake Erie Chemical	D-8900 A
300 lb Army Air Corps (M-31)	H-39B4770
500 lb Army Air Corps (M-43)	H-39B4771
500 lb Army Air Corps (M-32)	H-39B4773
325 lb Navy Depth Bomb MK. XVII	234547
500 lb Navy MK. XII MOD. 1	264692
500 lb Navy Practice MK. XI MOD. 1	227480
500 lb Navy MK. IX	227491
500 lb Navy MK. XII	227492
100 lb (M 39) MK. IMIII Demolition Practice	H-39B4766

The bombs or belly tanks are loaded on a type B-7 bomb shackle on the center line of the airplane below the keel fairing. The type A-3 release control handle is mounted on the aft side of station No. 3 bulkhead at the left side of the cockpit. The arming control handle is mounted on a tripod to the left of the pilot's seat. Four sway braces with adjustable turn-buckles retain the bomb or belly tank in a rigid attitude while in flight.

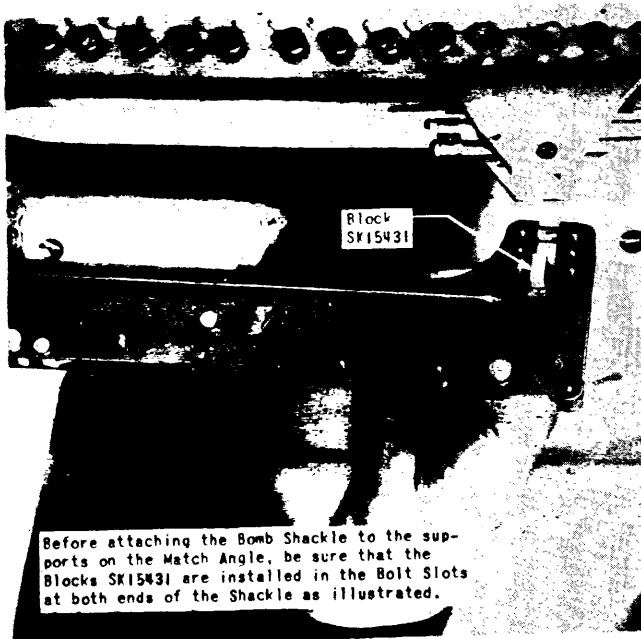


Figure 64 - Inserting Block in Shackle Prior to Installation on Support

b. To Install the Type B-7 Bomb Shackle. - Remove the keel fairing, insert the two blocks, SK15431, in the bolt slots, one on each end of the shackle and bolt the bomb shackle to the fore and aft support on the wing match angle as illustrated in figure 64. Safety the nuts with cotters. Attach the clevis end of the release cable to the bomb release lever at the forward end of the shackle. Attach the arming control cable which runs around the pulley on the front of the bomb shackle attaching bracket, to the arming lever at the top center of the shackle. (See figure 65.) Attach the short spring from the screw on the front shackle support to the bomb release lever on the shackle. Attach the long spring from the screw on the rear bomb shackle support to the arming lever on the bomb shackle. (See figure 66.) Remove the bomb shackle opening cover plate on the keel fairing and reinstall the fairing.

c. To Install the Sway Braces. - If the sway brace hinge fittings are installed on the lower surface of the wing, bolt the sway braces to the fittings and turn the nuts up snug but do not tighten excessively. Install cotter keys on all four hinge bolt nuts. If the hinge fittings are not installed on the wing, attach each fitting to the wing with two bolts. Be sure that the hinge fittings are installed in the proper location to accommodate the type of bomb to be loaded or the belly tank installation. There are three locations for the hinge fittings on the wing; the "Blue" location (inboard), the "Green" location (center), and the "Red" location



Figure 65 - Bomb Shackle - Attaching Release Lever Tension Spring

(outboard). The "Blue" location is used for all bomb loads except the 300-pound, 325-pound, and 100-pound bombs. The "Blue" location is also employed for the 52-gallon belly tank installation. (See figure 67.) Attach the inboard ends of the sway brace turnbuckles to their respective supports and safety pin the attaching bolts. (See figure 68.)

**NOTE:** Before the sway brace turnbuckles are attached at their inboard end, determine the type bomb to be loaded or belly tank installation because the turnbuckle barrels are interchangeable and must be properly installed to accommodate the different loads to be braced. The long barrels must be installed on the front turnbuckles to properly brace all 500-pound bombs and belly tanks. The short barrels must be installed on the front turnbuckles to properly brace the 325-pound, 300-pound, and 100-pound bombs.

#### d. To Load the 500-Pound Bombs.

(1) Before moving the 500-pound bomb into position for loading, 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 if they are installed and be sure that the front and rear sway brace feet are installed as illustrated in figure 68. The front feet must be attached at the long leg of the fitting while the back feet are attached at the short leg. It is imperative that the sway brace feet be installed in this manner to



Figure 66 - Attaching Tension Spring to Arming Lever

properly brace the bomb for instant release in flight. Be sure that the long barrels are installed on the front sway brace turnbuckles.

(2) Move the bomb under the shackle so that the two lugs on the bomb line up with the two carrying hooks on the shackle. (See figure 68.)

(3) Unbutton the front fuel drain access door on the left side of the keel fairing as illustrated in figure 68. If the carrying hooks are not open, insert a hand through the access door opening and pull back on the release lever at the forward end of the shackle as far as it will go. This action will release the carrying hooks.

(4) Be sure that the sway braces are adjusted so that they will not contact and foul the bomb when it is hoisted to the shackle.

(5) Raise the bomb to the shackle and guide the lugs up into the two carrying hook slots in the bomb shackle. (See figure 70.)

(6) When the bomb lugs are engaged in the shackle slots, insert a hand in the access door opening, push the lugs above the shackle which will move the carrying hooks up to their closed position, and pull back on the release lever a distance of approximately 1 inch to engage the carrying hook locking device. Slack off the hoisting cable until the weight of the bomb is retained by the carrying hooks. If the carrying hooks remain closed the carrying hooks are locked and the bomb loading mechanism may be removed.

(7) Adjust the sway braces with the turnbuckles to contact the bomb surface evenly and positively at all sway brace feet as illustrated in figure 69. Do not tighten sway bracing excessively or the shackle will not function. Be sure the bomb is secured rigidly in place before flying the airplane. Lockwire the turnbuckles as illustrated in figure 75.

(8) With the arming handle in the cockpit in the "SAFE" position insert a small screw driver or drift-pin into the hole immediately aft of the arming hook and apply pressure in the aft direction against the "SAFE" arming hook. Engage the loop of the arming wire in the hook slot on the rack and withdraw the pressure on the hook which will allow the spring loaded hook to return to its normal position and engage the loop on the arming wire. Be sure the Fahnstock friction clips are installed on the fore and aft end of the arming wire as required.

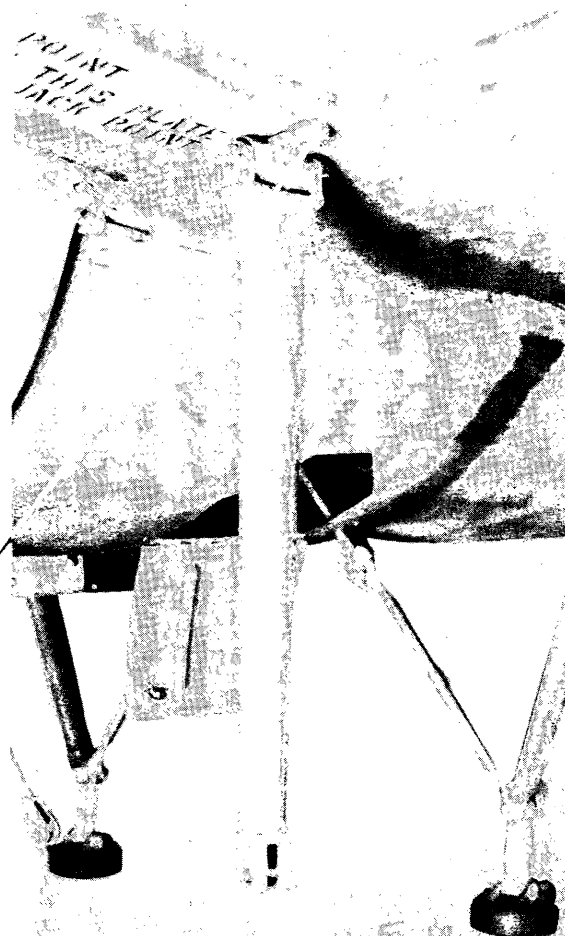
#### 2. To Unload the 500-Pound Bomb.

a. General. - When a 500-pound belly bomb is about to be unloaded be sure that the arming handle in the cockpit is in the down ("SAFE") position then proceed as follows:

(1) Attach the loading mechanism cable or move a bomb truck under the bomb and take up the slack in



"Blue" Location (Inboard) of the Front Sway Brace Hinge Fitting is used for all Bomb Loads except the 300 and 325 pound Bombs. The 52 gallon Belly Tank is also installed with the Front Braces in the "Blue" Location.



"Red" Location (Outboard) is employed for loading the 300 and 325 pound Bombs as well as the 75 gallon Belly Tank.

Figure 67 - Front Sway Brace in the "Blue" and "Red" Locations

Before loading 500 pound Bomb, be sure that the Front Sway Brace Hinge Fittings are in the "Blue" (Inboard) Location as illustrated. Also be certain that the Sway Brace Feet are installed as illustrated, the Front Feet at the Long Leg and the Back Feet at the Short Leg, also unbutton the Fuel Drain Access Door as shown to release the Carrying Hooks for loading and to securely lock the Hooks when Bomb is loaded.

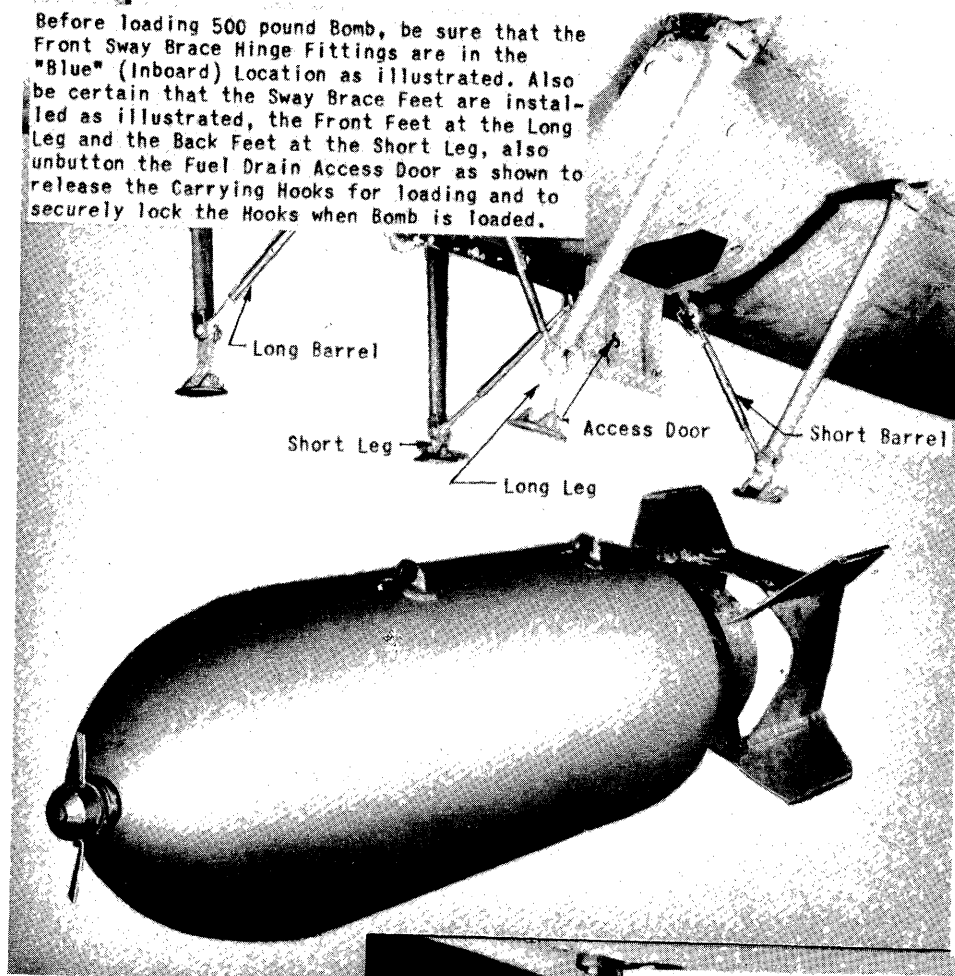


Figure 68 - 500-Pound Bomb Ready for Loading

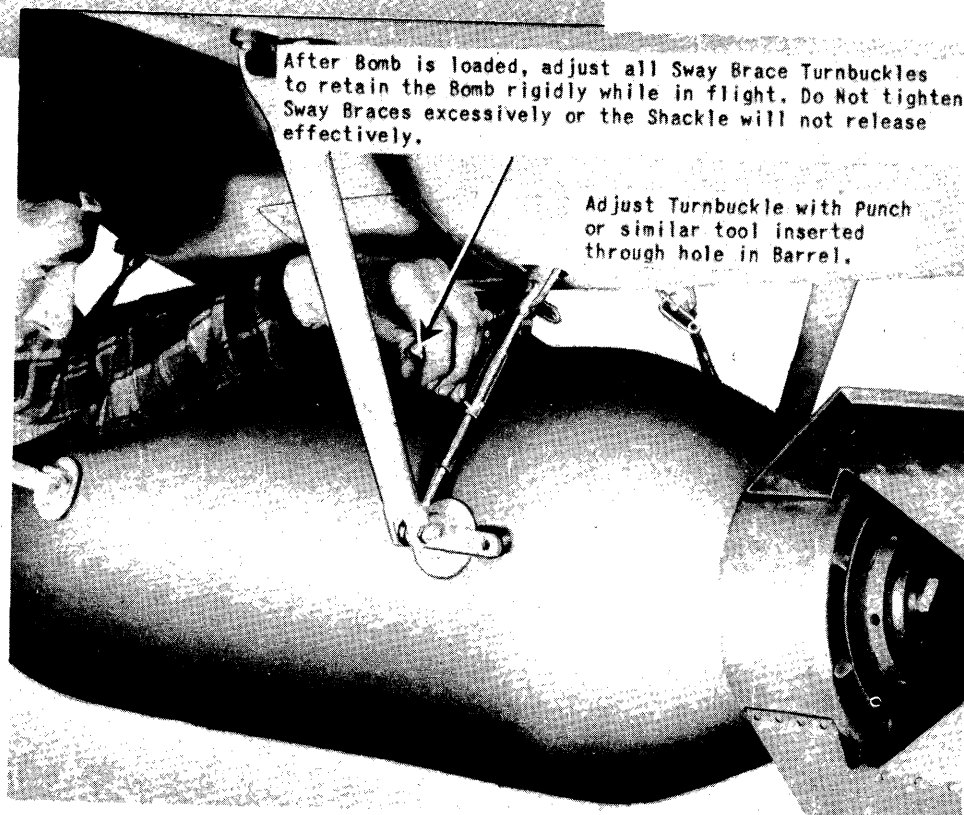


Figure 69 - Adjusting Sway Brace Turnbuckle on 500-Pound Bomb



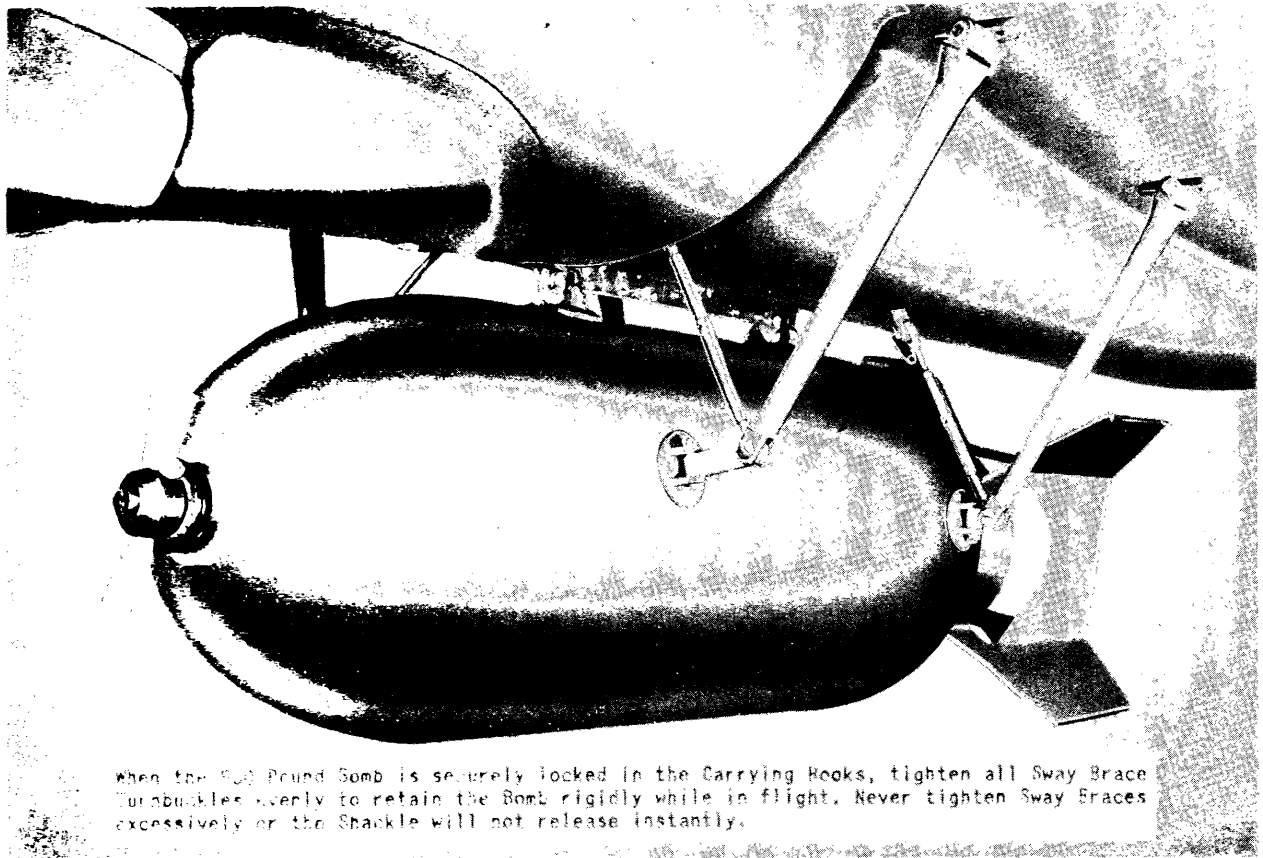


Figure 70 - 500-Pound Bomb Loaded - Sway Braces Adjusted

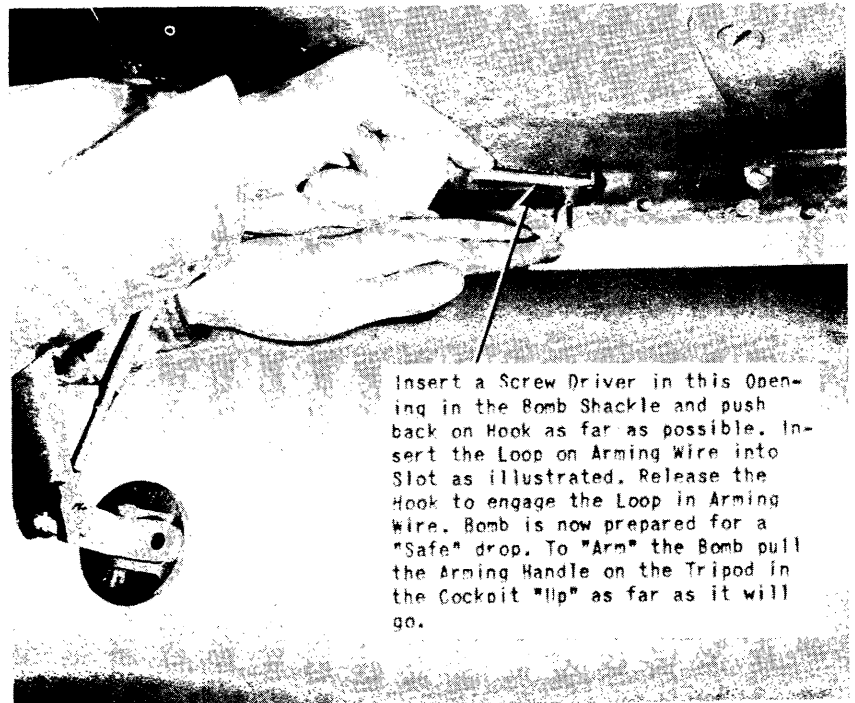


Figure 71 - Attaching Arming Wire to Arming Hook

the cable or hoist truck. Back off the sway brace turnbuckles until all sway brace feet are free of the bomb. Pull the loop end of the arming wire from the shackle arming hook by hand.

(2) Unbutton the fuel drain access door and insert a hand to pull the release lever back as far as possible to unlock the carrying hooks engaged in the bomb lugs. Lower the bomb on a truck and remove it from under the airplane.

### 3. To Install the 52-Gallon Belly Fuel Tank.

a. General. - The belly fuel tank with a 52-gallon capacity may be installed in place of the belly bomb when an extra fuel load is required. Install the 52-gallon belly tank as follows:

(1) Before moving the belly tank under the fuselage for installation be sure that the front sway brace hinge fittings are in the "Blue" location and that all sway brace feet are attached to the short leg of the fittings as illustrated in figure 74. Install the rubber pads on all the feet and be sure that the long barrels are installed on the front turnbuckles.

(2) Be sure all sway braces are backed off so that they will not foul the tank when raised to install in the shackle.

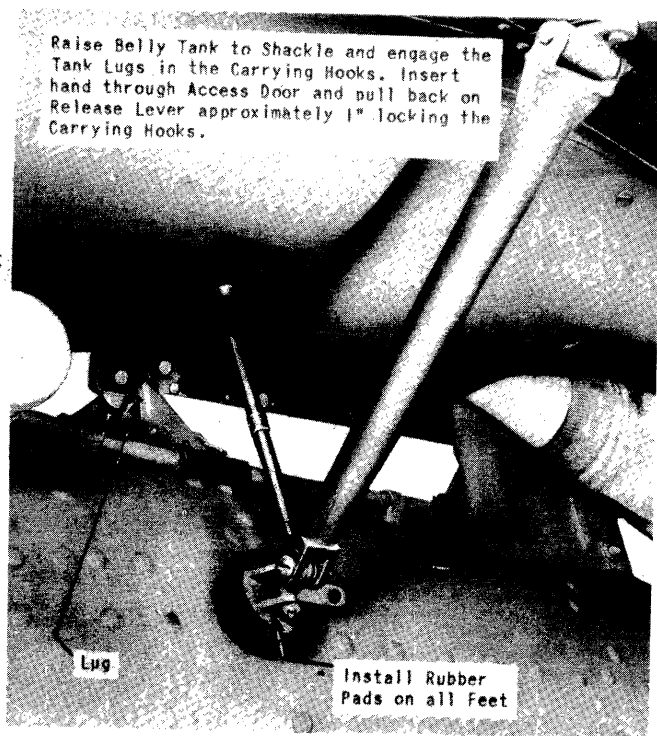


Figure 72 - Locking Carrying Hooks with Belly Tank Installed

(3) Unbutton the front tank fuel drain access door on the keel fairing and insert a hand to pull the release lever back until the carrying hooks are open.

(4) With a man at each end of the belly tank, raise the tank and guide the fuel supply line on top of the tank into the synthetic rubber fitting on the bottom of the exit duct forward of the bomb shackle. (See figure 74.)

(5) Raise the tank until the lugs on the top of the tank are inserted in the slots on the bomb shackle. (See figure 72.)

(6) Insert a hand through the fuel drain access door as illustrated in figure 72, push the two carrying hooks up to the lock position and pull back on the release lever on the bomb shackle approximately 1 inch to engage the carrying hook locks.

(7) Unbutton the oil drain access door on the right side of the exit duct. Working through this access door remove the synthetic rubber cap on the fuel line to the fuel cock and complete the connection between the tank line and fuel cock line with a short length of synthetic rubber hose. Tighten the clamps at either end of the hose connection. Stow the synthetic rubber cap in the tool kit on the duffle bag. On all P-40F airplanes, due to the difference in design of the exit duct, it will be necessary to unbutton the Dzus fasteners on the fuel strainer access fairing and turn the fairing to one side to gain access to the belly tank and fuel cock connection as illustrated in figure 76. Remove the synthetic rubber cap and complete the hose connection as outlined above.

(8) Adjust the sway braces at the turnbuckles as illustrated in figure 73 to hold the tank rigidly when the airplane is in flight. Lockwire the turnbuckles as illustrated in figure 75.

### 4. To Remove the 52-Gallon Belly Fuel Tank.

a. Drain the tank through the drain cock on the bottom of the tank and be sure all safety precautions are taken to prevent fire or explosion. Have at least two hand fire extinguishers within reach as an extra precaution against fire.

b. Unbutton the oil drain access door on the right side of the exit duct and loosen the two clamp fittings on the synthetic rubber hose connection on the fuel supply line to the fuel cock. Take the synthetic rubber cap from the tool kit and install it on the end of the fuel cock inlet line. On all P-40F airplanes unbutton the fuel strainer access door and swing to one side as illustrated in figure 76. This will provide easy access to complete the steps outlined above.

c. Cut the lock wire and loosen the sway braces by backing off the turnbuckles a few turns.

d. Unbutton the fuel tank drain access door and with a man supporting the tank at the fore and aft end,

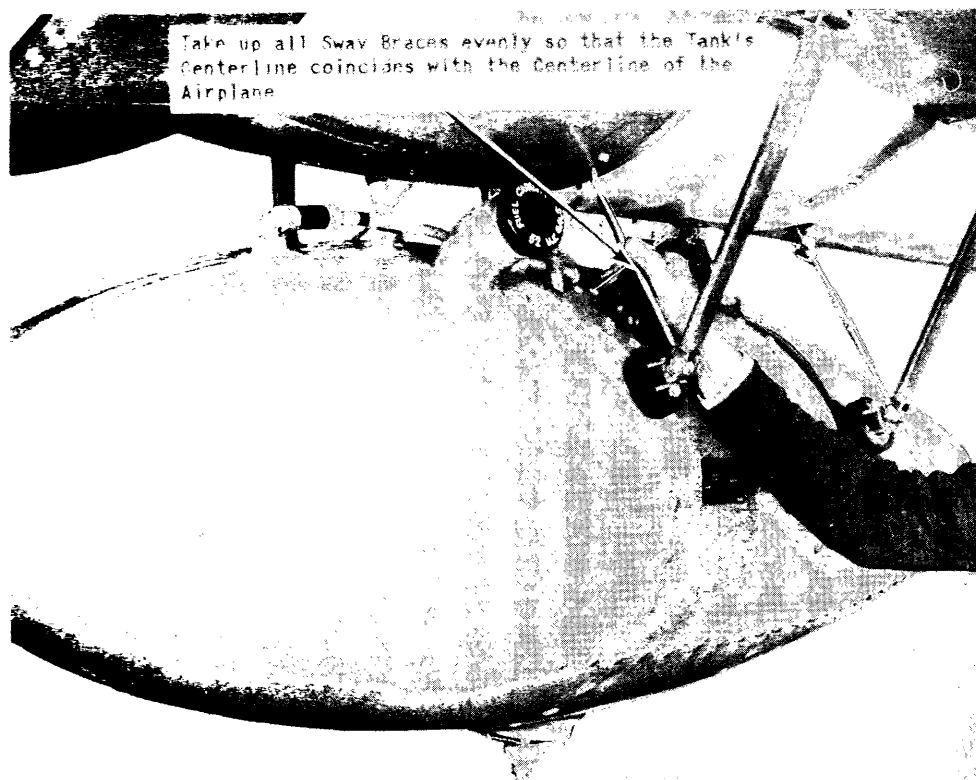


Figure 73 - Adjusting Sway Brace Turnbuckle

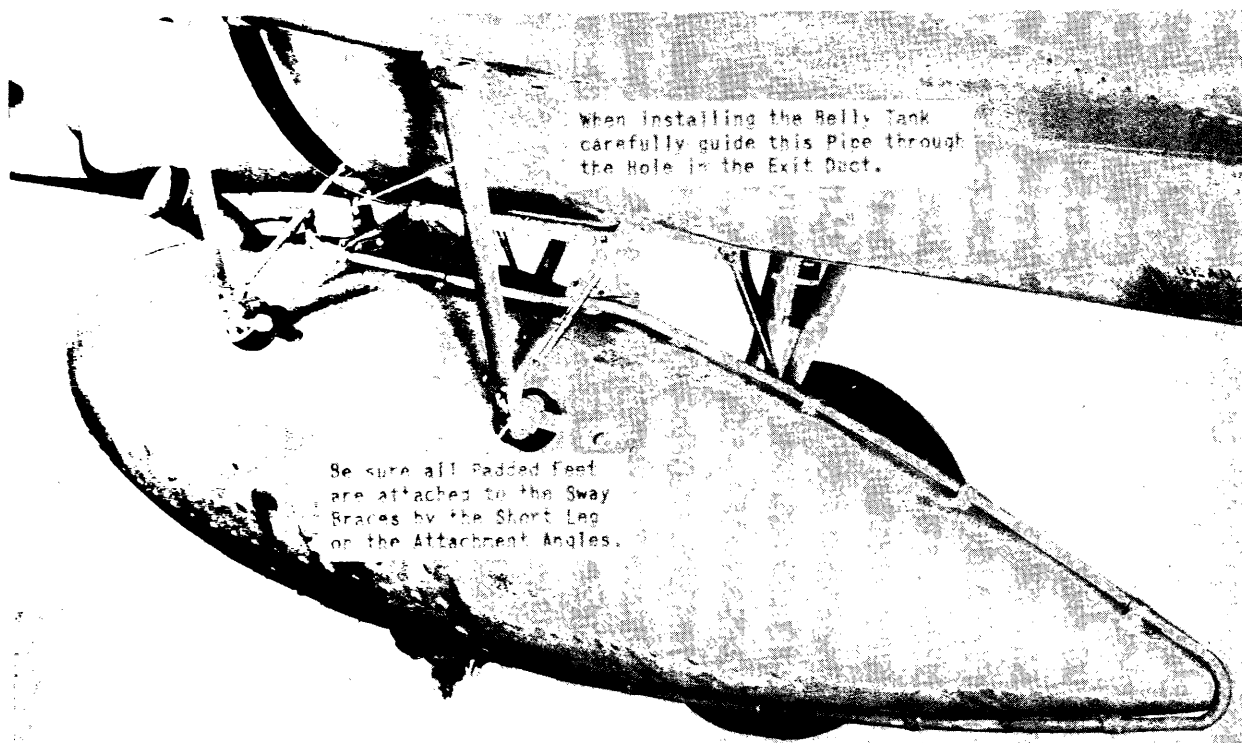


Figure 74 - 52-Gallon Belly Tank Installed

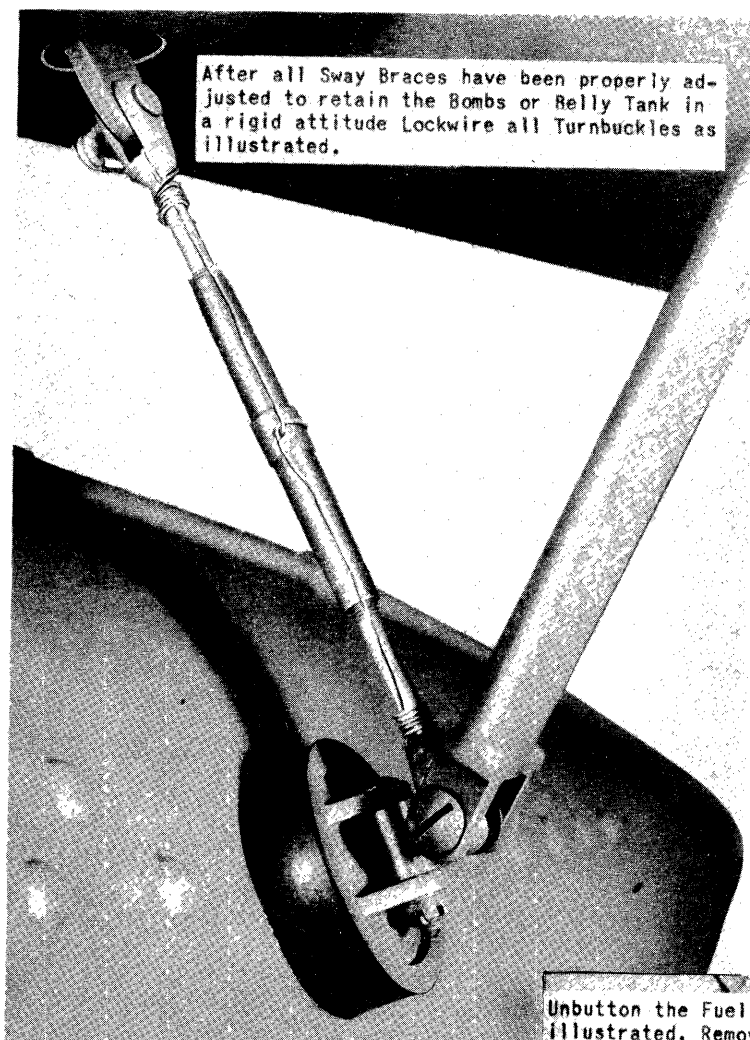


Figure 75 - Aft Sway Brace  
Turnbuckle Lockwired

Unbutton the Fuel Strainer Access Fairing and swing it to one side as illustrated. Remove the Neoprene Cap on the Fuel Cock Inlet Line and complete the hose connection between the Belly Tank Feed Line and the Fuel Cock Line. Tighten the Clamp Fittings on either end of the Short Connecting Hose. Do not tighten these Clamps excessively.

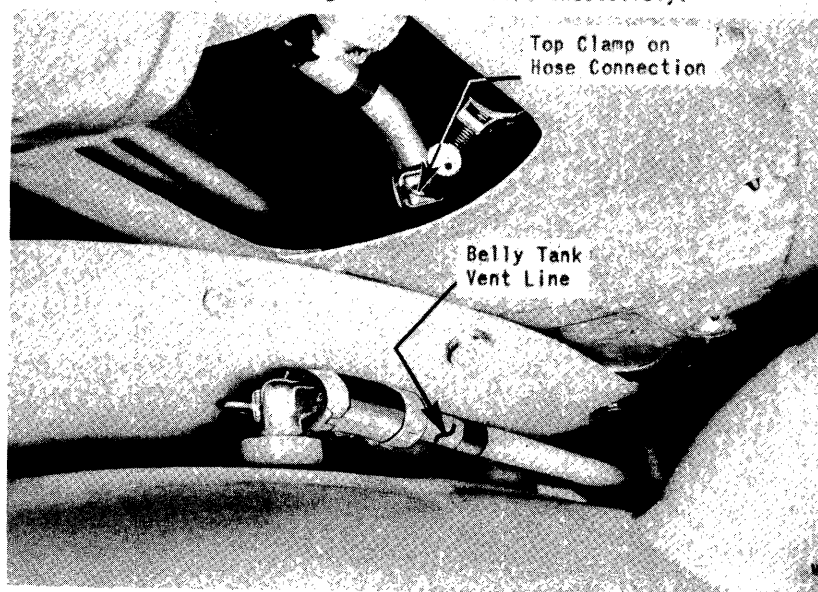


Figure 76 - Access to Belly Tank Fuel Line  
Connection on P-40F Airplane

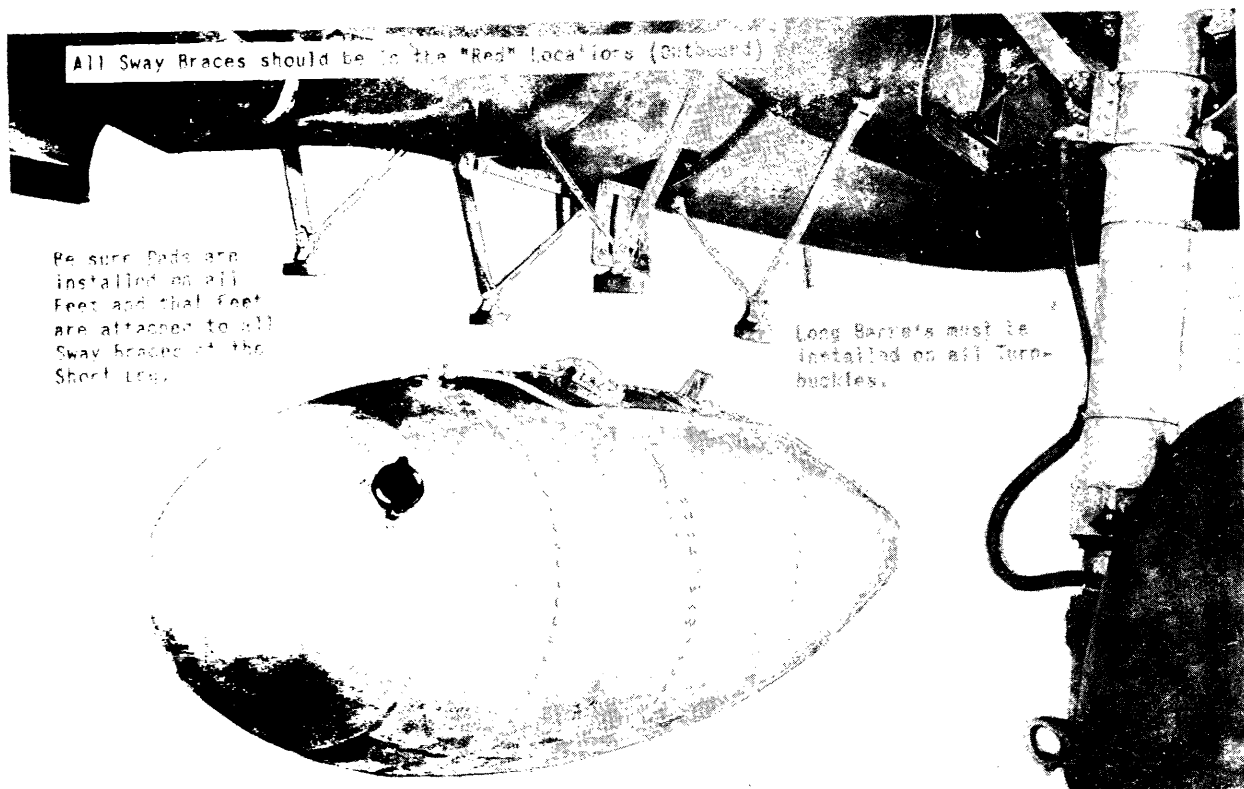


Figure 77 - 75-Gallon Belly Tank Ready for Installation

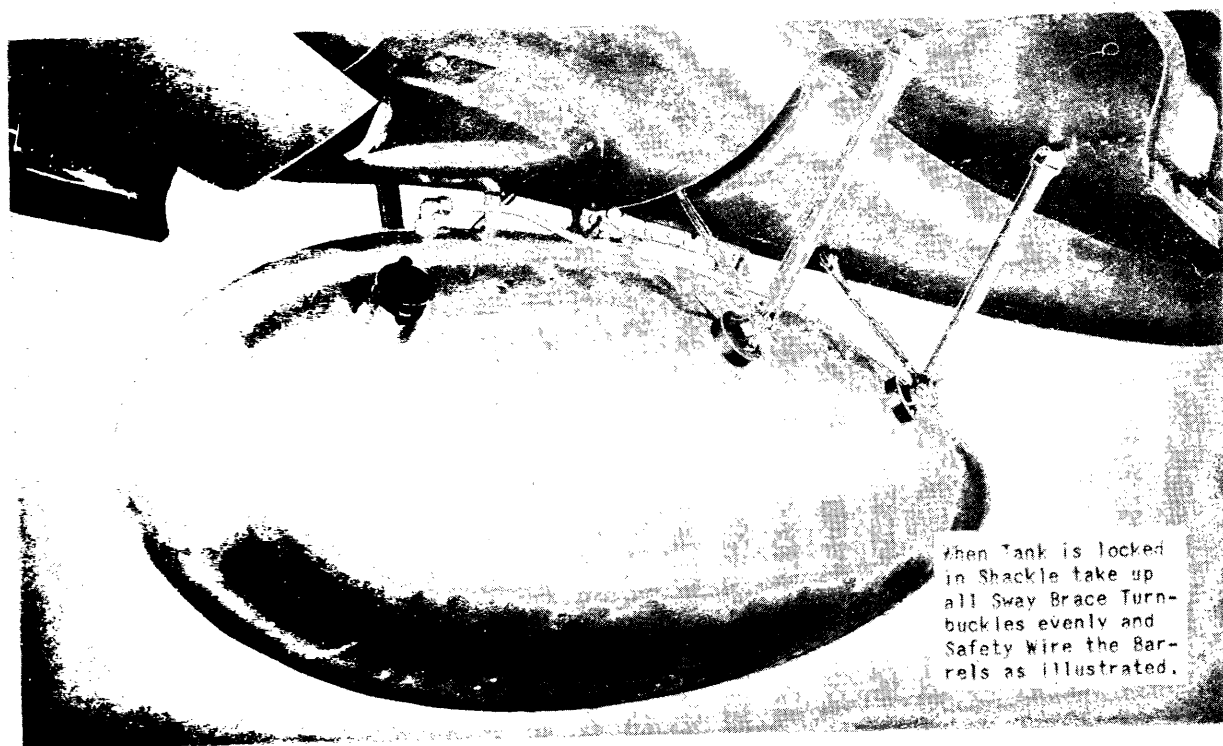


Figure 78 - 75-Gallon Belly Tank Installed

insert a hand in the access door as illustrated in figure 72 and pull back on the release lever as far as possible. This will release the carrying hooks and allow the tank to drop free of the shackle. Use extreme caution when removing the tank not to damage the short feed line connection on top of the tank. Remove the tank from under the airplane and if the tank is not completely empty of fuel be sure and keep the tank upright until it is thoroughly drained. Spilling fuel creates a dangerous fire hazard and extreme care should always be exercised against spilling fuel on depot or hangar floors. If fuel is accidentally spilled, clean it up immediately.

#### 5. To Install the 75-Gallon Belly Fuel Tanks.

a. General. - The 75-gallon belly tank may be installed on the bomb shackle when a greater fuel load is desired. Install the 75-gallon tank as follows:

(1) Before moving the tank under the fuselage be sure that all sway brace hinge fittings are attached to

the wing at the "Red" location (outboard), and that all feet have their pads installed and are attached at the short leg to the sway braces.

(2) Install long barrels on all sway brace turnbuckles. (See figure 77.)

(3) Proceed with the installation as outlined in 3.a.(2) through (8).

#### 6. To Remove the 75-Gallon Belly Tank.

a. If it is desired to remove the 75-gallon belly tank on the ground proceed as follows:

(1) Siphon or pump the fuel from the tank if the tank is full. Observe all safety precautions and have at least two fire extinguishers within reach to safeguard against fire.

(2) After the tank is emptied follow the procedure outlined in 4.b. through d.

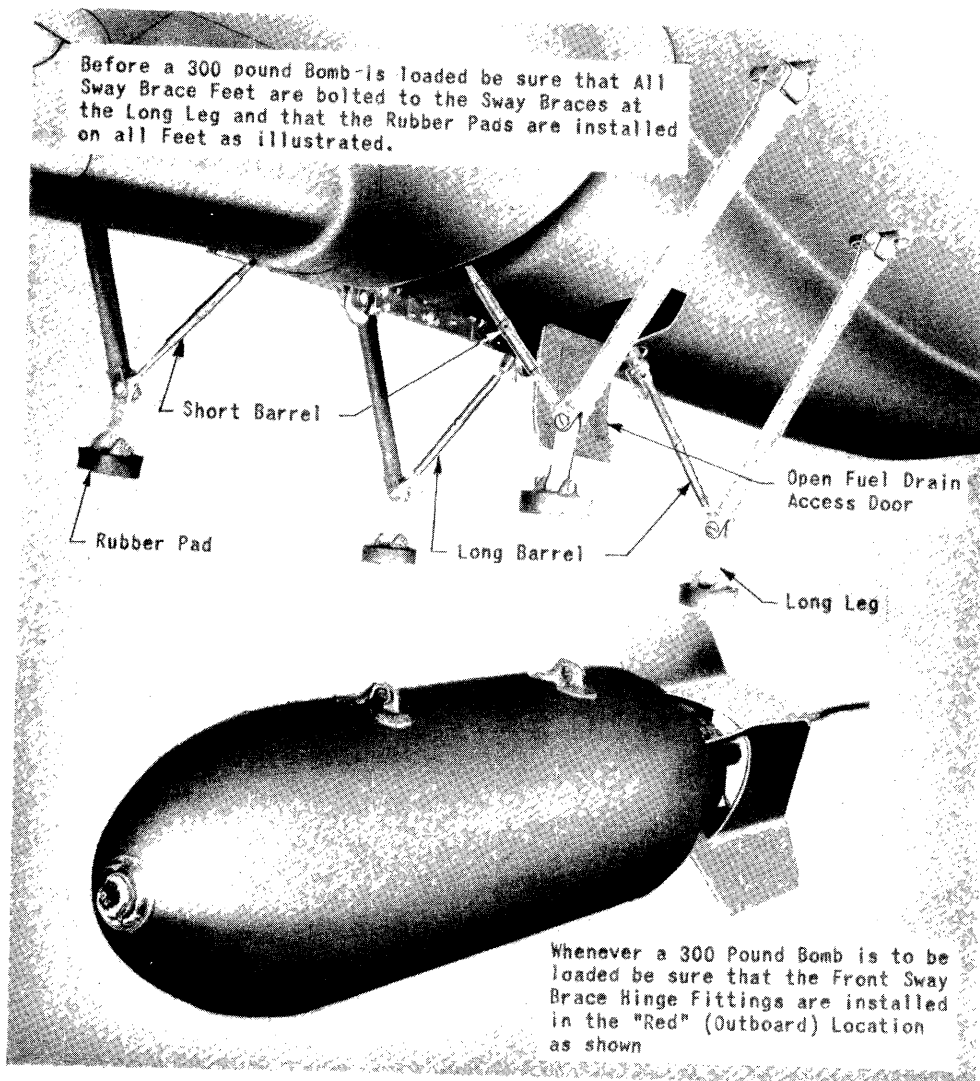


Figure 79 - 300-Pound Bomb Prior to Loading

7. To Load the 300-Pound Belly Bomb.

a. To load the 300-pound belly bomb the same procedure should be followed as employed for loading the 500-pound bomb with the following exceptions:

(1) Move the front sway brace hinge fittings from the "Blue" location (inboard) to the "Red" location (outboard) as illustrated in figure 79. Be sure that the short barrels are installed on the front sway brace turnbuckles. (See figure 79.)

(2) All sway brace feet should be attached with the long angle leg as illustrated in figure 79 and rubber pads should be installed on all sway brace feet as shown in figure 79.

b. After these changes have been made the loading of the 300-pound bomb in the carrying hooks on the shackle is exactly the same as that of the 500-pound bomb.

c. To arm the 300-pound bomb employ the same procedure outlined in d.(8), for the 500-pound bomb.

8. To Unload the 300-Pound Bombs.

a. Unload the 300-pound bomb exactly the same as the 500-pound bomb.

9. To Load the 100-Pound Type M 39 Practice Bomb.

a. Be sure that the hinge fittings on the front sway braces are attached to the wing at the "Blue" location (inboard) and the rear sway brace fittings at the "Green" location (center). Short barrels should be installed on all sway brace turnbuckles.

b. Disconnect the turnbuckles at the clevis bolt and install the special eyebolt extensions, with one nut, to the turnbuckle supports. Attach the turnbuckle clevis ends to the eyebolts as illustrated in figure 82.

c. Be sure that the sway brace feet are attached by the long leg on the fittings as illustrated in figure 83, and that the rubber pads are installed on the front feet only.

d. Load the 100-pound bomb in the shackle the same as the 300- and 500-pound bombs and tighten the

Raise Bomb up to Shackle and Guide Bomb Lugs into Carrying Hook Slots on Shackle. Raise Bomb until Bomb contacts Carrying Hooks and closes them. Insert a hand through the Access Door as illustrated and pull back on the Release Lever approximately one inch. This action will lock the Carrying Hooks.

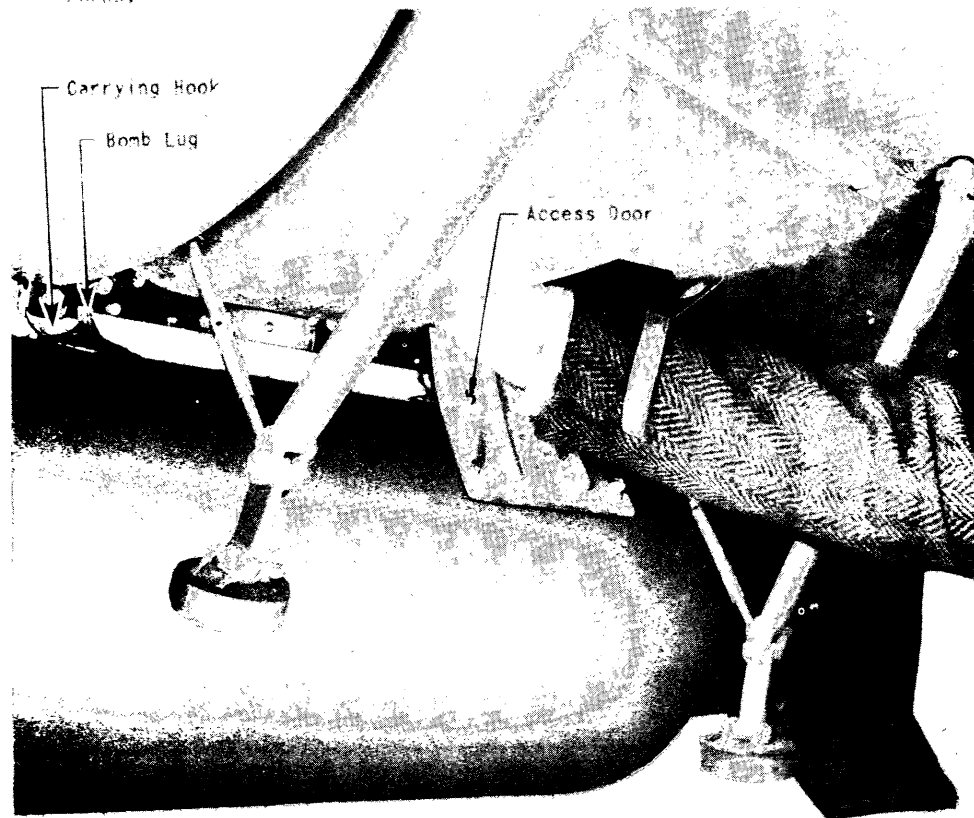


Figure 80 - Locking Carrying Hooks on Bomb Shackle  
300-Pound Bomb Loaded



sway braces. Never tighten the sway bracing excessively or the shackle will not function properly. Lockwire the sway brace turnbuckle barrels.

10. To Unload the 100-Pound Type M 39 Practice Bomb.

a. To unload the 100-pound practice bomb follow the same procedure outlined in paragraph 2.a.(1) and (2) in this section.

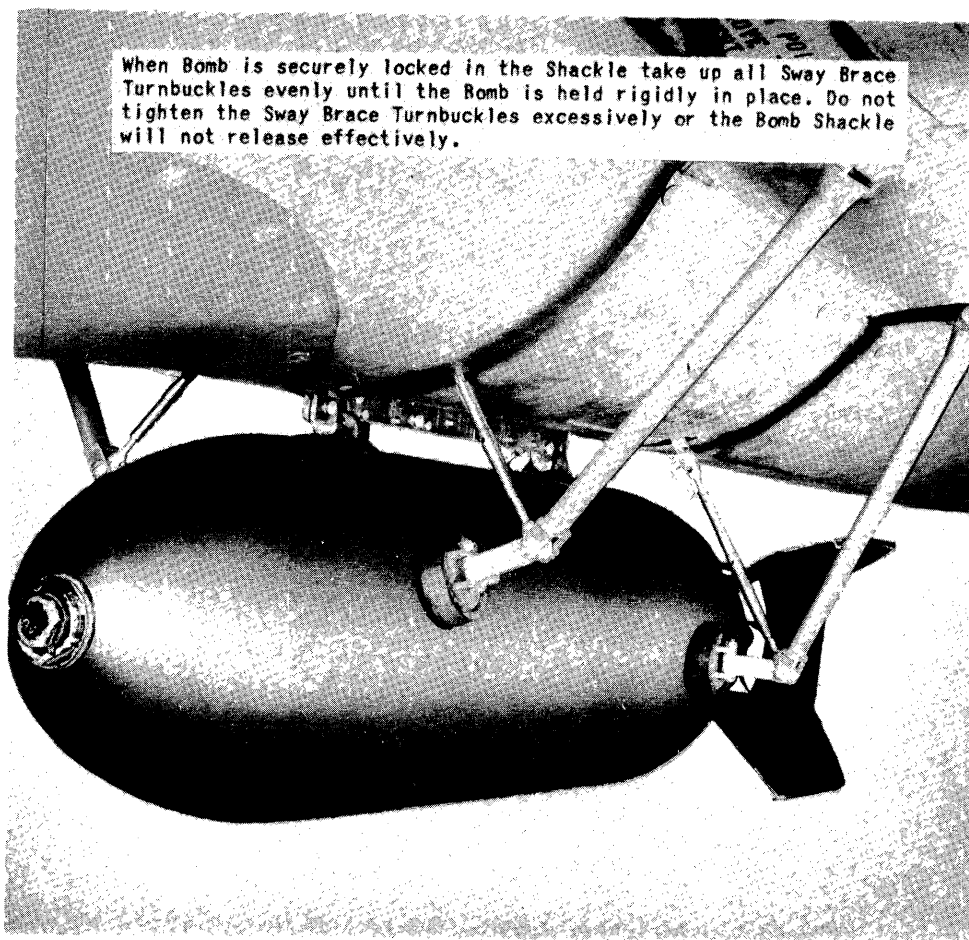


Figure 81 - 300-Pound Bomb Loaded -  
Sway Braces Adjusted



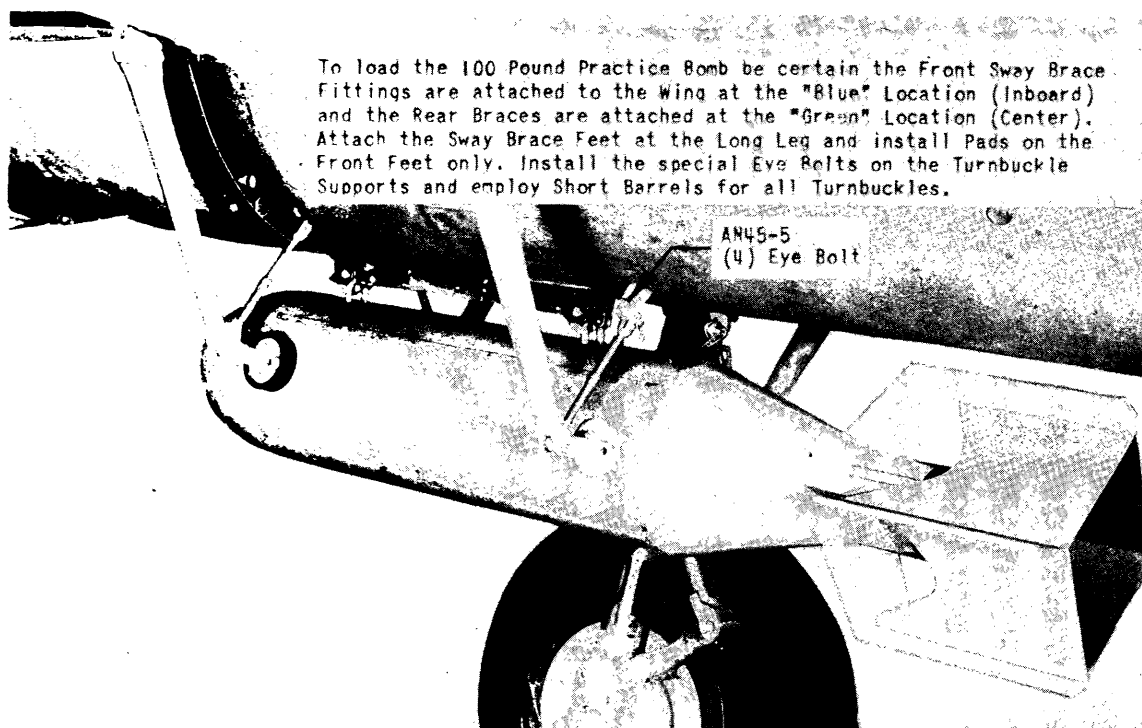


Figure 82 - 100-Pound Practice Bomb Loaded

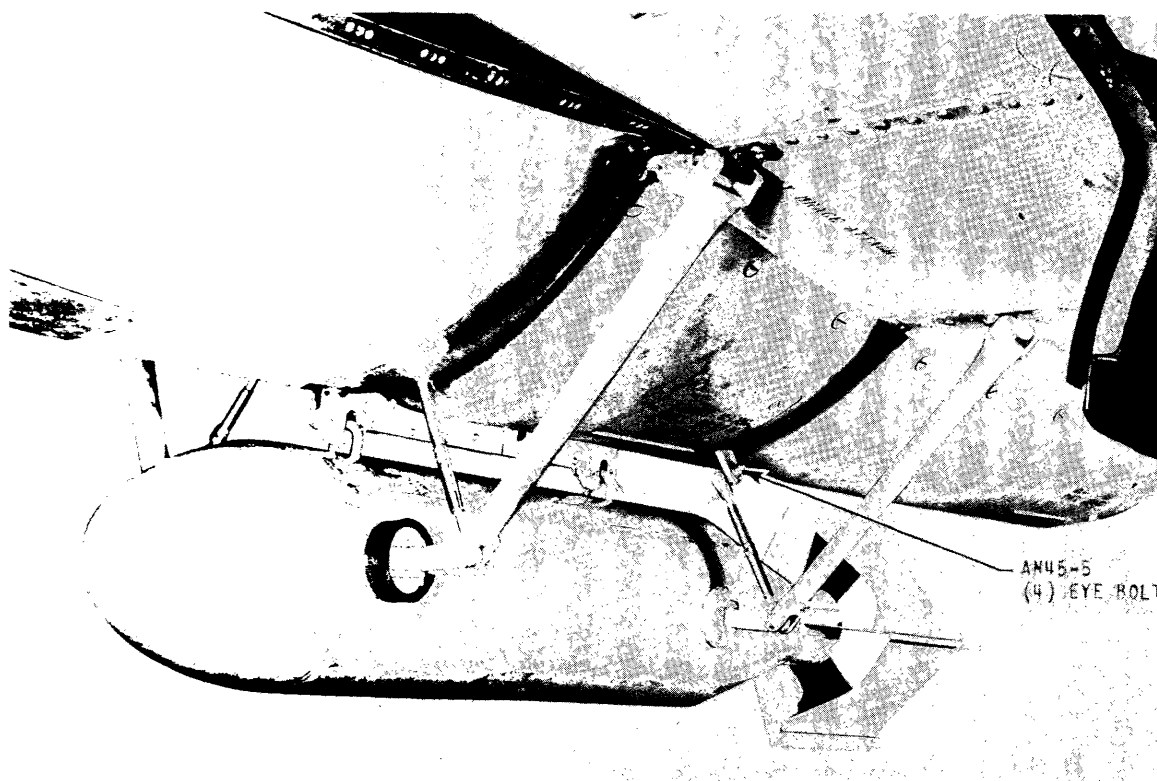


Figure 83 - 100-Pound Practice Bomb Loaded

SECTION IVGUN SIGHT1. To Install the Type N-3A Gun Sight.

a. General. - The gun sight assembly consists of a base bolted to the armor plate at station No. 2A (figure 84), a yoke, three adjusting bolts, three adjusting screws, a sun screen and reflector glass, a crash pad with a periscopic mirror attached, a second periscopic mirror attached to the top of the windshield, center panel, and the sight assembly. (See figure 86.) On all airplanes for the British Government a ring and bead sight are also a part of the sight assembly.

b. To Assemble the Yoke and Gun Sight. - To assemble the yoke and gun sight, first install the three adjusting bolts "Y" and the three adjustment screws "Z" in the nut plates on the yoke as illustrated in figure 85.

(1) Install the yoke "B" on the sight assembly "A" with the bolt and nut assembly "D" installed in holes "C." (See figure 85.) Do not tighten the bolt so that the yoke will be free to rotate.

(2) Swing the yoke into place on the sight assembly so that the large holes "E" in the yoke align with the large holes "E" in the forward section of the sight assembly. Install the spacer "F" between the

lugs on the sight assembly, and insert the bearing "G" through the yoke assembly, the sight assembly lugs, and the spacer. Align the holes in the spacer and bearing and insert the bolt "H." Install the washer and lock nut on bolt "H" and tighten the nut.

(3) Tighten bolt "D" at the rear of the yoke.

(4) Place the sun screen guide on the sight and yoke assembly so that holes "I" on the guide line up with holes "I" on the yoke. Attach the guide to the yoke with the bolt, spacer, and washer assembly "J." Attach the top of the guide "K" to the plate "L" on the sight with the four screws "M." Slide the sun screen assembly "N" into the guide from the top with the base of the assembly "O" inserted first. Allow the sun screen to slide down in the guide and attach rod "P" to the clevis end "Q" with the pin and cotter "R." Next attach the crash pad and periscopic mirror assembly "S" to the sight body at "T" with the two cap screws "U." The reflector glass "V" should now be inserted in the sight body at "W" and the assembly is ready for installation in the airplane.

(5) Raise the yoke and sight assembly to the base assembly and insert the bolt in the base assembly into the hole in the center of the yoke mounting

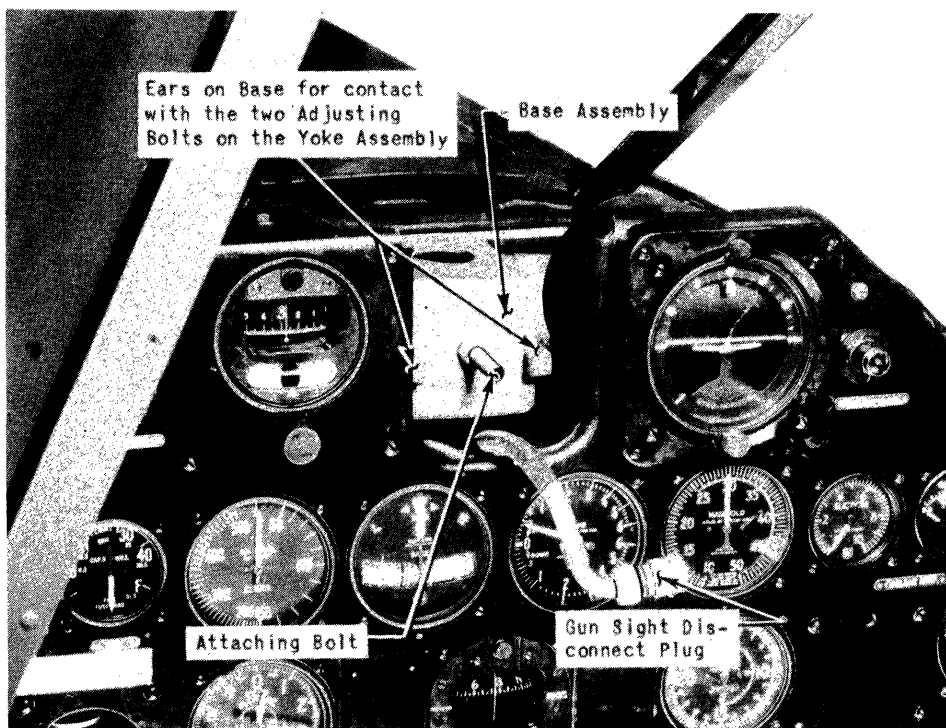


Figure 84 - Gun Sight Base Installed

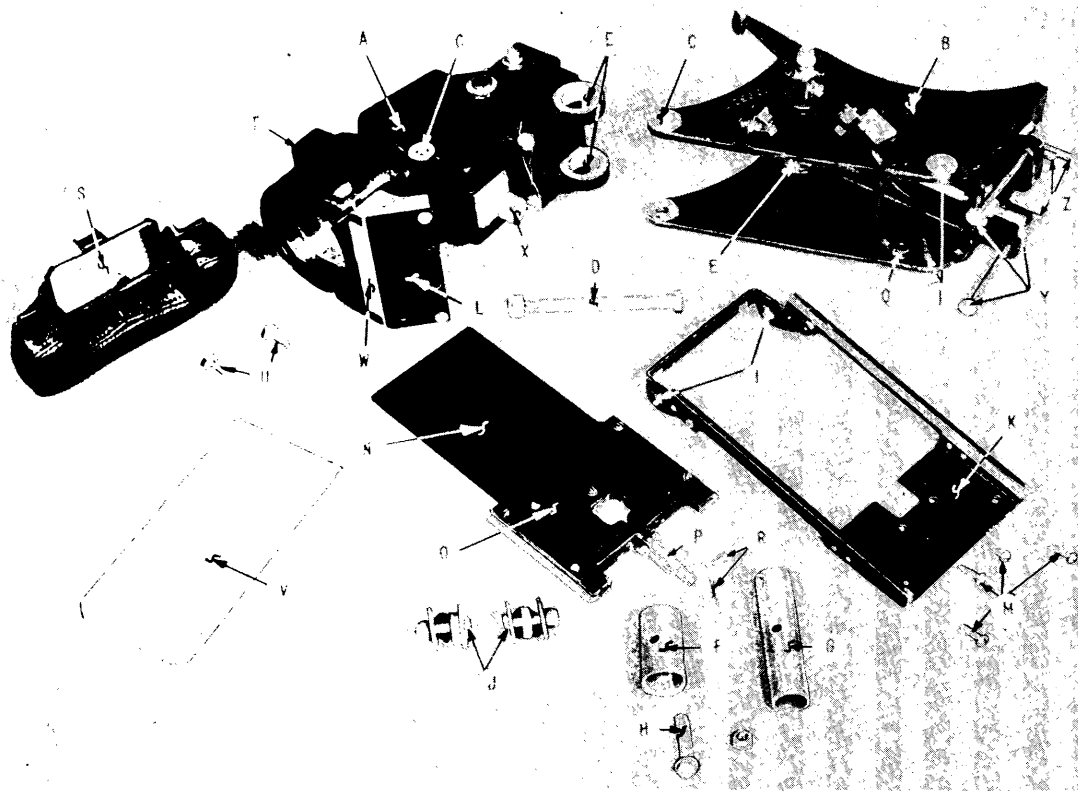


Figure 85 - N-3A  
Gun Sight and  
Yoke Disassembled

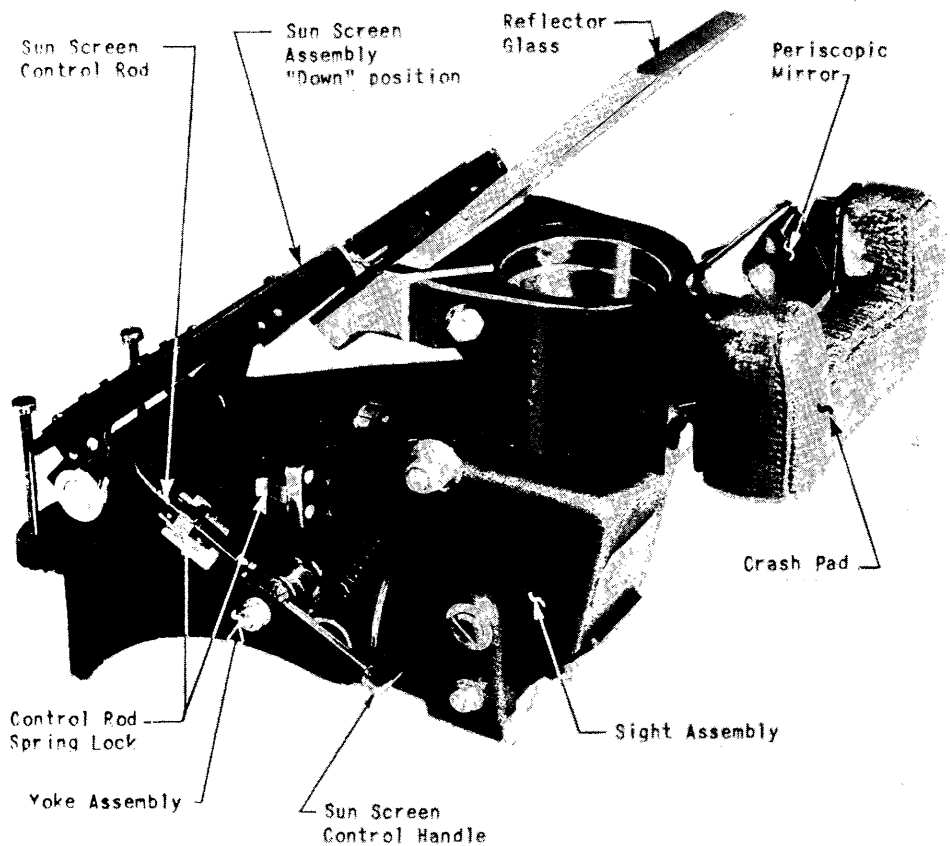
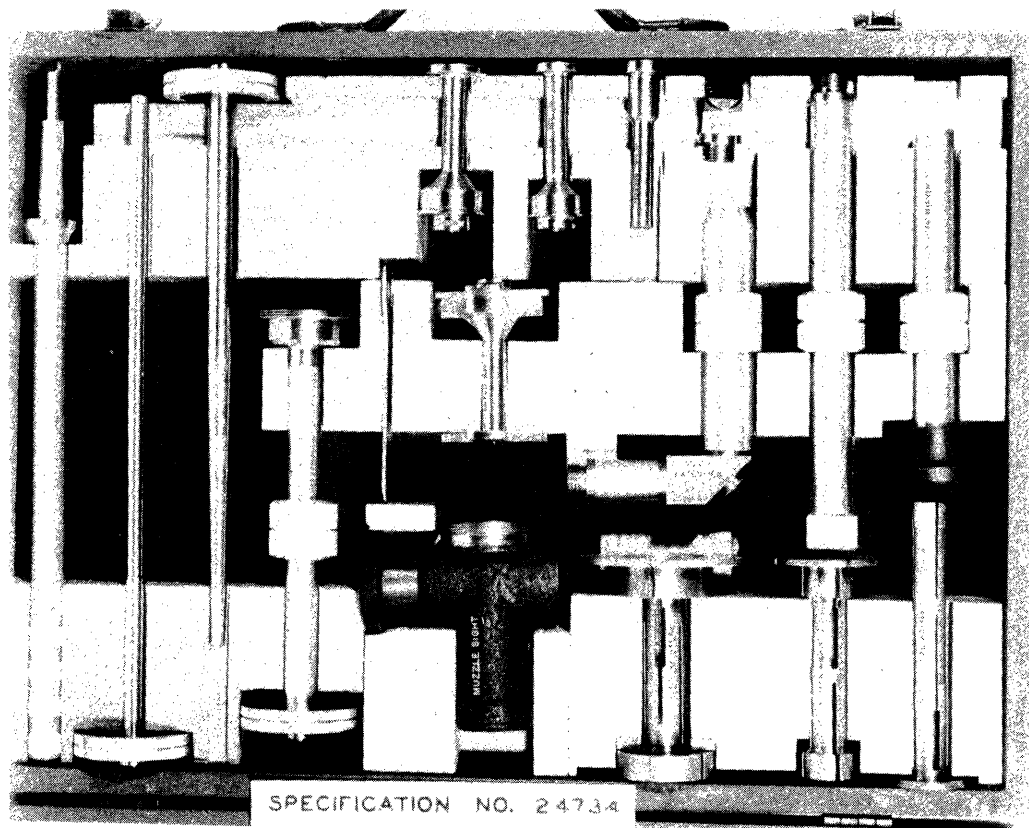
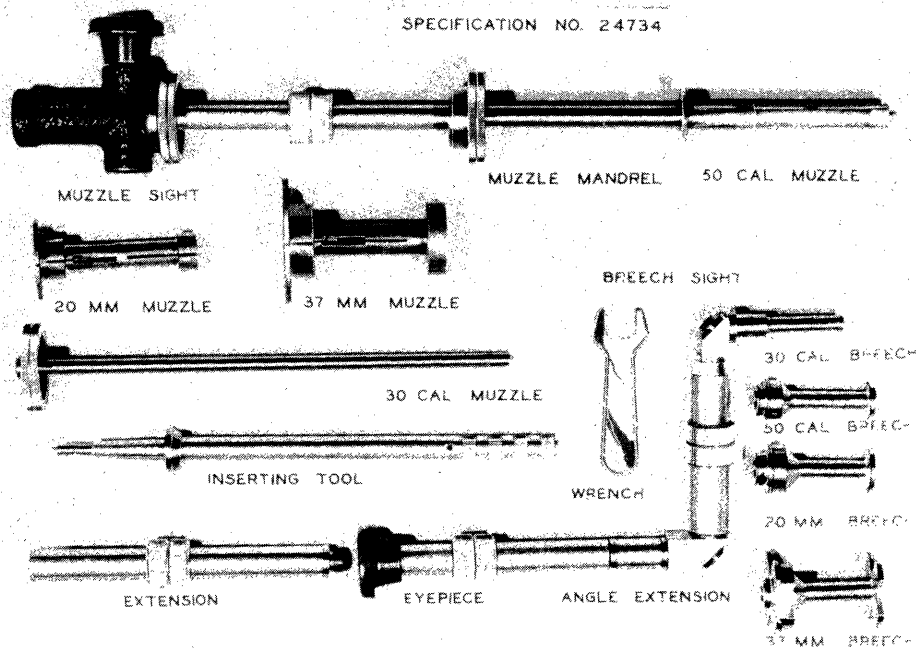


Figure 86 - Gun Sight and  
Yoke Assembly - Left Side



Kit in Case



Kit Assembled

Figure 86A - Bore-Sighting Kit

face. Install the washer and nut on the bolt and turn the nut up to take up the slack. Do not tighten the nut excessively. Attach the reflector screen around the instrument panel to the two lugs on the yoke assembly.

(6) Make the connection of electrical conduit plug to the socket "X" on the forward side of the sight assembly.

(7) If a ring and bead sight are also used, install these sights by screwing them into their supports and locking them with lock nuts. The ring sight is installed on the fuselage cover plate at station No. 2 and the bead sight is mounted on the top engine cowling 23 inches forward of the ring sight.

## 2. Bore-Sighting the .50 Caliber Fixed Wing Guns by the Target Method.

### a. General.

(1) This procedure requires a level working space of approximately 50 feet by 120 feet.

(2) A target stand was used in this procedure, however, in some cases it may be more advantageous to position the target on a wall. The greater part of the weight of the airplane is removed from the landing gear and taken up by the jacks in order to eliminate any deflection during the procedure.

(3) The special gun wrench is kept in the pocket on the inside of the gun access door in the left wing. (See figure 87, sheet 6.)

(4) The step by step method in figure 87 is for the right wing guns, however, the procedure is identical for the left side except that the target stand must be reversed.

(5) The following equipment is required for bore-sighting the guns:

(a) Bore-Sighting Targets made in accordance with the following figures:

Figure 93 for P-40D Models  
Figure 93A for P-40E Models  
Figure 93B for P-40F Models

**NOTE:** For figures of models not listed, see Handbook for that particular model.

(b) Bore-Sighting Equipment Set, T. O. No. 00-30-137, which includes two sight line level indicators, part No. 41D3689. See figure 86A for Bore-Sighting Kit, Specification No. 24734.

**NOTE:** If the above kit is not available, use gun bore reflector, ordnance drawing No. C64255 with plug shown in figure 95A. Necessary plugs should be made locally.

(c) Clinometer, machine gun, M1917 for setting the airplane in the correct attitude for level flight. See Table of Basic Allowances, AAF, No. 1, section VI, part I, Ordnance Equipment.

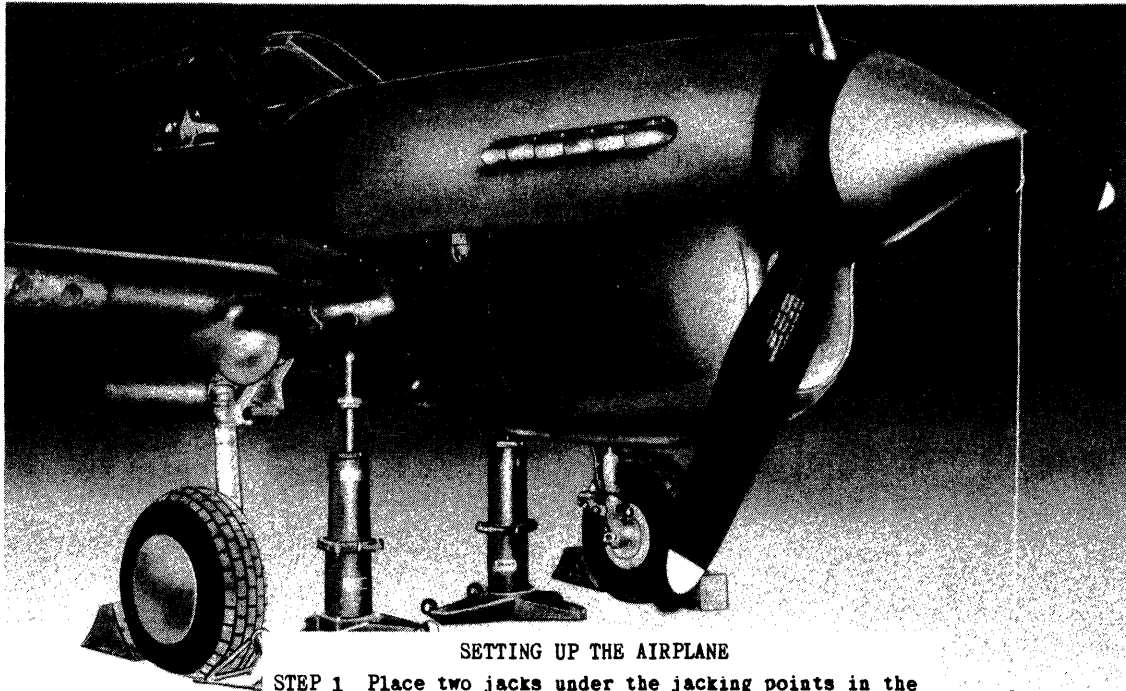
(d) Three Jacks. (The screw type are preferable.)

(e) Two plumb bobs.

(f) A surface or carpenters spirit hand level.

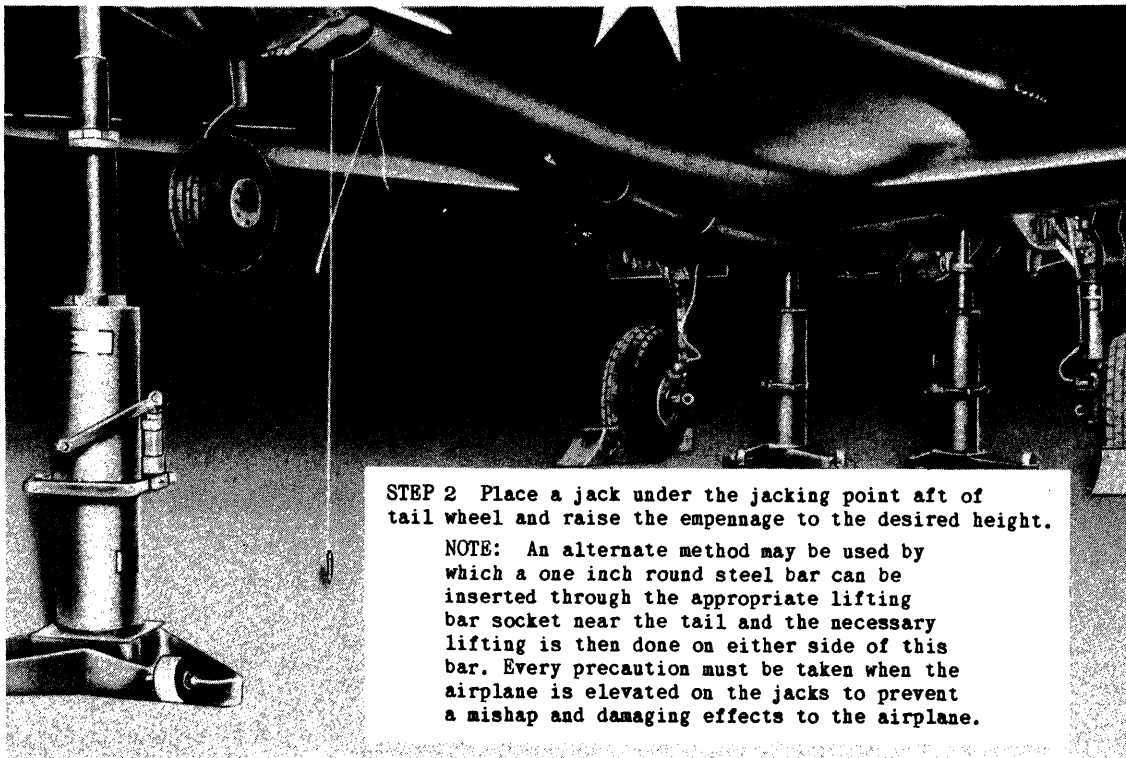
(g) Steel measuring tape (50 or 100 feet).

b. Procedure. - The accuracy of the gun adjustment will depend to a large extent on the care exercised by the personnel in performing the operation. Figure 87 illustrates the bore-sighting method in step by step procedure.



#### SETTING UP THE AIRPLANE

STEP 1 Place two jacks under the jacking points in the wing center section and raise the plane an inch or so in order to take a good portion of the weight off the landing gear and in so doing eliminate any deflection.



STEP 2 Place a jack under the jacking point aft of tail wheel and raise the empennage to the desired height.

NOTE: An alternate method may be used by which a one inch round steel bar can be inserted through the appropriate lifting bar socket near the tail and the necessary lifting is then done on either side of this bar. Every precaution must be taken when the airplane is elevated on the jacks to prevent a mishap and damaging effects to the airplane.

Figure 87 - Bore-Sighting Guns - Target Method (Sheet 1 of 8 Sheets)

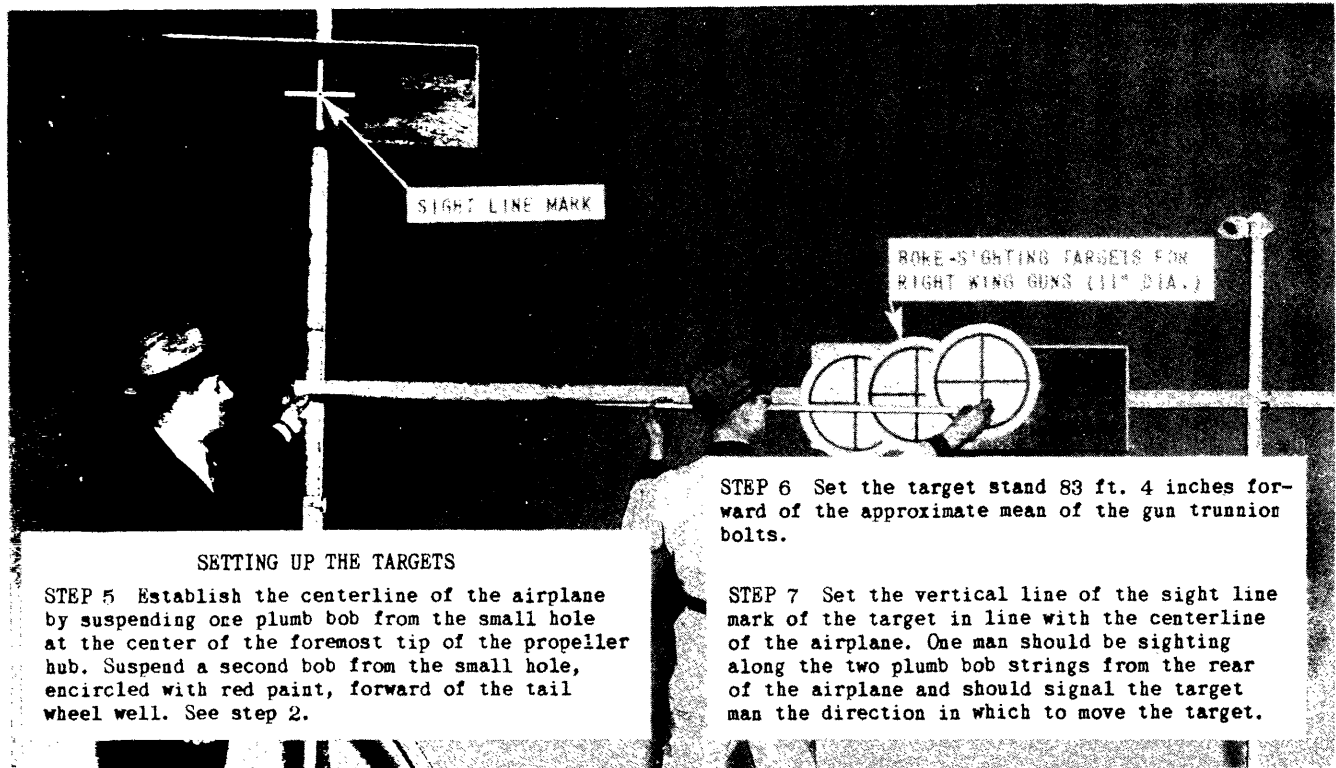
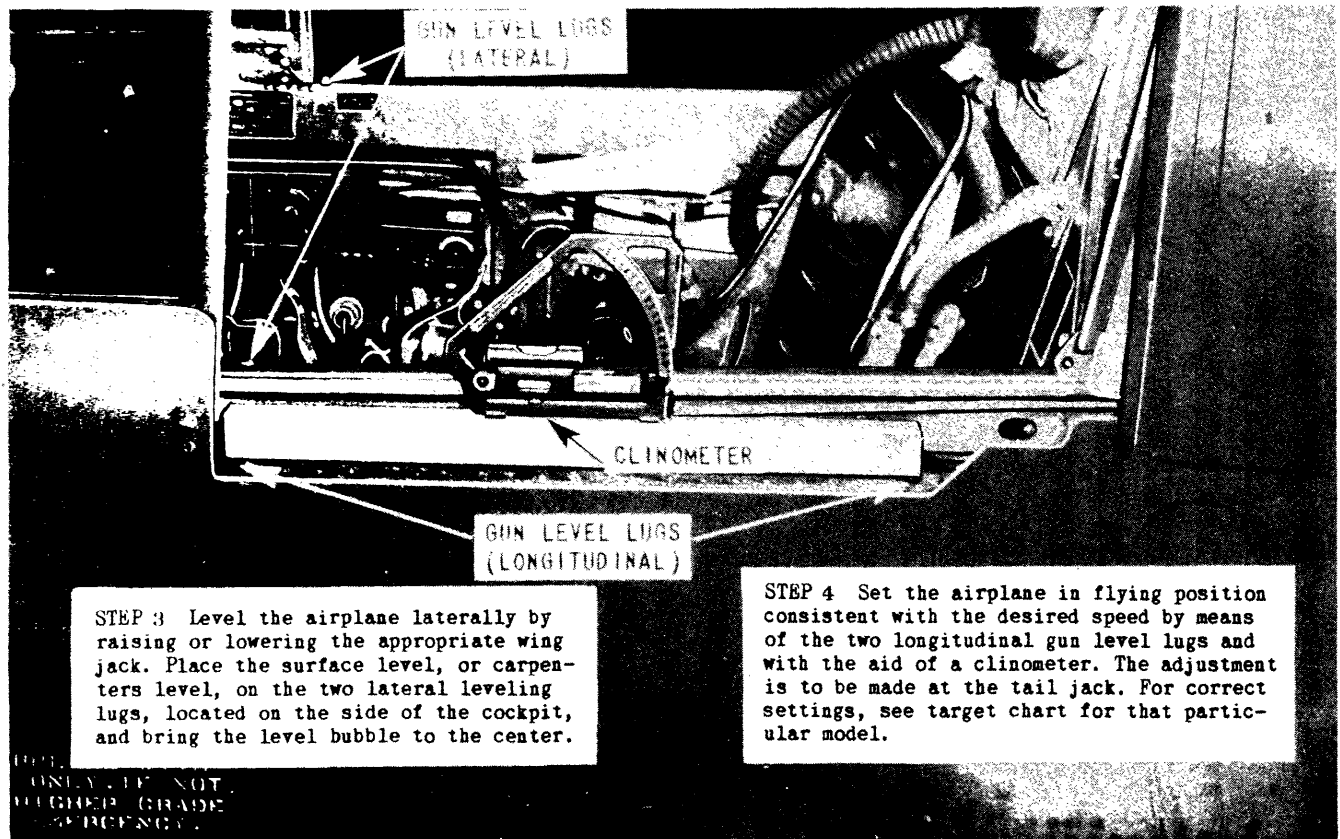


Figure 87 - Bore-Sighting Guns - Target Method (Sheet 2 of 8 Sheets)

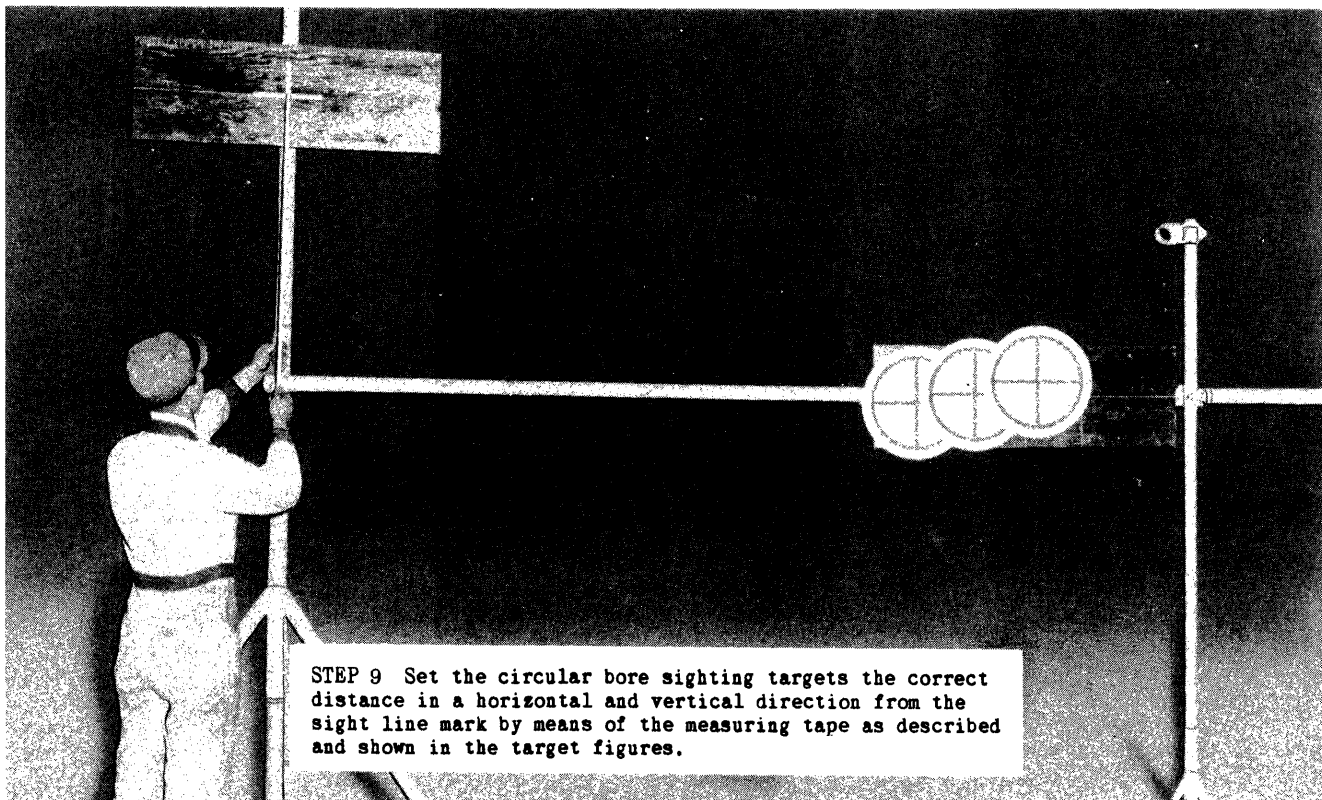
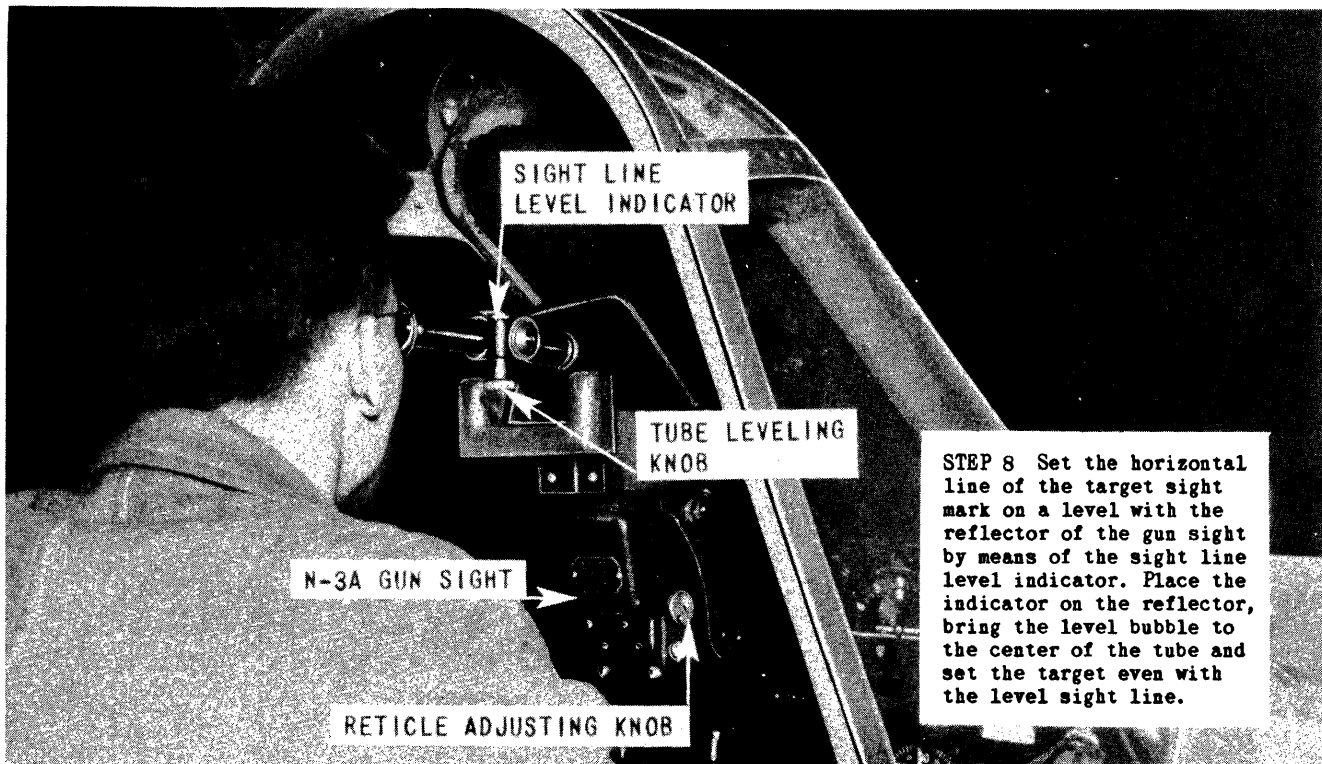
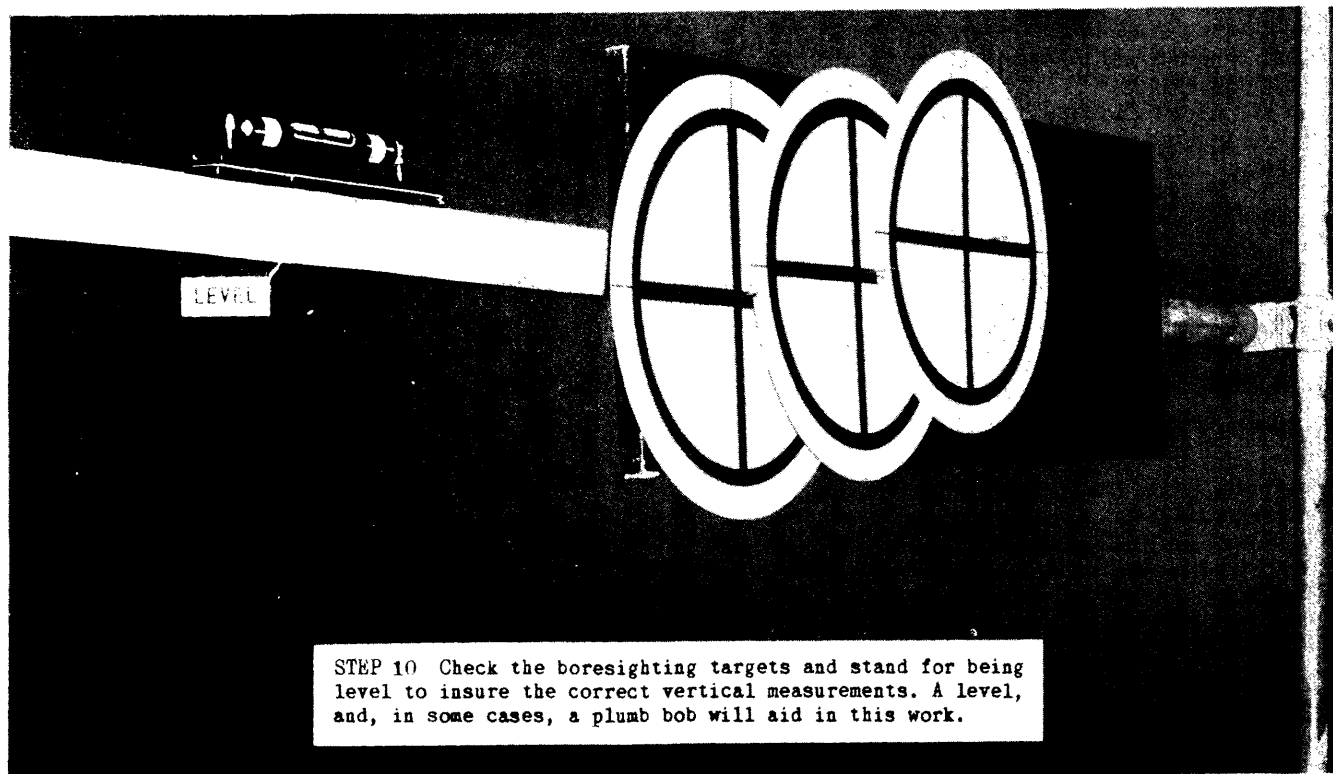


Figure 87 - Bore-Sighting Guns - Target Method (Sheet 3 of 8 Sheets)





#### GUN SIGHT ADJUSTMENT

STEP 11 Adjust the N-3A gun sight to make the line of sight coincident with the sight line mark of target. Rotational or horizontal adjustment is made by means of two vertical bolts in the forward side of the mounting yoke. Vertical adjustment may be accomplished by loosening the 9/16" mounting nut below the sight assembly and turning the screw directly below this nut in the desired direction. Directional or lateral adjustment is made by means of the two screws on either side of the mounting nut. After adjustment, re-tighten the mounting nut securely. The knob on the right hand side of the sight may be used as a finer directional adjustment. This knob moves the reticle sideways. Parallax, or movement of the reticle image with respect to a fixed target is characteristic of the reflex type gun sight. At the target distance of 1000 inches, a total lateral movement of four inches is permissible; if a greater movement than this is present, a lens adjustment is necessary. The appearance of a double image in the circular portion of the reticle pattern is due to a faulty reflector glass plate.

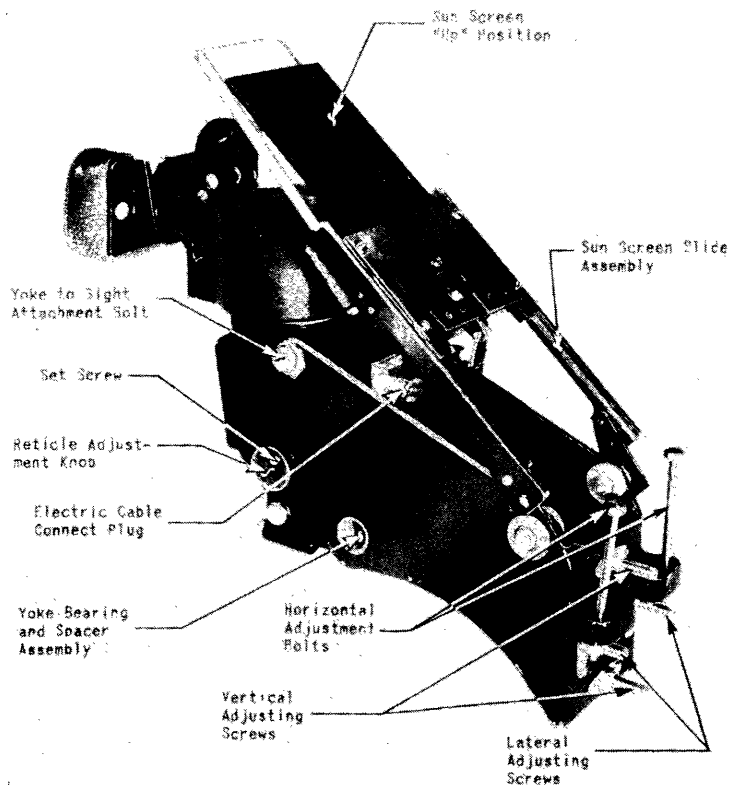


Figure 87 - Bore-Sighting Guns - Target Method (Sheet 4 of 8 Sheets)

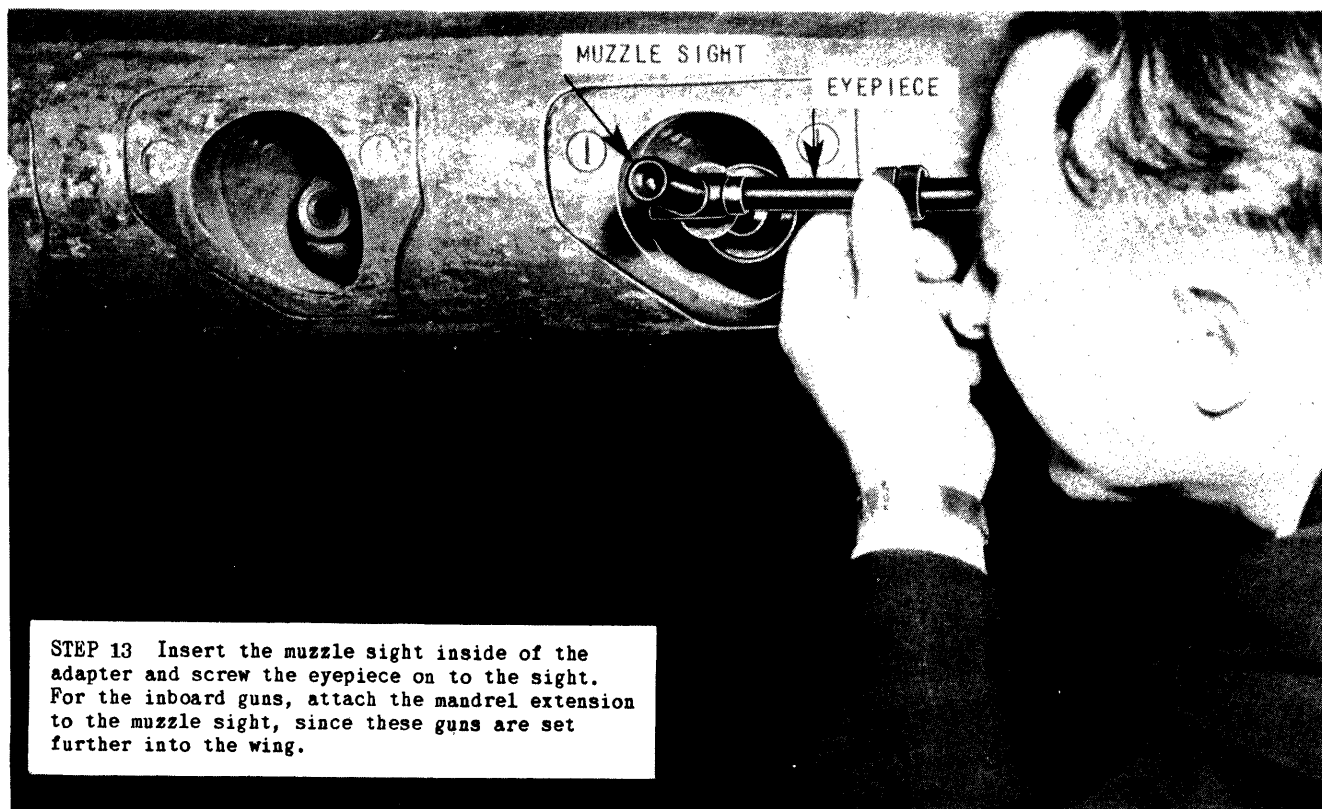
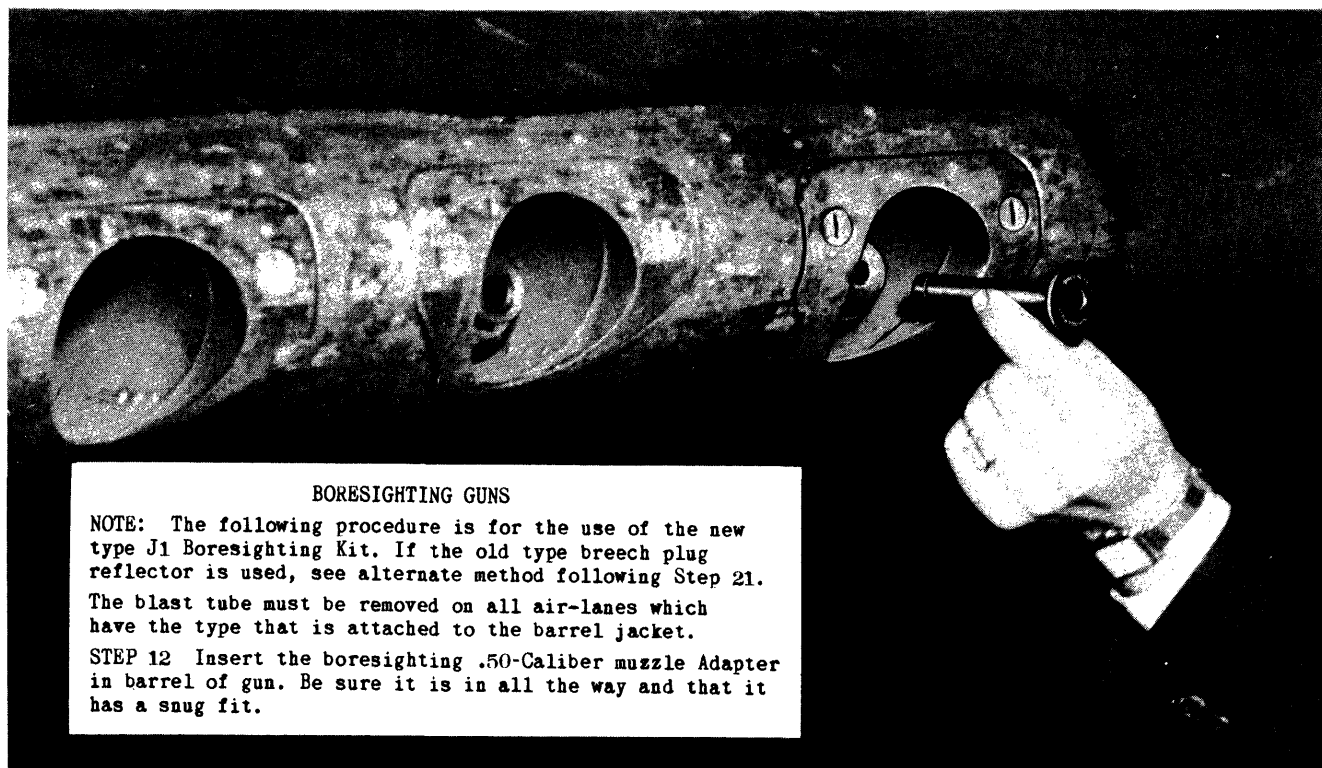


Figure 87 - Bore-Sighting Guns - Target Method (Sheet 5 of 8 Sheets)

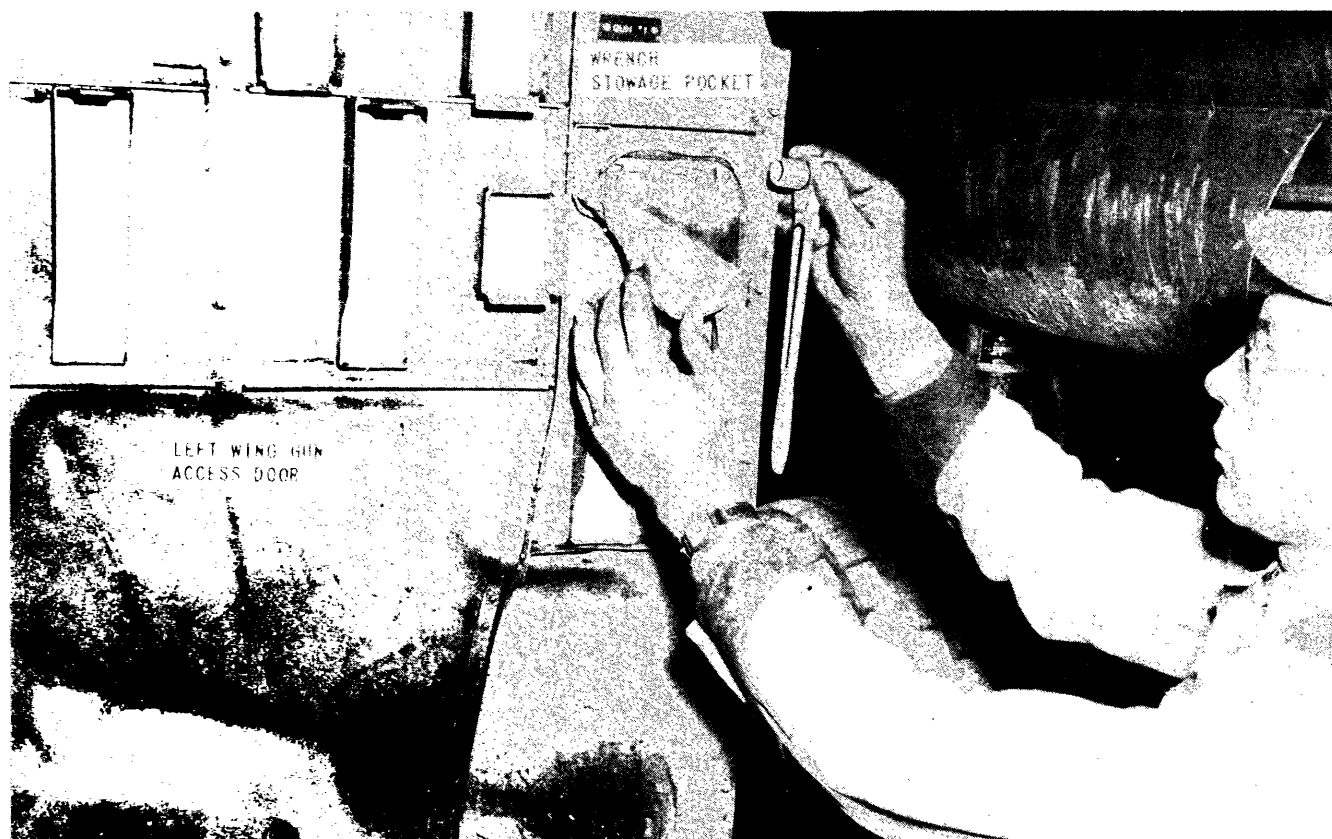
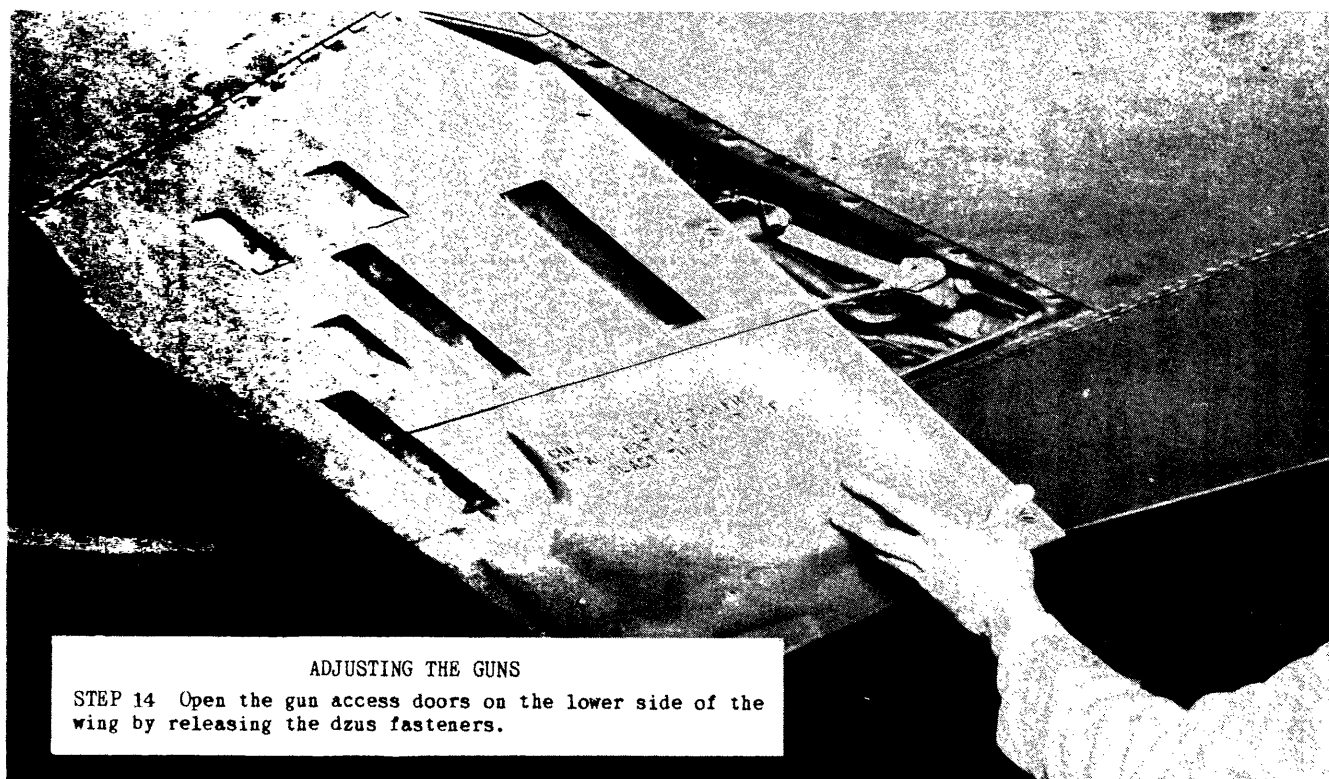


Figure 87 - Bore-Sighting Guns - Target Method (Sheet 6 of 8 Sheets)

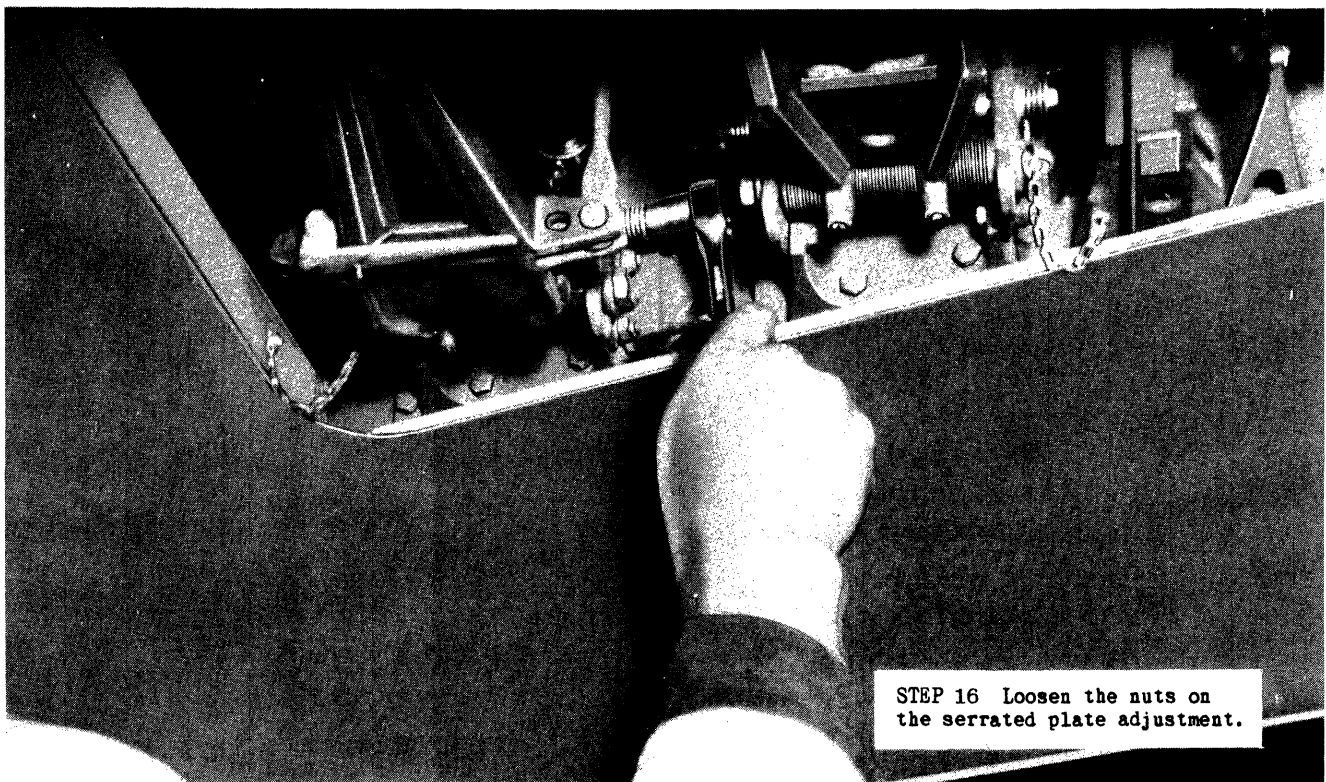
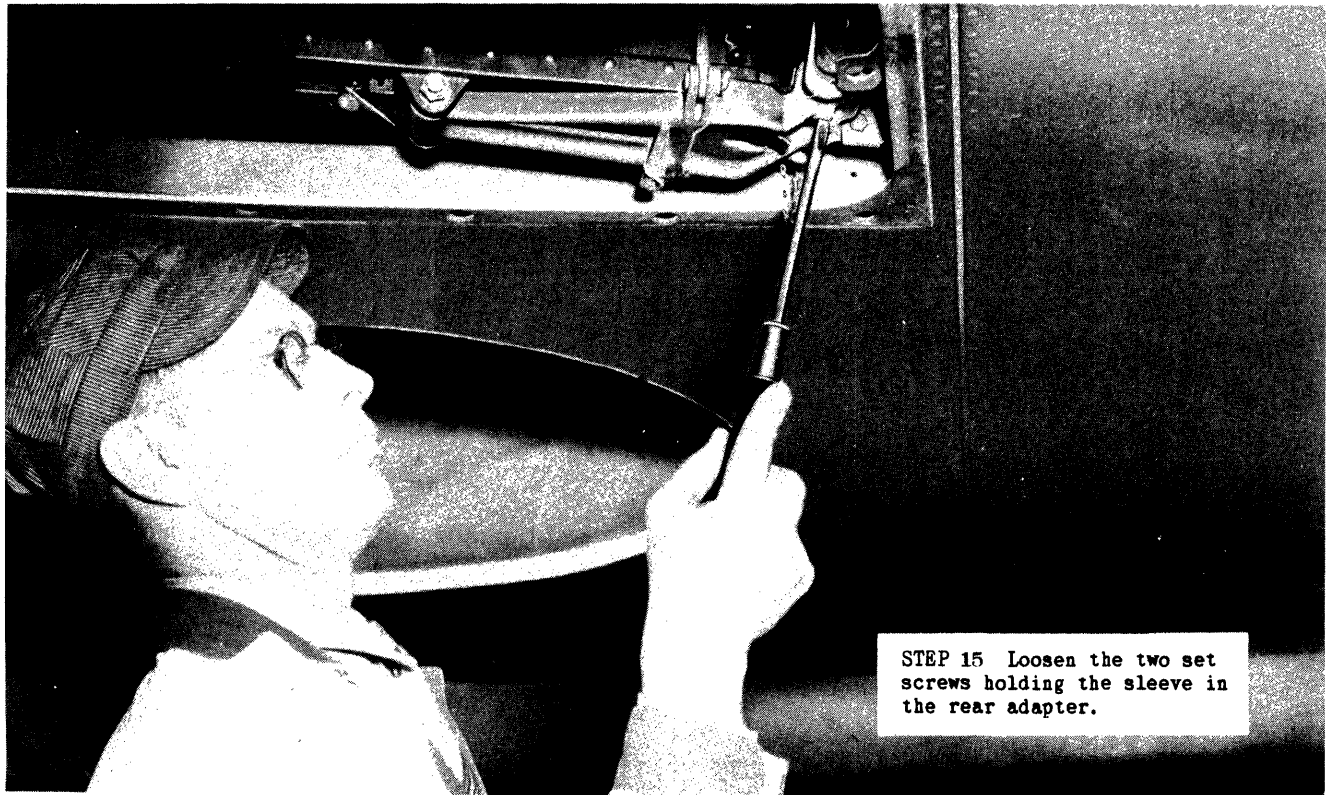


Figure 87 - Bore-Sighting Guns - Target Method (Sheet 7 of 8 Sheets)

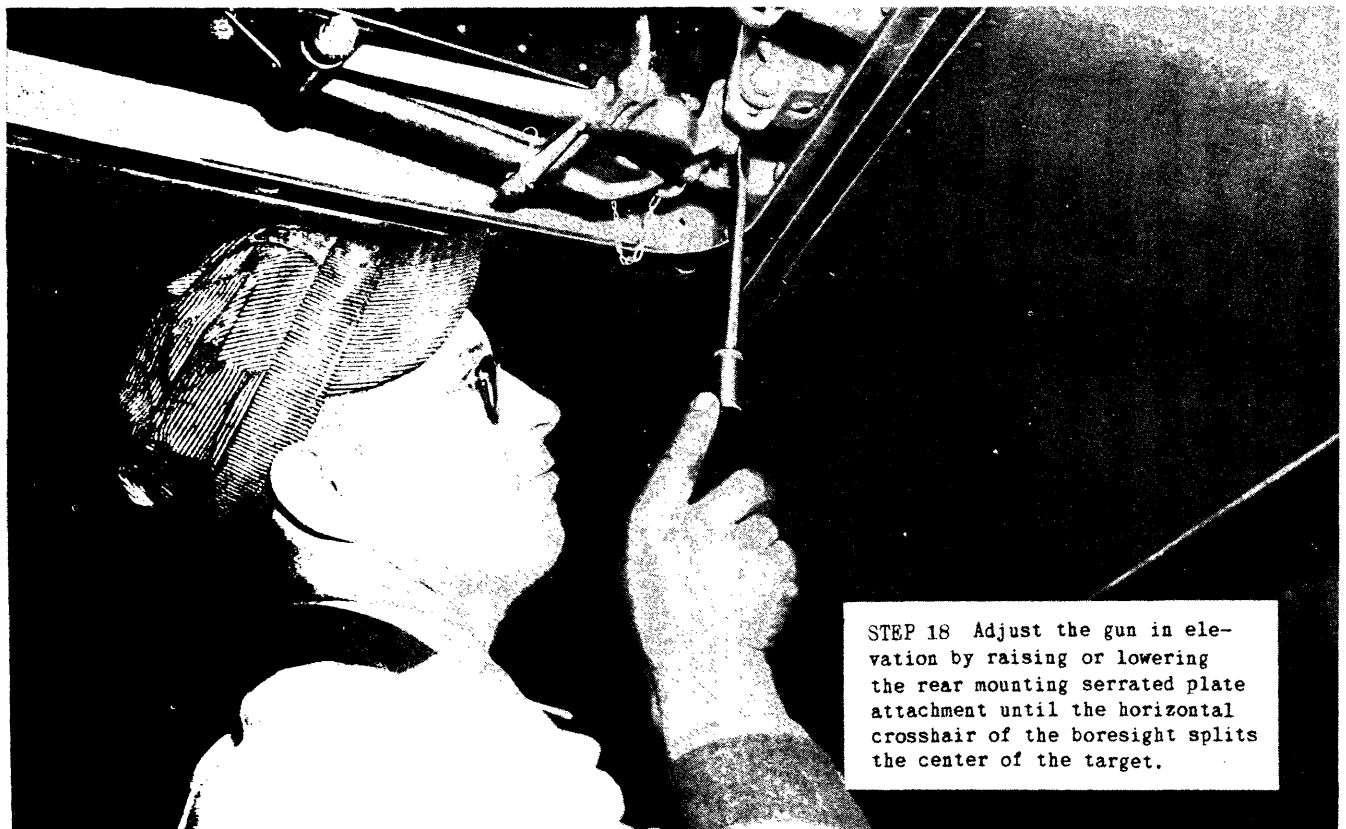
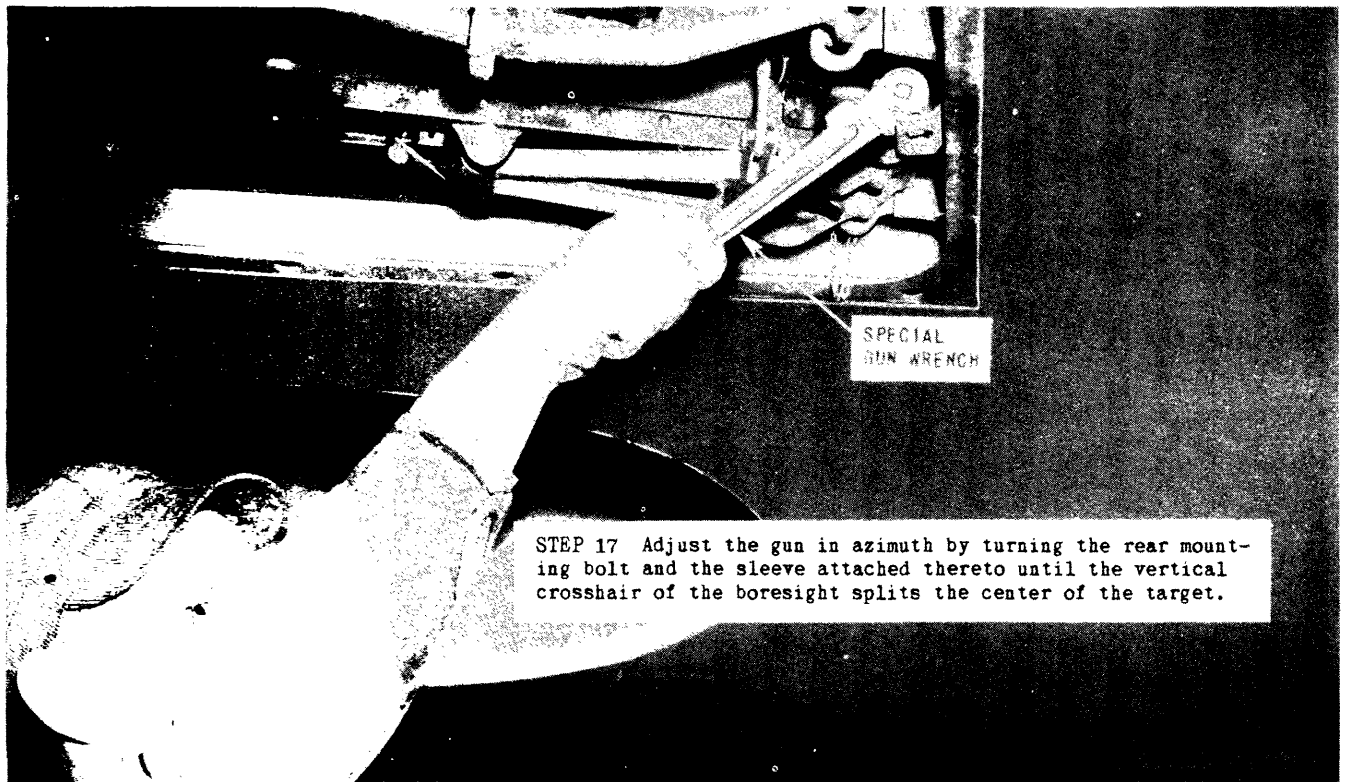


Figure 87 - Bore-Sighting Guns - Target Method (Sheet 8 of 8 Sheets)

STEP 19. Check for any movement or settlement of the airplane during the procedure by repeating the leveling instructions in steps 3 and 4. If any are detected, the targets and guns must be readjusted for this change.

STEP 20. Tighten all adjustments and close gun access door.

STEP 21. Install blast tube in leading edge of wing.

#### ALTERNATE METHOD OF BORE-SIGHTING GUNS

The only difference in this method is the bore-sighting tool, itself, which is inserted in the breech of the gun and not in the muzzle. The gun bolt is first retracted and should be held back securely by means of a block or similar item. The gun Bore Reflector is then inserted and the observer merely looks vertically upward in the reflector. The gun adjustments are identical with those described previously.

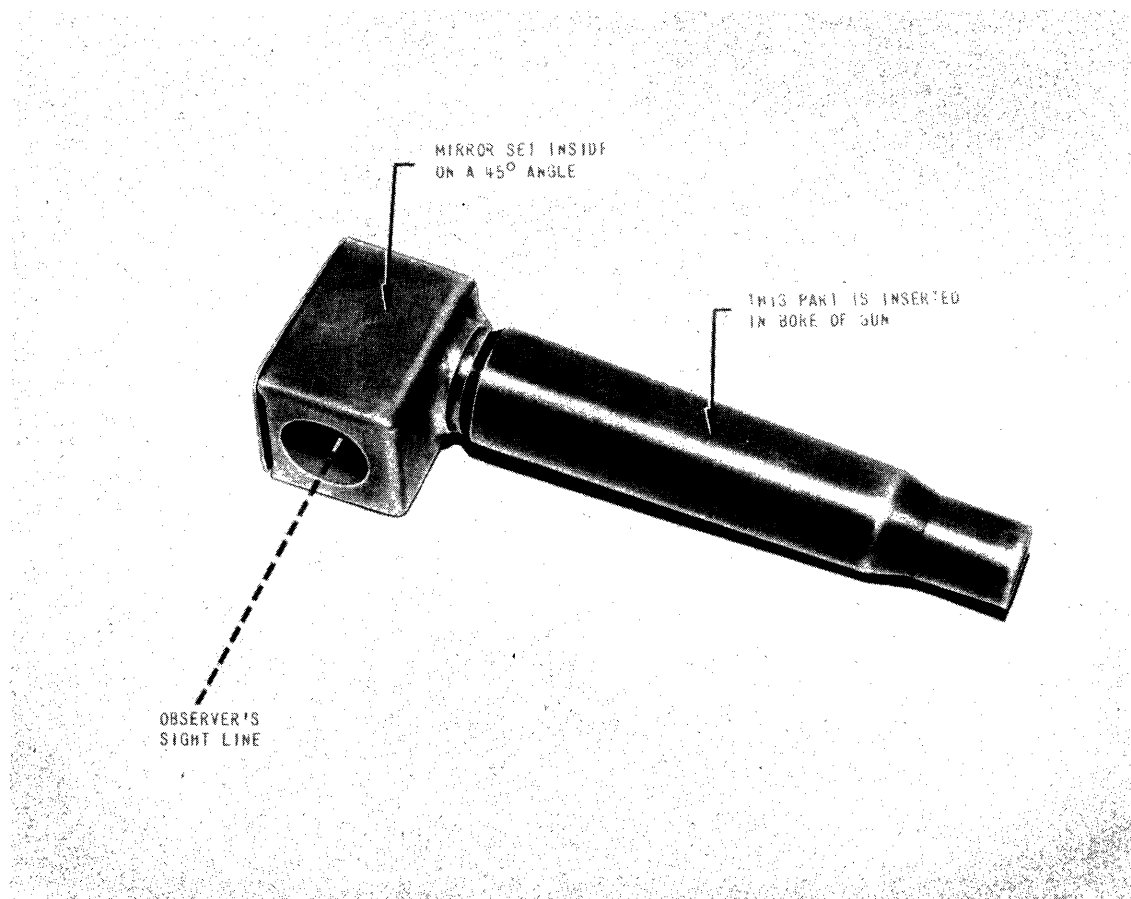


Figure 87A - Gun Bore Reflector



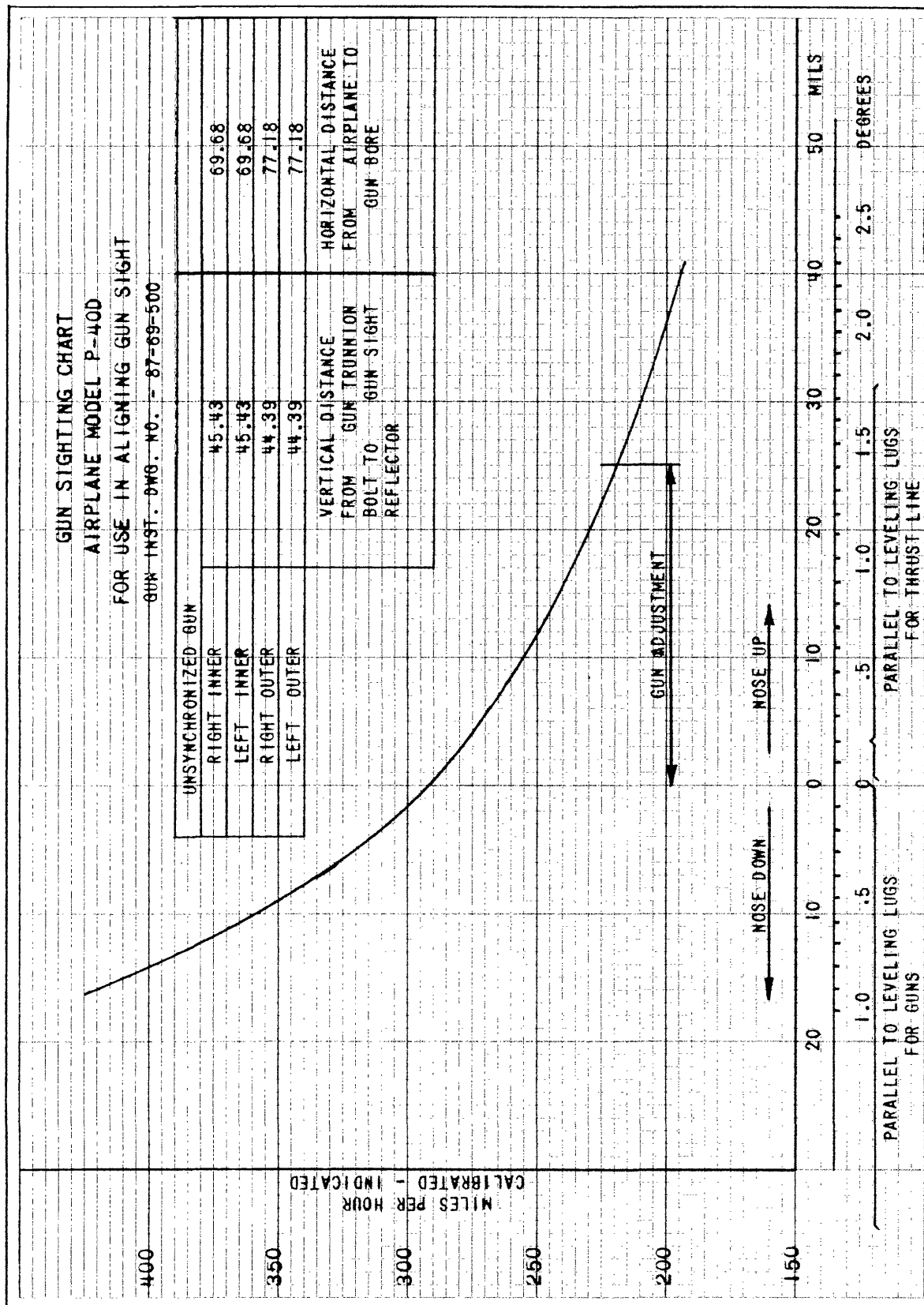
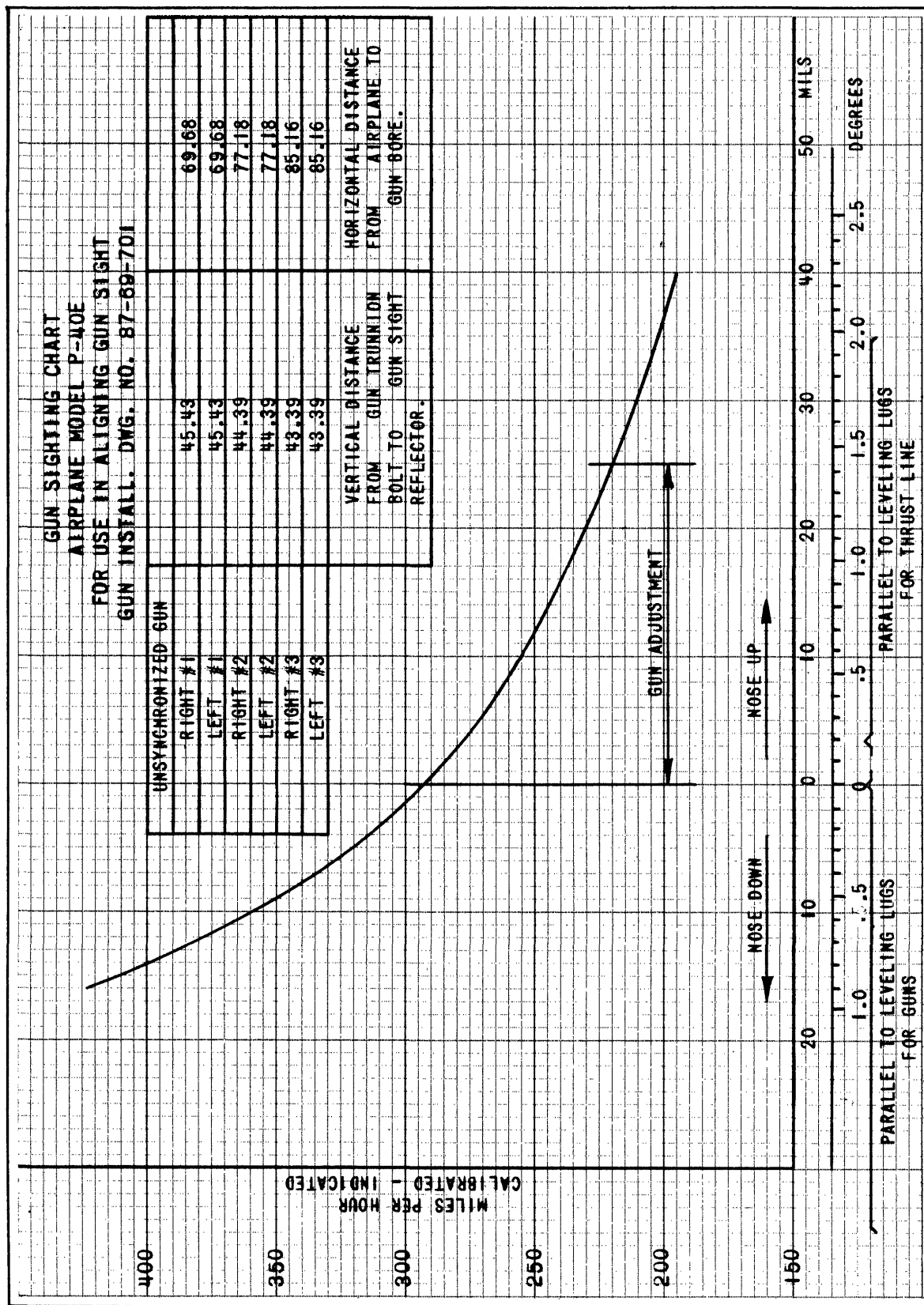


Figure 88 - Gun Sighting Chart - P-40D



**Figure 88A - Gun Sighting Chart - P-40E**



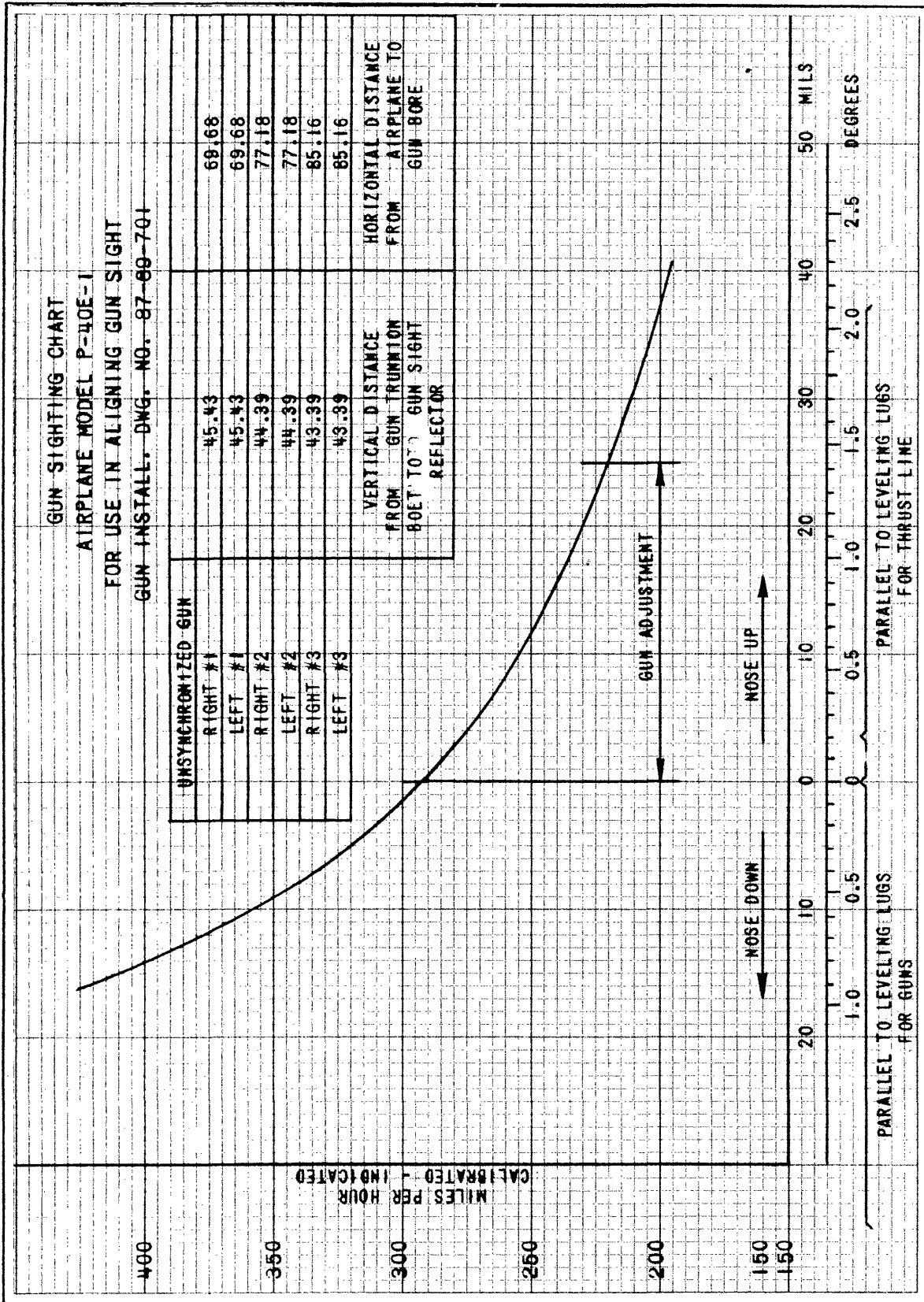


Figure 89 - Gun Sighting Chart - P-40E-1

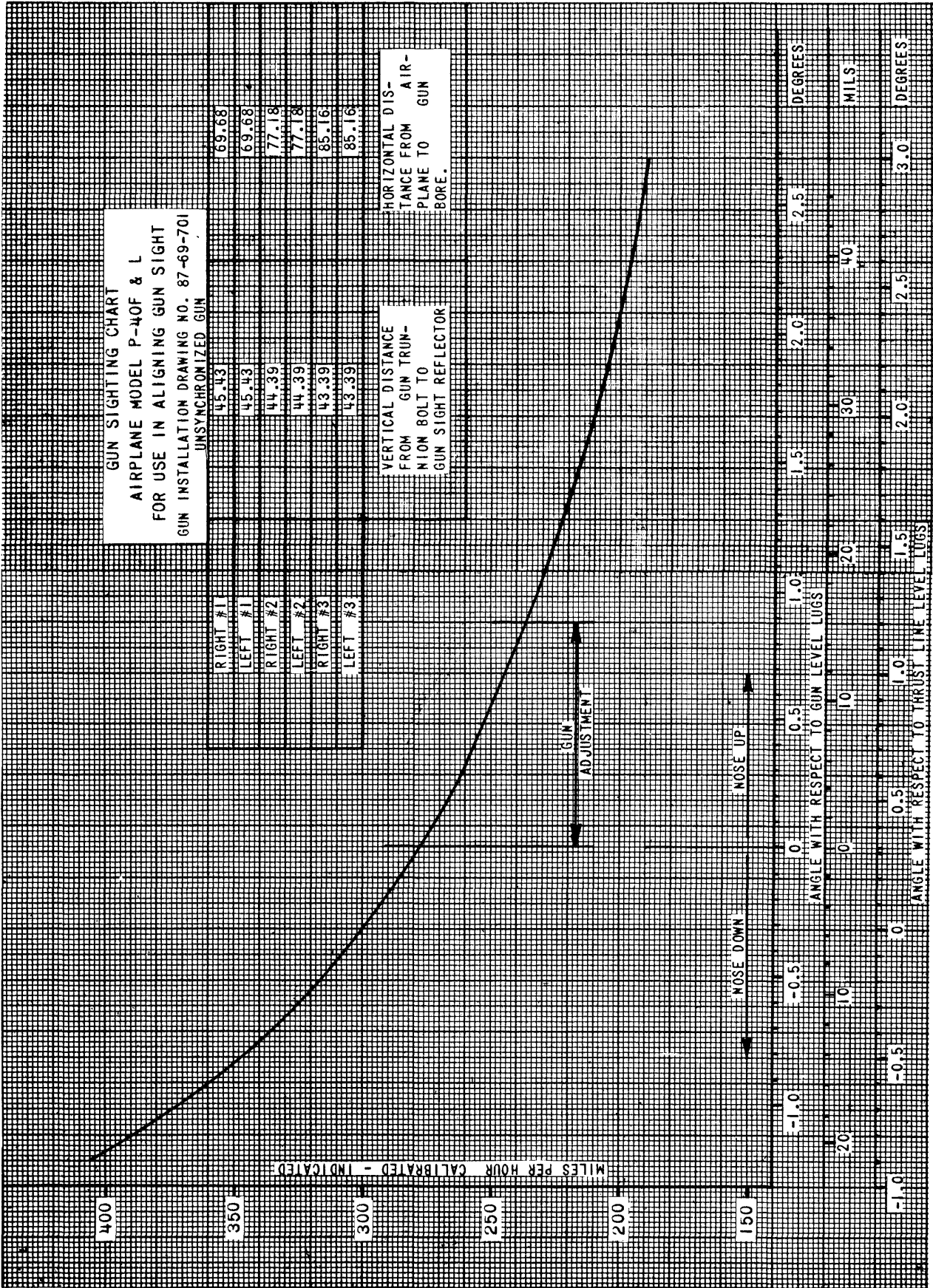


Figure 89A - Gun Sighting Chart - P-40F and P-40L

Figure 90 - Adjustment of Lower Vertical and Lateral Adjusting Screws

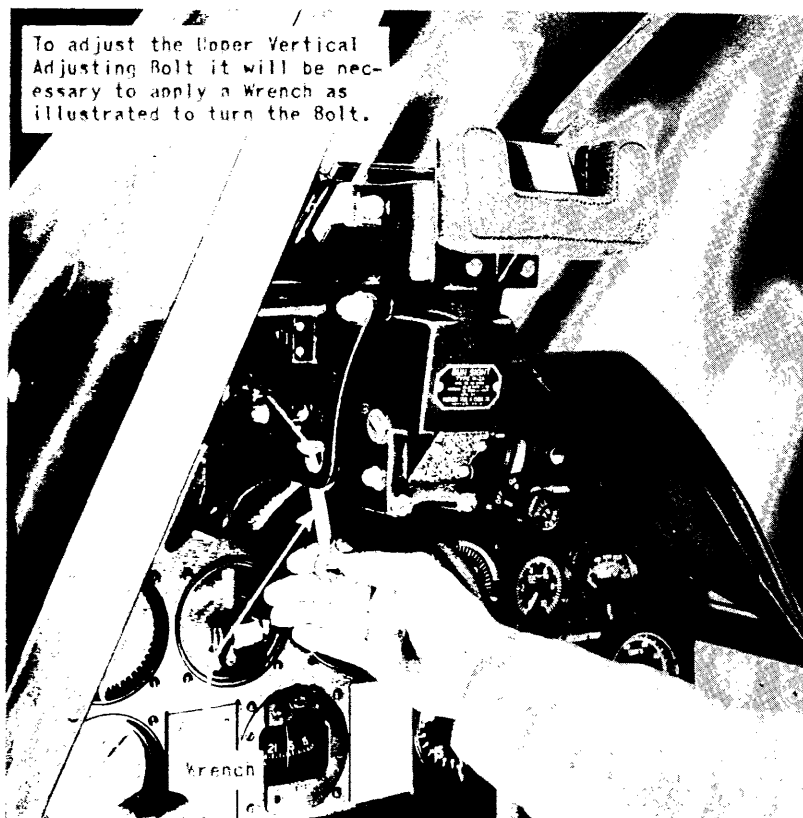
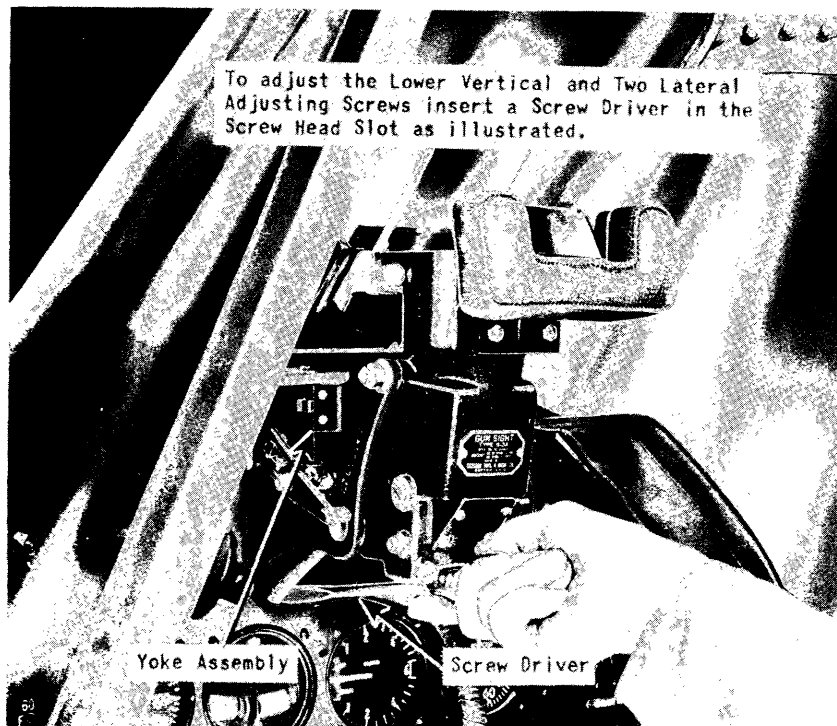


Figure 91 - Adjusting Upper Vertical Adjustment Bolt

3. Bore-Sighting Guns by Fixture Method. - P-40D, P-40E, P-40E-1, P-40F, P-40K, P-40K-1, and P-40L Aircraft.

**NOTE:** The fixture kits (figure 103) used in the following bore-sighting method are not available at the time of this revision (February 25, 1943).

**a. Introduction.** - Bore-sighting guns by fixture method is a system devised to expedite and facilitate bore-sighting of guns in field with minimum equipment and man hours. It also provides accomplishing this operation almost anywhere, and at any time, regardless of the existing position of the aircraft.

By this is meant that lifting the tail of the aircraft to the gun level position, using plumb bobs and spirit levels to bore sight on a target set at some distance from the airplane, is entirely eliminated. The fixture method provides for adjusting the guns and sight by merely setting them to the fixture aligning positions without applying any other formalities. The principle that makes this fixture method suitable is based on accurate gun mount jiggling in the aircraft and extremely good interchangeability.

**b. Description.** - Sight aligner is a fixture that can be folded into a compact form and carried in a chest. When this fixture is set up, it rests on the lateral and longitudinal level lugs of the aircraft and with pads located on the inner side of the longitudinal

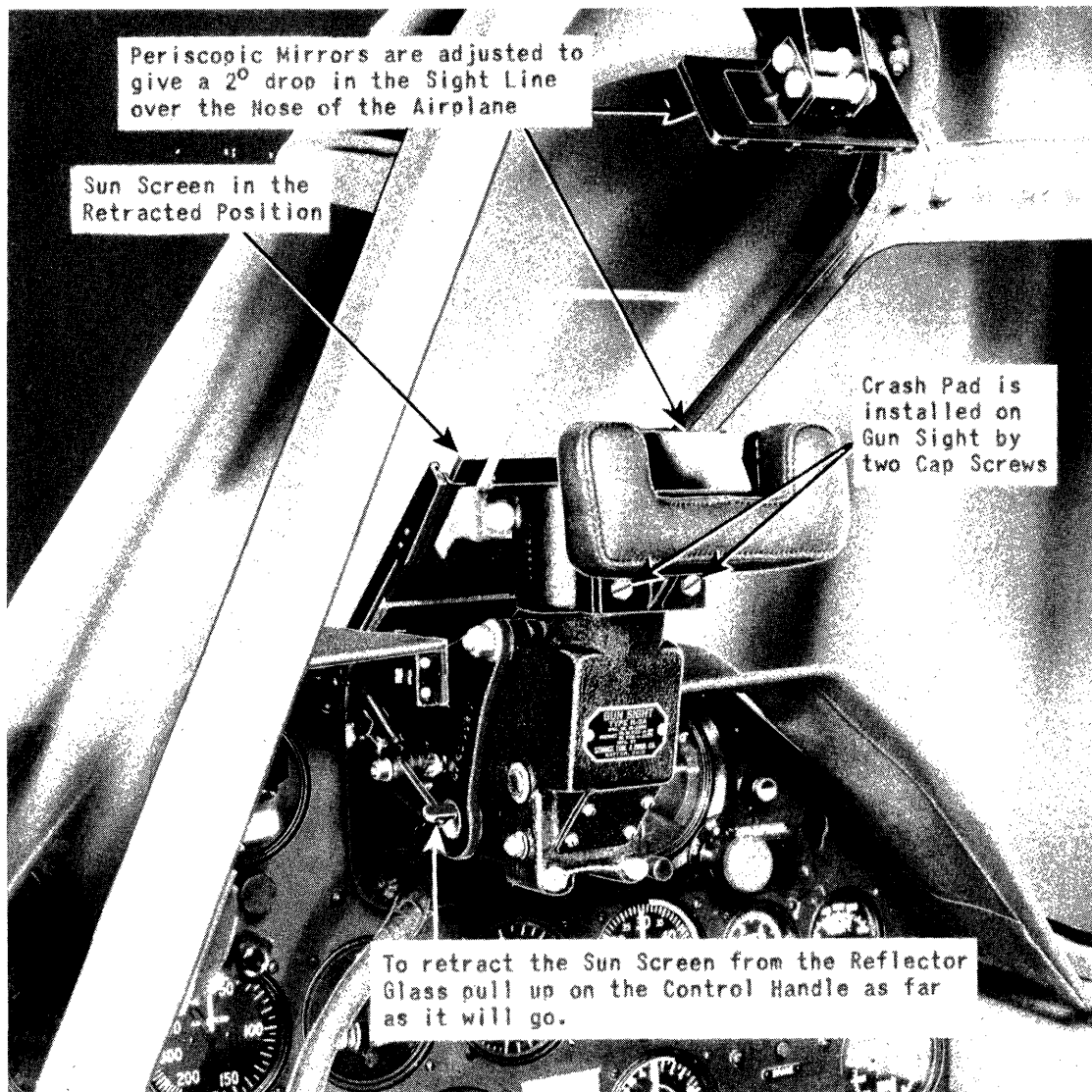


Figure 92 - Sun Screen Retracted From Reflector Glass

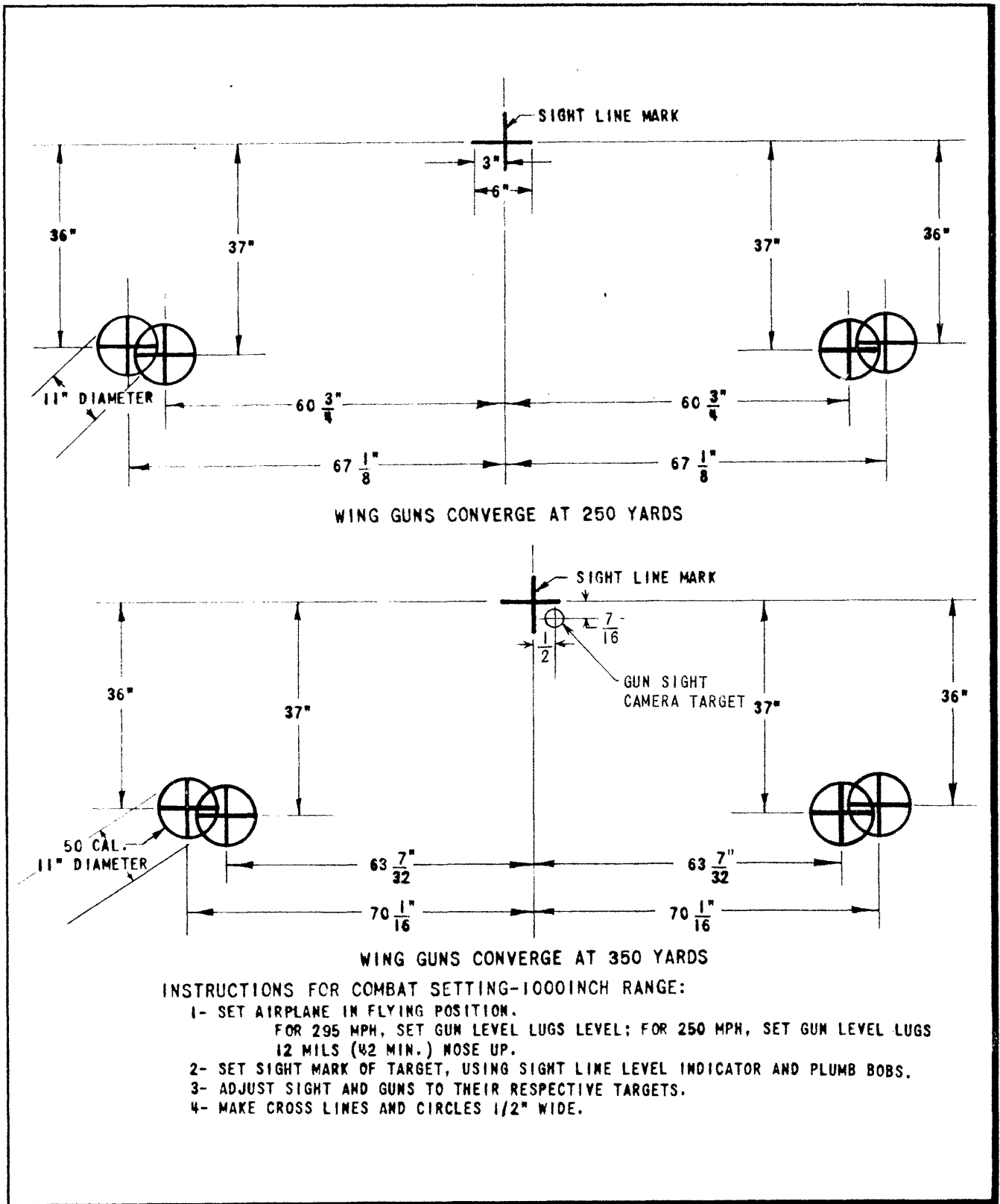
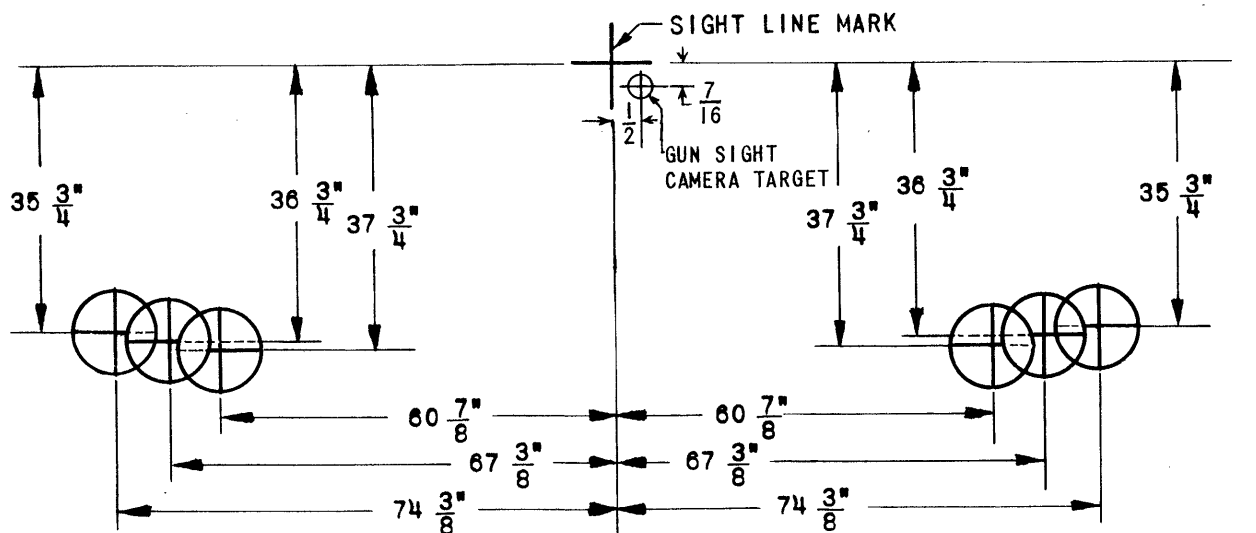
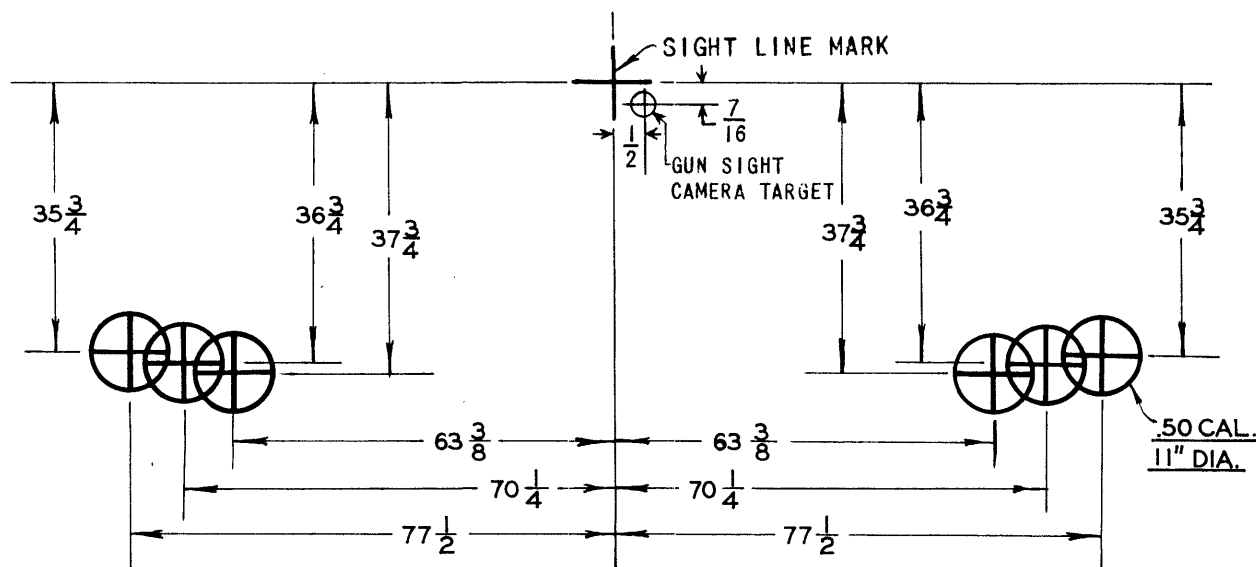


Figure 93 - Bore-Sighting Diagram - P-40D



WING GUNS CONVERGE AT 250 YARDS



WING GUNS CONVERGE AT 350 YARDS

## INSTRUCTIONS FOR COMBAT SETTING-1000 INCH RANGE

- 1 - SET AIRPLANE IN FLYING POSITION.  
FOR 290 M.P.H. SET GUN LEVEL LUGS LEVEL-250 M.P.H. SET GUN LEVEL  
LUGS 12 MILS (42 MIN.) NOSE UP.
- 2 - SET SIGHT MARK OF TARGET USING SIGHT LINE LEVEL INDICATOR AND  
PLUMB BOBS.
- 3 - ADJUST SIGHT AND GUNS TO THEIR RESPECTIVE TARGETS.

Figure 93A - Bore-Sighting Diagram - P-40E

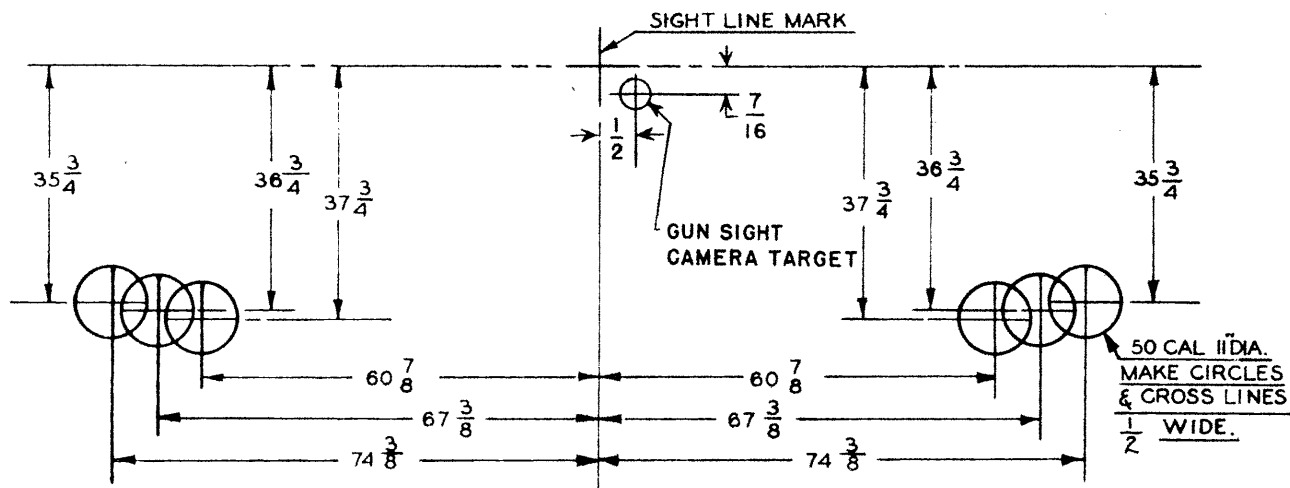
P-40F TARGET 1000 INCH RANGE GUNS  
CONVERGE AT 250 YARDS.

1- SET AIRPLANE IN FLYING POSITION.

FOR 278 M.P.H. SET GUN LEVEL LUGS LEVEL — 240 M.P.H. SET GUN LEVEL LUG 14 MILES (0°47.8) NOSE UP

2- SET SIGHT MARK OF TARGET USING SIGHT LINE LEVEL INDICATOR AND PLUMB BOBS

3- ADJUST SIGHT AND GUNS TO THEIR RESPECTIVE TARGETS



P-40F TARGET-1000 INCH RANGE GUNS CONVERGE  
AT 350 YARDS.

1- SET AIRPLANE IN FLYING POSITION.

FOR 278 M.P.H. SET GUN LEVEL LUGS LEVEL - 240 M.P.H. SET GUN LEVEL LUGS 14 MILES (0°47.8) NOSE UP

2- SET SIGHT MARK OF TARGET USING SIGHT LINE LEVEL INDICATOR AND PLUMB BOBS

3- ADJUST SIGHT AND GUNS TO THEIR RESPECTIVE TARGETS.

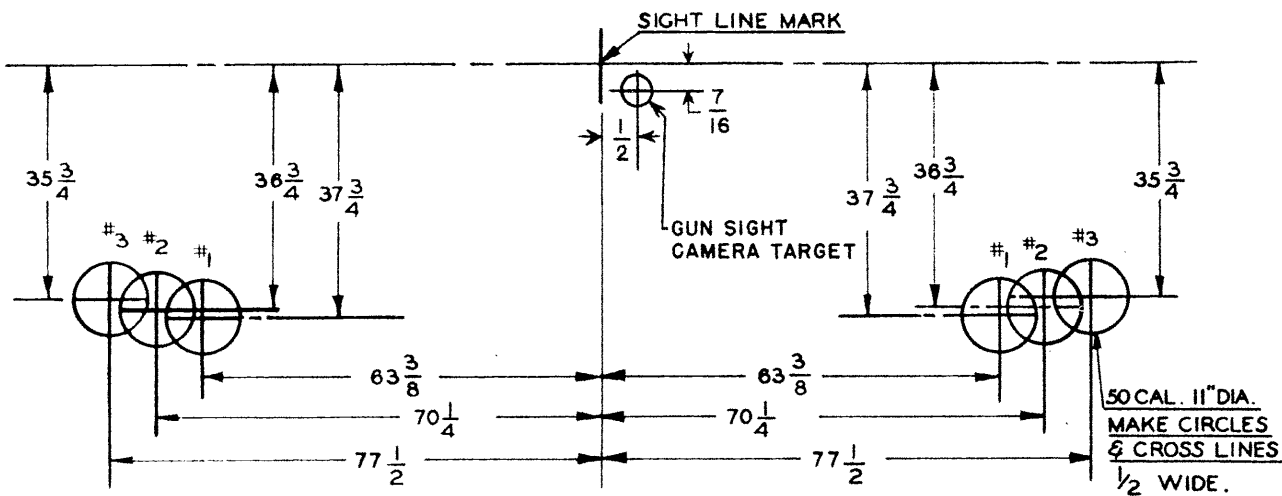


Figure 93B - Bore-Sighting Diagram - P-40F



Level the Airplane laterally and raise or lower the Tail to position the Gun Level Lugs to correspond to the angle of attack characteristics of the Airplane for the desired airspeed. When the Guns are bore sighted in the open anchor the Airplane securely in position as illustrated so that air currents will not alter the position of the Airplane.

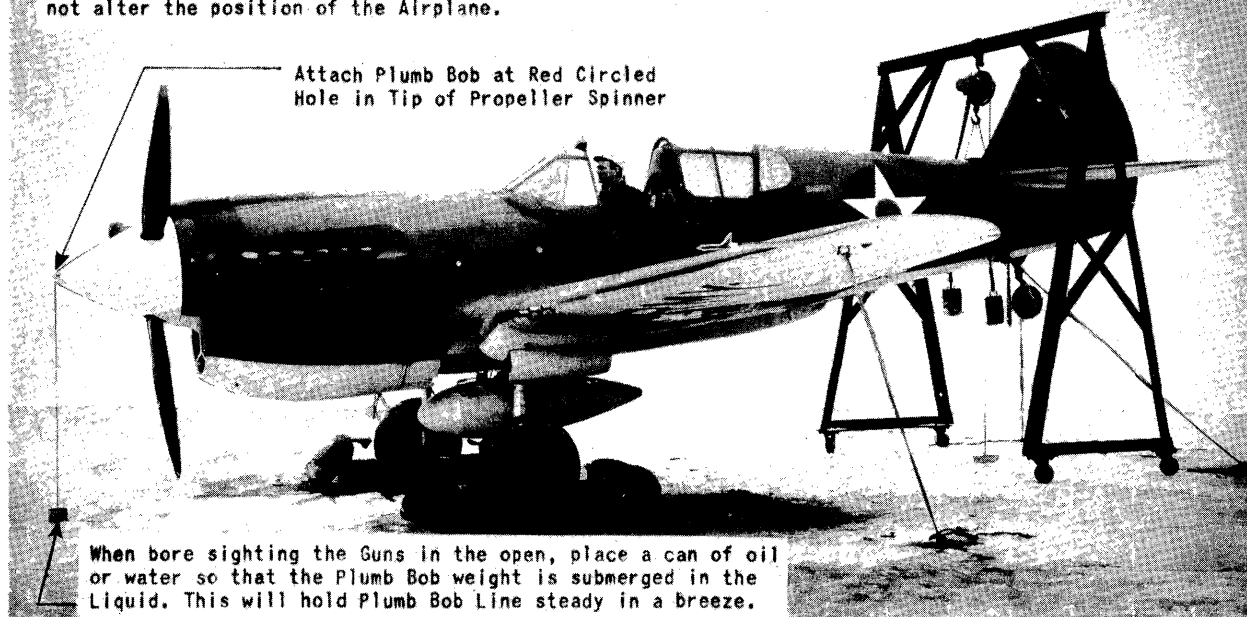


Figure 94 - Airplane in Flight Attitude for Bore Sighting the Guns

Attach Plumb Bob to the Red Circled Hole immediately forward of the Tail Wheel Doors. Place the weighted end of the Plumb Bob in a pan of oil or water.

Bore Sight Target is positioned 1000 inches from the approximate mean of the Gun Trunnion Bolts.

Hang a 100 pound weight on both ends of the Tail Hoisting Bar as illustrated.

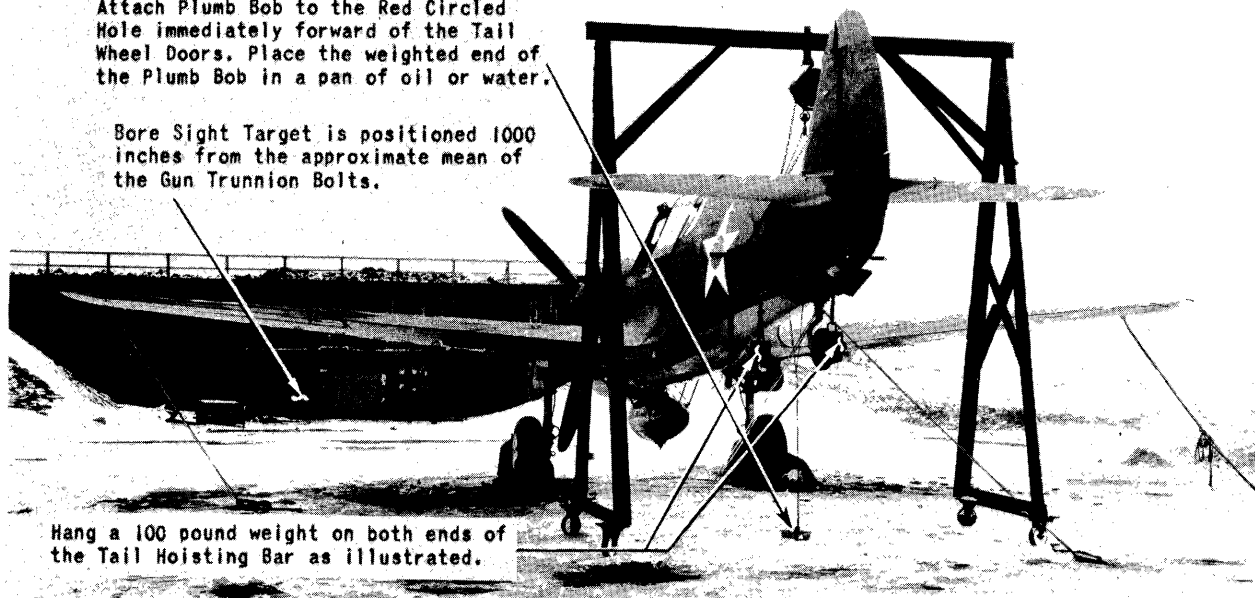


Figure 95 - Aft View of Airplane in Correct Attitude for Bore Sighting the Guns in the Open



member, aligns itself with the airplane center line. With the aligner in this position, the gun sight can be adjusted to the aligner cross hair and peep sight telescope. Since the level lugs are set in the same relative high speed position on all P-40 models covered by this article, the sight aligner can be universally used without the necessity of making adjustments.

**Gun Aligner:** Is a fixture that attaches to the leading edge of the wing over the gun opening, being secured by means of two "T" handle operated Dzus fasteners. Due to the variations in the gun positions, it is necessary to have a different fixture for each gun on both sides of the aircraft. These fixtures have vertically elongated holes for the various P-40 models mentioned herein, in which the registering rod mentioned later must be symmetrically located for the proper lateral adjustment, which gives 250 yards converged fire. On each side adjacent to the elongated hole are graduated lines for the various airplane models giving the vertical high speed firing settings when the line on the registering rod is aligned with these graduations. In each case the setting is based on the normal high speed flight attitude of the particular model aircraft shown on the fixture. The registering rod is inserted into the gun barrel and extends into the fixture so that its forward end is flush with the face side of the fixture. The gun is then adjusted until the rod is centered in the elongated slot and the line on the rod is aligned with the graduations on the fixture for the particular aircraft at hand. The rod contains a cross handle for ease in its manipulation. Two rods of the same design are furnished with each set of fixtures to permit the guns being adjusted on each side of the aircraft simultaneously.

c. **Function.** - The sight and gun aligners can be used independent of each other, which means that separate crews can operate simultaneously to align the sight and the guns at each side of the aircraft.

The method of using the fixture method is as follows:

(1) **Gun Aligners.** (Method of adjusting the guns.)

- (a) **Figure 96.** - Gun installation intact.
- (b) **Figure 97.** - Remove blast tube fairings, using screw driver.
- (c) **Figure 98.** - Remove blast tubes by unscrewing by hand.
- (d) **Figure 99.** - Insert registering rod in gun barrel.
- (e) **Figure 100.** - Attach proper fixture - for example, the one marked "3 LH" is for No. 3 outboard left-hand gun, the fixture being attached to the leading edge by means of the hand operated Dzus

fastener. Then adjust the gun until the rod can be inserted through the elongated slot of the fixture so that it is flush with the face side. The gun must be adjusted until the rod is in the center of the elongated slot for the lateral adjustment, which gives a 250-yard converged fire setting. Then align the line on the forward end of the rod with the corresponding lines adjacent to the elongated slot on the fixture, selecting the proper lines compatible with the model aircraft for which the vertical setting is being made. This gives the 100 percent high speed firing condition.

**NOTE:** On all P-40D, P-40E, P-40E-1, and P-40F airplanes through AF41-13970 work the bore-sighting rods to within 1/16 inch of the unmarked side of the elongated slot. On P-40F airplanes AF41-13971 and subsequent, as well as all P-40K, P-40K-1, and P-40L airplanes work the bore-sighting rods to within 1/16 inch of the "X" side of the elongated slot.

(f) **Figure 101.** - Each gun position requires a special fixture which is marked "1 LH," "2 LH," "3 LH" for inboard, center, and outboard left-hand guns respectively, and "1 RH," "2 RH," "3 RH" for inboard, center, and outboard right-hand guns respectively.

(g) **Figure 102.** - Shows full complement of bore-sighting fixture parts. This includes collapsible sight aligner, six gun aligners, and two registering rods.

(h) **Figure 103.** - Shows complete bore-sighting fixtures packed in carrying case and includes an

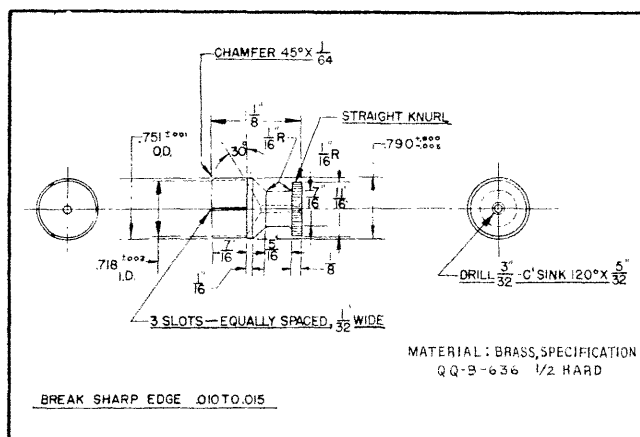


Figure 95A - Bore-Sight Reflector Plug

instruction manual. To collapse the sight aligner prior to placing same in carrying case, loosen the two top wing nuts and the two diagonal uprights can be folded downward to a flat position. The side leveling bar assembly can be removed by removing the wing nut at the forward end. The parts can then be placed in the case as shown in the photograph.

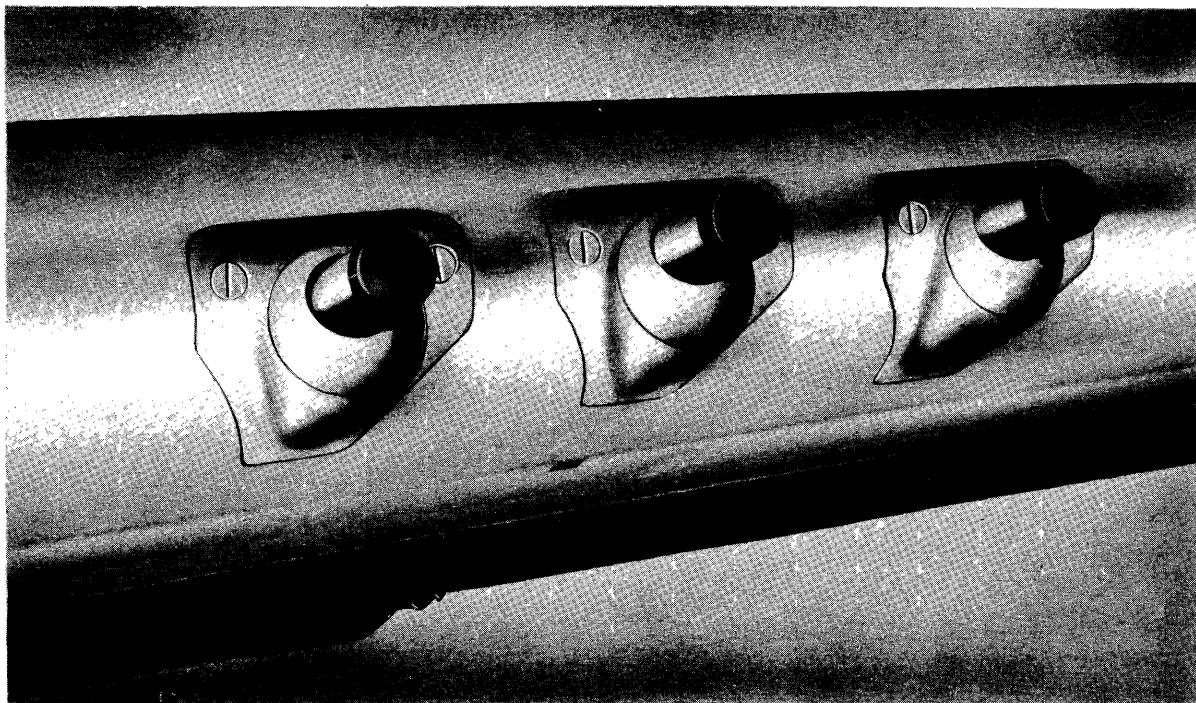


Figure 96 - Gun Installation Intact

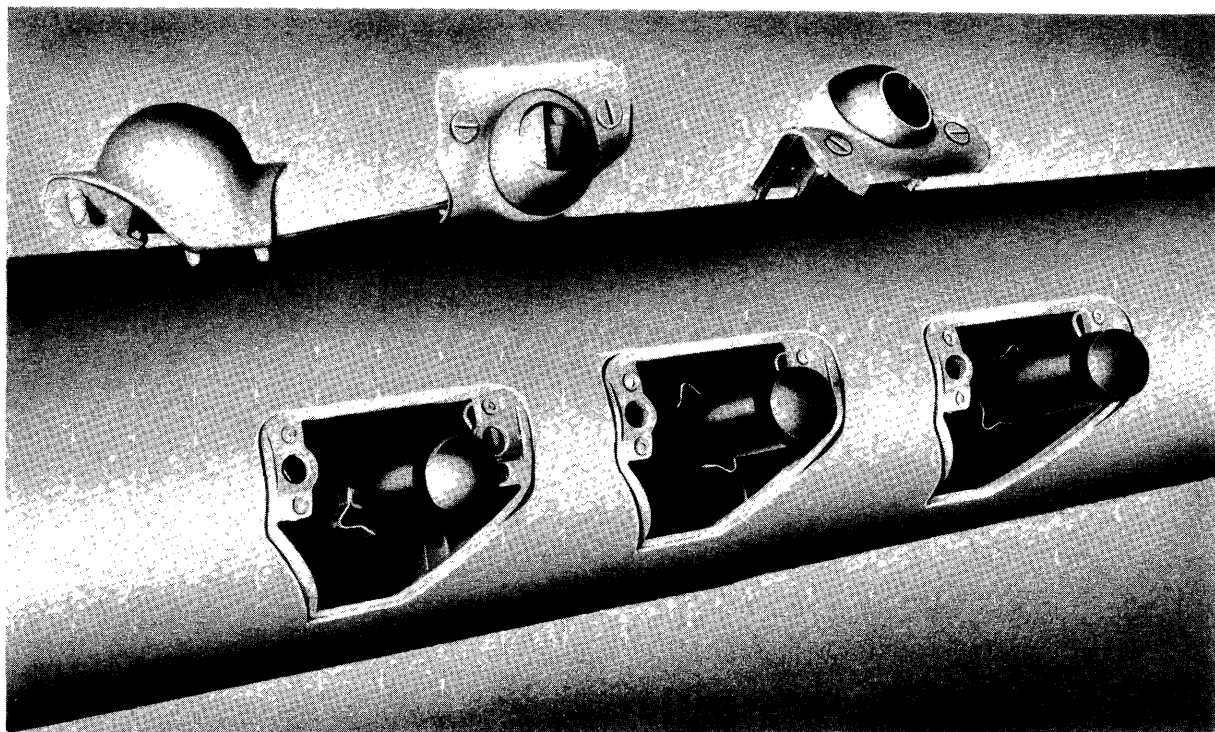


Figure 97 - Blast Tube Fairings Removed

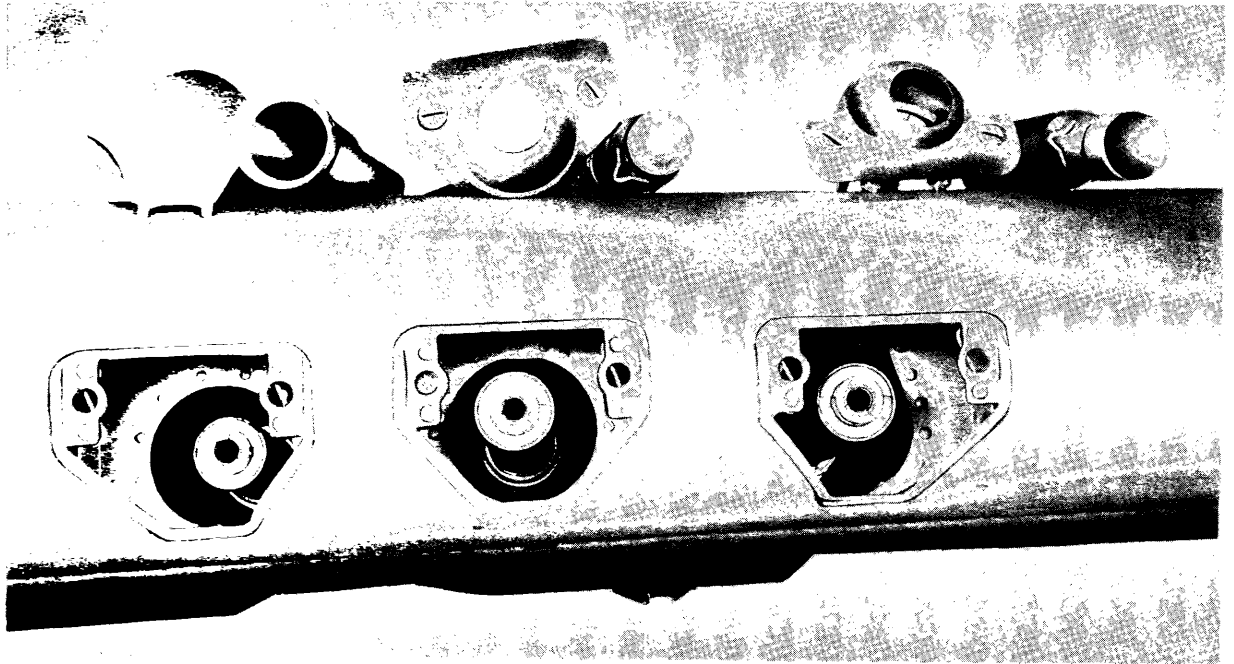


Figure 98 - Blast Tubes Removed from Retainers

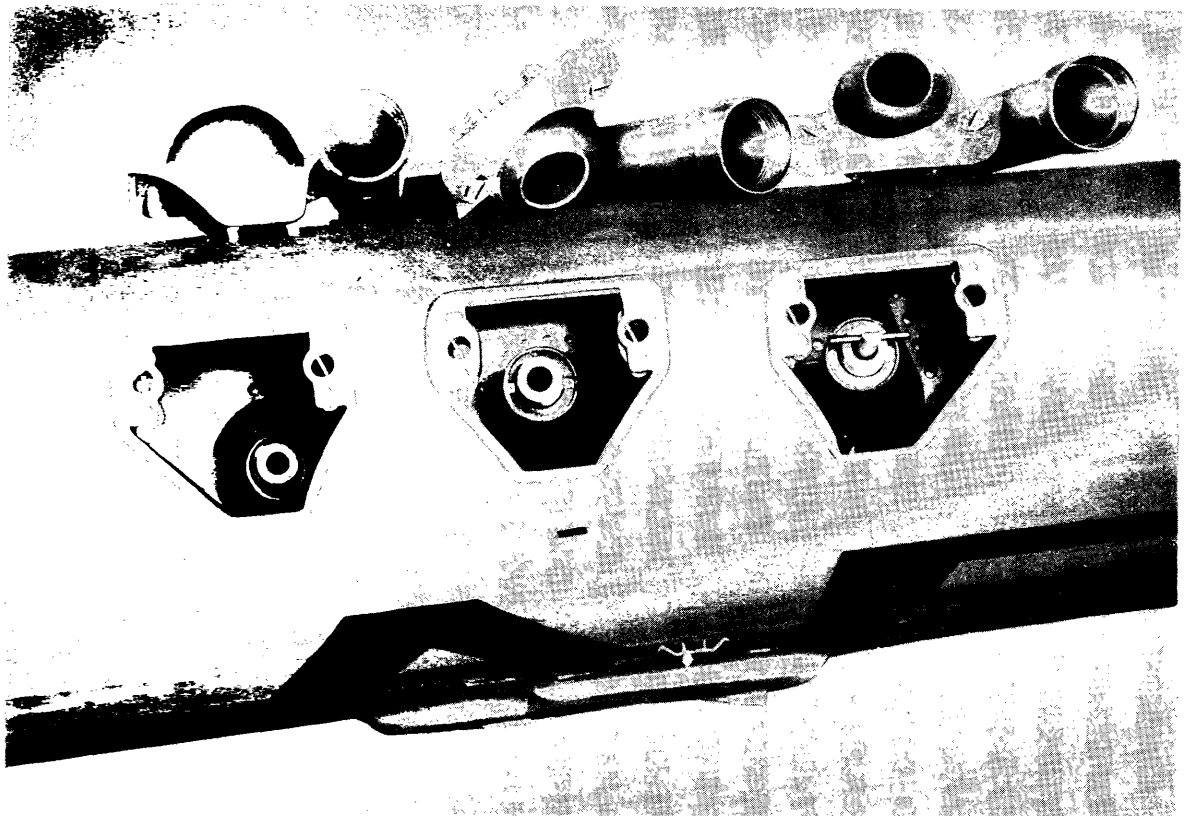


Figure 99 - Registering Rod Inserted in Gun Barrel

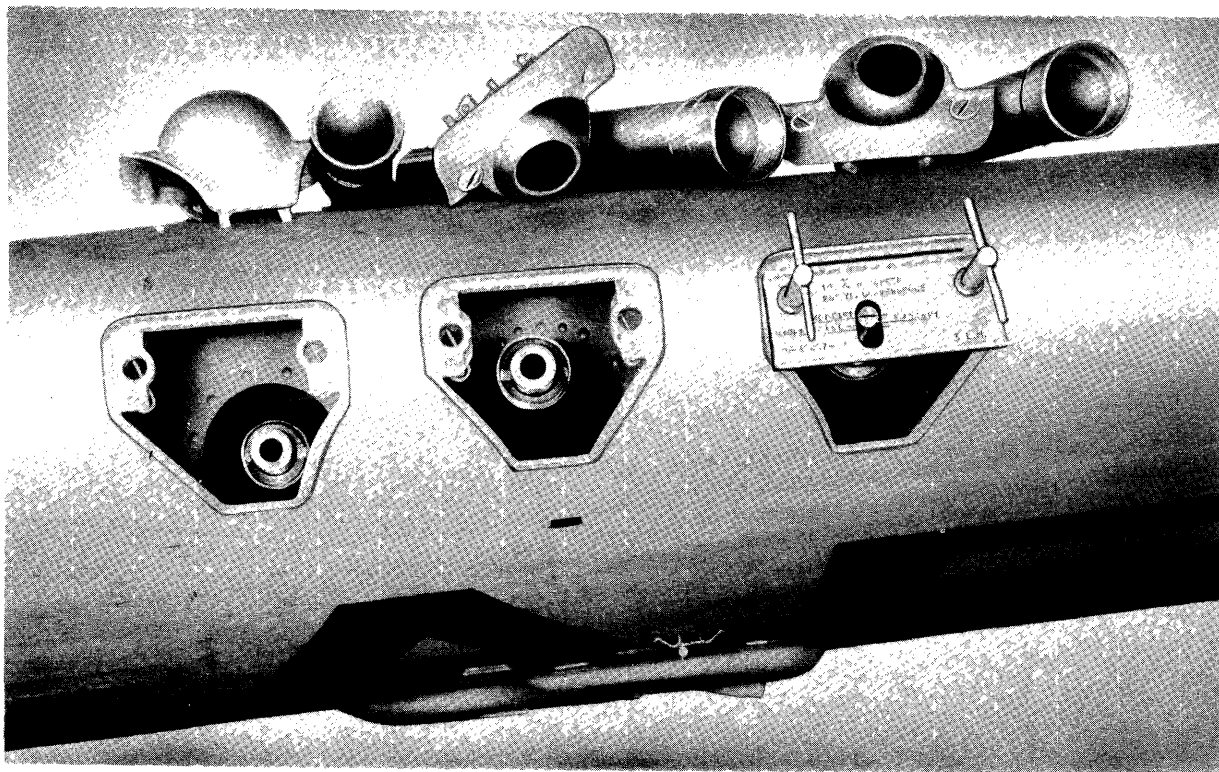


Figure 100 - No. 3 Left-Hand Fixture Attached to Leading Edge

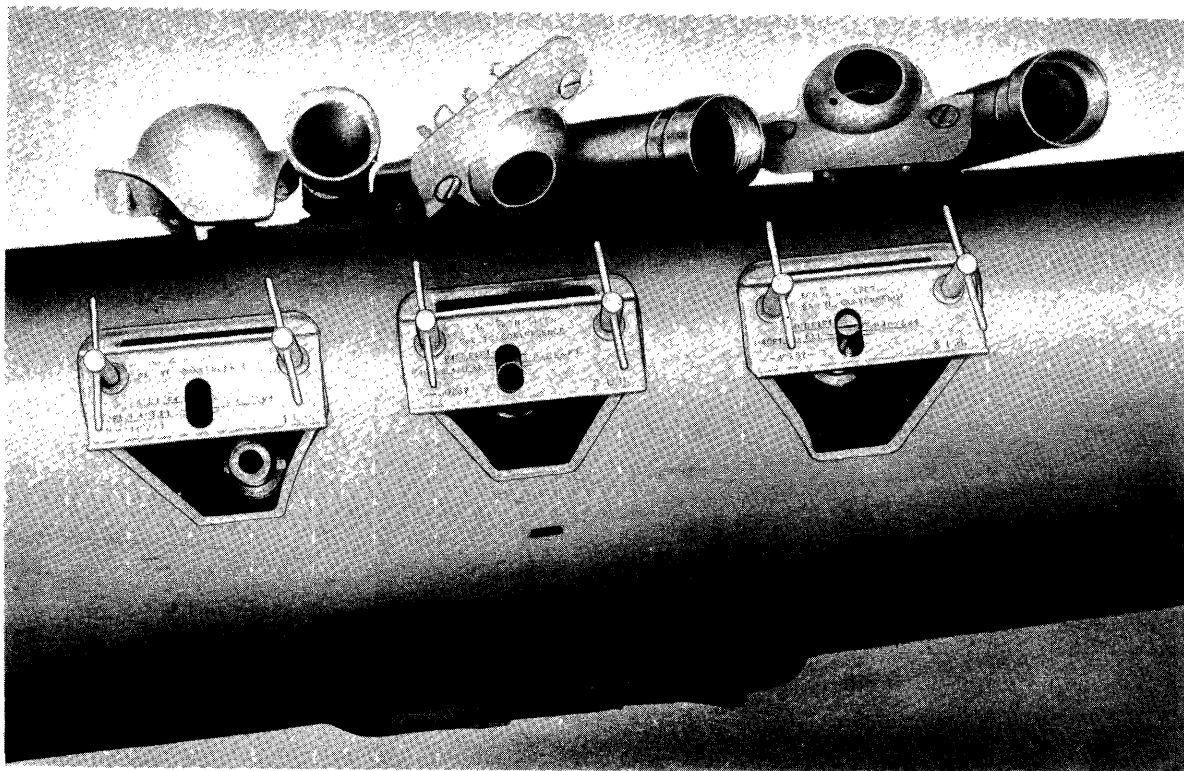


Figure 101 - Left-Hand Fixture, No. 1, No. 2 and No. 3 Installed

(i) **Figure 104.** - The sight aligner is placed on the lateral leveling lugs of the aircraft and the movable side level bar is adjusted until it rests on the longitudinal level lugs of the airplane marked gun level. The adjustment is then locked by means of the wing nut. The aligner is then moved forward adjacent to the windshield frame and against the left-hand side of the airplane until the inside pads contact the longeron. This places the sight aligner telescope in the center of the airplane. Then by means of a screw driver, adjust the gun sight as described in this Handbook until the upper horizontal and the vertical cross hairs of the illuminated image coincide with the cross hairs at the front and peep at the rear of the sight aligner telescope. On airplanes equipped with the circle and dot reticle the intersection of the cross hairs should coincide with the dot in the reticle. Due to the small peep hole in the telescope, it is necessary to have the eye very close to the telescope.

(j) **Figure 105.** - Shows right-side view of sight aligner and how it rests on the lateral leveling lugs.

d. **Maintenance.** - Sight Aligner: Periodically, the sight aligner should be checked for inaccuracy which

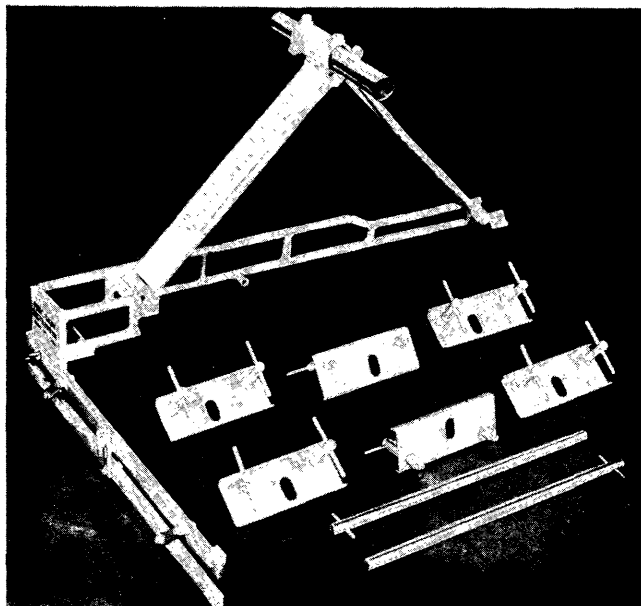


Figure 102 - Bore-Sighting Fixture Components

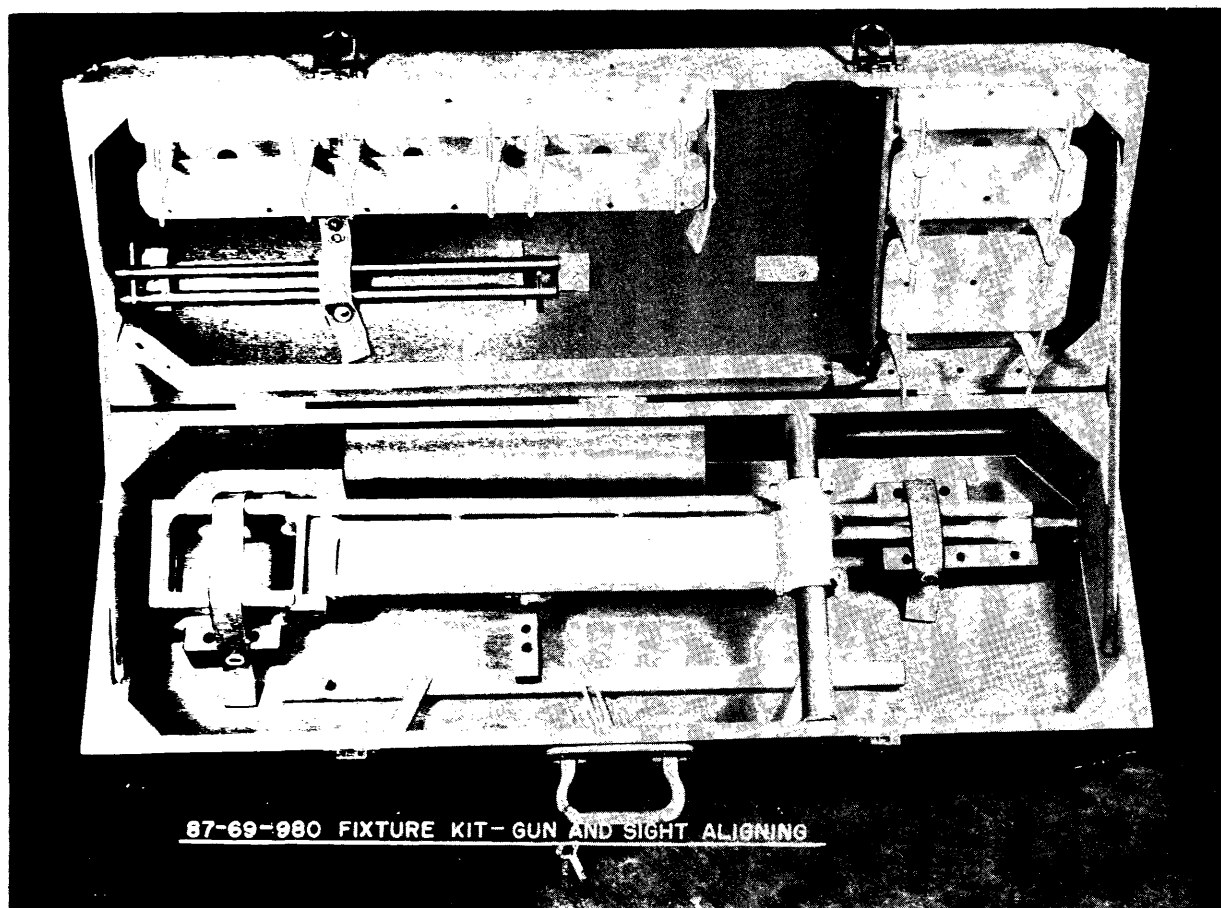


Figure 103 - Bore-Sighting Fixtures Packed in Carrying Case



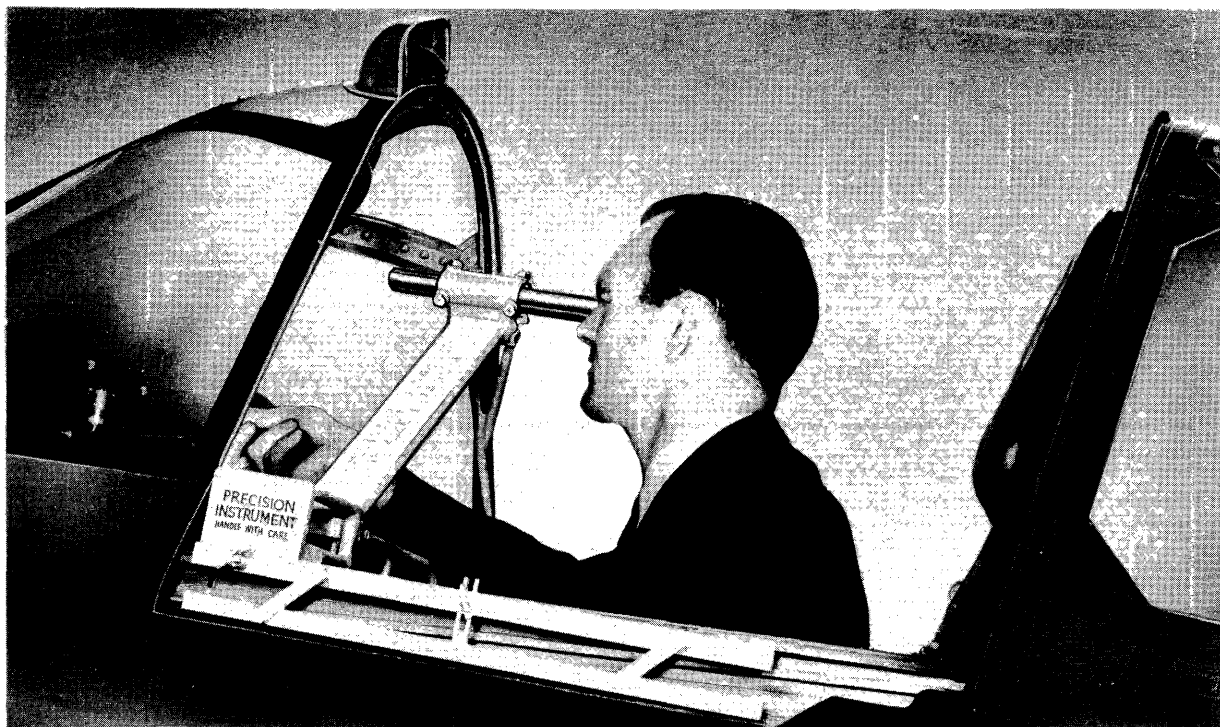


Figure 104 - Adjusting Gun Sight with Sight Aligner

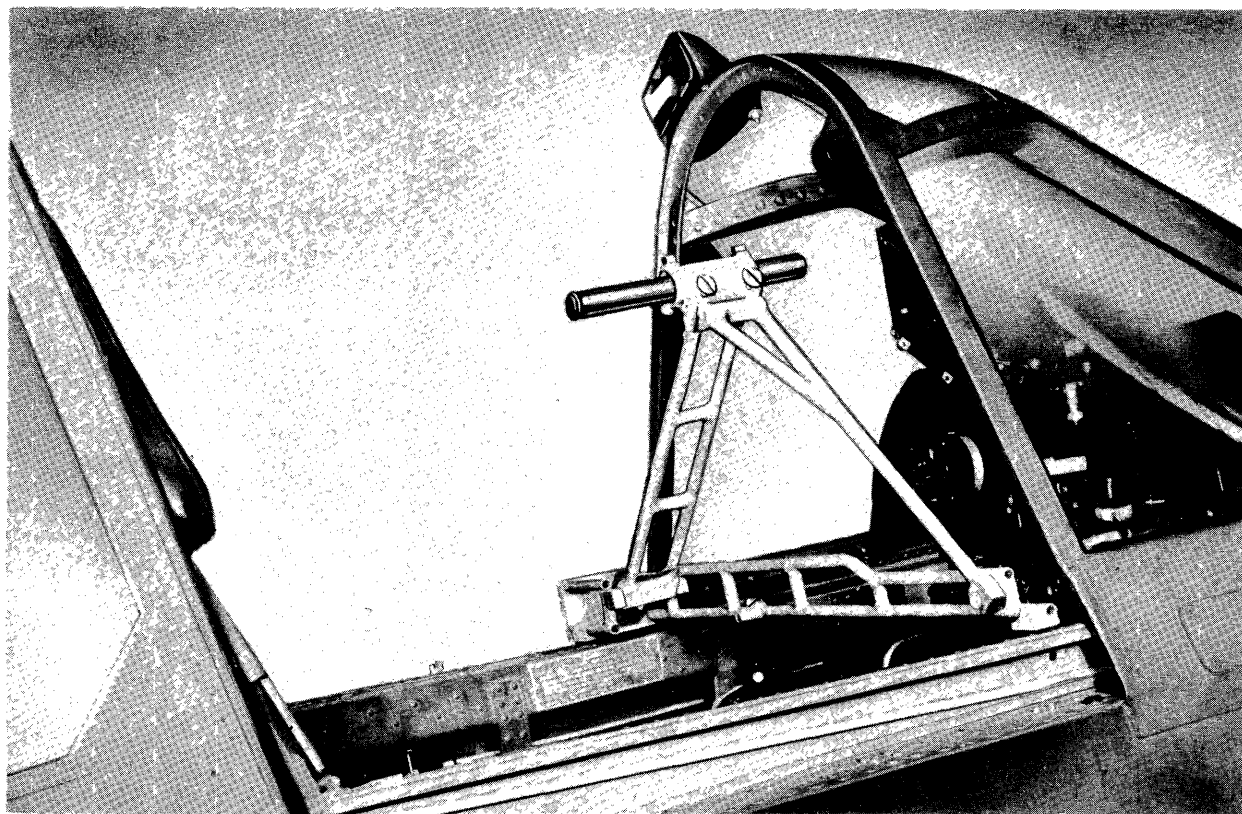


Figure 105 - Sight Aligner Installed on Leveling Lugs

may result from extended use or accidental damage. This may be accomplished by checking to an accurately set installation or by setting to a target and resetting the telescope by means of the adjustable set screws. After readjustment of the set screws they should be resealed. The target method of resetting is accomplished by using the 1000-inch range position for target. Level the airplane to the gun level lugs and airplane lateral level lugs and center the target by plumb bobs dropped from the nose of propeller spinner and tail of aircraft, the target to be arranged in accordance with figure 93. First set gun sight to target using the vertical line and highest horizontal line of illuminated gun sight image, then adjust the sight aligner to the gun sight using the same setting.

Gun Aligner: There appears to be no reason for resetting the gun aligner in the field since all conditions pertaining to them are quite permanent.

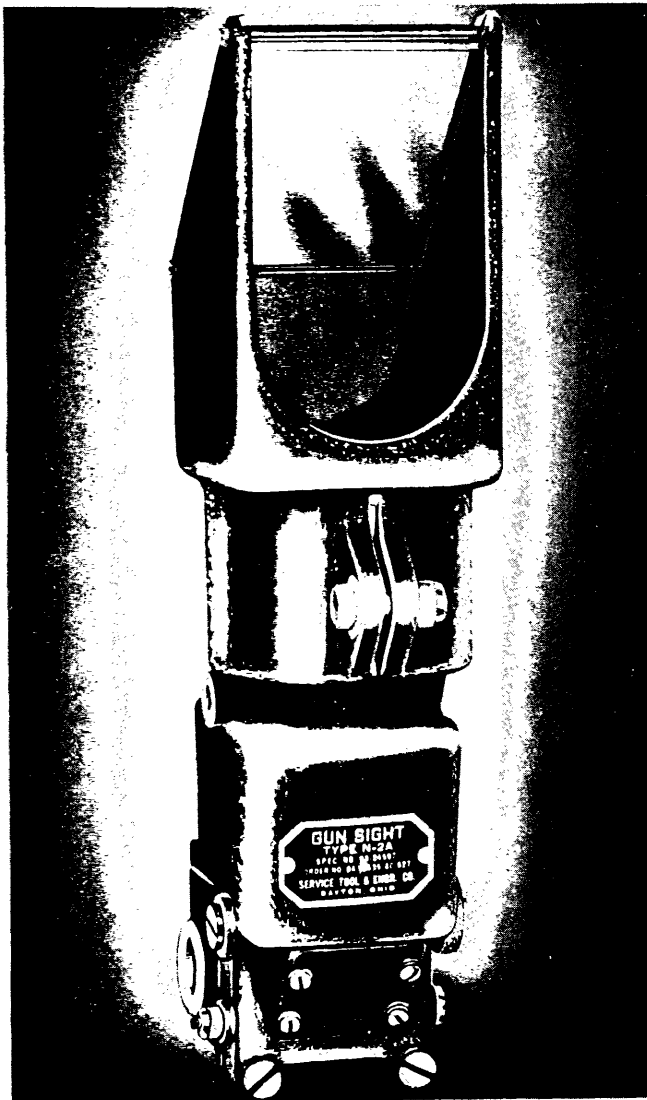


Figure 105A

Apparently only replacements should be made for unserviceable parts.

#### 4. To Disassemble the Gun Sight.

a. To disassemble the gun sight first unscrew the bolts attaching the instrument panel reflector screen assembly to the two lugs on the yoke assembly.

b. Disconnect the conduit plug from the forward side of the sight assembly.

c. Unscrew the central clamping nut from the clamping bolt and remove the yoke and sight assembly from the base.

**NOTE:** Short circuits in the gun sight electrical system will render the gun circuit inoperative. This may be corrected by turning off the gun sight rheostat and throwing the circuit breaker to the "ON" position.

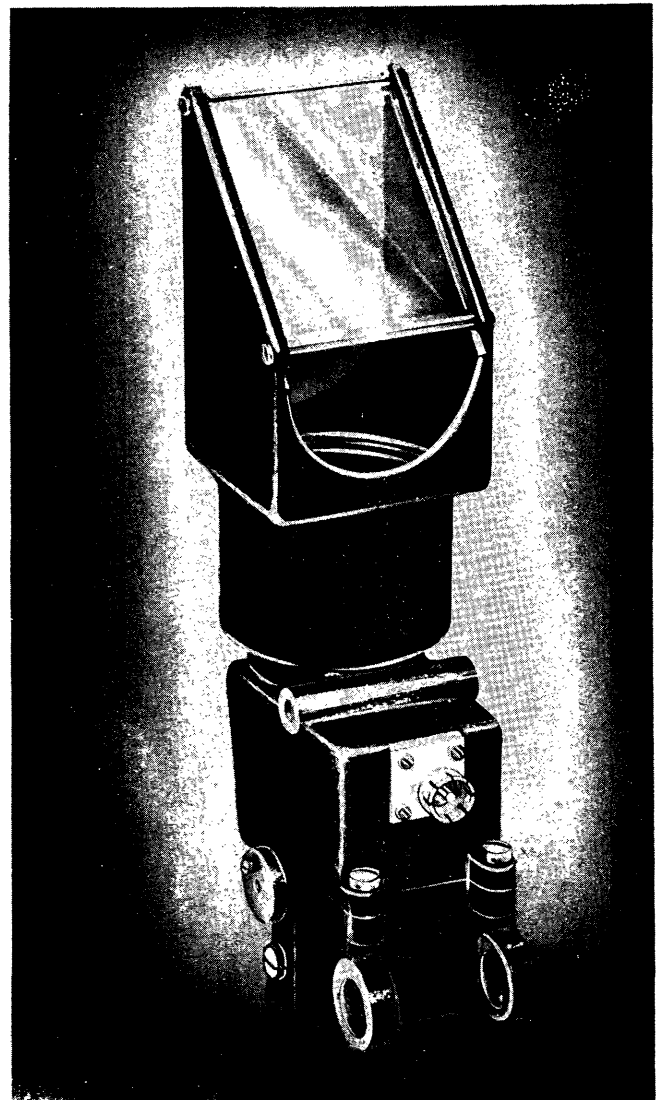


Figure 105B

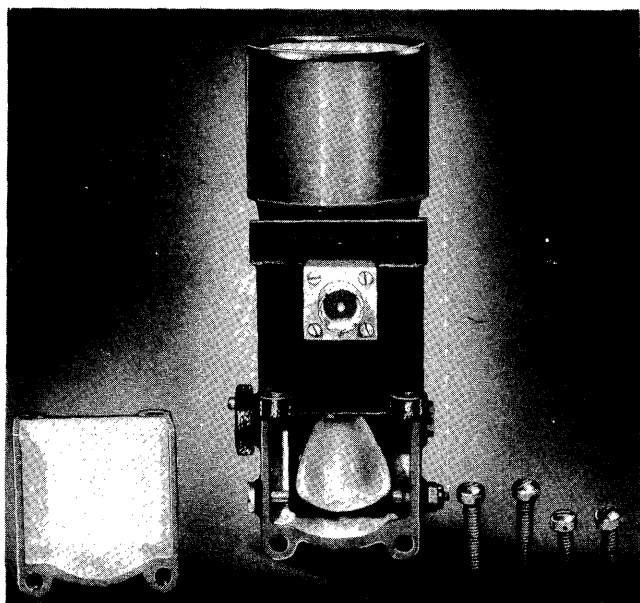


Figure 105C

d. If the sight assembly is to be disassembled and serviced, personnel should proceed as follows:

(1) Disassembly.

(a) Reflector Parts.

1. Remove the setscrew located on the reflector housing barrel.
2. Remove the reflector housing from the sight.

**NOTE:** Some reflector supports have two ears which are clamped together by a bolt and nut. (See figure 105A.) To remove this type housing, the nut must be loosened before the housing can be removed. Some type N-3A and N-3B sights having this housing must also be unscrewed from the main housing.

3. Remove the four bolts and nuts holding the reflector. (See figure 105B.)

4. Remove the reflector.

(b) Lamp.

1. Remove the four large screws in the lamp house cover. (See figure 105C.)

2. Remove the lamp. (This may be readily done by hand.)

(c) Reticle. - Remove the sight reticle by taking out the two small retaining plates and attaching screws. (See figure 105D.) Tilt the sight until the reticle slips out.

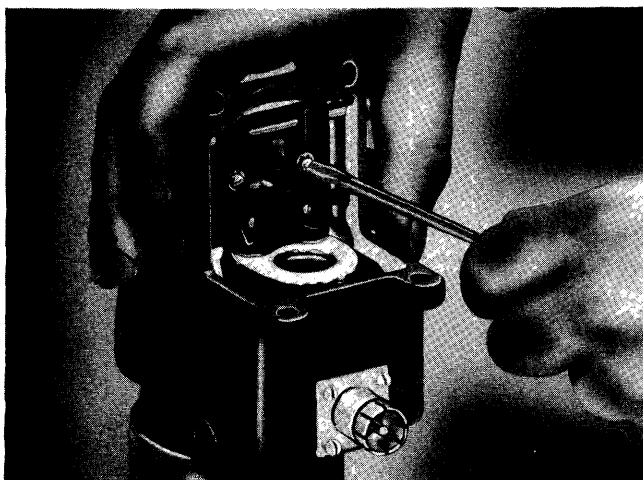


Figure 105D

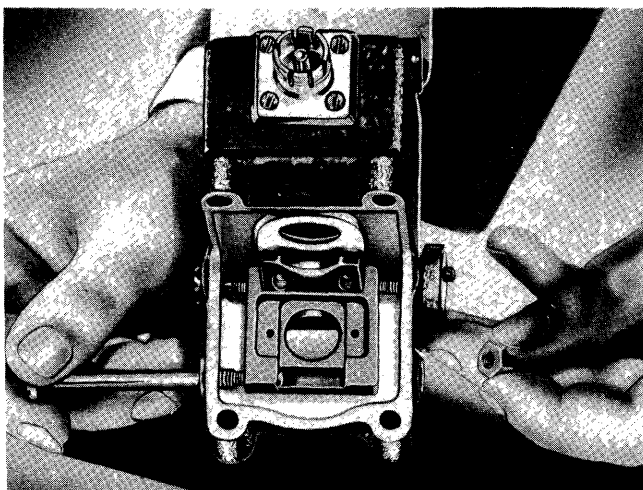


Figure 105E

**CAUTION:** Hold the reticle by its edges.

- (d) Removal of reticle carriage and electrical assembly.

1. Unscrew the nut on the reticle slide and remove the slide. (See figure 105E.)

2. Knock out the pin holding the deflection knob, using a 1/16-inch drill rod punch. (See figure 105F.) Unscrew the deflection knob lock, then unscrew the knob and the long screw which passes through the reticle mount.

3. Remove the four screws holding the electrical connector plug housing. (See figure 105G.) Detach the electrical connector socket pin mounted in the moulded-phenolic base, but do not break the cable connection.



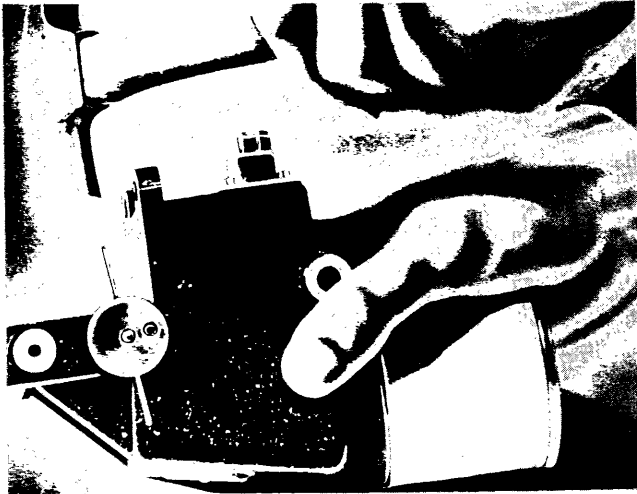


Figure 105F

4. Remove the socket assembly from the socket sleeve by pushing in the small locator button projecting from the sleeve.

5. Remove the reticle mount by unscrewing the two screws which pass through the metal reticle slide spacer and hold the reticle carriage to the sleeve spacer. (See figure 105H.)

(e) Mirror. - Remove the four screws which hold the mirror assembly to the sight housing. Then pry the assembly gently away from the housing by breaking the shellac seal. (See figure 105I.)

NOTE: The shellac seal may give way suddenly, therefore, care should be taken that the prying instrument does not scratch the front surfaced mirror.

Remove the two crimped retaining lugs which hold the mirror in its well and remove the mirror.

(f) Lens.

1. Insert the prongs of a spanner wrench into the two opposite holes of the glass dust shield assembly and unscrew the shield. (See figure 105J.)

2. Remove the lens cell setscrew located on the front of the barrel holding the lens assembly.

3. Warm the sight to overcome the sluggishness of the sealing compound. Then insert the sight wrench in the two slots in the lens barrel and remove the lens by turning the lens assembly firmly in a counterclockwise direction. (See figure 105K.)

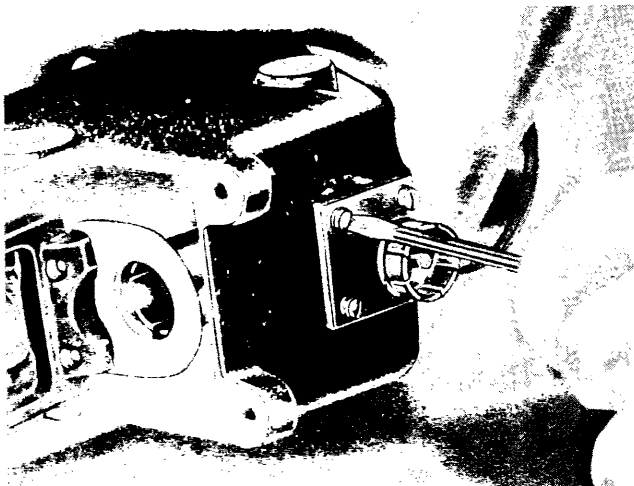


Figure 105G

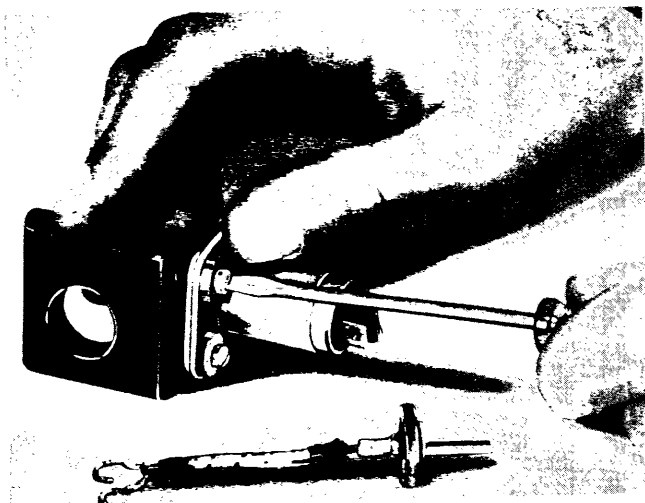


Figure 105H

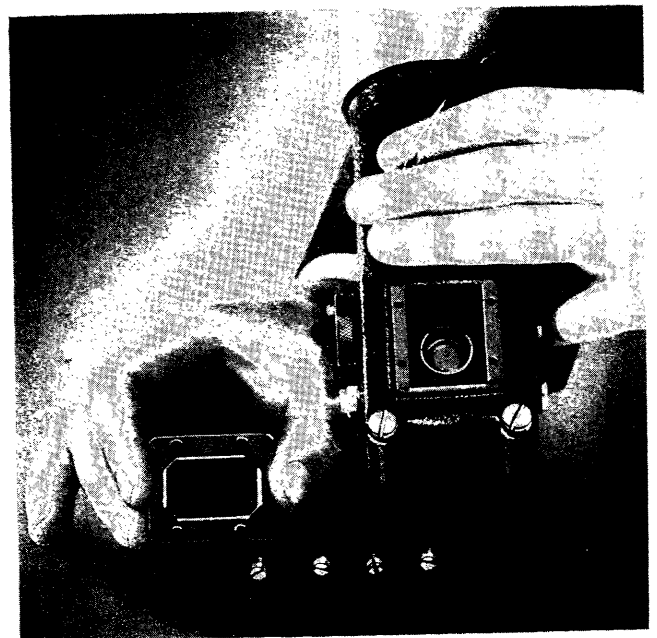


Figure 105I

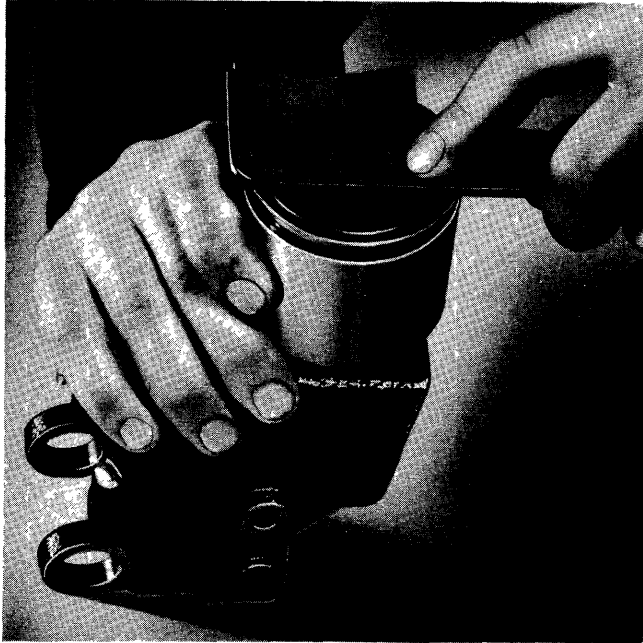


Figure 105J

(2) Adjustment. - Normally the gun sights are adjusted properly by the manufacturer so that it should not be necessary to readjust either the reticle or the main lens assembly. If, however, such adjustments become necessary, they be made as follows:

(a) The reticle may be adjusted approximately by centering the reticle carriage on its slide.

(b) Adjust the main lens assembly as follows:

NOTE: Unless movement exists between the reticle image and a target at least 500 yards distant, it should not be necessary during the life of the sight to adjust the main lens assembly.

1. Remove the reflector support.
2. Unscrew the dust shield.
3. Unscrew the lens setscrew.
4. Turn the lens assembly with the wrench until the reticle image, as viewed in the reflector



Figure 105K

glass and superimposed upon a target approximately 500 yards distant, does not change in relation to the target as the head is moved from side to side over the field of view of the sight. Tighten the setscrew.

5. Insert the lens shield.

6. Attach the image reflector support.

NOTE: In installations which do not make use of the reflector support, it will be necessary to accomplish the above operation with the sight and reflector installed in the airplane unless one of the following optional methods for lens adjustment is used.

1 Use of a collimating telescope with which the lens is set for the sharpest image in the viewing screen.

2 Use of a C-3 ground camera, set for infinity focus, (marked as ∞ on the distance scale of the camera). Set lens for the sharpest image on ground glass screen.

SECTION VGUN CAMERA1. To Assemble the Type N-2 Gun Camera.

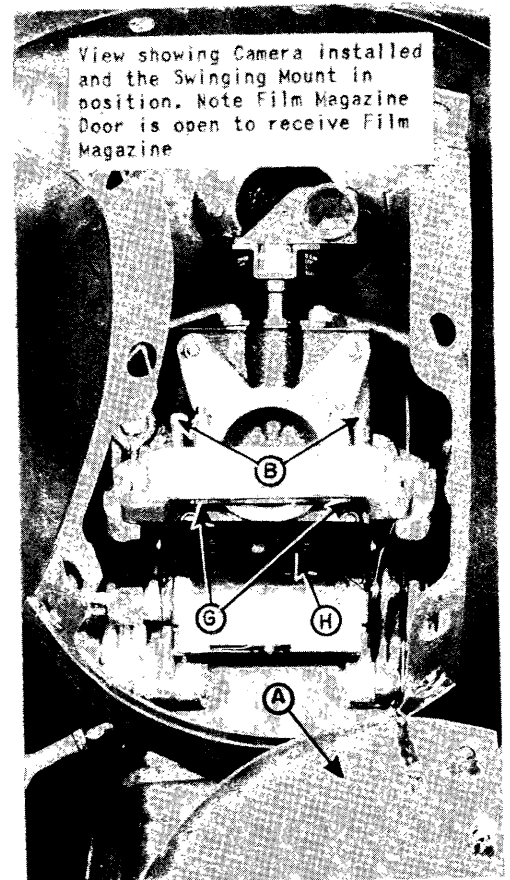
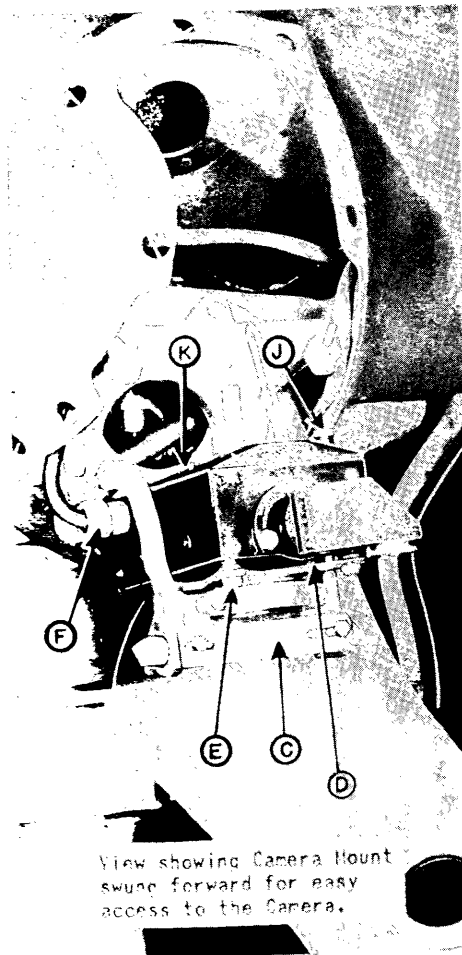
- a. General. - The type N-2 gun camera is a gun sight aiming point camera, 24-volt unit designed for use as an aerial machine gun camera. It is equipped with an F4.5 3-inch 90-degree erecting system lens, an F4.5 3-inch plain lens and interchangeable minus blue filters. It is designed for selective speeds of 16, 32, and 64 exposures per second.

The camera employing the 90-degree erecting system lens is mounted on an adapter and mount assembly in the leading edge of the right-hand landing gear fairing. The camera is quickly accessible for loading and adjusting through a door on the spherical face of the fairing. The fairing door has a round glass window and is buttoned onto the fairing with Dzus fasteners. (See figure 106.)

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 shown 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

Figure 106 - Type N-2  
Gun Camera Installed



carried and the change of magazines is very simple because no threading is required.

**b. To Install the Camera.**

(1) To install the gun camera in the landing gear fairing, unbutton the Dzus fasteners and remove the fairing door "A" from the leading edge of the fairing. (See figure 106.) Squeeze together the two projecting knobs "B" on the swinging mount and tilt the mount "C" forward. Set the camera on the adapter assembly "D" on the mount and insert the four studs on the camera into the four holes in the adapter. Install lock nuts "E" on the four camera studs.

(2) Connect the electric conduit "F" to the socket on the lower right side of the camera.

(3) The adjustment of the gun camera can be made only at the time of sighting the guns at a target. To adjust the camera, insert the optical camera aligner in place of the film magazine. Loosen the

two screws "G" which tighten the collar assembly to the adapter ball and adjust the camera to bring the target into the reticle of the optical aligner. Tighten the two screws "G" and check the image of the target in the aligner.

(4) Install the overrun control box on the bracket on the left side of the cockpit, just forward of station No. 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. (See figure 107.)

(5) 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.

(6) 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

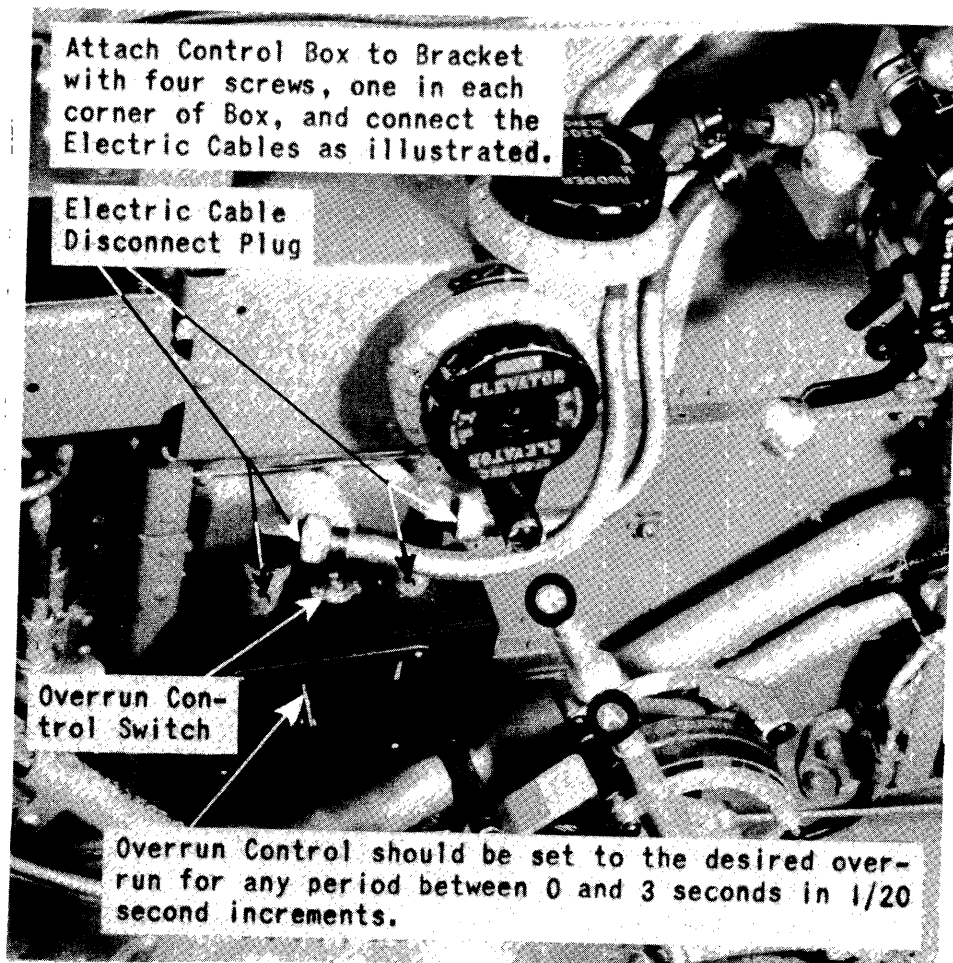


Figure 107 - Overrun Control Box Installed

the switch is released for the length of time indicated on the dial setting.

(7) Insert the magazine into the camera as follows: Open the door "H" at the bottom 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. (See figure 108.)

(8) Select the desired speed with the shutter speed knob "J." (See figure 106.)

**WARNING:** Never try to set the speed control knob when the camera is running and always have the speed numbers opposite the index.

(9) Set the film footage indicator by pushing in and turning the knurled knob "K." (See figure 106.) 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 number of film footage remaining in the magazine.

(10) Operate the trigger switch for a very short burst to insure that the camera is functioning and the film is feeding properly.

(11) Set the ring on the lens to correspond to the speed on the shutter speed knob. Then set the dia-

phragm 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.

(12) 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.

(13) 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.

#### c. To Remove the Gun Camera.

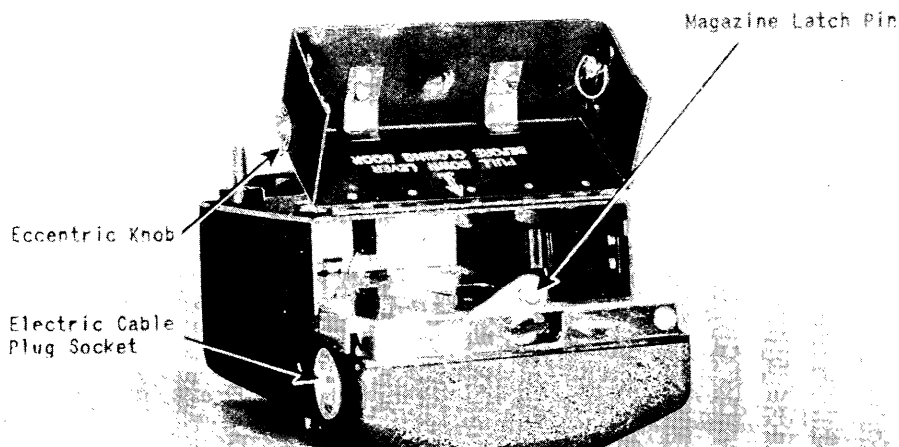
(1) Unbutton the Dzus fasteners in the leading edge of the landing gear fairing. Squeeze together the two projecting knobs on the swinging mount and tilt the camera forward. This will give access to the electrical conduit plug on the right side of the camera which may be removed by unscrewing from the camera socket. Remove the four nuts from the camera studs attaching the camera to the adapter. This method of removal will not change the adjustment of the camera.

#### d. To Remove the Overrun Control Box.

(1) Remove the two electric cable plugs on top of the box.

(2) Unscrew the four attaching bolts and remove the control box from the mounting bracket.

Figure 108 - Type N-2 Gun Camera with Magazine Door Open



To load the Camera open the Door as illustrated by pushing the Eccentric Knobs forward. Push the Magazine Latch Pin out of the way and insert the Magazine in 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 and close the Door.

e. Lubrication of the Gun Camera.

(1) Gun Camera. - A thin film of grease, grade No. 375, Specification No. 3560, should be applied to the gear teeth. A drop of oil, Specification No. 3562, should be applied to the pivots and bearings. Remove all excess oil to prevent its spread to the lens or film.

(2) Overrun Control Box. - A very small amount of grease, grade No. 375, Specification No. 3560, may be applied to the gears, cam, and ratchet teeth and a drop of oil, Specification No. 3562, to the pivots.

2. To Assemble the Type G-45 Gun Camera.

a. General. - Provisions have been made on these airplanes for the mounting of a type G-45 gun camera in a fairing on the under surface of the right wing. (See figure 114.) The camera fairing is attached at the nine nut plates indicated by an arrow on the lower wing surface outboard of the landing gear door fairing.

b. To assemble the camera remove the camera fairing and install the type 27 mounting on the shelf in the bottom of the fairing with four bolts through

the holes in the four corners of the mounting plate. Install the nuts and tighten. (See figure 110.)

c. Assemble the type 32 adapter to the base of the camera and tighten the two screws on either end of the adapter. (See figure 111.)

d. Install the camera body and adapter on the mounting plate and tighten the nuts on the two horizontal bolts on the mounting plate with the box spanner wrench. (See figure 112.)

e. Remove the grommet at the rear of the nut plates, indicated by a decalcomania, and remove the stowed electric cable plug. Raise the fairing up and attach the plug to the socket on the rear of the camera.

f. Raise the fairing to the wing and install the nine screws through the flange on the fairing to the nut plates on the wing.

g. Unbutton the fairing access door on the outboard side of the fairing to adjust the camera setting. Allowance is made for a total vertical adjustment of 6 degrees (3 degrees up or 3 degrees down) from the

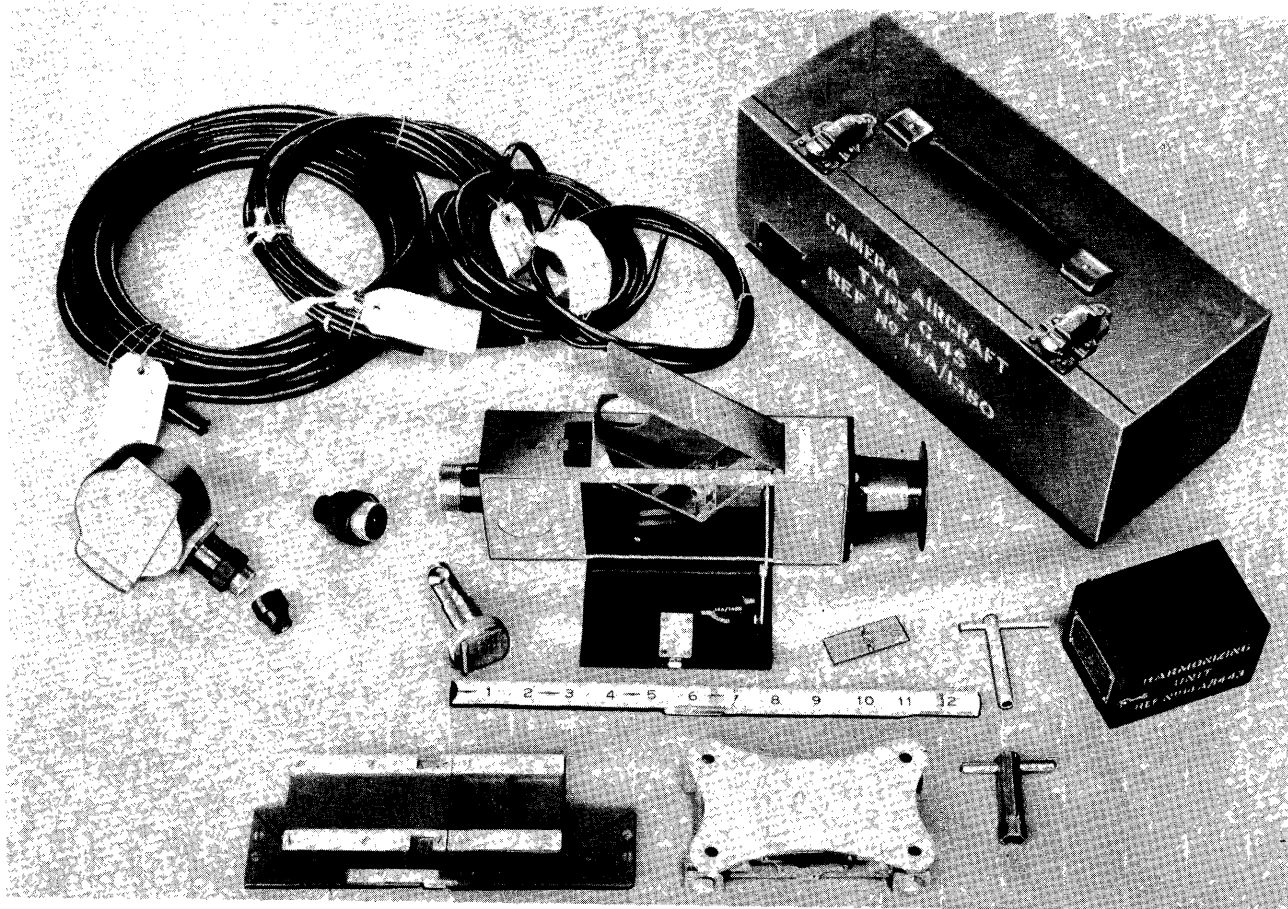


Figure 109 - G-45 Gun Camera Equipment



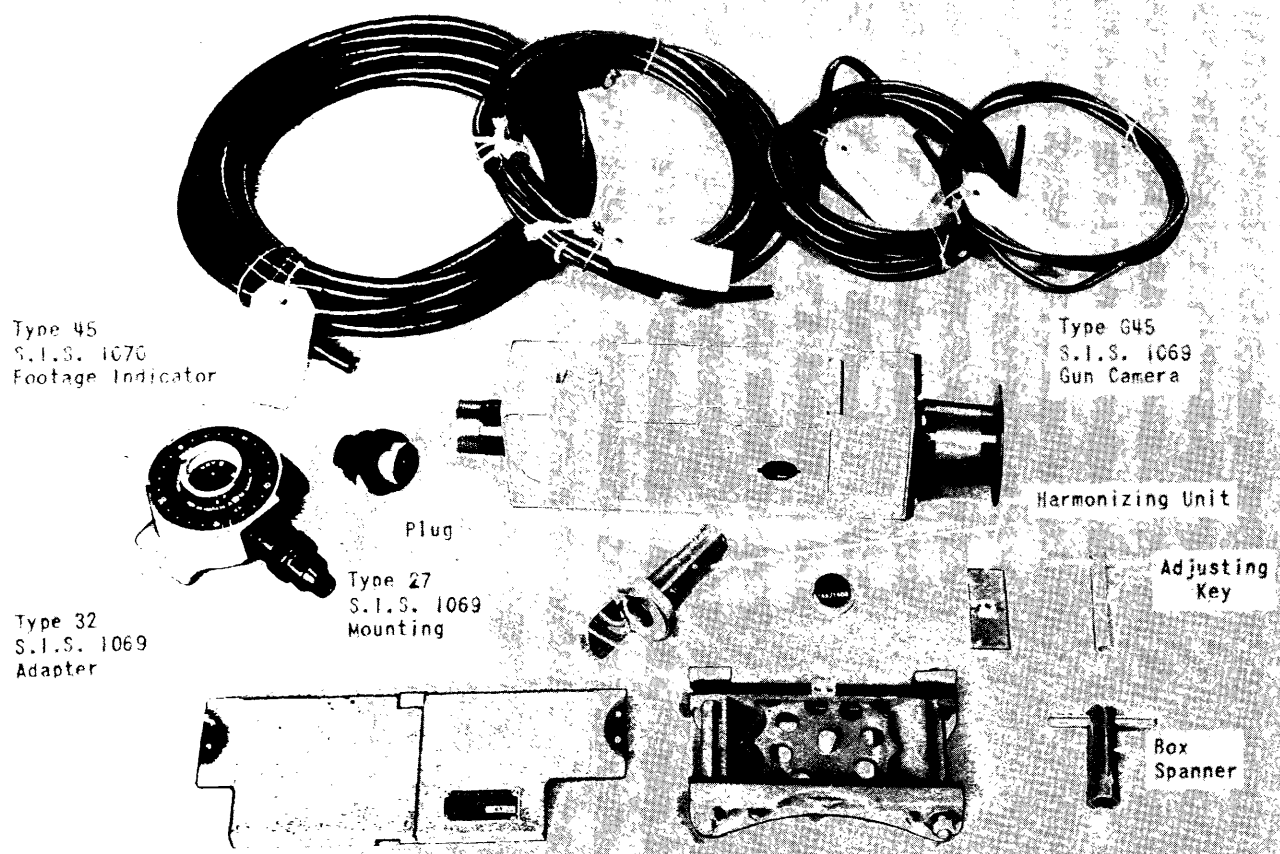
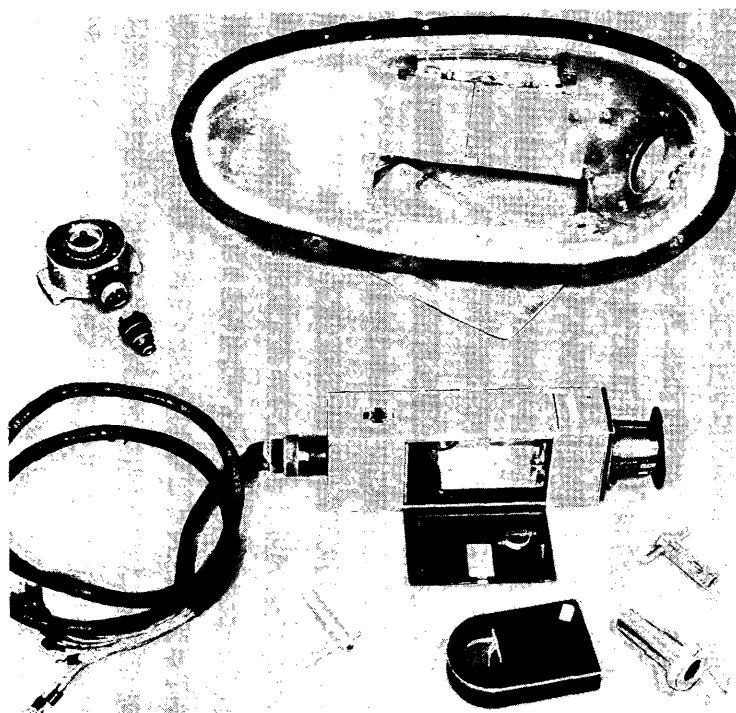


Figure 110 - G-45 Gun Camera and Accessories

Figure 111 - G-45 Gun Camera Ready for Installation in Camera Fairing



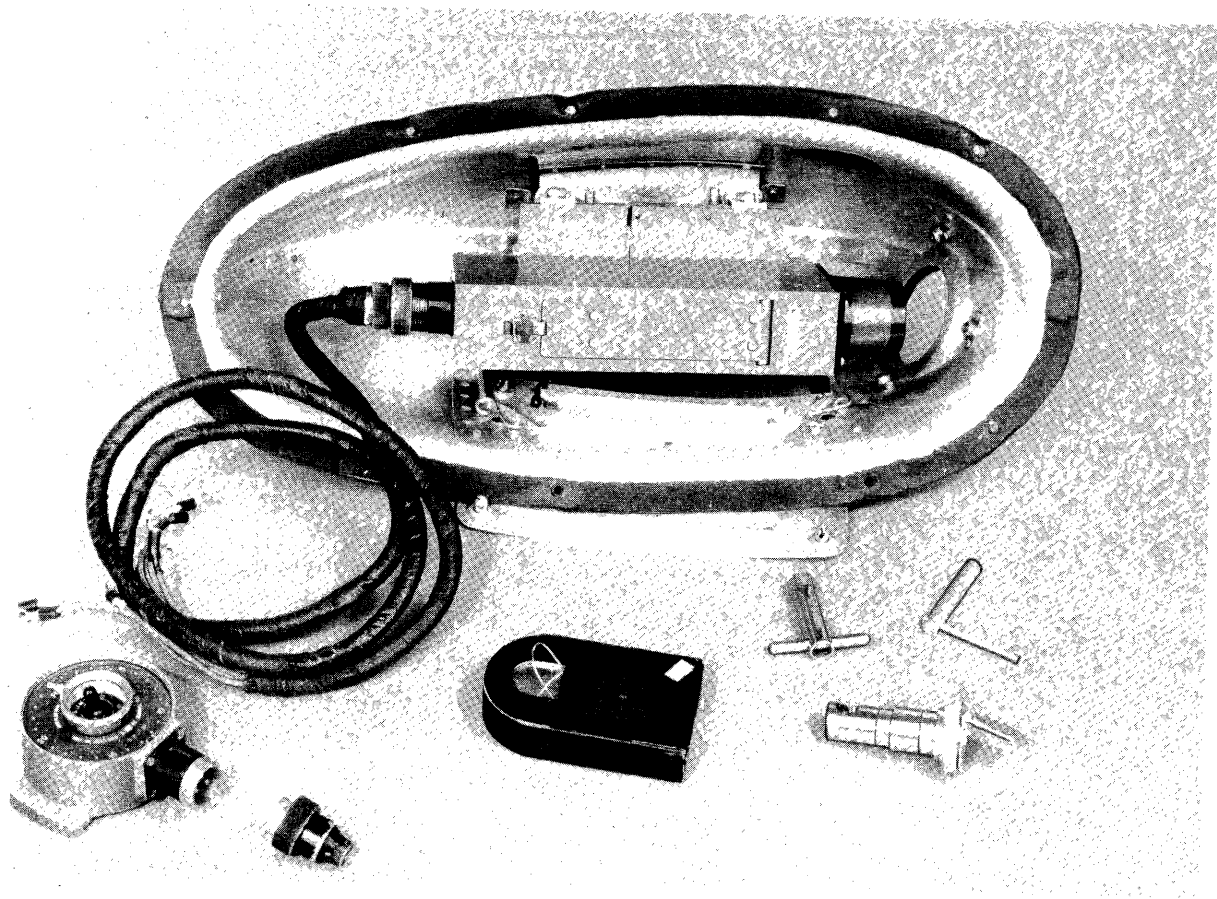


Figure 112 - G-45 Gun Camera Installed in Fairing

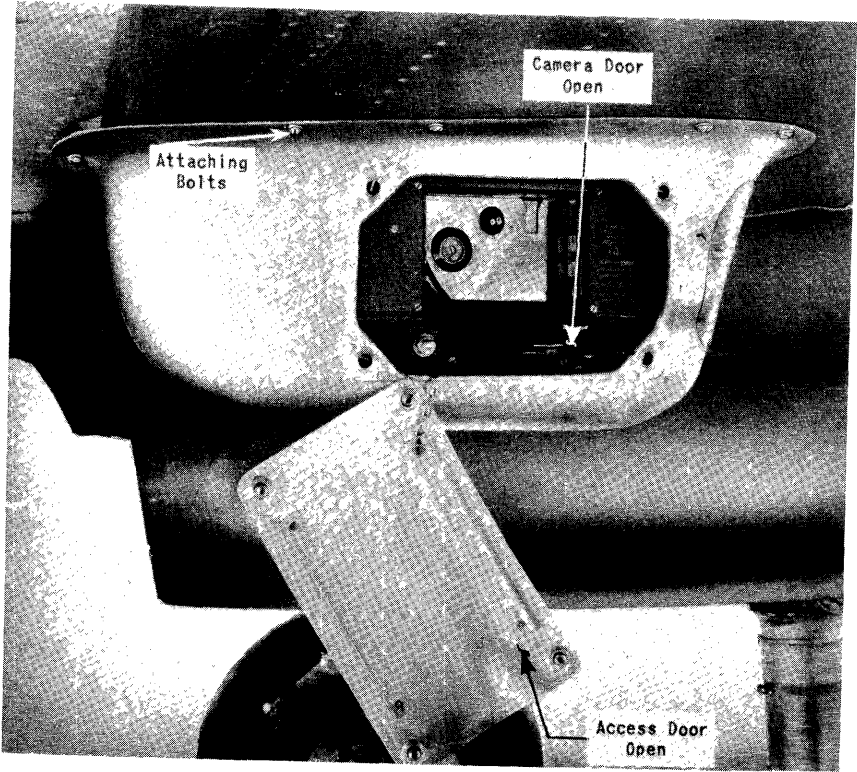


Figure 113 - G-45 Gun Camera and Fairing Mounted on Wing



camera center line parallel to the thrust line. Allowance is also made for a horizontal adjustment of 3 degrees or 1 degree 30 minutes either side of the camera center line. These adjustments may be made with the adjusting key (figure 110) inserted on the adjustment screws in the mounting plate.

h. Install the type 45 footage indicator on the

bracket provided on the left side of the cockpit below the trim tab controls. Make the electrical connection to the footage indicator.

### 3. To Disassemble the Type G-45 Gun Camera.

To disassemble the gun camera reverse the procedure noted in this section, 3.a. through f.

Figure 114 - G-45 Gun  
Camera Fairing - Access  
Door Closed

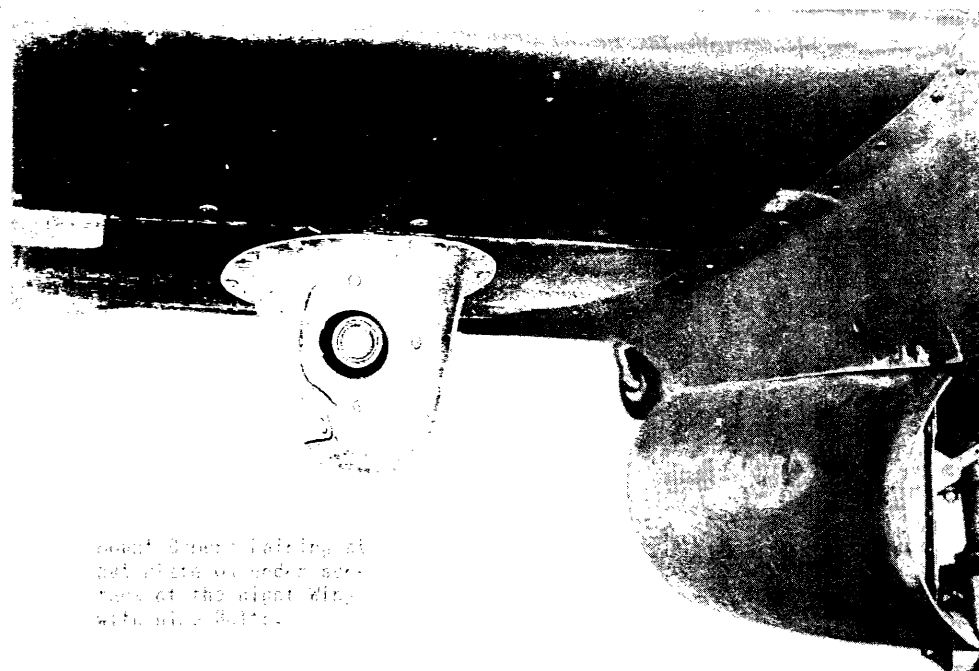
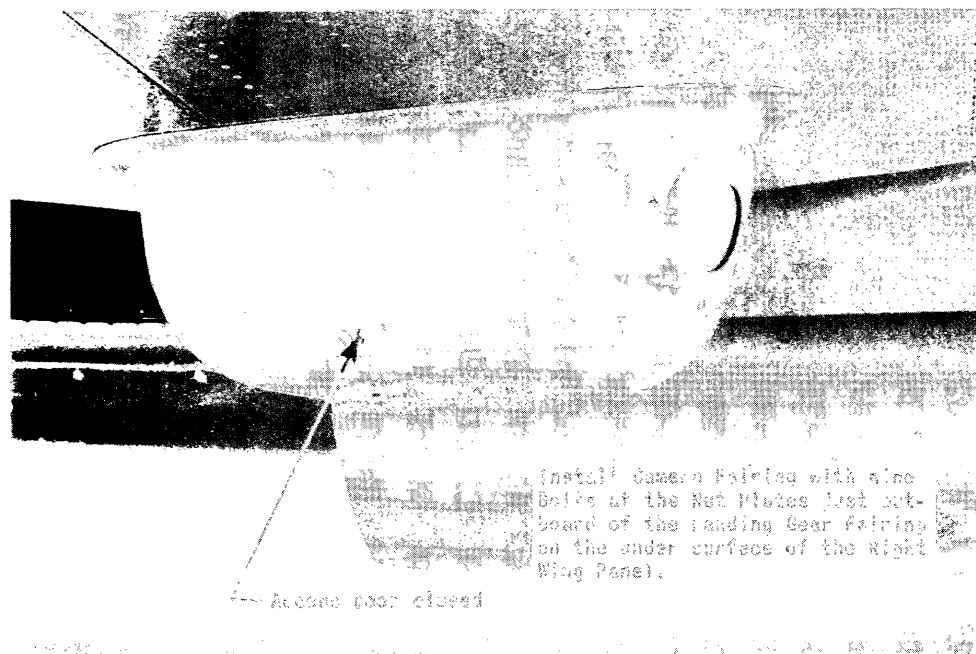


Figure 115 - Front View  
G-45 Gun Camera and  
Fairing Mounted on Wing

SECTION VIHYDRAULICS1. Hydraulic System.

a. General. - The hydraulic controls consist of an electrically driven hydraulic pump for operating the retractable landing gear, tail wheel, wing flaps, and hydraulic gun chargers. 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 fire wall 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 built up in the retracting strut when the emergency hand pump is in operation regardless of the selector valve setting. The tubing material in the hydraulic controls is "Everdur" or stainless steel tubing throughout, Specification No. 57, except vent and drain lines which are aluminum alloy.

The hydraulic system should be kept filled with "Lockheed Hydraulic Fluid No. 5" or equivalent,

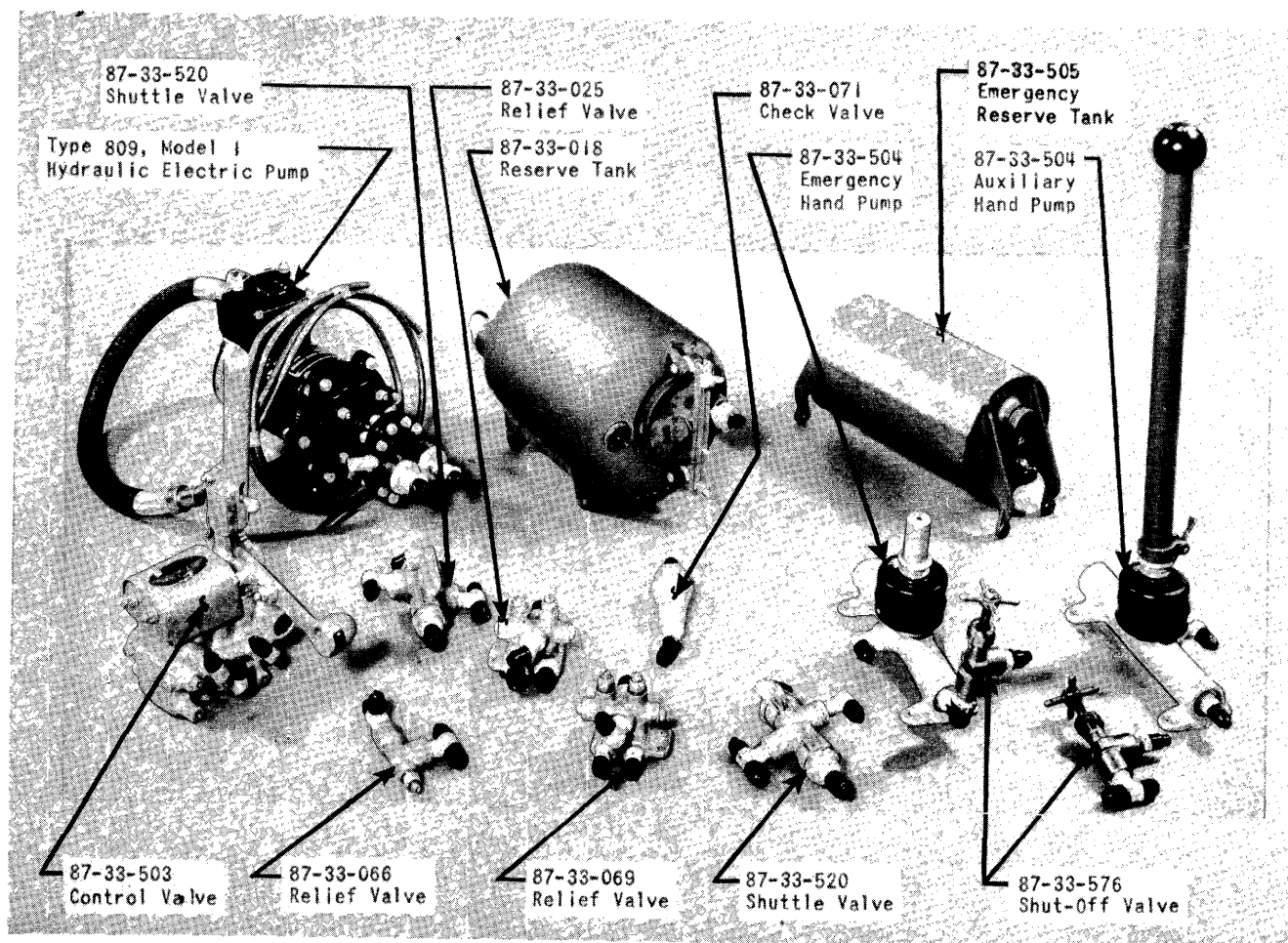


Figure 116 - Hydraulic System Components

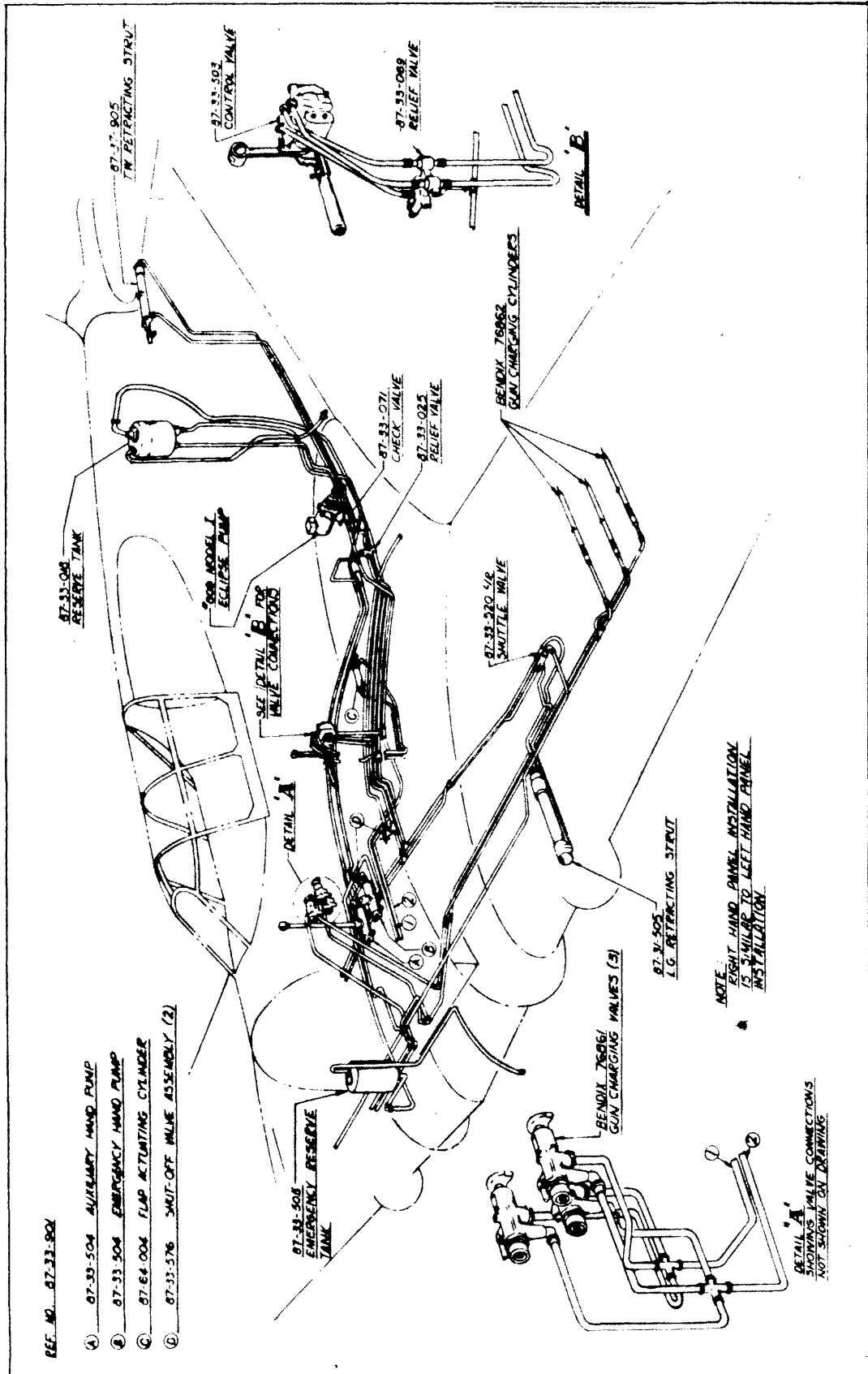


Figure 117 - Hydraulic System Diagram

Specification No. 3586, 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.

The hydraulic system is composed of the following units. (See figure 116.)

- (1) No. 809 model 1 Eclipse electric pump
- (2) Reserve supply tank (87-33-018)
- (3) Emergency reserve supply tank (87-33-505)
- (4) Control valve (87-33-503)
- (5) Auxiliary hand pump (87-33-504)
- (6) Emergency hand pump (87-33-504)
- (7) Two shut-off valves (87-33-576)
- (8) Check valve (87-33-071)
- (9) Two shuttle valves (87-33-520)
- (10) Relief valve (87-33-025)
- (11) Relief valve (87-33-066)
- (12) Relief valve (87-33-069)

For a complete perspective view of the hydraulic system see figure 117.

## 2. Electric Pump.

a. General. - The electric pump assembly is the Eclipse No. 809 model 1 (24 volts, 64 amperes maximum). The pump is equipped with an integral relief bypass valve adjusted to 1150 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.

b. 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 pounds per square inch. 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 eight bolts and two cap screws. The two pump housing sections are held in alignment by two staked pins through the pump flanges.

### c. 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.

### d. 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 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 brushes 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, or 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.

e. Lubrication. - If the pump overheats, check for worn or binding parts or sustained operation at high pressure. Also check for lubrication at oil holes. Lubricate at each 25-, 50-, etc., hour inspection.

### f. To Disassemble the Hydraulic Electrically Driven Pump.

(1) Remove the motor and pump unit from the fuselage by first disconnecting the inlet and outlet port hydraulic lines, the electric cable connections, and removing the bolts attaching the base of the motor housing to the fuselage mounting shelf.

(2) Place the pump and motor assembly in a vise with aluminum covered jaws. (See figure 118.)

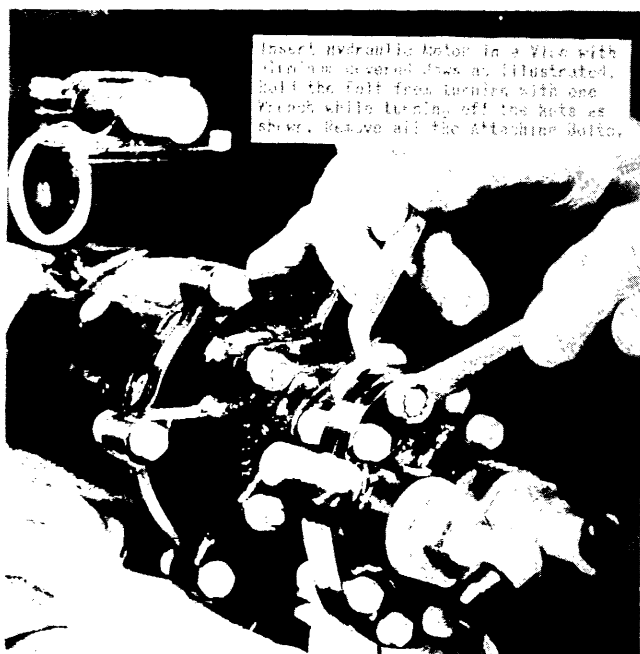


Figure 118 - Removing Bolts to Separate Hydraulic Pump Unit



Figure 119 - Removing Pins from Pump Housing Flange

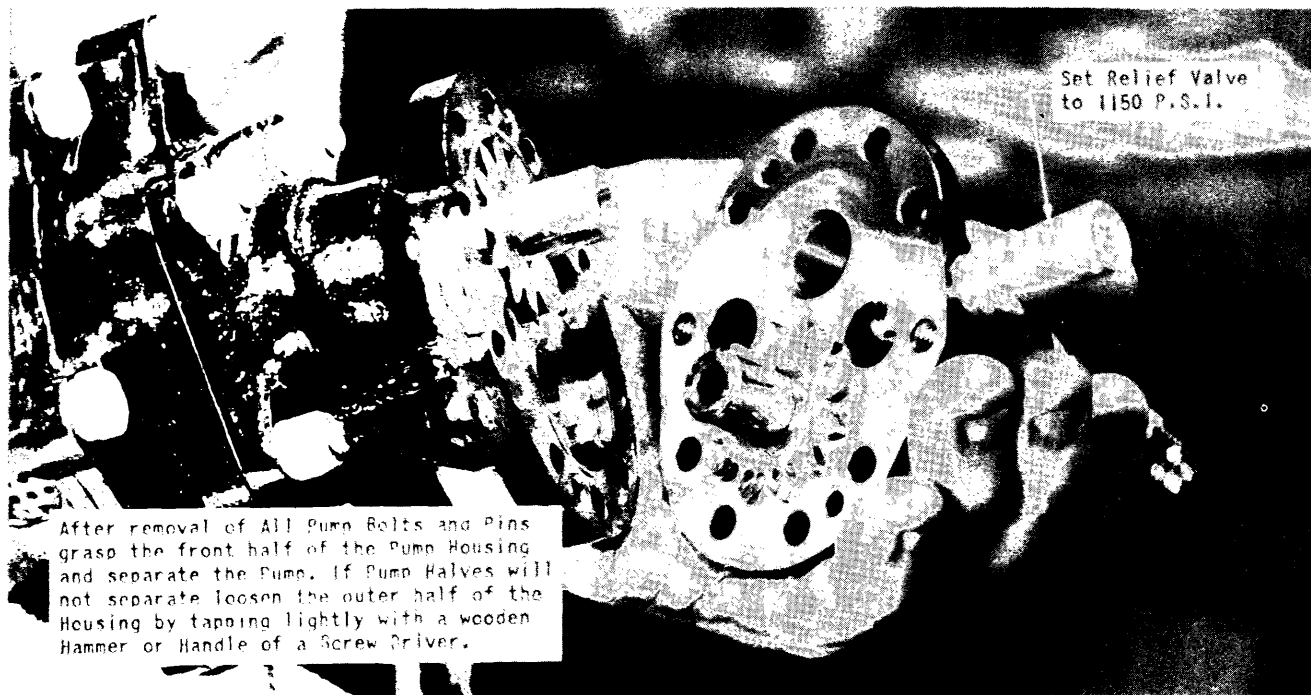


Figure 120 - Separating Hydraulic Pump Housing

(3) Cut the lock wire on the two cap screws on the pump body and remove the screws. Hold the pump port plate and pump body attaching bolts with a wrench and turn the nuts off the bolts with a second wrench. (See figure 118.)

(4) Release the pump motor from the vise and turn it to a vertical position and secure it again in the vise. Tap the two pins from the port plate and pump body with a punch and a light hammer. (See figure 119.)

(5) Tap lightly around the port plate until the port plate separates from the pump body exposing the spur gears.

(6) The spur gears must be handled with extreme care to prevent nicks and scratches on the parts. When overhauling more than one pump at a time, keep the spur gears in sets, so that they may be reinstalled in the same pump body.

(7) The pump section may be separated from the motor assembly by removing the four lock nuts on the flange of the pump housing.

(8) Removal of the oil seal at the drive end of the pump body may be accomplished by unscrewing the slotted nut in the pump body.

(9) Disassembly of the relief valve simply requires the removal of the cap and unscrewing the relief spring retainer.

(10) When the pump is disassembled, thoroughly clean all parts and examine carefully for signs of wear or damage and for the presence of foreign matter such as metal chips, grit, dirt, sand, etc.

In event that any foreign matter is found, the complete hydraulic system should be drained and thoroughly cleaned.

g. To Assemble the Hydraulic Electrically Driven Pump. - Thoroughly inspect and clean all parts with alcohol and blow out with compressed air, if available, to dislodge any dirt or foreign matter that might cling to the parts. If the spur gears or pump housing are damaged install a new pump unit, to assure efficient pump performance. Proceed with the assembly by reversing the steps outlined in e.(1) through (9).

### 3. Hydraulic Hand Pump.

a. General. - The hydraulic hand pump is a single cylinder, reciprocating, double action pump. Each cylinder is equipped with an intake check and a discharge check valve. The outboard pump is the auxiliary hand pump and operates the hydraulic system when the electric motor driven pump fails. The inboard pump is the emergency hand pump and operates the landing gear only. The emergency hand pump will lower the landing gear with the control lever in any position.

#### b. To Disassemble the Hydraulic Hand Pump.

(1) Remove the hand pump from the floor of the cockpit by disconnecting all hydraulic lines and unscrewing the four hold-down bolts.

(2) To facilitate the servicing of the hand pump it is suggested that a pump table be made so that the pump may be held firmly at all times without damaging the cylinder. For the pump table use a piece of metal large enough to extend at least 1/2 inch beyond

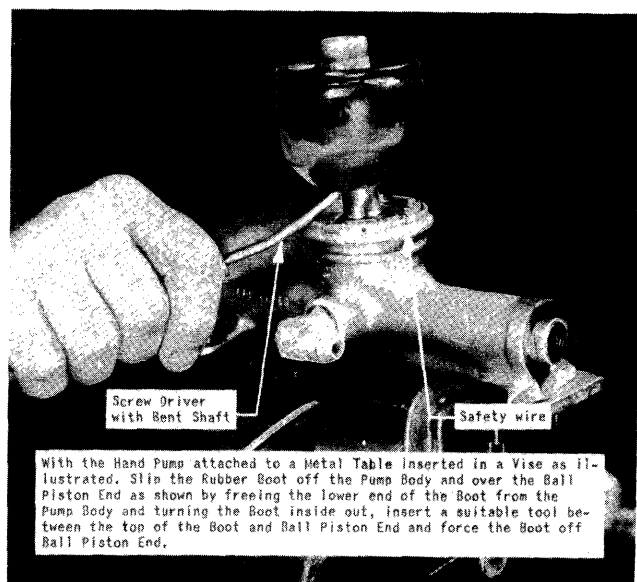


Figure 121 - Removing Rubber Boot from Hydraulic Hand Pump

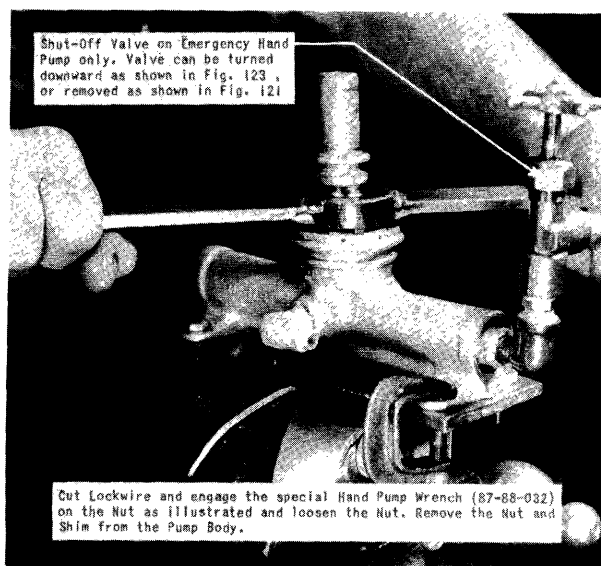


Figure 122 - Removing Nut from Pump Body

the outside dimensions of the pump body. Place the pump on the metal and drill four holes to correspond in size and location to the holes in the pump body that house the tie-down bolts. Lay the table top piece of metal on a bench and take a heavier piece of metal the same length or a little less than the table top and weld it to the table top along the center line in a vertical position. The table top and the base will take the form of a letter "T." Insert the base of the table assembly in a vise, set the pump on the table and line up the holes. Insert two bolts, one on either end of the pump and diagonally opposite, through the pump and table. Then safety the remaining two bolt lugs, on the pump to the table with two clamps. (See figure 121.)

(3) If the pump to be serviced is the emergency pump remove the shut-off valve on the end and then remove the rubber boot by forcing the lower part of the boot up over the flange on the pump body. Turn the boot inside out and force the upper end of the boot off the flange on the ball-piston end. A suitable tool for these operations can be easily made by bending the shaft of a light screw driver in an arc so that it can be easily hooked under the boot. (See figure 121.)

(4) Cut the lock wires on the pump nut and release the nut from the pump body by the special hand pump wrench (87-88-032) carried in the airplane tool kit. (See figure 122.) Remove the shim under the nut flange.

(5) Pull the ball-piston end out of the pump housing. (See figure 123.)

(6) Pull the snap rings with a snap-ring wrench and remove the valve assemblies at both ends of the pump cylinder. (See figure 124.)

(7) A screw driver may be inserted through either end to push the piston assembly from the pump cylinder. Insert the screw driver into the slot on the retainer when applying force to remove the piston so that the face of the retainer will not be disfigured.

(8) The pump is now completely disassembled and the piston and valves may be disassembled to check the ball and ball seats as well as the springs.

(9) To disassemble the piston proceed as follows:

(a) Insert the correct size Allen wrench in a vise in a horizontal position with just enough of the wrench protruding to engage the Allen setscrew in the retainers at either end of the piston.

(b) Engage the Allen wrench in the Allen setscrew and apply an adjustable wrench to the piston at its flat sides. Turn the piston with the wrench to loosen the Allen setscrew. Extreme care must be exercised in this operation so that the wrench will not be broken.

(c) When the Allen setscrew has been turned out a couple turns pull the piston from the Allen wrench and unscrew the retainer with a screw driver. This will free the packing ring and packings as well as the spring and hardened steel ball. (See figure 126.)

(d) Reverse the piston and remove the other retainer in the same manner as described in (b) and (c).

(e) To remove the ball and spring in the two valves extreme care must be used not to damage the retainer end by twisting off the ears. If a small screw driver is used for this operation the retainer is quite often damaged beyond repair, therefore, it is suggested that a special tool be made for this delicate operation. A tool for this operation can be easily made by taking a small size concrete drill and grinding the point down flat so that the four fins on the drill engage the four slots on the retainer. Insert this special tool in a vise in vertical position and slip the valve over the tool until the retainer is engaged properly. Place an adjustable wrench on the flat sides of the valve end and turn the valve until the retainer is loosened. Remove the valve from the special tool and remove the retainer with a small screw driver. The spring and hardened steel ball will now drop out of the valve.

(f) The valve cup packings can now be slipped off the valve. Remove the packing under the pump nut and the pump is completely disassembled.



Figure 123 - Removing Ball-Piston End from Pump Body

(10) Thoroughly inspect all parts, clean in alcohol and blow out with air pressure if available. It has been found that most pump failures are due to grit, dirt, or other foreign matter lodging in between the steel balls and seats in the piston assembly, therefore, inspect these units carefully and be sure that they are thoroughly cleaned before reassembly. A special tool can be easily made to grind the ball seat in, if it has become roughened in any way, to assure a perfect lap fit with the ball. To make this special tool take a short length of tubing the same diameter as the ball and place a spare ball on the end of the tube. Solder the ball securely to the end of the tube and grind off

any rough edges at the solder joint. Insert this tube into the piston, ball end first with a fine grinding compound smeared on the ball. Insert the other end of the tube in an electric or hand drill and grind the seat in with the revolving motion of the ball end. Clean the seat and piston thoroughly after this operation.

(11) Inspect all packing cups for torn edges.

c. To Assemble the Hydraulic Hand Pump.

(1) When assembling a hydraulic hand pump it is very important that all parts are in perfect condi-

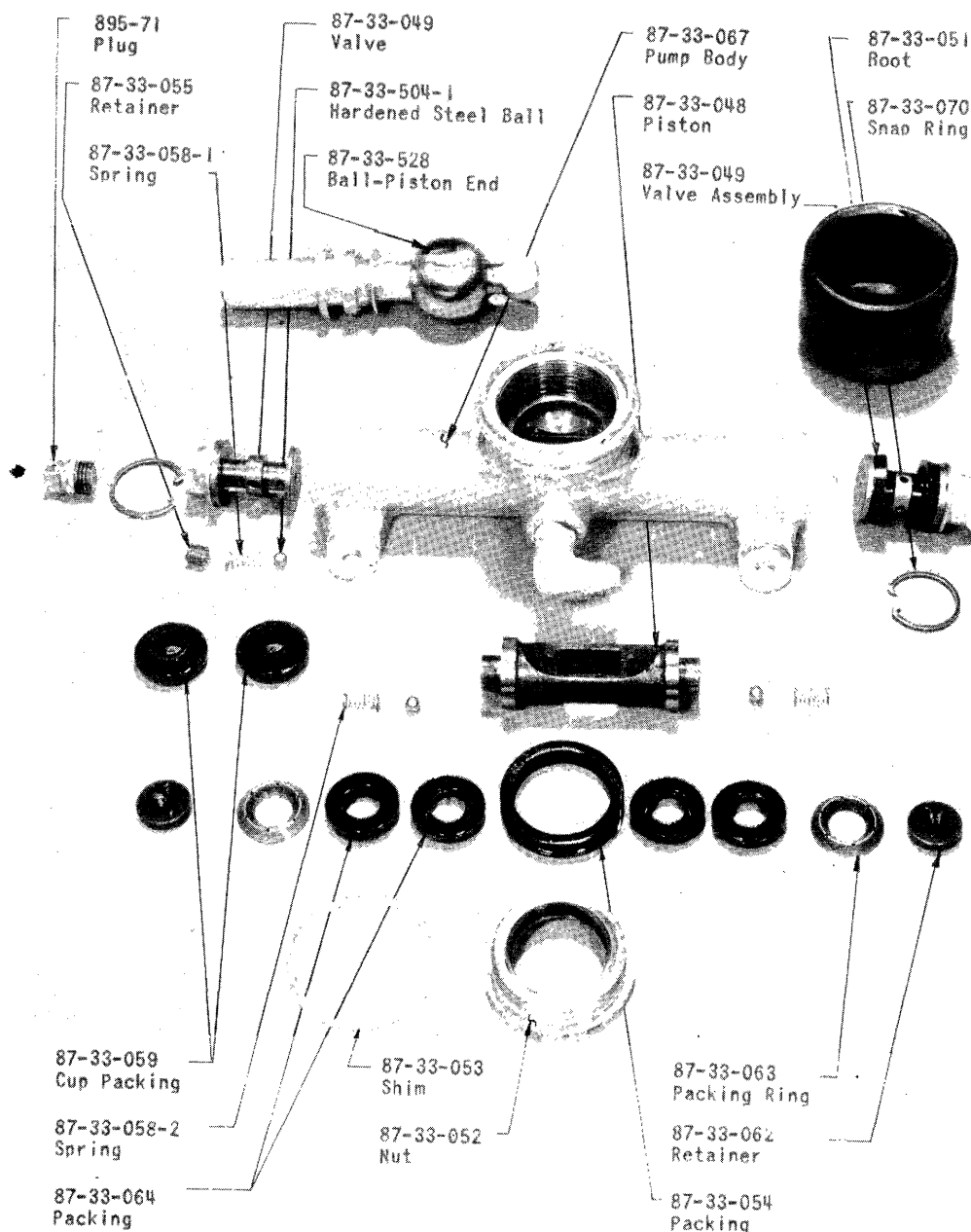


Figure 124 - Hydraulic Hand Pump Disassembled



tion and assembled in their proper location to insure the efficient operation of the unit.

(2) Attach the pump body to the special table inserted in a vise as illustrated in figure 121 and install the piston in the cylinder.

(3) Replace the ball-piston end packing ring.

(4) Insert the ball-piston end in its place and be sure that it engages the rectangular slot in the piston.

(5) Drop the shim on to the nut flange and screw the nut in by hand to retain the ball-piston end in place.

(6) Turn the special table in the vise as illustrated in figure 125. Wet the piston cups with hydraulic oil, Specification No. 3586, and be sure the ball-piston end is pushed as far forward as possible so that the piston will be near the top of the cylinder and insert the first piston cup packing. Push the packing down on the piston and insert the second

piston cup packing, push this cup down on the first cup and install the packing ring. It is mandatory that these cup packings and packing rings be installed before the ball and spring are inserted so that they cannot accidentally fall down into the packing groove on the piston.

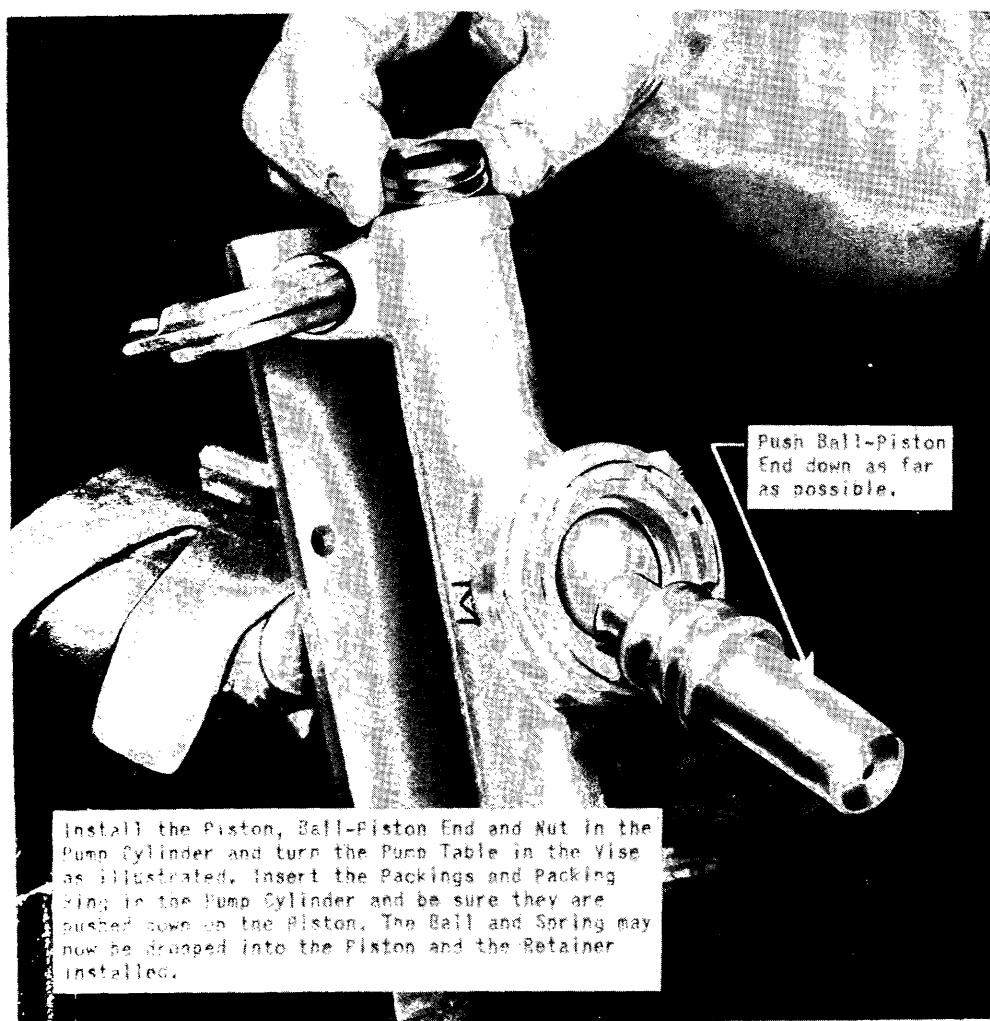
(7) Insert the hardened steel ball and spring in the piston end.

(8) Place an Allen wrench on the Allen setscrew in the retainer and guide the retainer down into place on the piston. Engage a screw driver in the slot on the face of the retainer and screw the retainer into place. Tighten the Allen setscrew with the Allen wrench.

(9) Reassemble the valve by reversing the procedure outlined in b.(9)(e), (f), and install the valve in the pump cylinder. Safety the valve in the cylinder end with the snap ring.

(10) Reverse the position of the pump cylinder and table in the vise and reinstall the cup packings

Figure 125 - Installing Packing in Hand Pump



REF. PART NO.	NAME OF PART	NO. IN SET	PART NO.	NAME OF PART	NO. IN SET	PART NO.	NAME OF PART	NO. IN SET	PART NO.	NAME OF PART	NO. IN SET	PART NO.	NAME OF PART	NO. IN SET
A	87-33-047 BODY	1	C	87-33-042 RETAINER	2	M	87-33-055 SNAP RING	2	5	87-33-050 NUT	1			
B	87-33-048 PISTON	1	H	87-33-504-2 VALVE ASSEMBLY	2	N	87-33-070 PLUG	2	T	87-33-051 BOOT	1			
C	87-33-064 PACKING	4	I	87-33-049 VALVE	1	O	845-71 BALL INSTALLATION	1	U	87-33-052 PLUG	2			
D	87-33-063 PACKING RING	2	J	87-33-059 CUP-PACKING	4	P	87-33-054 BALL-PISTON END	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 SHIM	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.

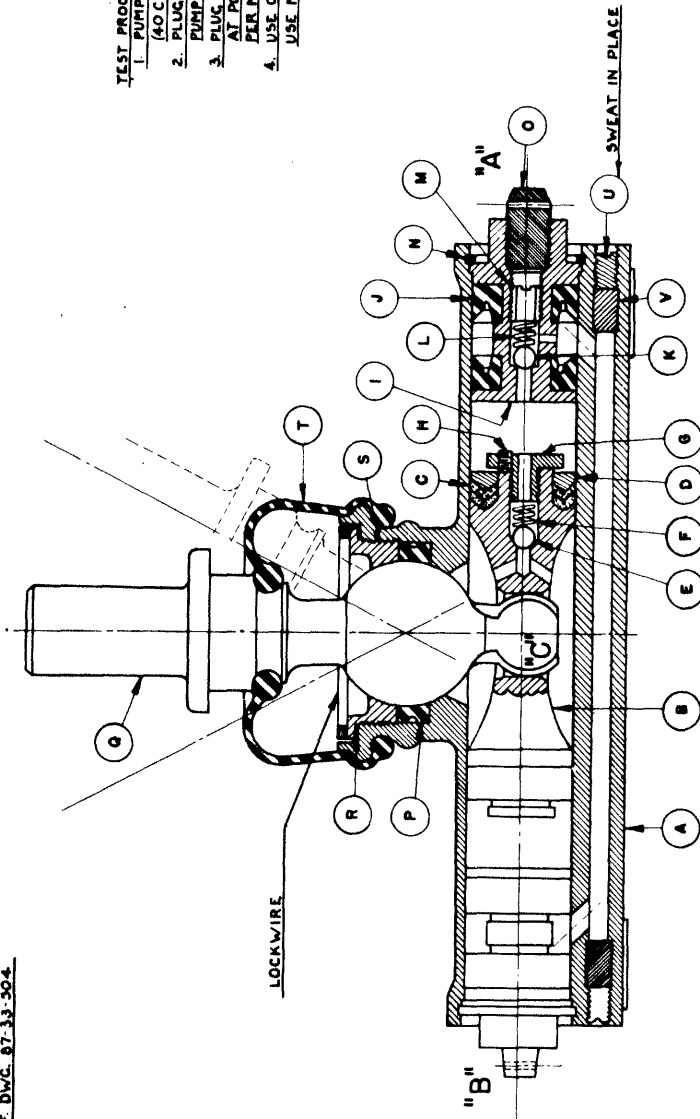


Figure 126 - Hydraulic Hand Pump

and packing ring on the piston. Replace the ball and spring in the piston and screw in and safety the retainer with the Allen setscrew. (See (6) through (8) paragraph c.)

(11) To reassemble the valves, wet the cups with hydraulic oil and install them in either end of the cylinder. Install the snap rings to retain the valves in position.

(12) Turn the cylinder to a horizontal position in the vise and tighten the nut with the spanner wrench. Safety wire the nut. (See figure 121.)

(13) Turn the boot inside out and slide the top of the boot over the ball-piston end first. Stretch the boot end over the retaining flange on the ball-piston end and turn the boot down into its correct position. Stretch the bottom of the boot over the retaining flange on the pump cylinder and the pump is assembled ready for testing.

(14) Before the hand pump is installed in the airplane it must be tested in accordance with the test procedure outlined in figure 126.

#### 4. Hydraulic Control Valve.

a. General. - The hydraulic control valve for the retracting and lowering of the landing gear and wing flaps is located on a mounting bracket at the left side of the cockpit just forward of station No. 5 bulkhead. This control valve meters the flow of hydraulic pres-

sure through a series of poppet valves operated by camshafts attached to the control handles when either the electric hydraulic pump or the auxiliary hand pump is employed to produce the hydraulic pressure. If any foreign substance finds its way into the hydraulic system or parts become worn the efficiency of the control valve may be seriously affected necessitating the removal and disassembly of the valve.

b. To Disassemble the Hydraulic Control Valve. - Disconnect all hydraulic lines to the valve and remove the valve from its mounting bracket on station No. 5 bulkhead (figure 127) and proceed as follows:

(1) Place the control valve in a vise with aluminum covered jaws (figure 128) and remove the cotters and nuts from the two camshaft bolts.

(2) Push the bolts back beyond the valve cover and remove the cover from the valve body.

(3) Pull the bolts and the segment completely out of the camshafts and lift the camshafts from the valve body. (See figure 129.)

(4) Remove the retainer spring on top of the valve body and pull the followers out of the valve as illustrated in figure 130. It is very important that the followers and gaskets including the shims be kept together and in order, so that they may be replaced in the same order in the valve body upon installation. It is, therefore, suggested that a board with eight pegs and eight holes be assembled to re-

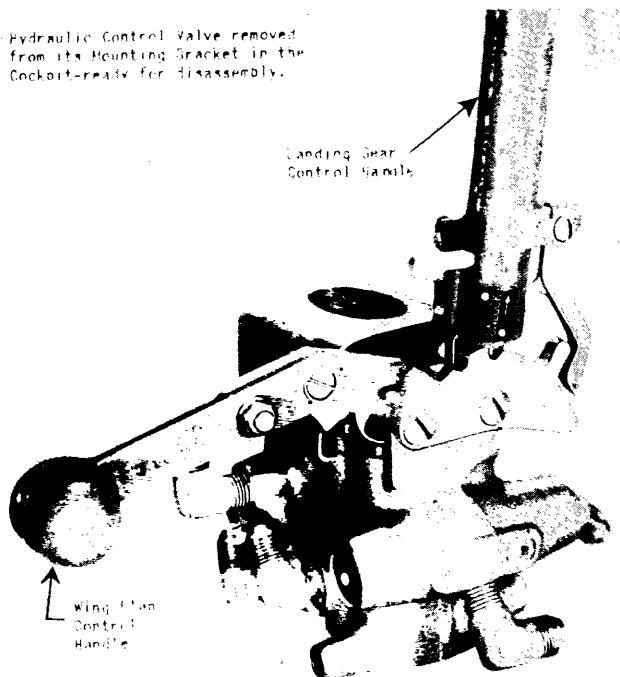


Figure 127 - Hydraulic Control Valve

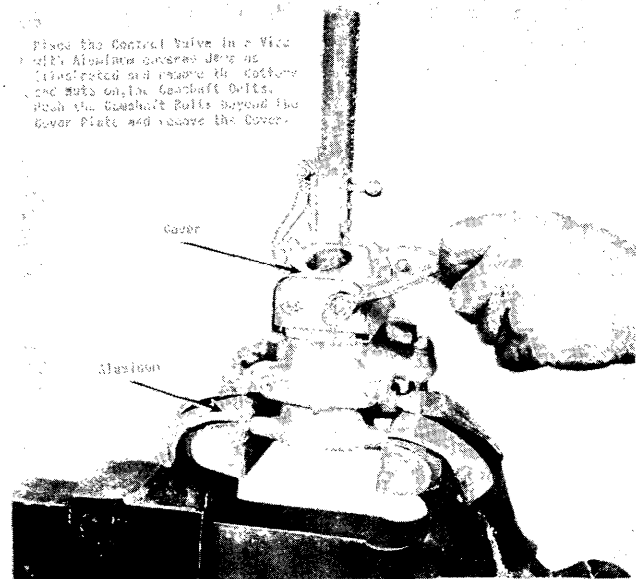


Figure 128 - Removing Nut on Camshaft Bolt

tain the followers, gaskets, shims, and the valves in their proper location while service operations are carried on. (See figure 131.)

(5) Remove one row of followers and place them on the pegs in the center of the board. Remove the other row of followers and place them on the board. (See figure 131.)

(6) Remove the gaskets and shims from the first row in the valve and place them on the peg opposite the correct follower. (See figure 132.) When the four pegs are filled move the followers from the pegs in the center of the board to the ones on the outside. This will place the proper follower over the correct gasket and shim assemblies. Remove the remaining gaskets and shims and place them on the center row

of pegs alongside of the correct followers. (See figure 131.) When all gaskets and shims are removed from the valve body place the followers on the pegs atop the gaskets and shims.

(7) Release the valve body from the vise and turn it upside down and replace it in the vise as illustrated in figure 133. Next remove the eight snap rings locking the retainers in the valve body. Use either a snap-ring wrench (figure 133) or a small pair of pliers.

(8) After the rings are all removed engage the ends of the retainers by a pair of pliers and pull the retainers free of the valve body. (See figure 134.) When removing the retainers exercise extreme care

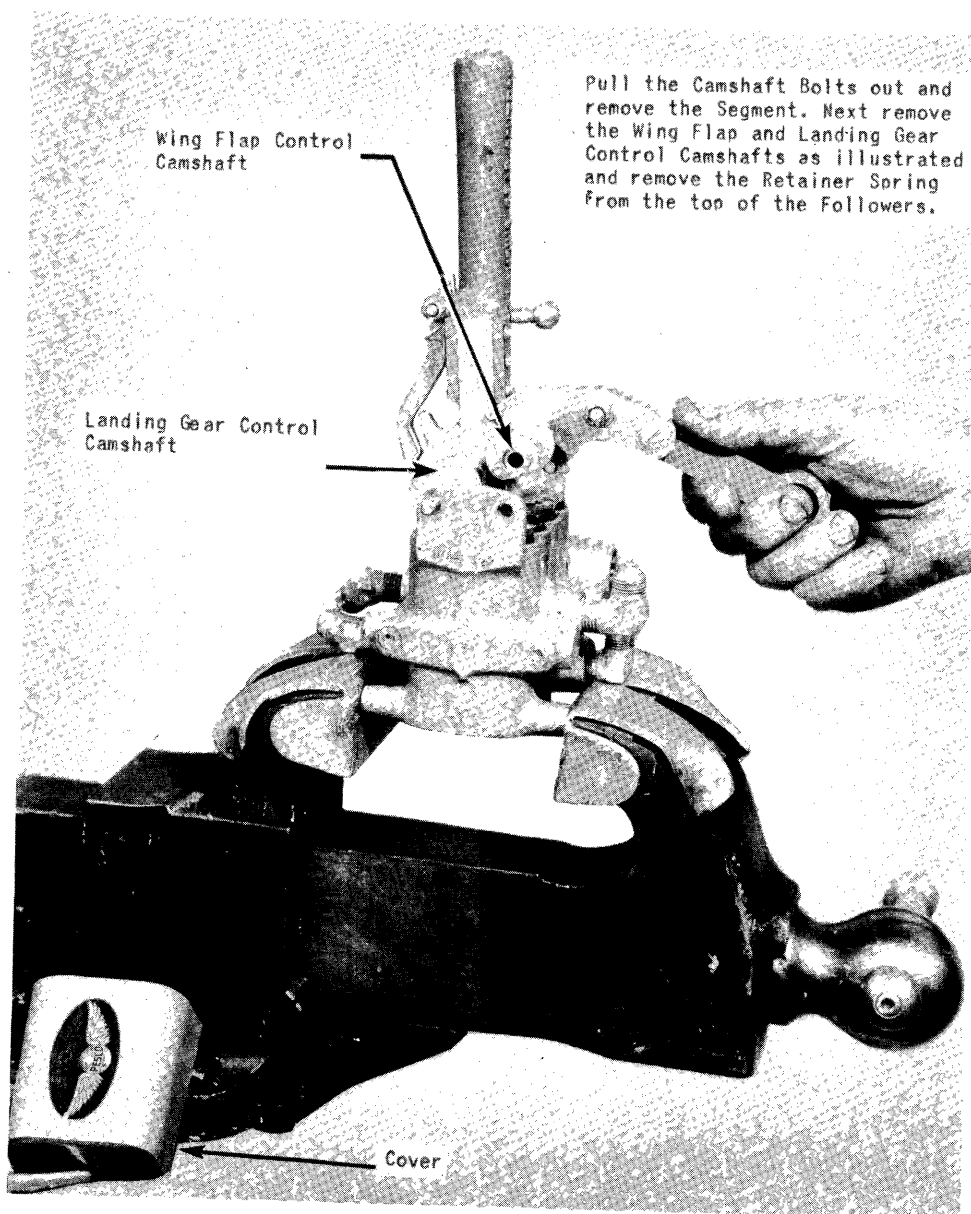


Figure 129 - Removing Control Camshaft

When removing the followers, Gaskets and Shims it is very important that these Complete Assemblies are kept intact and replaced to coincide exactly with the original installation. Therefore, it is recommended that a Board with Two Rows of four Pegs each be used to keep these Assemblies together and in their correct position. Remove the followers and place them on the Pegs as illustrated, remove the second row of Followers and place them on the outside edge of the Board.

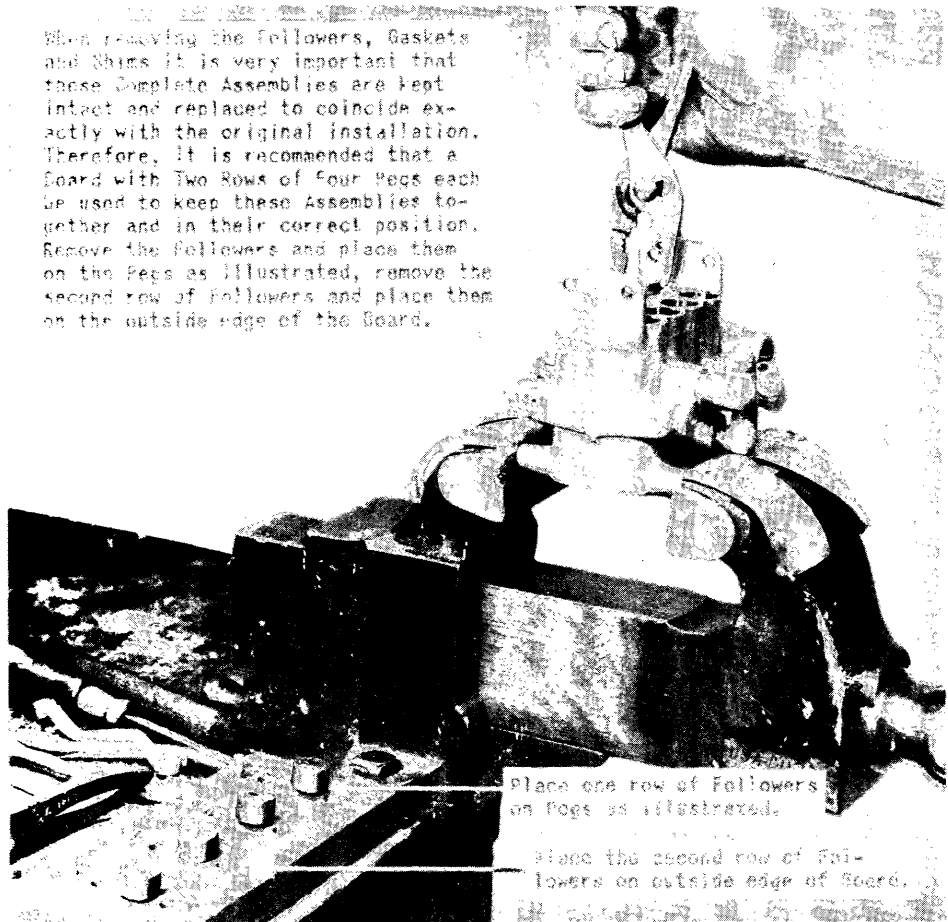
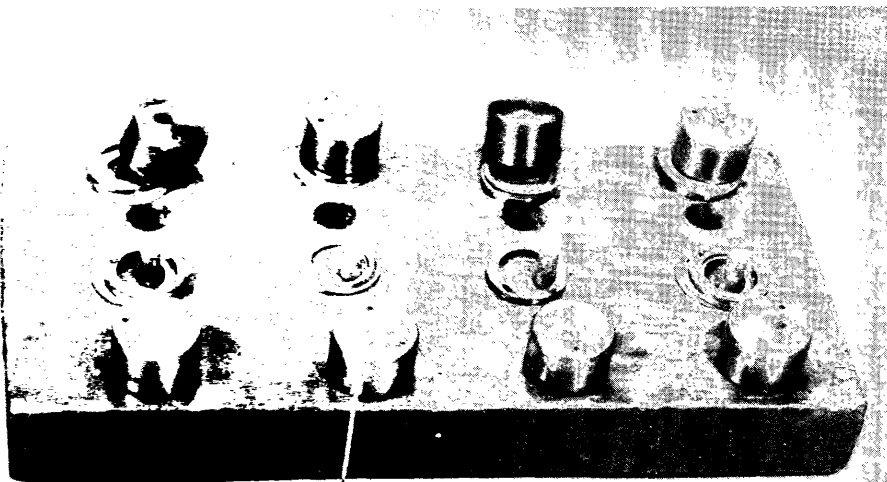


Figure 130 - Removing Followers from the Valve Body



When all Pegs on the second row are encircled with the proper Gaskets and Shims, move the Followers on the edge of the Board onto the Pegs over the Gaskets and Shims.

Figure 131 - Recommended Method for Keeping Follower Assemblies Intact and in Order

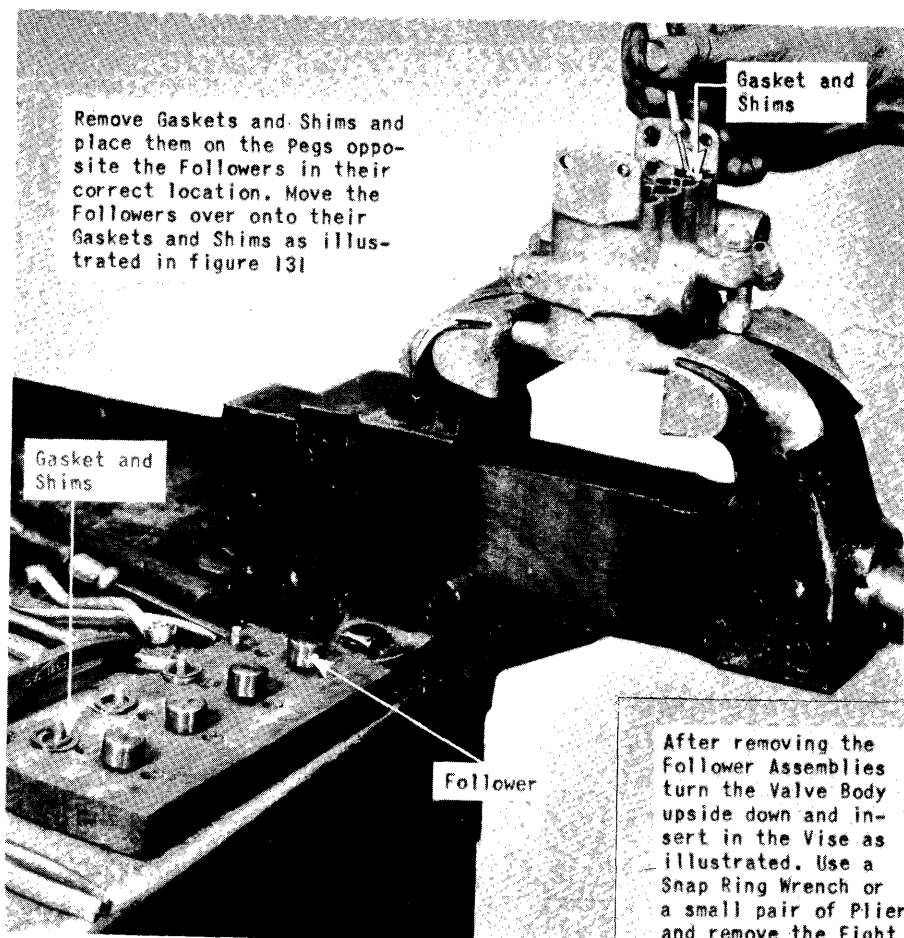
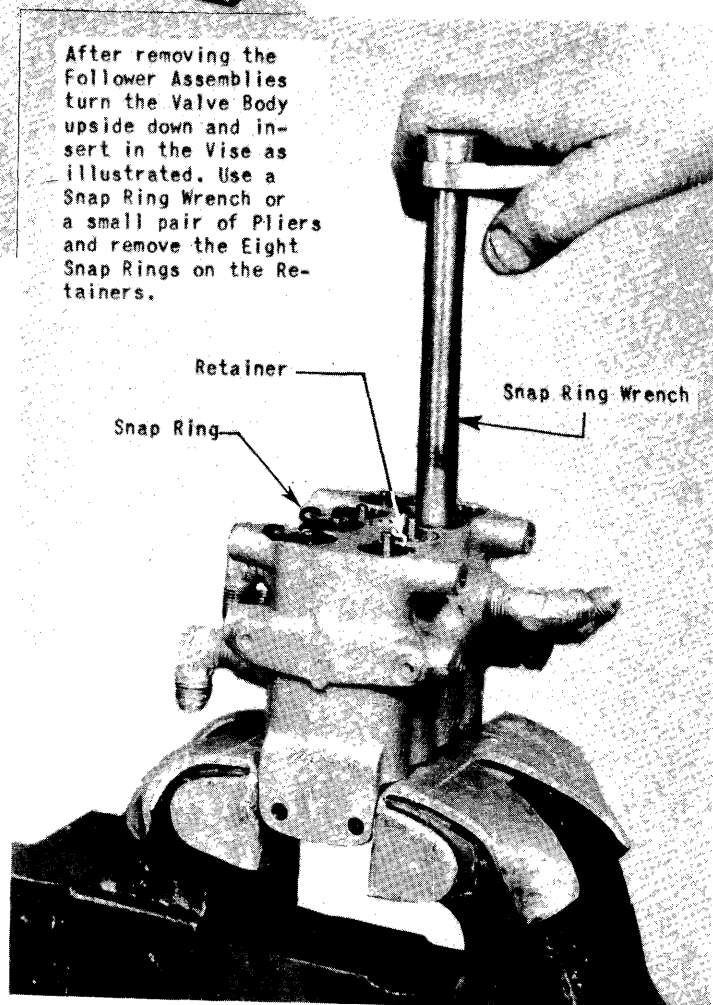


Figure 132 - Removing Gaskets and Shims from Valve Body

Figure 133 - Removing Snap Ring from Retainer



Remove the Retainers as illustrated and use extreme care not to damage the Rubber Cups unless replacements are contemplated.

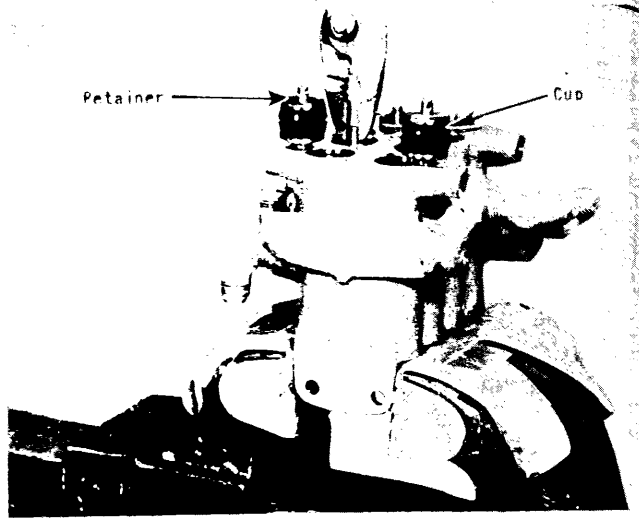


Figure 134 - Removing Retainers

Use a light pair of Pliers and remove the Valve Springs by pulling them straight up. Be very careful not to scratch the inner surface of the Valve Body with the Pliers or Springs.

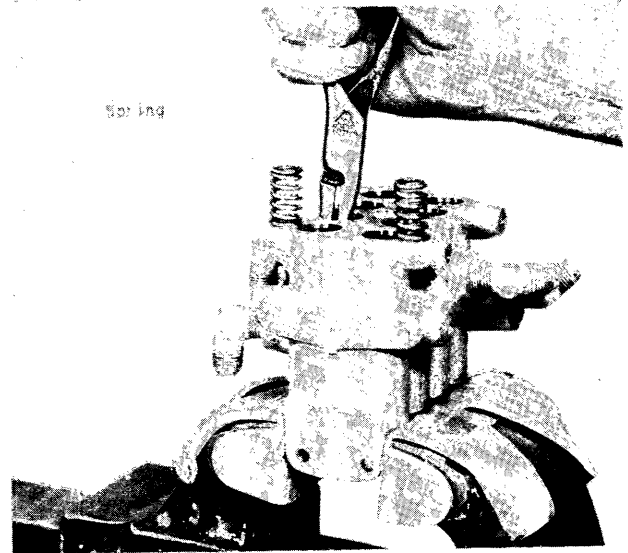


Figure 135 - Removal of Valve Springs

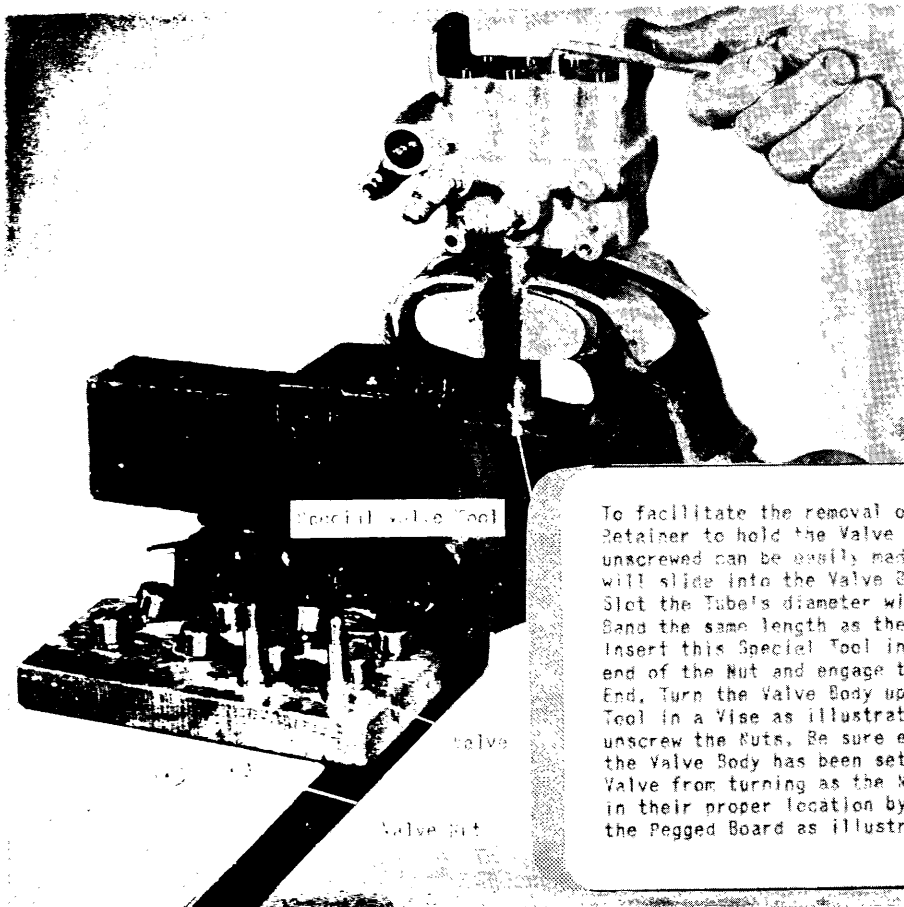


Figure 136 - Removing Valve from Valve Body

To facilitate the removal of the Valve Nuts a Special Valve Retainer to hold the Valve from turning when the Nuts are unscrewed can be easily made. Take a piece of tubing that will slide into the Valve Body and fit around the Valve End. Slot the Tube's diameter with a Hack Saw about 1/4" Steel Band the same length as the Tube's diameter into the slot. Insert this Special Tool into the Valve Body on the opposite end of the Nut and engage the Tool in the Slot on the Valve End. Turn the Valve Body upside down and insert the Special Tool in a Vise as illustrated. Remove the Cotter and then unscrew the Nuts. Be sure each time a Nut is unscrewed that the Valve Body has been set on the Special Tool to hold the Valve from turning as the Nut is removed. Keep the Valves in their proper location by inserting them in the Holes on the Pegged Board as illustrated.



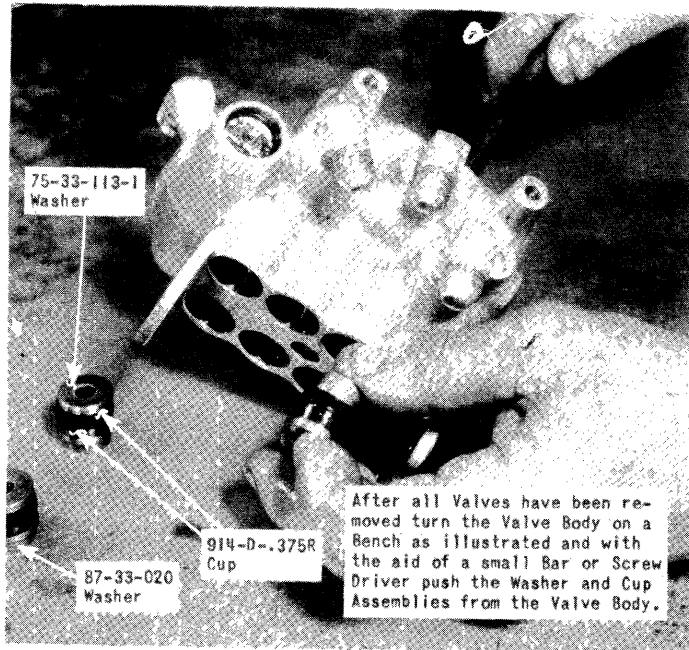


Figure 137 - Removing Valve Cups and Washers from Valve Body

Hold the Valve Body on a Bench as illustrated and release the Snap Ring on either side of the Port with a Snap Ring Wrench. Remove the Retainer Spring and Valve from both sides of the Inlet Port. The Valve Body is now completely disassembled.

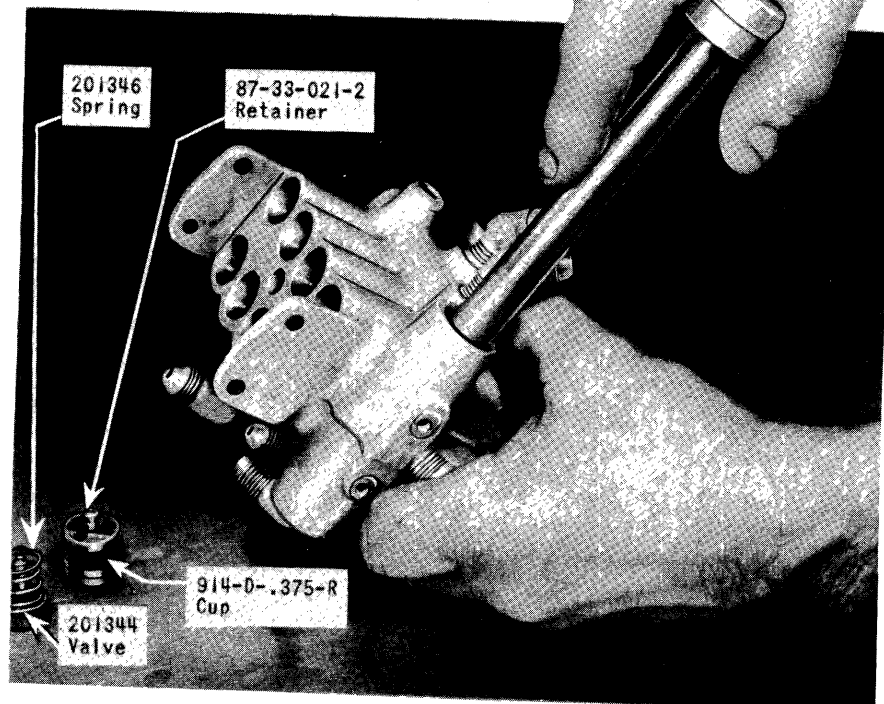


Figure 138 - Removing Retainers and Valves - Inlet Port of Valve Body

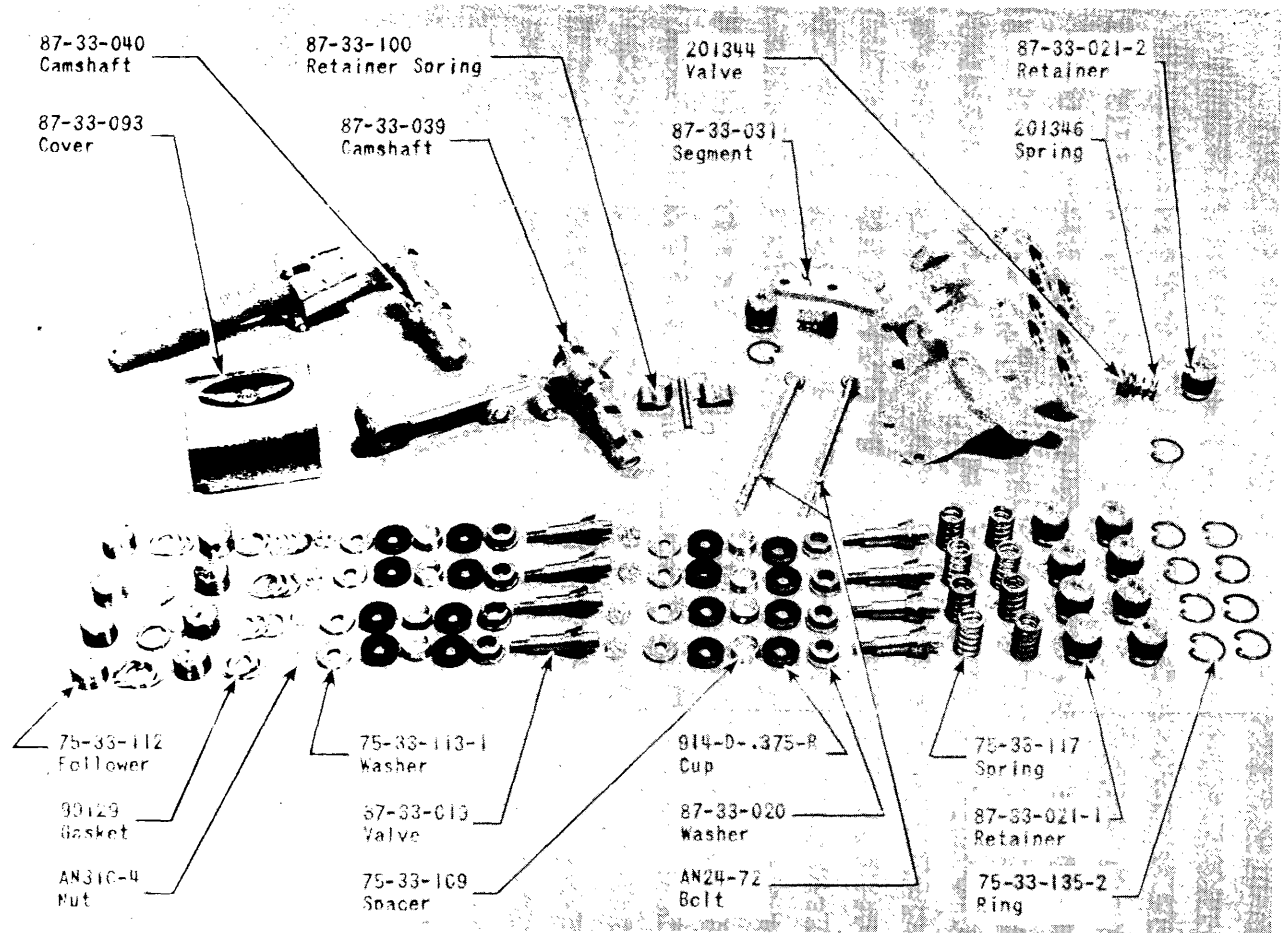


Figure 139 - Hydraulic Control Valve Disassembled

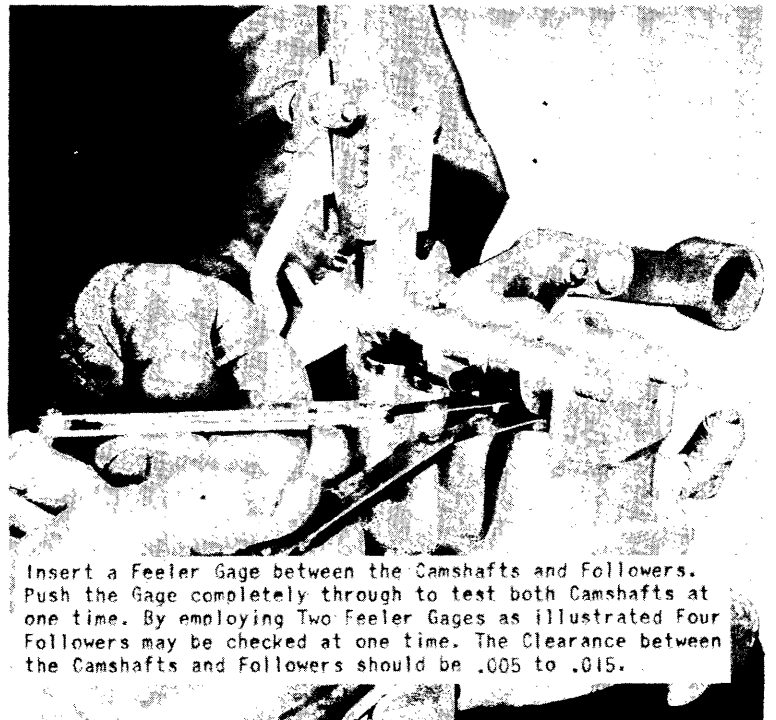


Figure 140 - Testing Clearance of Camshafts and Followers

not to damage the rubber cups by fouling them in the snap-ring grooves inside the valve body.

(9) The valve springs may now be removed from the valve body with a light pair of pliers. (See figure 135.) Be very careful not to score the valve cylinder surface with the pliers or spring.

(10) Remove the valve body from the vise, turn it upside down and insert it into the vise. (See figure 132.) Pull the cotters from the valve nuts. Remove the valve body from the vise.

(11) To facilitate the removal of the valve nuts it is suggested that a tool be made up to engage the slotted ends of the valves to keep the valves from turning with the nuts. Such a tool can be easily fashioned from a piece of tubing that may be inserted into the valve cylinders. Saw a slot in the diameter of one end of the tube 1/4 inch deep and cut a piece of 1/4-inch steel band the length of the diameter of the tube. Insert the steel band into the slot on the tube and anchor the steel into the slot with solder. Grind the end of the bar down to be sure that no sharp edges of the steel band protrude beyond the tubes circumference to score the valve cylinder surfaces when installed.

(12) Line up all the slots in the ends of the valves to parallel each other so that the valve slots can be quickly lined up and engaged by the special tube wrench.

(13) Insert the tube in the vise with the special end up to engage the valve slots and retain the valves while the nuts are turned off. (See figure 136.)

(14) As the valves are removed from the valve body insert them in their proper location on the special board containing the follower assemblies. (See figure 136.)

(15) After all valves are removed, free the valve body from the vise and lay it on the bench so that a small diameter bar or screw driver may be inserted from the bottom side of the valve body to push the assemblies containing a top and bottom washer, two rubber cups and a spacer out of the valve body. (See figure 137.)

(16) Next remove the snap rings from both sides of the inlet port with a snap-ring wrench. (See figure 138.)

(17) Remove the retainer, the spring, and the valve on each side of the inlet port. The control valve is now completely disassembled. (See figure 139.)

#### c. To Assemble the Hydraulic Control Valve.

(1) General. - Before assembling the control valve note that all passages are free of grit, dirt, or other foreign matter. Clean the valve body and all parts with alcohol and blow out with compressed air, if available.

(2) Assemble the valve, reversing the procedure outlined in a.(1) through (17).

(3) When assembling the valves in the valve body it is extremely important that each valve is replaced in its proper location as all valves are lapped into the respective seats on the original installation. If new valves are installed they too must be lapped into their seats.

(4) Be sure that the proper gasket and shims are installed below each follower.

(5) When the valve is completely assembled check the clearance of the camshafts and followers with feeler gages. (See figure 140.) The clearance between camshafts and followers must be between .005 and .015.

(6) Before installing the control valve in the airplane test the valve under pressure in accordance with the instructions outlined in figure 141.

#### 5. Landing Gear.

a. General. - The P-40E-1 and P-40F airplanes are equipped with a retractable landing gear. The two landing gear main wheels are installed in an identical manner on the under surface of each wing. Each landing gear has an air-oil shock absorber strut which rotates aft about trunnions on the top of the strut. During retraction, bevel gears rotate the strut approximately 90 degrees 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 retracting strut, the lower set and side braces to the lower 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 wing. A retracting arm connects the upper and lower retracting links to a fitting in the lower surface of the wing.

#### b. To Disassemble the Landing Gear.

(1) To remove the complete landing gear assembly from the wing panel proceed as follows:

(a) Disconnect the clevis end of the turnbuckle which controls the opening and closing of the inboard landing gear fairing door and the end of the cable from the outboard door to the support on the pinion gear ring. The inboard door turnbuckle is attached to the side brace and the outboard door cable is attached to a support on the under side of the oleo strut pinion gear. Disconnect the bearing end of the spring loaded rod at the forward end of the outboard door. (See figure 143.)

(b) Remove the screws attaching the landing gear leading edge fairing and outboard fairing door to

the wing and remove the fairing. (See figure 144.) The leading edge section of the wing fillet must be removed to gain access to the inboard screws on the landing gear fairing at the leading edge. (See figure 143.)

(c) Insert jack point studs and jack the front and rear of the airplane until the landing gear wheels are off the ground.

(d) Remove the bleeder screw at the brake cylinder on the inner wheel fairing and drain the brake system. Disconnect the hydraulic brake hose at the fitting below the bleeder screw on the inner fairing. Remove the two hose clamp fittings from their supports, one at the lower end of the oleo cylinder and the other at the lower trunnion. (See figure 143.)

(e) Unbutton the four Dzus fasteners on the wheel's outerfairing and remove the fairing.

(f) Remove the axle cap, the cotter and turn the large nut off the axle freeing the wheel. Pull the wheel and wheel bearings from the axle. (See figure 145.)

(g) Free the upper forward circumference of the canvas in the wheel pocket and turn the canvas out exposing the structural detail in the wheel pocket.

(h) 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 figure 146.)

(i) Disconnect the landing gear position transmitter linkage at the lower end. (See figure 147.)

(j) Remove the cotter, nut, and through bolt connecting the retracting strut piston end to the upper landing gear retracting links.

(k) Return the piston completely into the retracting strut by placing the landing gear handle on the control valve in the "DOWN" position and actuating the electric hydraulic pump switch on the control stick.

(l) Disconnect the two hydraulic lines, at the aft end of the retracting strut. (See figure 147.)

(m) Remove the three nuts which attach the retracting cylinder in the wing and remove the cylinder by pulling it aft into the wheel pocket. (See figure 147.)

(n) Working through the two lightening holes in web No. 3, at either side of the retracting strut cut-out, remove the through bolt which attaches the retracting arms to the wing at the remote pivot points. (See figure 147.)

(o) Move forward under the wing and pull the cotters and turn off the nuts attaching the lower re-

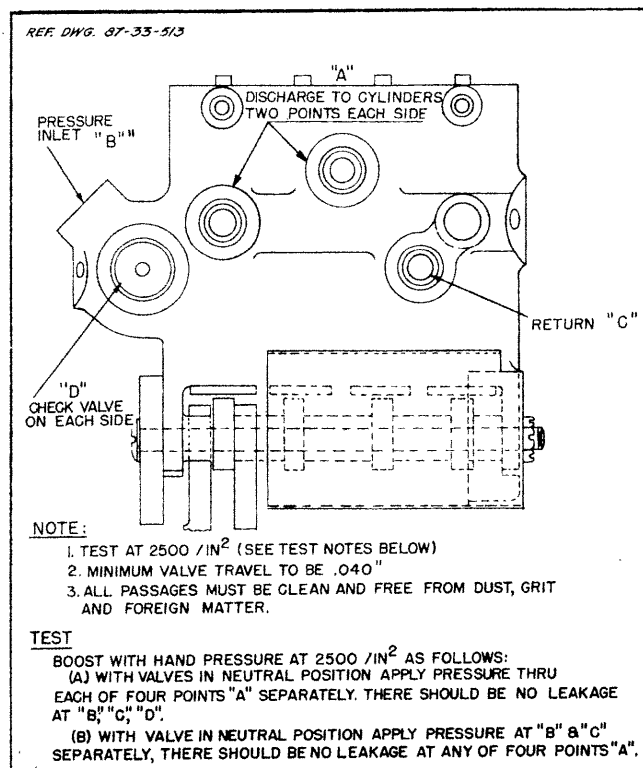


Figure 141 - Hydraulic Control Valve Pressure Test Data

tracting links to the lower oleo trunnion. With the retracting arms free in the wing there will be enough side play to remove the lower retracting links from the trunnion fittings. (See figure 148.)

(p) Disconnect the side brace link at the wing or at the oleo strut's lower trunnion as desired. (See figure 149.)

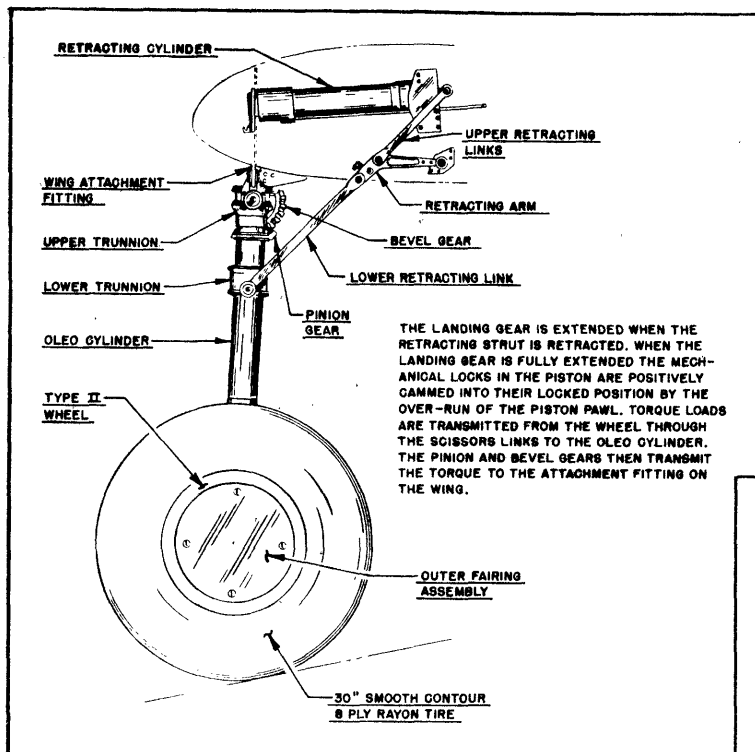
(q) Remove the cotters, nuts, and bolts from the wing attachment fittings and lower the oleo strut assembly from the wing. (See figure 150.)

(r) The retracting arms may now be pulled far enough through the wing opening to easily remove the nuts and pull the attaching bolts of the retracting arms and lower retracting links. (See figure 151.)

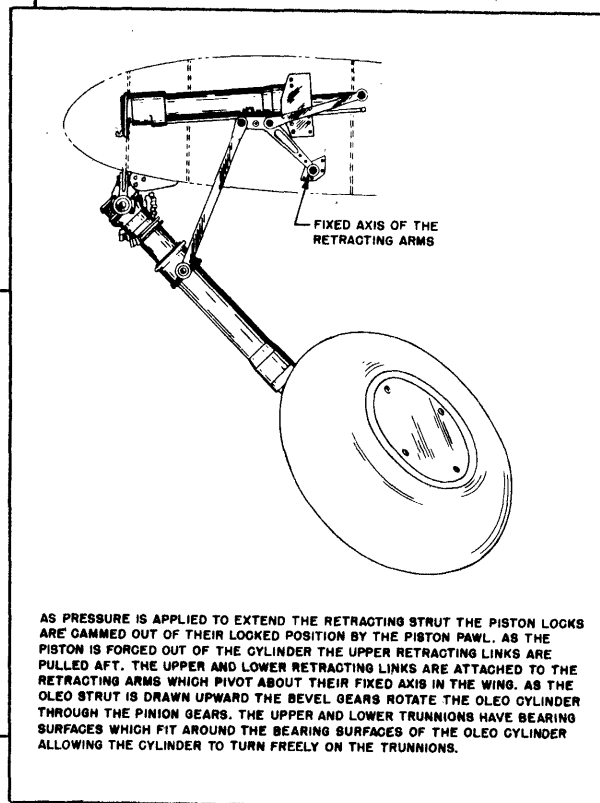
(s) Remove the upper retracting links and retracting arms from the wing. (See figure 152.)

#### c. To Disassemble the Oleo Strut.

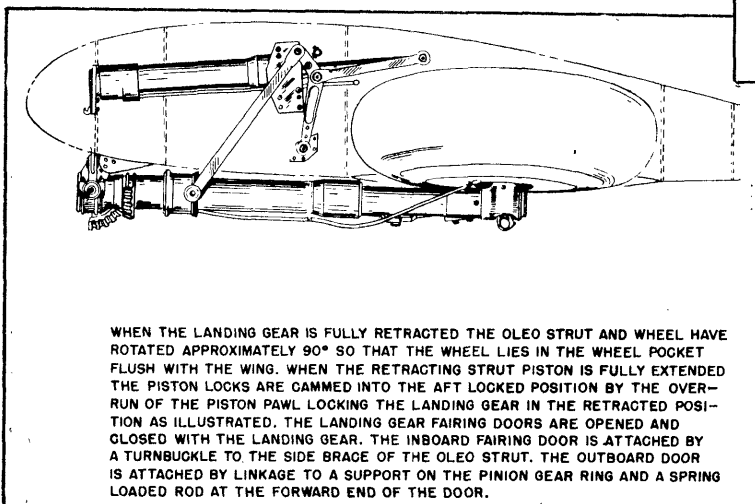
(1) After the oleo strut assembly has been removed from the wing, vent the air pressure carefully and drain the hydraulic fluid by removing the Schrader plug. Place the oleo strut in a wooden block clamp as illustrated in figure 153. Remove the six attaching bolts and lift the brake shoe and torque plate assembly from the axle. (See figure 153.)



View "A"



View "B"



View "C"

Figure 142 - Detailed Operation of the Landing Gear

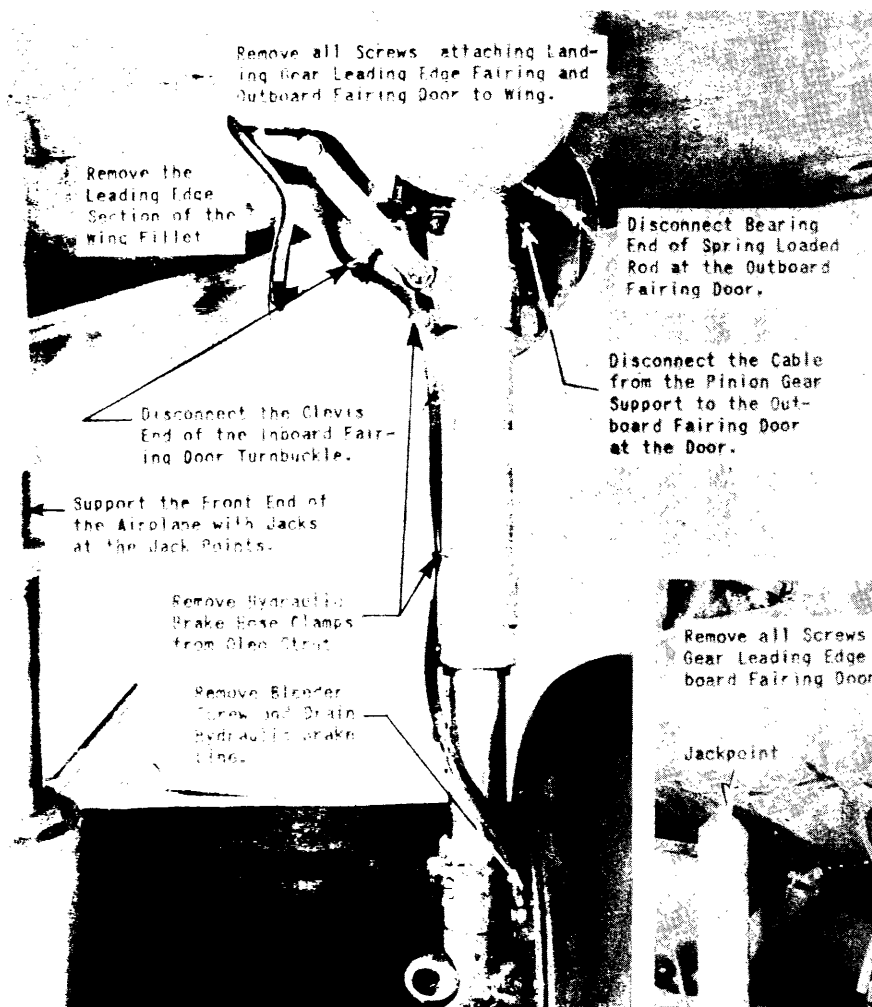


Figure 143 - Landing Gear Prior to Removal

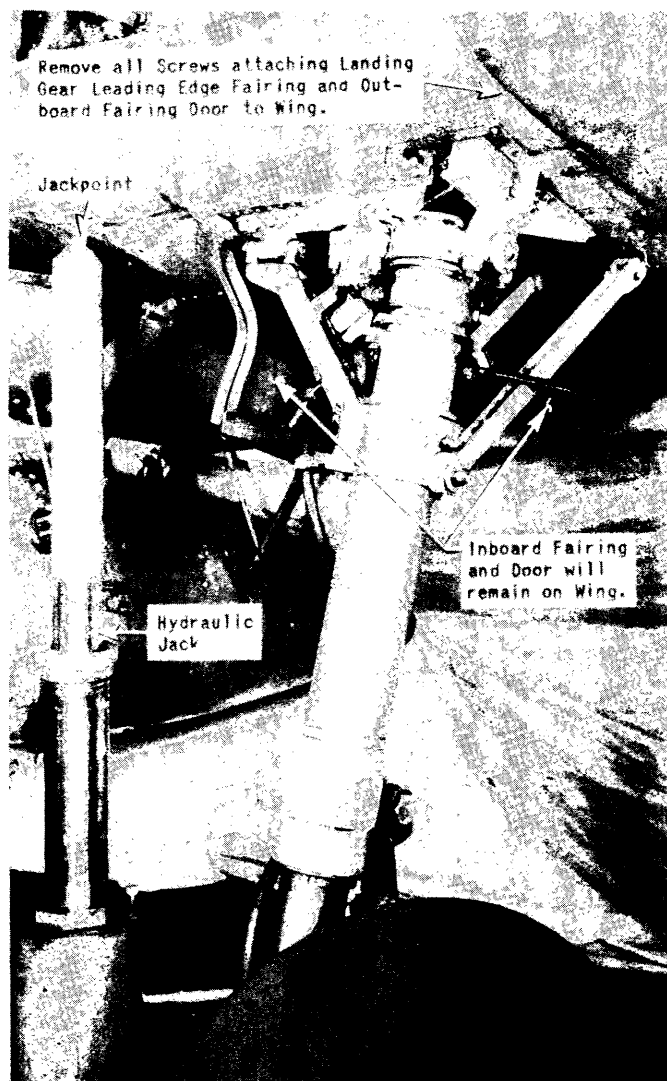


Figure 144 - Landing Gear Fairing Removed

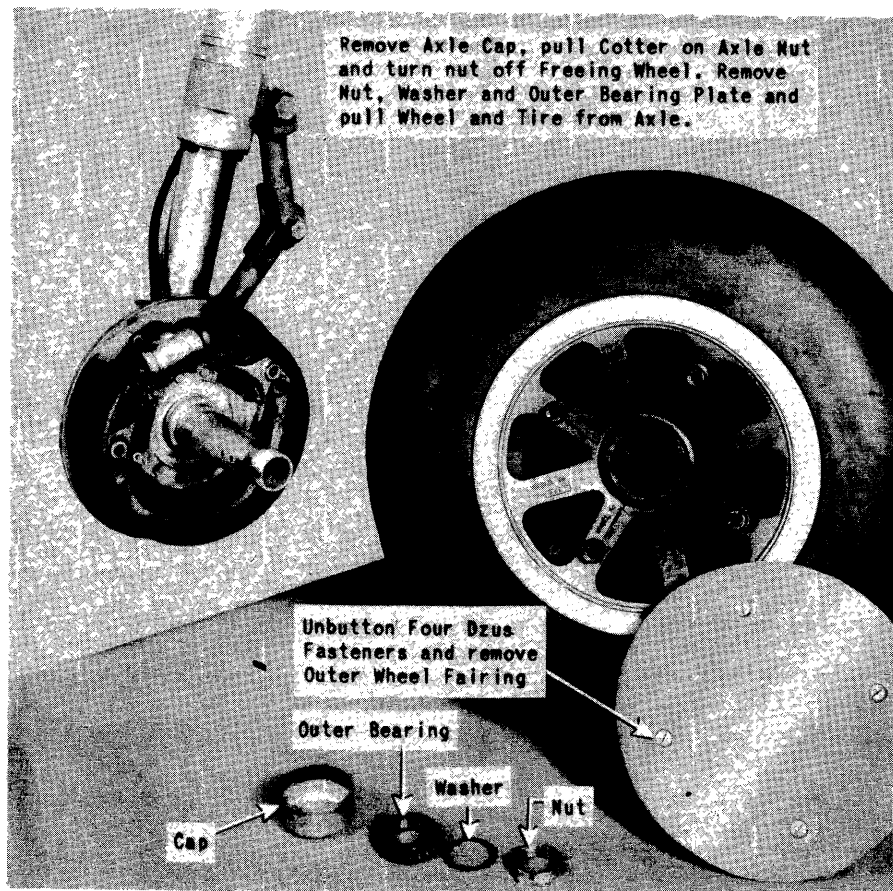


Figure 145 - Wheel and Tire Removed from Axle

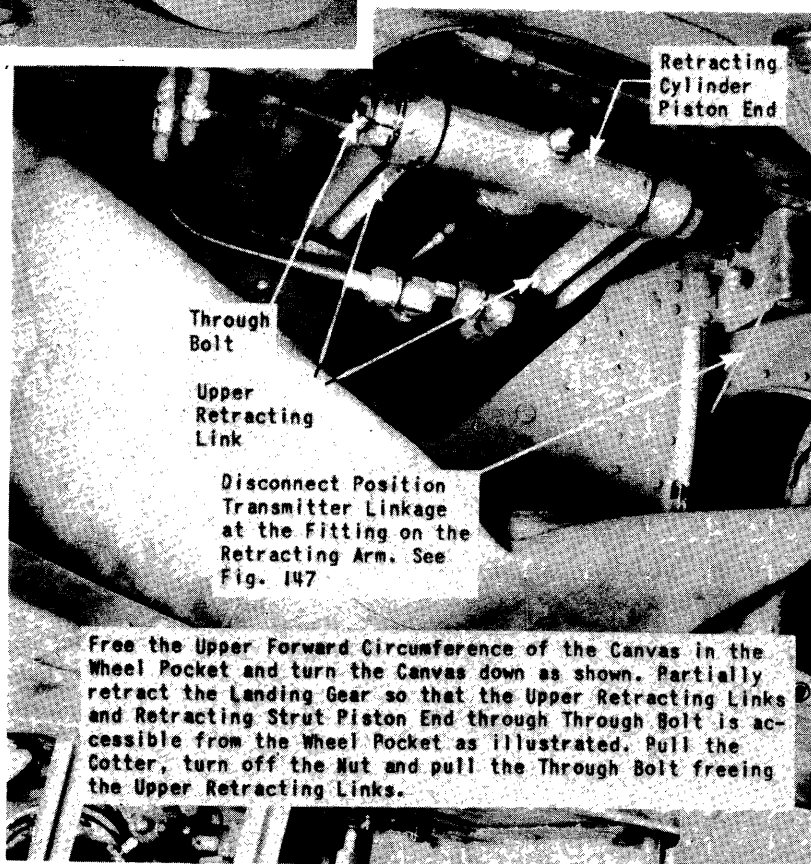


Figure 146 - Piston Half Extended for Removal of Piston End Through Bolt



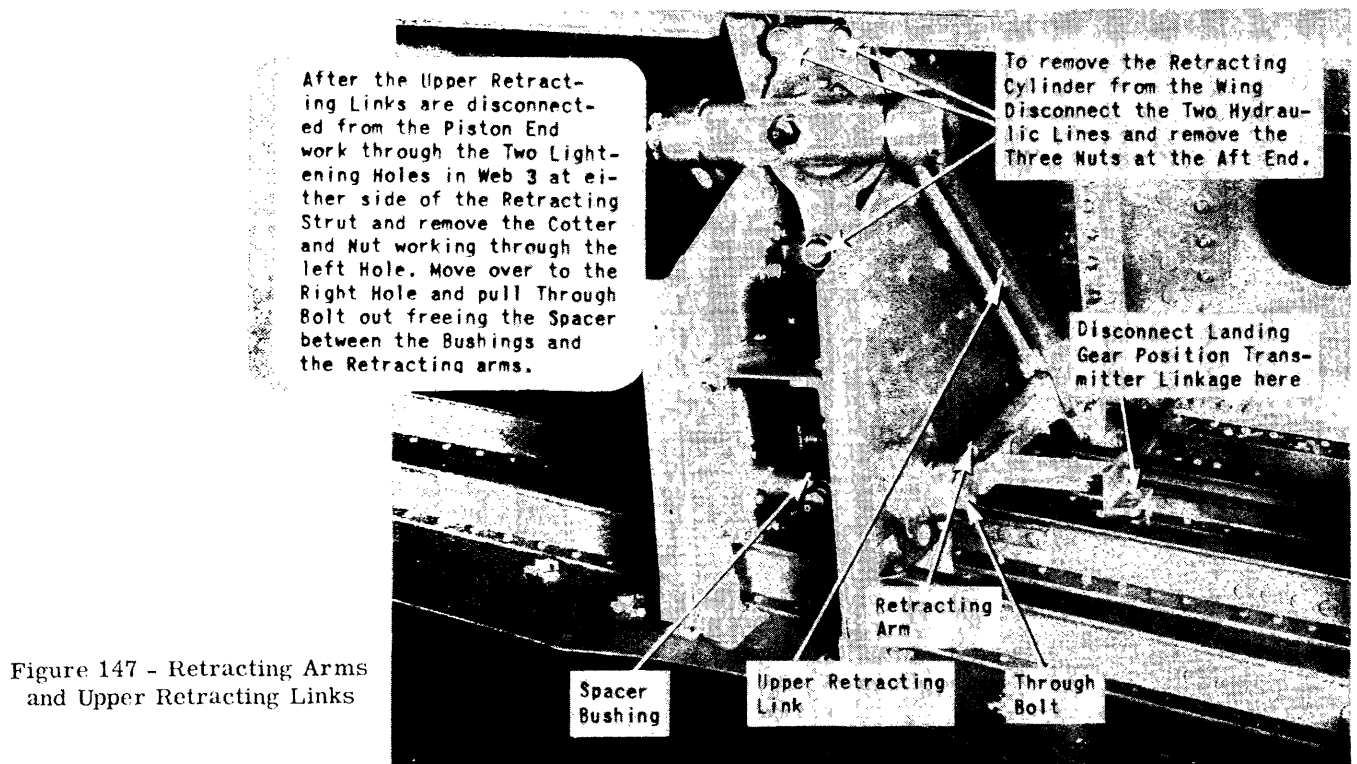


Figure 147 - Retracting Arms and Upper Retracting Links

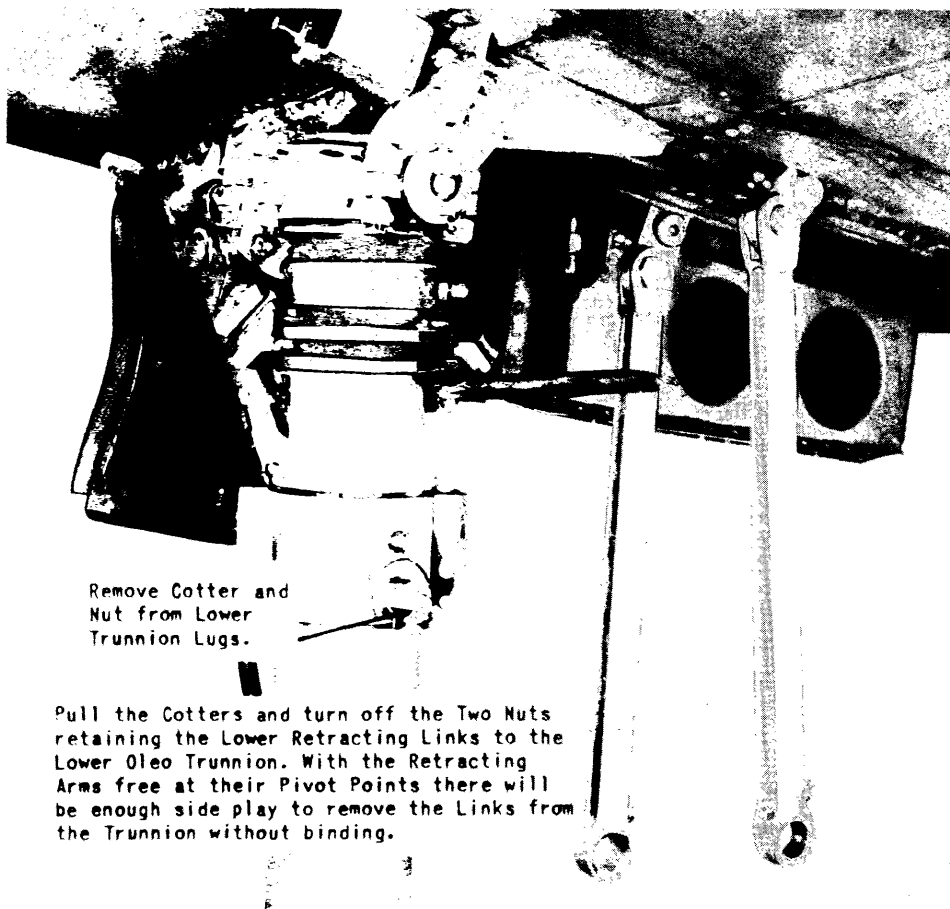


Figure 148 - Lower Retracting Links Disconnected

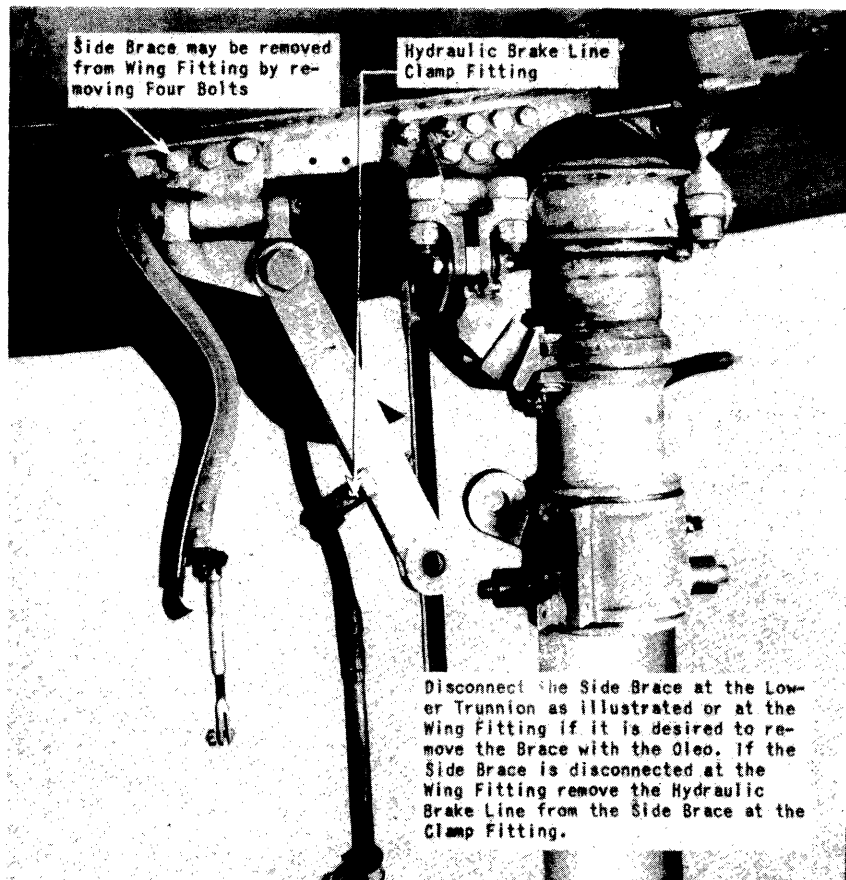


Figure 149 - Side Brace Disconnected from Lower Trunnion

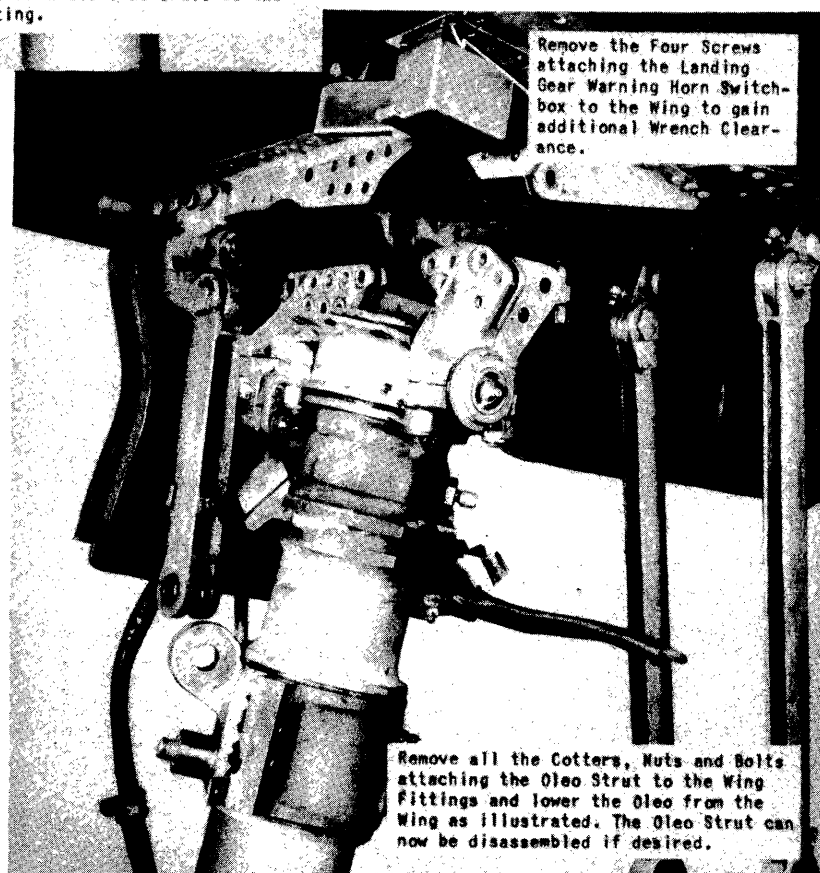


Figure 150 - Removing Oleo Strut Assembly from Wing

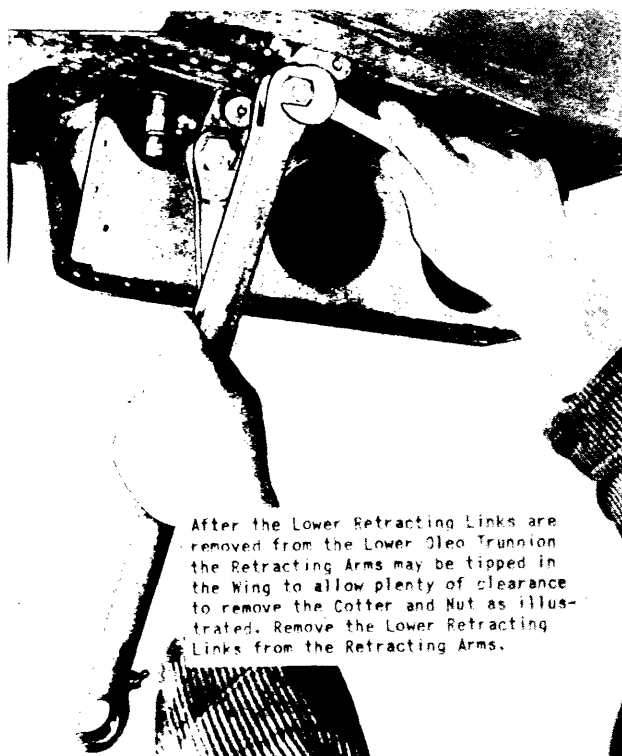


Figure 151 - Disconnecting Lower Retracting Link from Retracting Arm

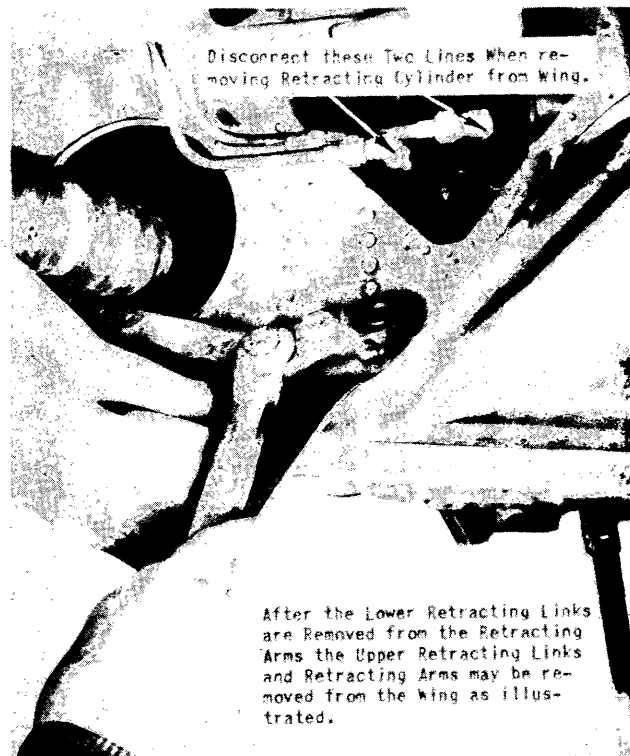


Figure 152 - Removing the Upper Retracting Link and Retracting Arm from Wing

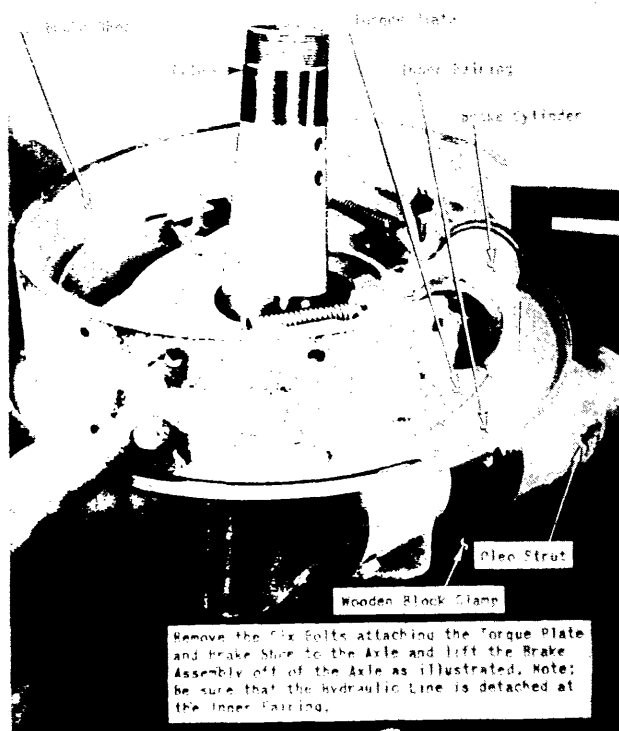


Figure 153 - Removing Torque Plate and Brake Shoe from Axle

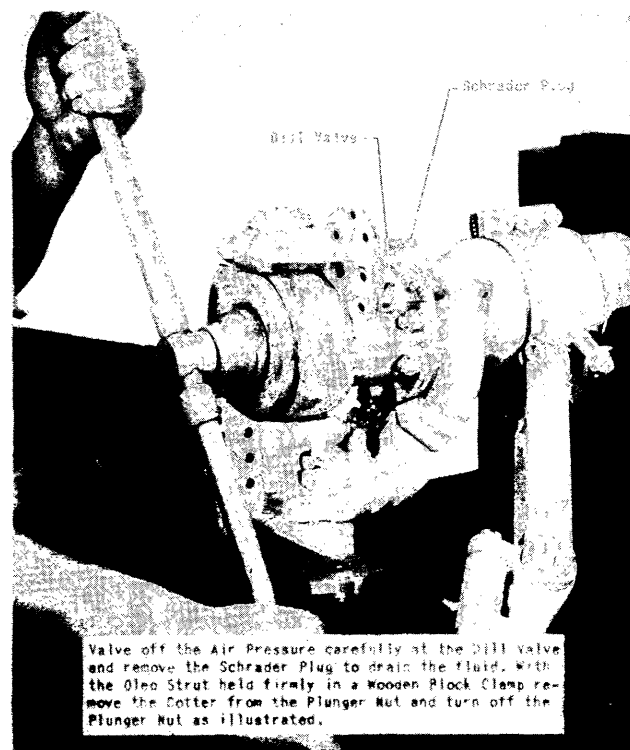


Figure 154 - Removing Plunger Nut from Oleo Strut

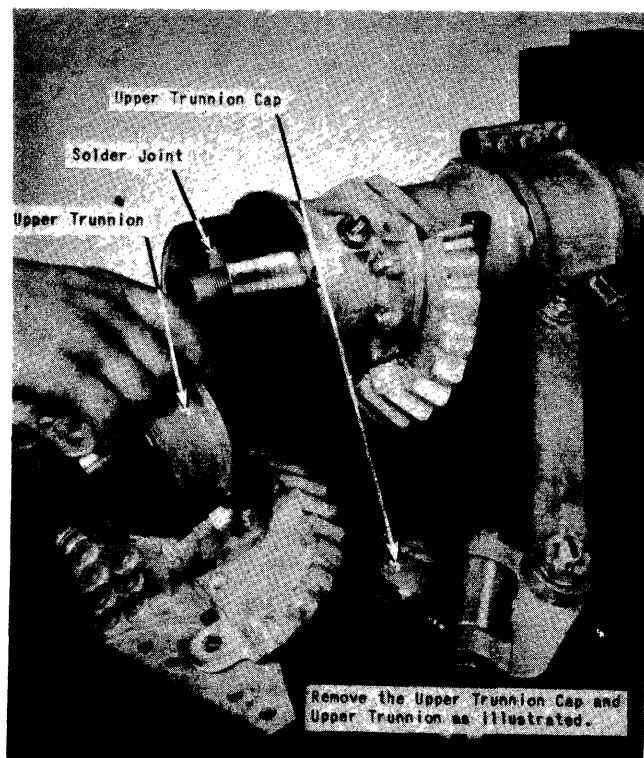


Figure 155 - Removing Upper Trunnion from Oleo Strut

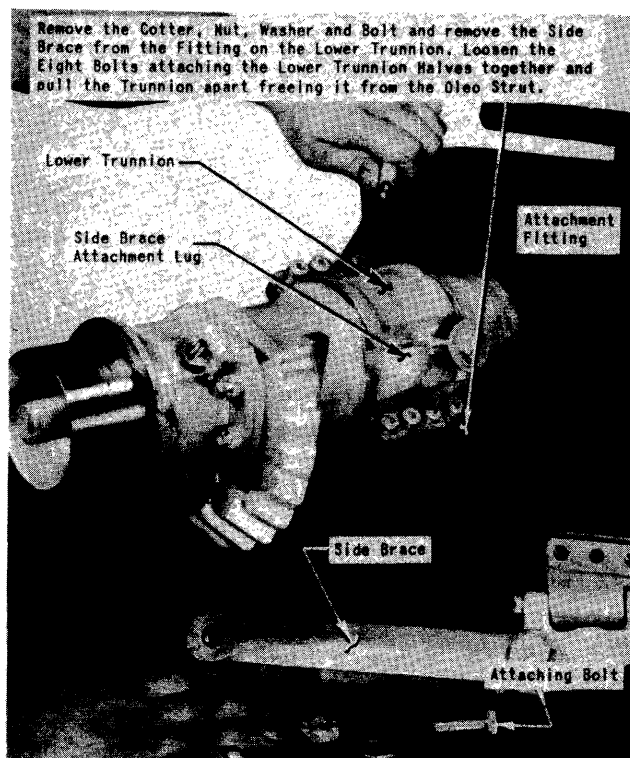


Figure 156 - Removing Side Brace and Lower Trunnion

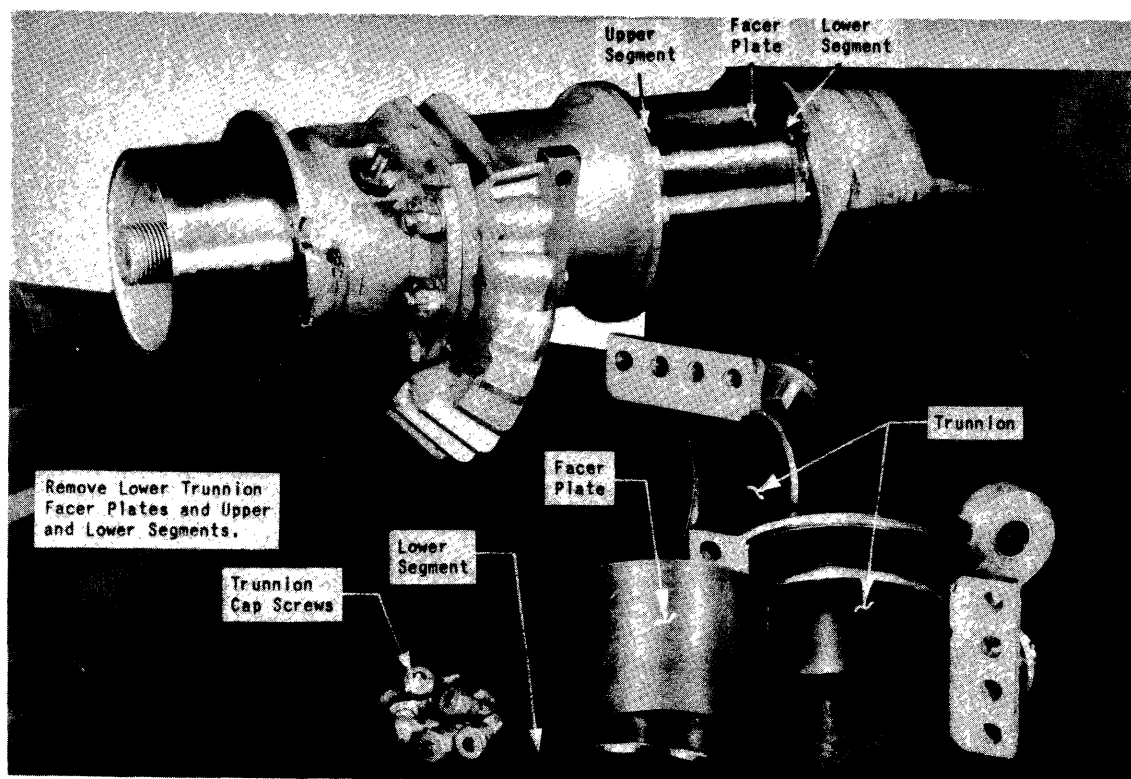


Figure 157 - Removing Lower Trunnion Facer Plates and Segments

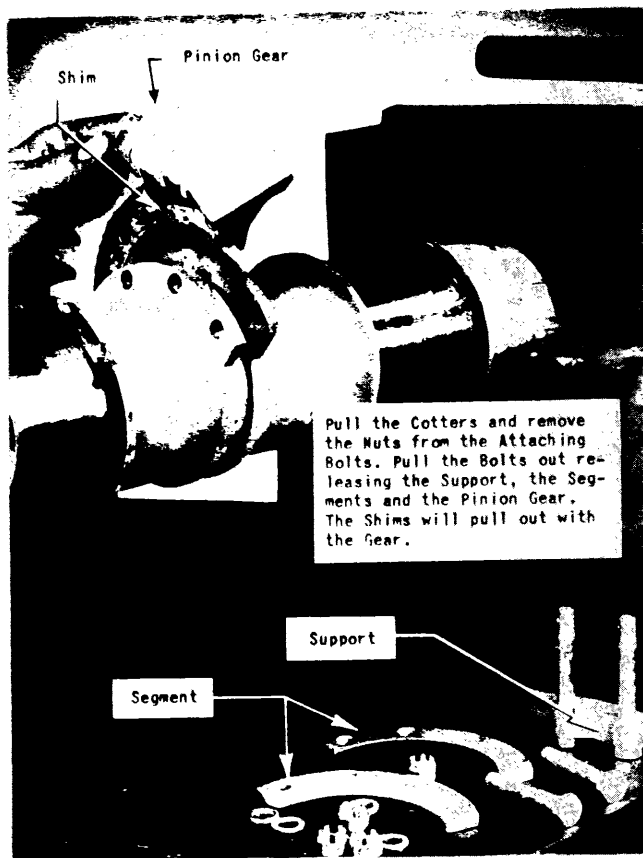


Figure 158 - Removing Pinion Gear from Oleo Strut

(2) Reverse the position of the oleo strut in the wooden block clamp as illustrated in figure 154, and pull the cotter from the plunger nut. Turn the plunger nut off with a socket wrench, as shown in figure 154, and remove the upper trunnion cap.

(3) After the upper trunnion cap is removed, the upper trunnion assembly, including the bevel gear and wing attachment fittings, may be pulled off the oleo strut. (See figure 155.)

(4) If the side brace has been removed with the oleo strut assembly, pull the cotter, loosen the nut, and remove the bolt that attaches the side brace to the lower trunnion. Remove the side brace from the trunnion. (See figure 156.)

(5) Unscrew the eight cap screws holding the two lower trunnion halves together and pull the trunnion halves from the oleo strut. (See figure 157.)

(6) Remove the two lower trunnion facer plates and the four segments. (See figure 157.)

(7) Pull the cotters and remove the nuts and washers from the four pinion gear attaching bolts, pull the bolts and remove the two segments and the support.

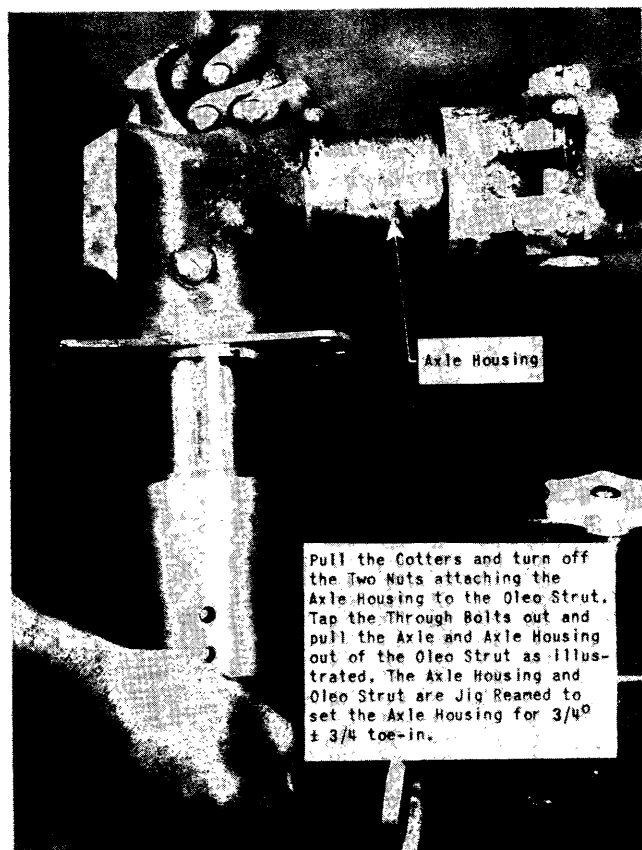


Figure 159 - Removing Axle Housing from Oleo Strut

The shims will come out with the pinion gear. (See figure 158.)

(8) Reverse the oleo strut cylinder in the wooden block clamp and pull the cotters, remove the nuts and pull the two bolts which attach the oleo piston to the axle housing. (See figure 159.) When the axle housing and oleo strut are assembled these two parts are fitted together with no clearance and jig reamed to set the axle housing for  $+3/4$  degrees  $-3/4$  degrees toe-in. Therefore, it is essential that the same axle housing and oleo strut be always reassembled together. If it is necessary to install a new axle housing the two assemblies should be lined up and jig reamed to coincide with the original assembly.

(9) Pull the cotters and remove the nuts and washers on the two bolts, one attaching the scissor link to the lugs on the piston and the other attaching the links to the lugs on the cylinder. (See figure 160.) Remove the bolts and on all P-40E-1 airplanes the spacers. (See figure 160.) On P-40F airplanes remove the bolts and pull the links free of the piston and cylinder lugs.

(10) With the oleo cylinder secure in a wooden block clamp loosen the setscrew on the cylinder and

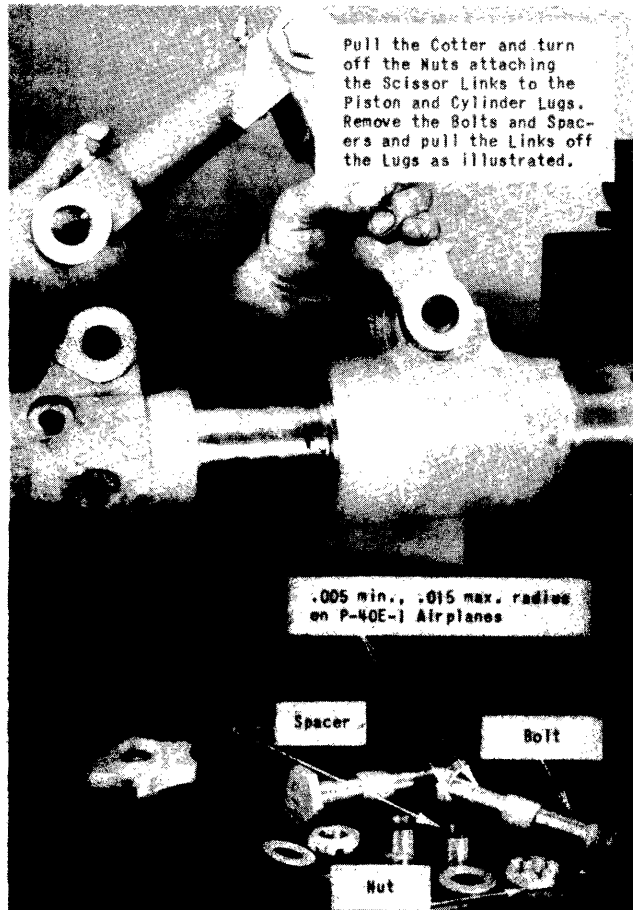


Figure 160 - Removing Scissor Links from Piston and Cylinder Lugs

turn the packing gland nut out of the cylinder with a spanner wrench. (See figure 161.) Turn the gland nut completely out of the cylinder.

(11) The piston assembly may now be pulled 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. (See figure 162.)

(12) If it is desired to remove the metering pin, place the piston assembly in a wooden block clamp and lock the clamp in a vise. Insert the metering-pin wrench (87-88-031) into the piston at the bearing end and unscrew the metering pin. Remove the metering pin and wrench and pull the metering pin from the wrench. (See figure 163.)

**NOTE:** Whenever a metering pin has been removed it will be necessary to install a new copper washer when the pin is reinstalled. Never install a used washer.

(13) While the piston is in the wooden clamp and secured in a vise remove the solder from the three

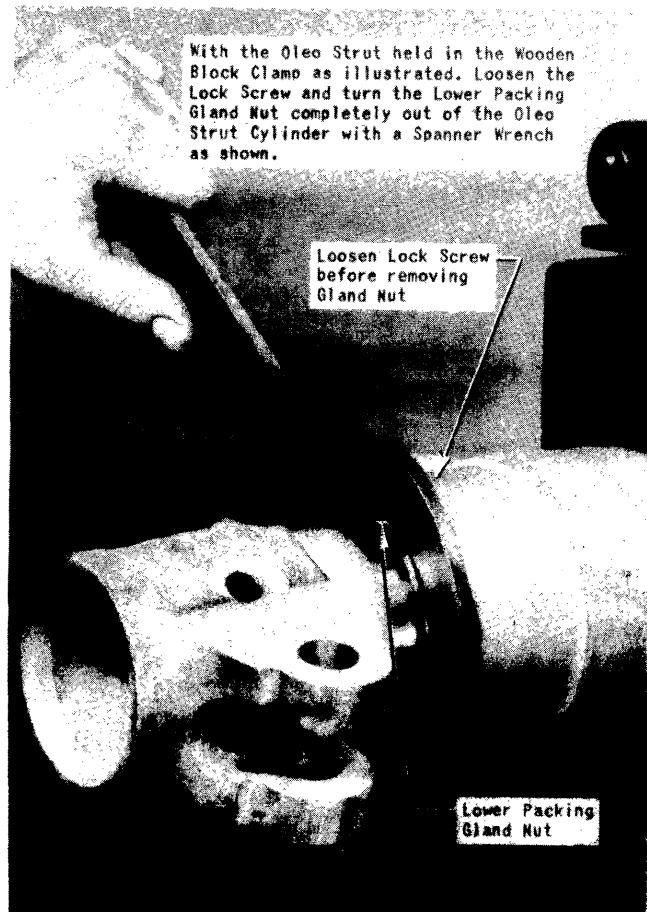


Figure 161 - Removing Lower Packing Gland Nut from Oleo Strut Cylinder

lock screws on the piston bearing either by digging the solder out or applying just enough heat to melt it away. (See figure 163.)

(14) Use a spanner wrench and turn the piston bearing off the piston. The sleeve, packing ring, packing, and gland nut can now be slid off the piston. The piston is now completely disassembled. (See figure 164.)

(15) If it is desired to remove the plunger from the oleo strut, place the oleo strut in a vertical position in a vise. (See figure 168.) Mix some asbestos sheets with water until a thick mixture is obtained and mold a generous ring of asbestos around the oleo. (See figure 168.) This will prevent the heat from the torch, when applied to melt the solder joint, from going down in the oleo cylinder.

(16) Apply heat from a torch and melt the solder.

(17) Free the oleo cylinder from the vise and turn the cylinder upside down so that the melted solder will run out into a container. Now the plunger can be turned out of the cylinder with a spanner wrench without the

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.

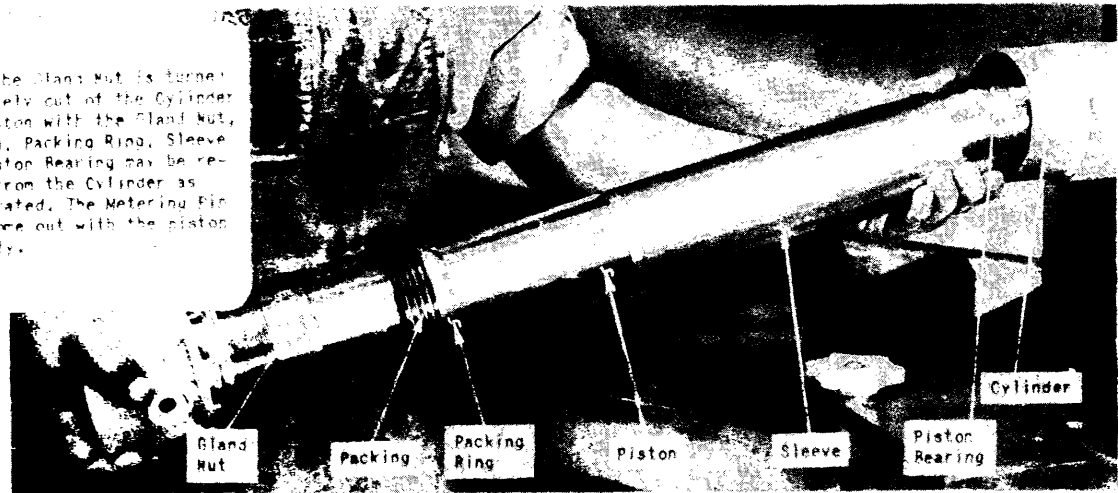


Figure 162 - Removing Piston Assembly from Cylinder

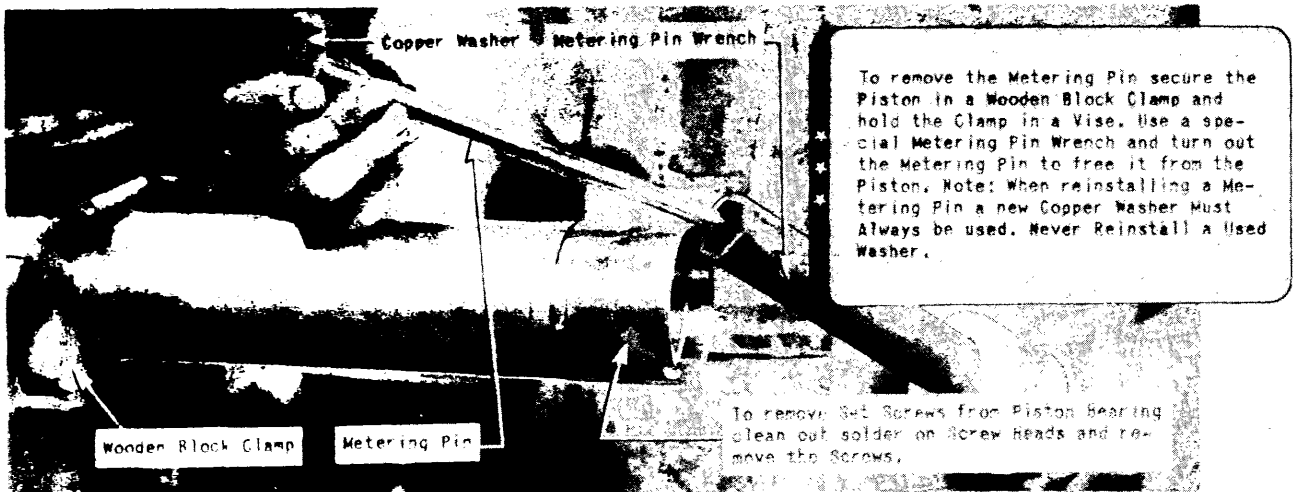


Figure 163 - Removing Metering Pin from Piston

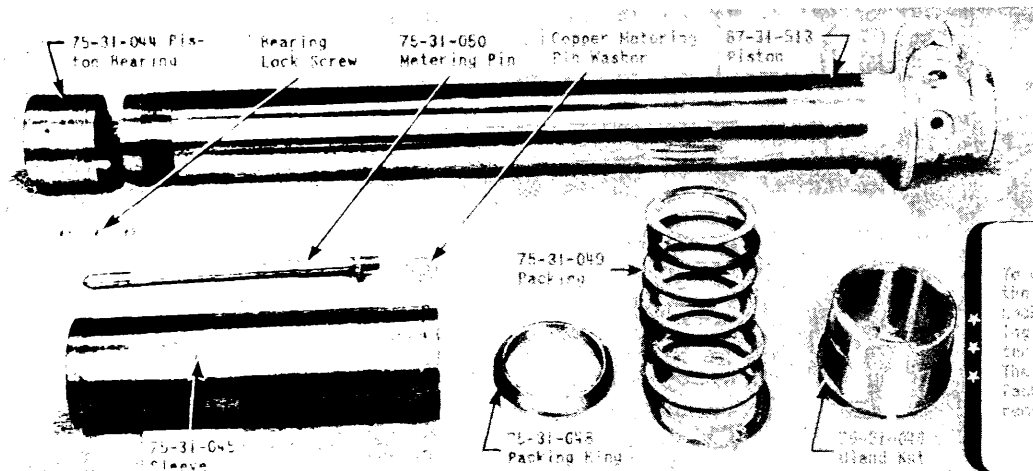


Figure 164 - Oleo Strut Piston Disassembled



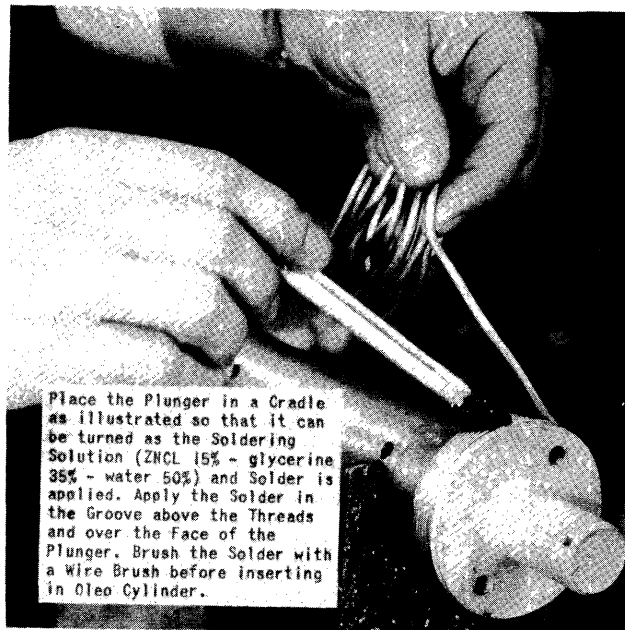


Figure 165 - Applying Soldering Fluid and Solder to Plunger

solder flowing down into the cylinder when the plunger is removed.

(18) The oleo strut is now completely disassembled for inspection and servicing.

d. To Assemble the Oleo Strut.

(1) Before assembling the oleo strut all parts should be thoroughly inspected and cleaned. All parts

found defective in any way should be replaced. Use only alcohol to clean the oleo strut parts. (See figure 164.)

(2) If the plunger has been removed from the cylinder, clean the cylinder top with "PERN-A-CLOR" degreasing solution (or equivalent).

(3) Place the cylinder in a vertical position and secure it in a vise. (See figure 166.)

(4) Mold a generous ring of asbestos and water mixture around the cylinder (figure 166) to restrain the heat from going down into the lower part of the cylinder.

(5) Apply a torch to the top of the cylinder and move the torch around the circumference of the cylinder continuously. Apply heat to both the inside and outside surfaces. Keep the torch moving continuously so that the metal will not be burned in one spot.

(6) Have several pieces of tube solder in ring form so that they will just fit inside the cylinder. Brush the inside of the cylinder around the flange with a soldering solution of 15 percent ZNCL, 35 percent glycerine, and 50 percent water. Drop a solder ring into the cylinder upon the flange.

(7) Place the plunger assembly on a cradle so that it may be revolved. (See figure 165.) Heat the end of the plunger around the groove above the threads.

(8) Brush on soldering solution and apply a generous coating of solder in the groove and on the nut face. Do not solder up the two spanner-wrench holes on the nut face.

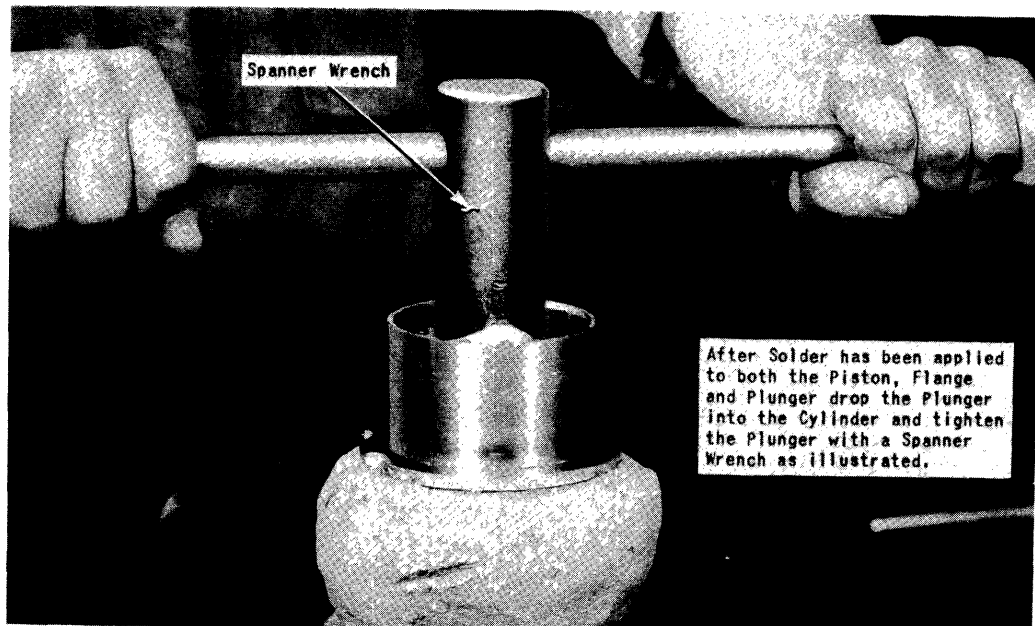


Figure 166 - Installing Plunger in Oleo Cylinder

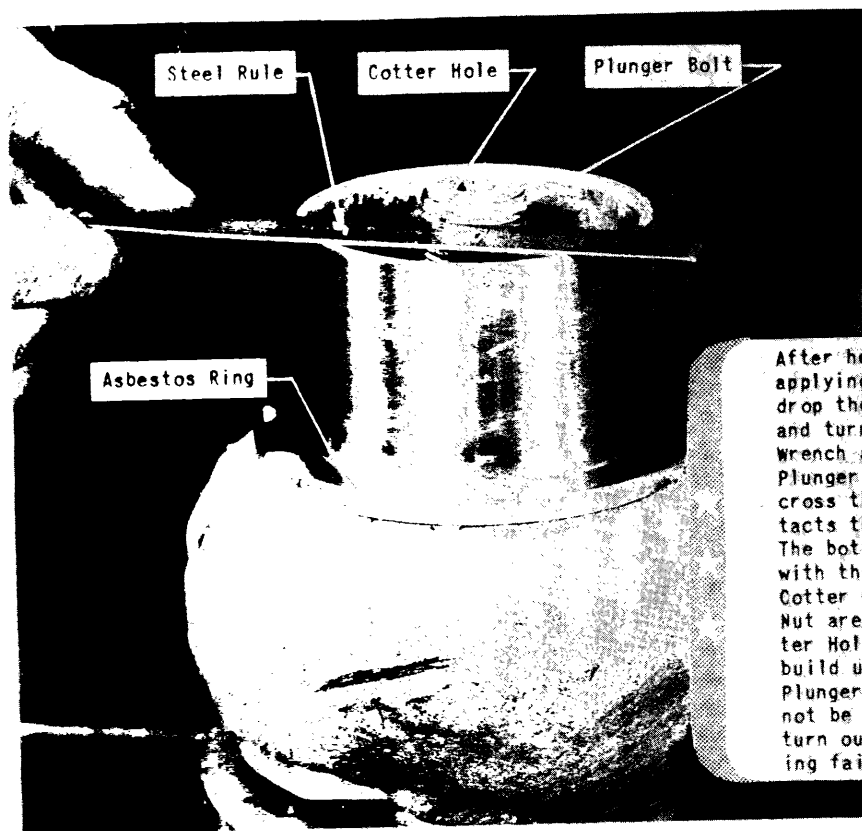


Figure 167 - Checking Cotter Hole Location in Plunger

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. 166. 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 cannot be safetyed with a Cotter as the Nut will turn out and loosen the upper Trunnion causing failure of the Oleo Strut assembly.

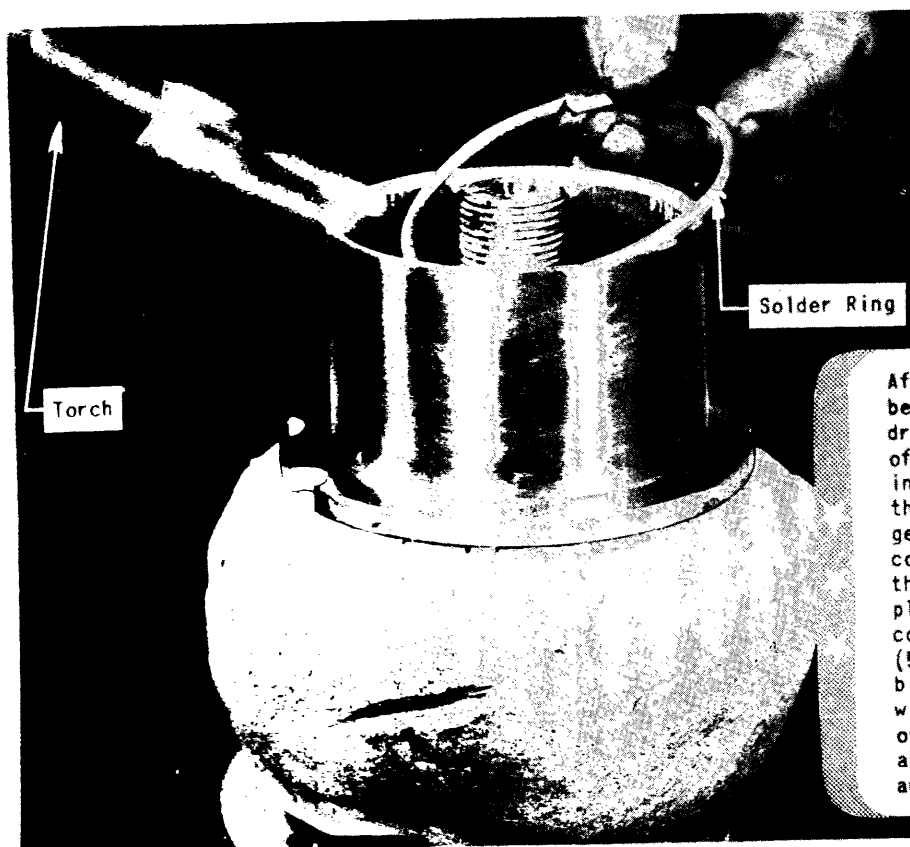


Figure 168 - Completing Solder Joint

After the Plunger has been tightened down drop about three rings of solder into the Cylinder one at a time so that the top of the Plunger Face is completely covered with solder. After the Plunger is soldered in place apply a generous coating of cleaning fluid (5% soda ash, 1% potassium bichromate and 94% water) with a brush around the outside of the Cylinder above the Asbestos Ring and polish with a cloth.

(9) Brush the solder with a wire brush and insert the plunger into the cylinder.

(10) Tighten the plunger into the cylinder with a spanner wrench. (See figure 166.)

(11) Place a steel rule on the top of the cylinder to see if the plunger has the proper protrusion above the cylinder. The bottom of the cotter hole in the plunger should be flush with the top of the steel rule. If the protrusion is not sufficient the plunger must be removed and more solder applied to build up the cylinder flange or another plunger installed. It is imperative that the cotter hole in the plunger comply with the above measurement or it will be impossible to safely the plunger nut when the upper trunnion cap and nut are installed. (See figure 167.)

(12) After the plunger is properly assembled in the cylinder, drop about three more rings of solder into the cylinder while applying heat. Drop these rings in one at a time as illustrated in figure 168. This should thoroughly seal the joint and build up a solid solder cap around the plunger face.

(13) Clean the outside of the top of the cylinder where the heat was applied with a solution of 5 percent soda ash, 1 percent potassium bichromate, and 94 percent water. Polish with a cloth and set the cylinder aside to cool.

(14) When the cylinder has cooled sufficiently remove the asbestos mold and the cylinder is now ready for the assembly of the remainder of the units.

(15) First assemble the piston by placing it in a wooden block clamp and inserting the clamp in a vise to secure it from turning. (See figure 163.)

(16) Insert the metering pin in the metering-pin wrench; be sure to install a new copper washer on the threaded end below the nut and insert the wrench with the pin into the piston. Screw the metering pin in tight.

(17) Slide the gland nut on the piston, threaded end first, then slide on the lower packing ring, the five packings, and the upper packing ring.

(18) Slide the sleeve over the piston and screw on the piston bearing until it is tight.

(19) Install the three lock screws and fill the screwheads with solder to safety them in place. Buff off the solder so that there are no burrs or sharp edges to score the cylinder wall.

(20) The piston is now completely assembled and ready for installation in the cylinder. Wet the packings thoroughly with hydraulic oil, Specification No. 3586, so that they will slide into the cylinder easily.

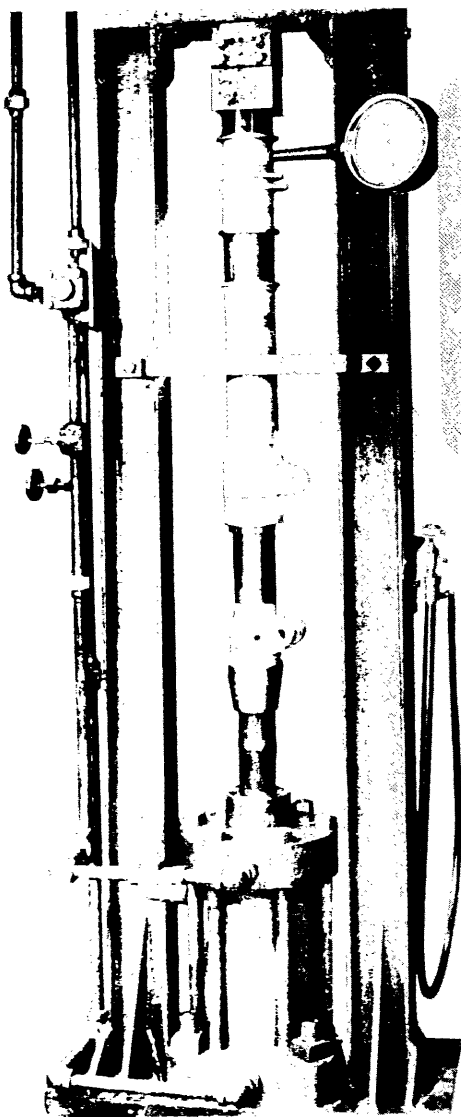
(21) Slide the piston into the cylinder secured in a wooden block clamp (figure 162) and tighten the gland

nut with a spanner wrench (figure 161). Tighten the nut firmly but not excessively and tighten the setscrew in the cylinder.

(22) The strut is now ready for the preliminary test. Lay the strut down on a bench horizontally with the Schrader plug up. Remove the plug and fill the cylinder with hydraulic oil, Specification No. 3586, while extending the piston, until oil flows over the plug hole. Screw a pressure gage into the plug hole and insert the strut in a vertical press as illustrated in figure 169. Apply a pressure of 2800 pounds and allow the strut to remain under this pressure for 10 minutes. Inspect the oleo strut for leaks, especially around the solder joint and packing gland nut.

(23) If the pressure test shows no leaks drain the hydraulic oil. If the packing has been replaced the oleo assembly should be run in on a machine that will move the piston in and out through at least half its total travel a minimum of 500 cycles. The strut must be fully serviced with fluid and air before running in. This servicing may be accomplished as follows: Push the piston into the cylinder as far as possible and stand the strut up in a vertical position. Fill the strut with hydraulic fluid, Specification No. 3586, until it overflows and replace the Schrader plug loosely. Place the oleo strut in the machine (figure 170) and cause the strut to be extended and retracted several times to eliminate air trapped in the strut. Remove the strut from the machine and check the fluid level. If additional fluid is added repeat the procedure outlined above each time fluid is added until the proper fluid level is obtained. Inflate the strut to 208-pound pressure with a high pressure hand pump. Do not use compressed air. Replace the strut in the machine and run in a minimum of 500 cycles. (See figure 170.)

(24) After the strut has been run in the scissors links can be assembled. Before installing the links on the P-40E-1 airplanes inspect the bolts for a radius of .005 minimum, .015 maximum in the two places shown in figure 160. If the radius is greater than .015, the bolts must be reworked or replaced to obtain the correct tolerances. Inspect the floating spacers on P-40E-1 links for wear and scoring. Badly worn or scored spacers must be replaced. Be sure that the links are thoroughly clean and that the bushings are not worn or scored. Replace badly worn or scored bushings. When bushings are replaced it will be necessary to drill a new grease passage in the bushing to align with the grease passages on both sides of the scissor link which are equipped with Zerk fittings. Coat the surfaces of the bushings, spacers, and bolts with mobilgrease "Zero" and install the scissors links on the piston and cylinder lugs. Insert the bolts and snug up the nuts, 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 bushings and spacers. Periodic inspection and greasing of the scissors links are required to assure satisfactory operation of the parts at all times.

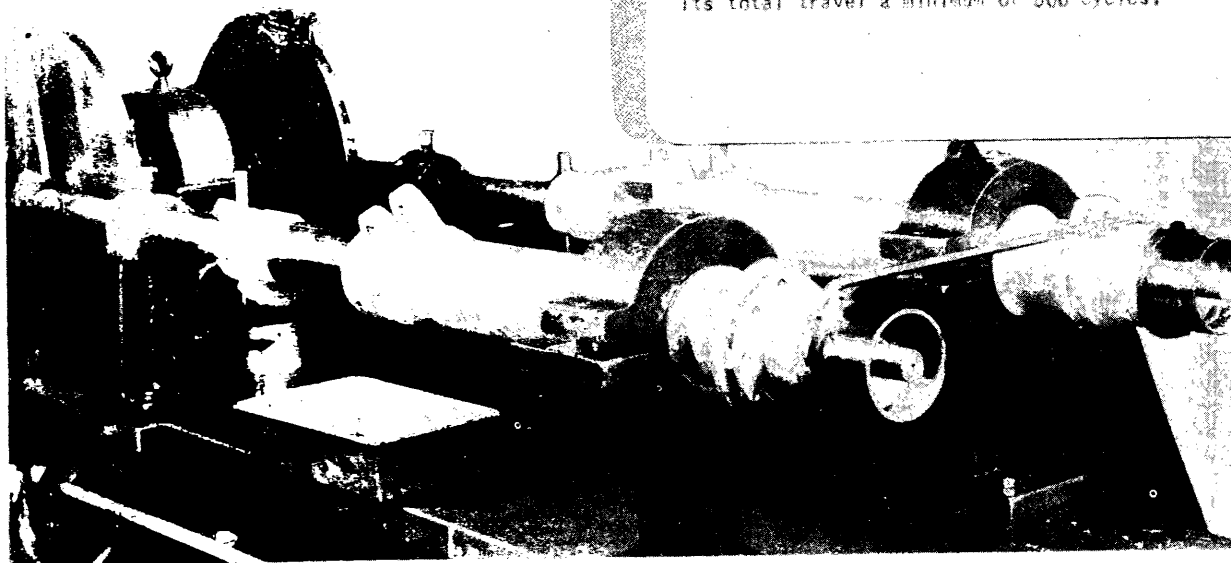


When the Oleo Cylinder and Piston are assembled lay the Oleo Strut on a Bench with the Schrader Plug up. Remove the Schrader Plug and extend the Piston. Fill the Oleo through the Schrader Plug Hole with Fluid (50% Diacetone Alcohol and 50% Castor Oil) until it overflows. Screw a Gage into the Plug Hole 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.

Figure 169 - Pressure Test of Oleo Strut

Figure 170 - Running the Oleo Strut In

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 200 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.



PART NUMBER	PART	NO.
A 87-33-510	CYLINDER	1
B 87-31-027	PISTON	1
C 87-33-515	END	1
D 75-33-027	LOCK	1/2
E 75-33-021	PAWL	1
F 75-33-029	ROCKER	1
G 75-33-023	CAP	1
H 87-31-034	SHAFT	1
I 75-33-026-1	PIN	1
J 75-33-026-2	PIN	1
K 87-31-028	BEARING	1
L 75-33-025-1	NUT	1
M 75-33-025-2	NUT	1
N 75-33-030-1	SHIM	2
O 75-33-030-2	SHIM	2

1. FOR TEST AND ASSEMBLY USE HYDRAULIC BRAKE FLUID #5. UNDER NO CONDITIONS SHOULD MINERAL OIL BE USED.
2. TO MANIPULATE PAWL "E" - USE  $\frac{5}{16}$ " DIA. DRILL ROD  $1\frac{1}{2}$ " OR LONGER, END THREADED  $\frac{1}{8}$ -36 - INSERT ROD THRU  $\frac{1}{4}$ " HOLE IN CAP "F".
3. ELIMINATE OR ADD SHIMS AS REQUIRED TO SHIMS "N" TO SO THAT LOCKS "D" WILL HAVE CLEARANCE OF .003"-.006" IN LOCKED POSITION.
4. TEST COMPLETE ASSEMBLY TO 2500#/SQ. IN.

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

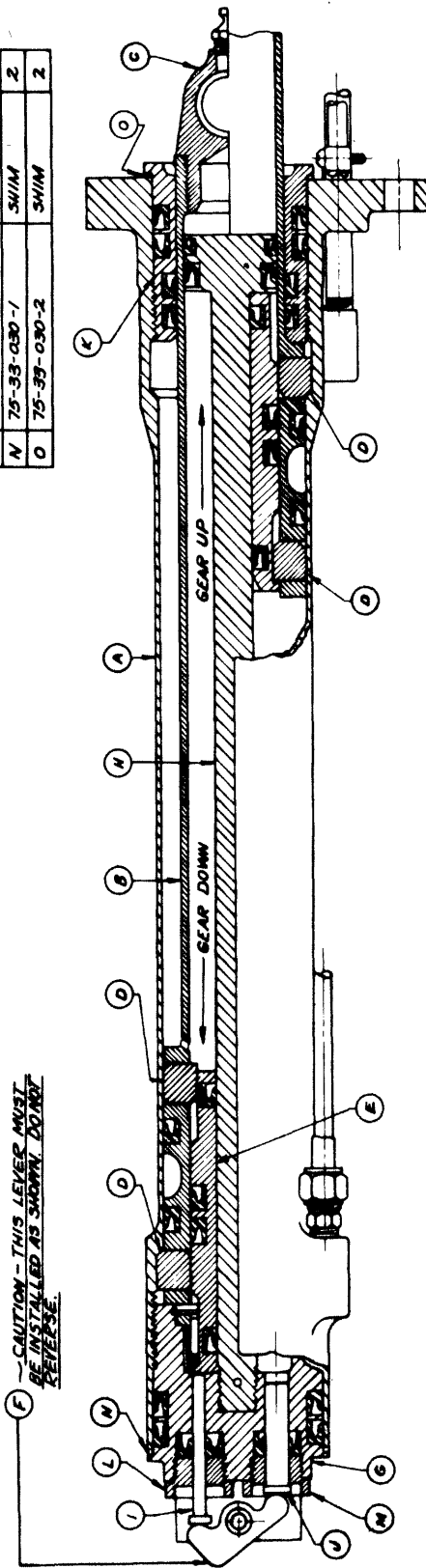


Figure 171 - Retracting Strut Diagram

REF. DWG. 87-31-505

(25) Install the axle housing and axle assembly and insert the two through bolts. Turn up the nuts tight and install cotters.

(26) Install the pinion gear with shims as on the original installation. These shims are sweat soldered in place. Slip the segments into place and install the four bolts and the support making sure that the support is installed on the same side of the cylinder as the scissor link lugs.

(27) Install the four segments, two facer plates, and the lower trunnion halves. Install the eight cap screws and the attachment fitting. (See figure 156.) Draw the cap screws up tight.

(28) Install the side brace on the lower trunnion and safety the nut with a cotter.

(29) Slide the upper trunnion with gears and wing fittings attached (figure 155) onto the cylinder.

(30) Slide the trunnion cap onto the plunger bolt and install the plunger nut. Take up the nut with a socket wrench. (See figure 154.) Safety the nut with a cotter.

(31) Reverse the oleo strut in the wooden block clamp and place the axle in a vertical position. Install the brake shoe and torque plate assembly on the axle as shown in figure 153 and install the six attaching bolts. The oleo strut is now ready for lubrication before installing on the wing. Force mobilgrease "Zero" through all the Zerk fittings with a grease gun until grease oozes out of the joints. Test the trunnions to see if they revolve freely.

(32) To install the oleo strut on the wing proceed as follows.

(a) Raise the oleo strut to the wing and guide the fittings on the upper trunnion into the fittings on the wing. Insert the attaching bolts, tighten the nuts and safety with cotters.

(b) Attach the side brace fitting to the wing, or the lower trunnion lug on the oleo strut if it was originally disconnected at this point.

(c) Attach the upper retracting links to the retracting arms and insert the assemblies into the wing through the two lightening holes in web No. 3. (See figure 152.) Be sure that the attachment for the landing gear position transmitter cable is installed on the inboard retracting arm.

(d) Tip the retracting arms so that the lower retracting links attachment end protrudes through the openings on the under surface of the wing far enough to provide clearance to attach the lower retracting links to the retracting arms. (See figure 151.) Attach the links to the arms with the attaching bolts and tighten the nuts. Do not tighten the nuts excessively. Safety the nuts with cotters.

(e) Slide the lower retracting links on the lower trunnion fittings, install and take up the nuts, safety the nuts with cotters.

(f) Attach the retracting arms at the pivot point in the wing with the through bolt. Do not tighten the nut on the through bolt excessively. Safety the nut on the bolt with a cotter.

**NOTE:** Be sure that the spacer with the Zerk fitting is installed between the pivot point bushings. (See figure 147.)

(g) If the retracting cylinder has been removed replace the cylinder in the wing by working through the wheel well. Slide the retracting cylinder through the web cut-outs and guide the attachment fitting on the aft end of the cylinder onto the three bolt studs on the wing support. Install lock nuts on the three studs.

(h) Attach the upper retracting links to the piston end on the retracting cylinder with a through bolt and tighten the nut. Do not tighten the nut excessively. Safety the nut with a cotter.

(i) Connect the two hydraulic lines to the retracting cylinder and the brake line to the wheel at the inner wheel fairing fitting. Attach the two clamp fittings supporting the brake line to the oleo cylinder. (See figure 143.)

(j) Coat the wheel bearings with mobilgrease "Zero" and slide the wheel and tire onto the axle. Install the axle nut and take it up snug. Back the nut off until the wheel turns freely and safety the nut with a cotter. Install the axle cap and button the outer wheel fairing on with the four Dzus fasteners.

(k) Lubricate the landing gear assembly with mobilgrease "Zero" at all Zerk fittings with a pressure gun. Do not miss any of the fittings on the links or retracting cylinder end.

(l) Test the landing gear for proper operation with both the electric hydraulic motor-driven pump and the auxiliary hand pump.

(m) Test the bevel and pinion gears for backlash adjustments. If there is too much backlash (.000 - .002) remove the shim from the top of the pinion gear ring and place it on the bottom. If the gears appear to bind and have no backlash remove the shim from below the pinion gear ring and place it above the gear.

(33) Connect the position transmitter linkage and adjust the transmitter to give the correct position on the flap and wheel indicator in the cockpit.

(34) Replace the landing gear fairing.

(35) Connect the inboard fairing door turnbuckle to the side brace and the outboard door linkage to the support on the pinion gear. Adjust the turnbuckles so

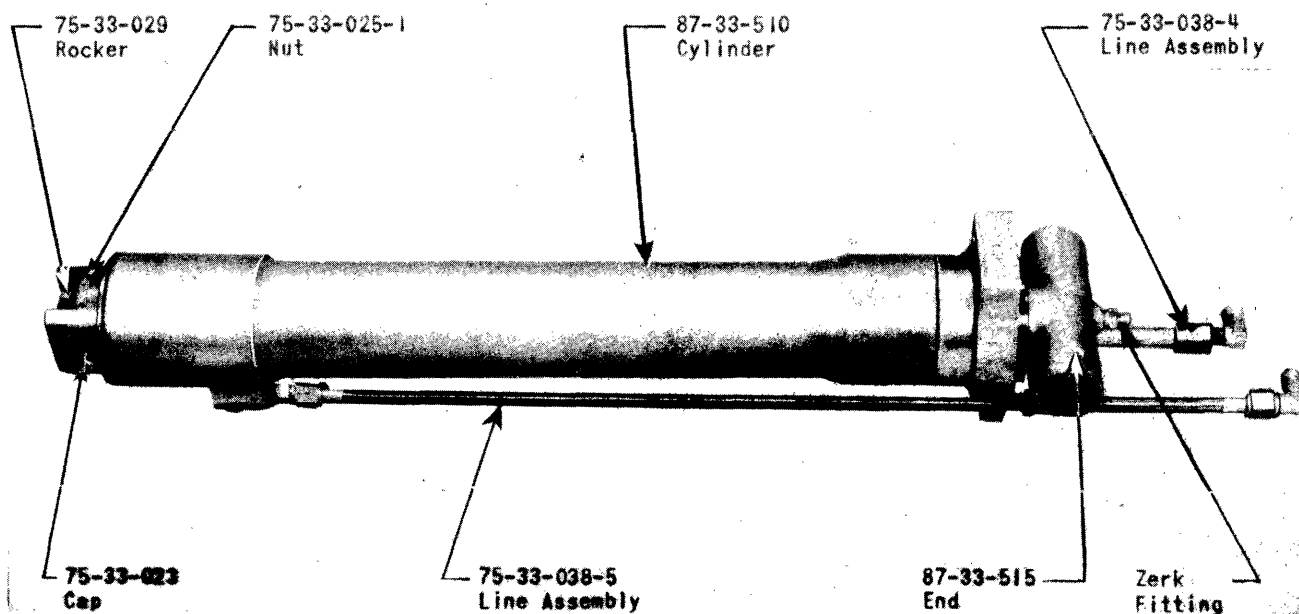


Figure 172 - Landing Gear Retracting Strut

that the doors close tight when the landing gear is fully retracted.

(36) Lower the airplane to the taxiing position and deflate the strut by backing off the filler plug slightly to allow 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 at high pressure air past its seat. Do not attempt to remove the filler plug without first completely deflating the strut.

(37) Back off the filler plug until all fizzing of air and fluid ceases.

(38) Remove the filler plug and fill the strut with hydraulic oil, Specification No. 3586, until it is level with the plug hole.

(39) Insert the plug loosely and cause the strut to be completely extended and retracted several times, preferably by raising and lowering the airplane with a hoist or jack. This will eliminate air trapped in the strut.

(40) Remove the plug and check the fluid level. If additional fluid is added repeat the procedure outlined in paragraph (39) each time fluid is added until the proper fluid level is obtained.

(41) Replace and tighten the filler plug carefully so as not to damage the threads or valve stem. The copper gasket should be replaced whenever a filler plug is reinstalled to guard against leakage at the filler plug.

(42) With the fluid at the proper level, inflate the strut through the air valve with a high pressure hand pump. Do not use compressed air. Rock the airplane while inflating the strut so that the strut will alternately extend and retract to overcome packing friction. When fully inflated both struts must have the proper extension under a full load of 2 inches between the cylinder and piston collar.

**NOTE:** Any checking or adjusting of the strut inflation should be done on a reasonably level surface, sheltered from the wind, with the airplane in a taxiing position and fully loaded.

(43) After inflation test the valve, valve core, and filler plug carefully for leaks by brushing a soap and water mixture around the unit.

(44) Small amounts of air can be removed from the strut by depressing the valve core. Exercise extreme care to allow the air to escape slowly to avoid damaging the valve seat. Support the tool used to depress the valve core against the lip of the valve stem. Care should be exercised to prevent damage to the filler plug and air valve assembly by excessive tightening of the air hose connection with pliers or other tools. If leakage occurs at the hose connection to the air valve and cannot be stopped by hand tightening, replace the fitting gasket in the pump hose.

## 6. Landing Gear Retracting Strut.

a. **General.** - The retracting strut is mounted above the oleo strut in the leading edge of the wing forward of the wheel pocket. Extension of the strut causes the landing gear to retract with the wheel lying flush in



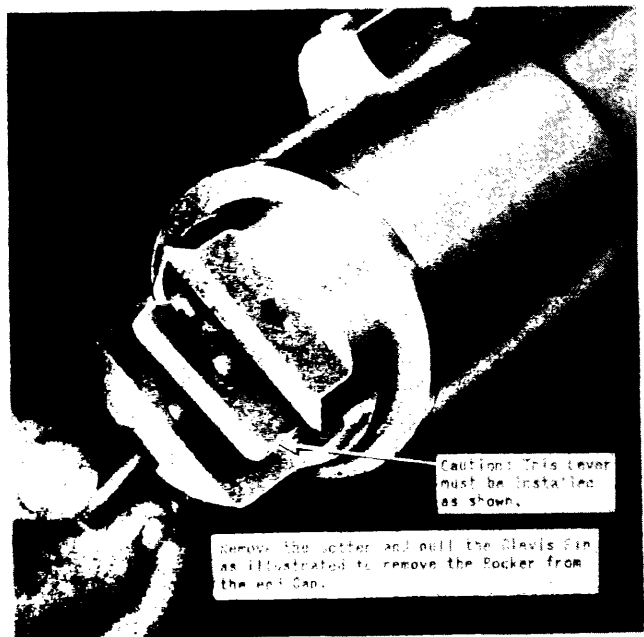


Figure 173 - Removing Rocker from Cap

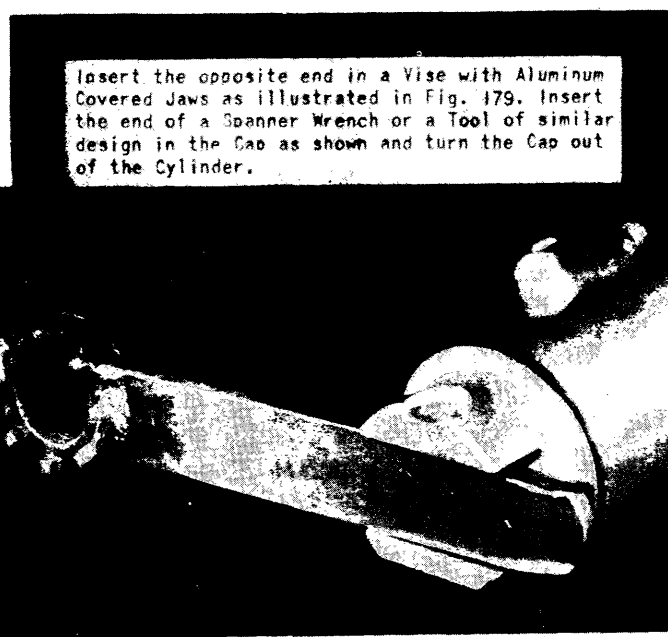


Figure 174 - Removing Cap from Retracting Strut

the wing. The strut piston has a travel of 11.06 inches for full retraction and has two sets of mechanical locks which are operated by the overtravel of an internal sliding pawl. The mechanical locks consist of two sets of six radial segments, retained in square broached holes in the piston, which are positively cammed into and out of the locked position by the sliding pawl. (See figure 171.)

b. To Remove the Retracting Strut from the Wing.

(1) Jack the airplane and extend the strut about halfway so that the piston end protrudes into the wheel pocket.

(2) Working through the wheel pocket remove the through bolt attaching the upper retracting links to the piston end.

(3) Retract the strut and disconnect the two hydraulic lines at the aft end of the strut.

(4) Remove the three attaching nuts at the aft end of the cylinder and pull the strut out of the wing through the wheel pocket. (See figure 147.)

c. To Disassemble the Retracting Strut.

(1) Remove the length of pipe extending to the forward end of the cylinder so that the cylinder may be placed in a wooden block clamp.

(2) Place the cylinder in a wooden block clamp and secure the clamp in a vise.

(3) Remove the cotter and pull the clevis pin retaining the rocker in the cap assembly. (See figure 173.)

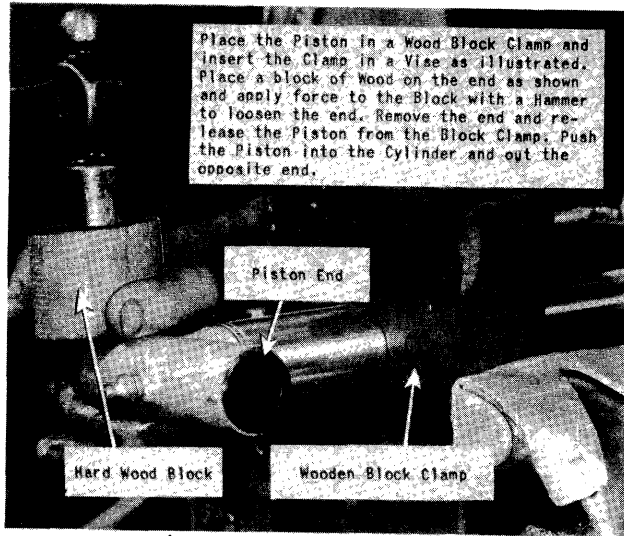


Figure 175 - Removing End from Piston

(4) Place the handle of the hand pump spanner wrench or some similar tool in the cap (figure 174) and turn the cap out of the cylinder.

(5) Remove the cylinder from the vise and wooden block clamps. Extend the piston by standing the strut on the piston end to allow the pawl to slide down the piston rod and disengage the mechanical locks. Pull the piston out of the cylinder far enough to insert the piston in a wooden block clamp and secure the clamp in a vise. (See figure 175.)

(6) Place a hard wood block on the piston end (figure 175) and tap the block with a hammer until the piston end is loosened. Turn the end off the piston and remove the piston from the wooden block clamp.

(7) Replace the cylinder in the wooden block clamp and secure it in a vise. Push the piston, piston rod and cap out of the cylinder and hold a hand under the cylinder (figure 176) to catch the locks as they drop out of the square broached holes in the piston. Revolve the piston until all locks have fallen out. Pull the piston assembly from the cylinder and remove the cylinder from the vise.

(8) Extend the piston rod beyond the piston enough to insert the piston rod in a wooden block clamp (figure 177) with the cap pin in a vertical position. Punch the pin from the cap with a hammer and punch (figure 177) and by using a tool such as illustrated in figure 174 turn the cap from the piston rod. Remove the piston rod from the vise and wooden block clamp.

(9) Pull the piston rod and pawl from the piston exercising extreme care not to injure the packing cups on the pawl and piston rod as they are pulled from the piston through the square broached holes that retain the locks. Use a light screw driver with a curved end (figure 178) to depress the packing cup edges as they

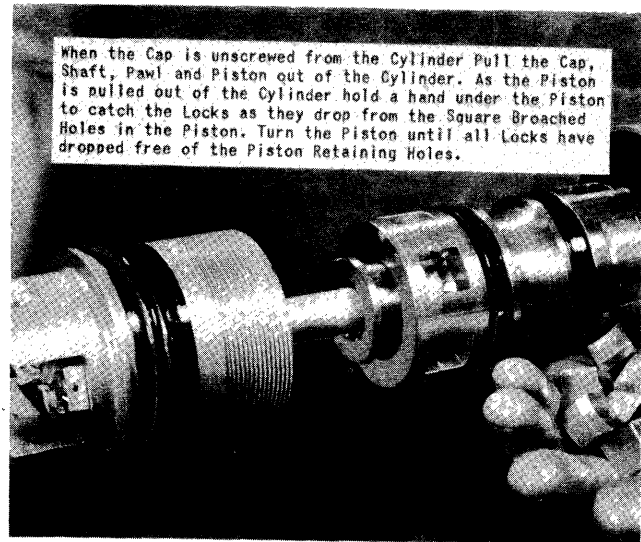


Figure 176 - Removing Piston and Pawl

are pulled past the broached holes. If this precaution is not taken the edges of the cups will be torn or cut and will not be fit for further service.

(10) Place the cylinder in a vise with aluminum covered jaws (figure 179) and turn the bearing out of the cylinder with a spanner wrench. (See figure 179.)

(11) The snap ring and spring may be removed from the cylinder cap if it is desired by depressing the ends of the snap ring with a pair of pliers and removing the ring. Tip the cap down and the spring will fall out.

(12) If there is evidence of leaks around the two pins in the cylinder cap, the pins and cups may be removed for inspection and replacement if necessary. To remove the pins and cups, cut the lock wires on both nuts on the cap and remove the nuts. The pins can now be pulled out and the cups removed through the nut openings. (See figure 180.) The retracting strut is now completely disassembled. (See figure 181.)

#### d. To Assemble the Retracting Strut.

(1) Before assembling the retracting strut wash all parts with alcohol and be sure the parts are free of chips and other foreign matter. Blow out all parts with compressed air if available.

(2) Place the cylinder in a vise with aluminum covered jaws as illustrated in figure 179. Wet the packing cups on the bearing with hydraulic oil, Specification No. 3586, and screw the bearing into the cylinder end. If there was a shim on the original installation be sure to replace the shim on the bearing. Tighten the bearing in place with a spanner wrench. (See figure 179.) Do not tighten excessively.



Figure 177 - Removing Pin from Cap

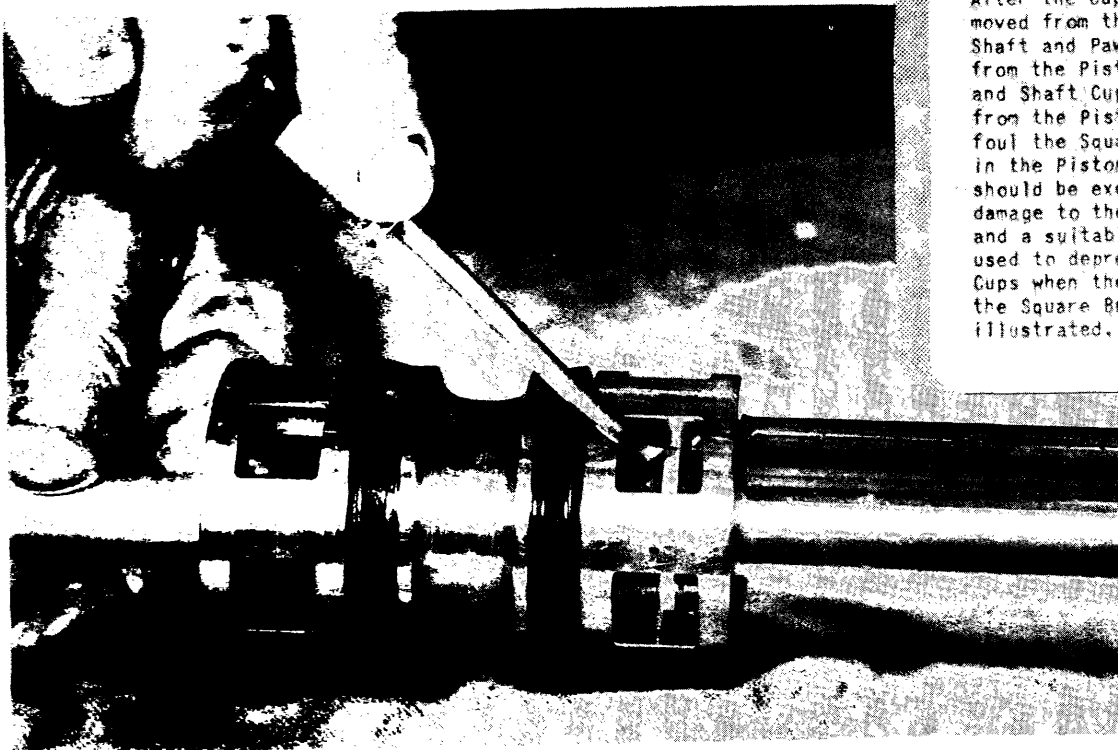


Figure 178 - Removing Shaft and Pawl from Piston

Figure 179 - Removing Bearing from Cylinder

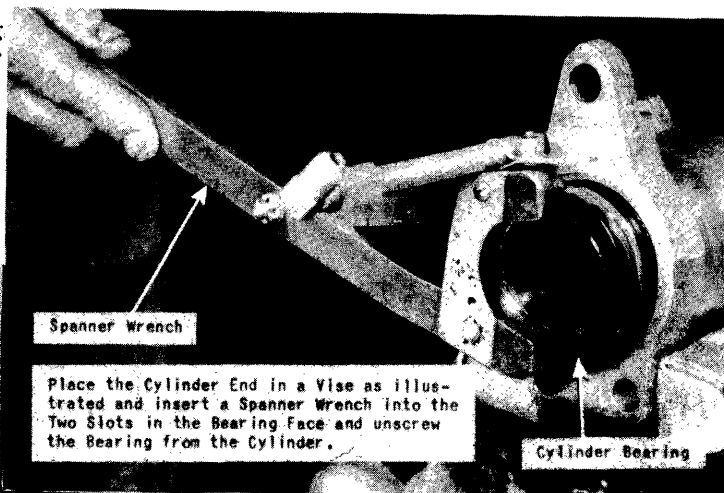
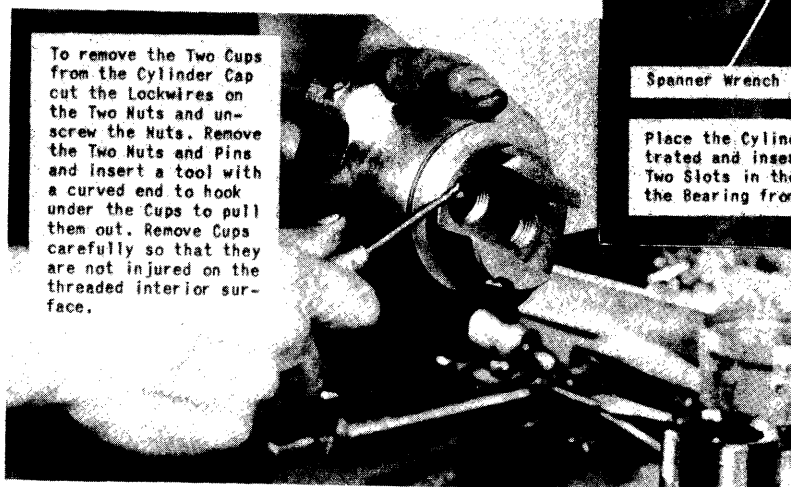


Figure 180 - Removing Cups from Cylinder Cap

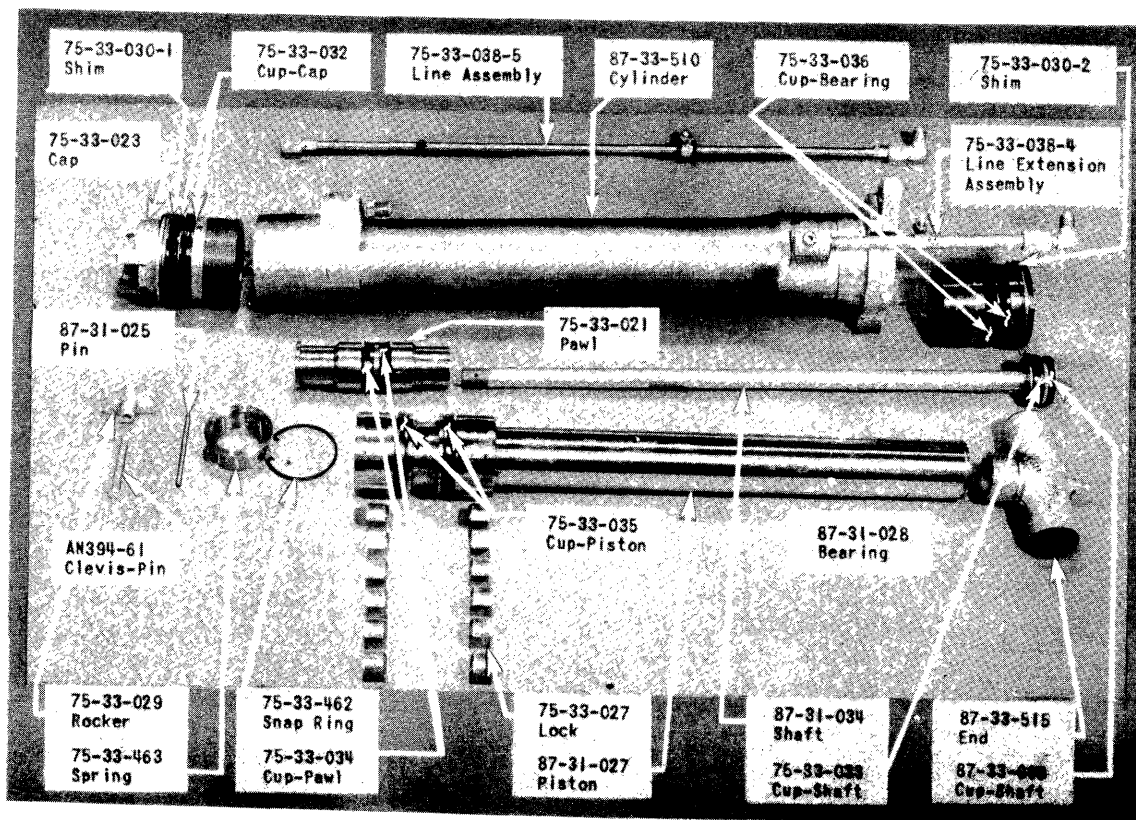


Figure 181 - Retracting Cylinder Units with Cups Installed Prior to Assembly

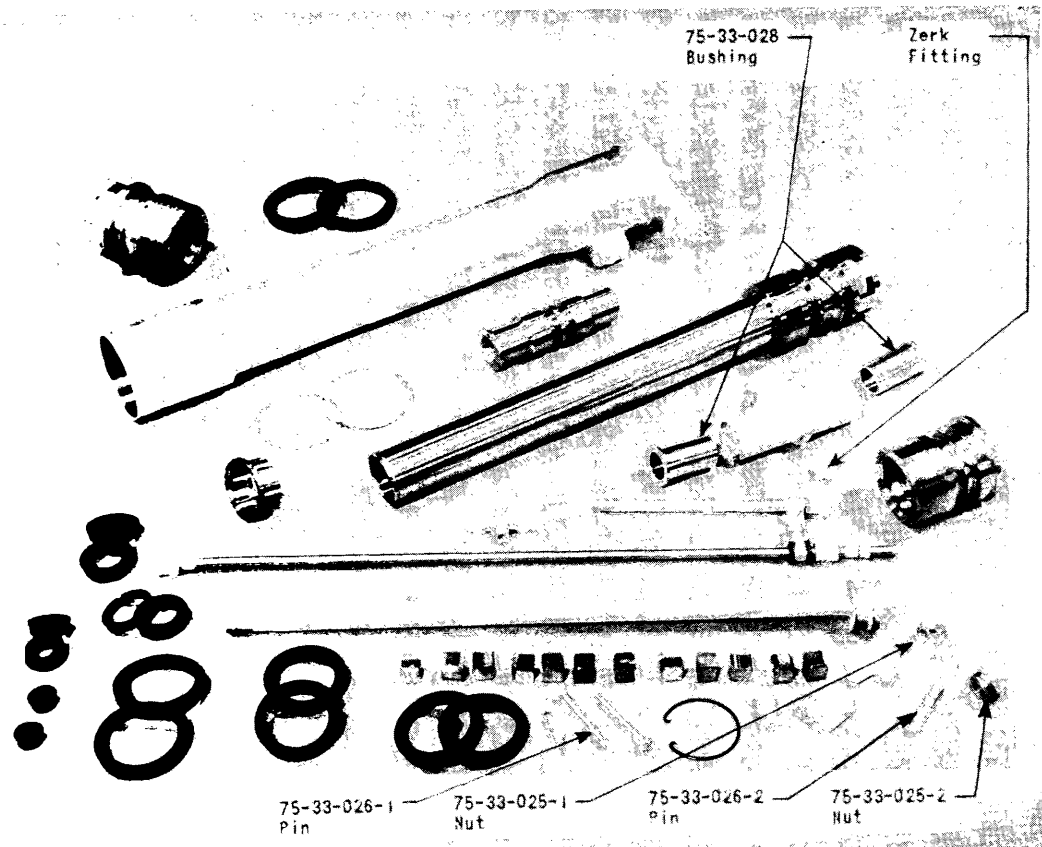


Figure 182 - Retracting Strut Completely Disassembled

To test the Back Lash of the Piston insert the Through Bolt in the End Fitting and attach and Indicator Assembly to the end of the Bolt as illustrated. Turn Face on Dial so that the Hand is on "0". Pull the Piston out as far as possible and turn the Adjustment Collar until the Indicator Ball contacts the Cylinder Attachment fitting as shown. The Indicator will register the movement of the Cylinder and show the Back Lash of the Piston in the locked position. Add or eliminate Shims 75-33-030-1 & 2 as required to give the Locks a clearance of .003 to .006 in the Locked Position.

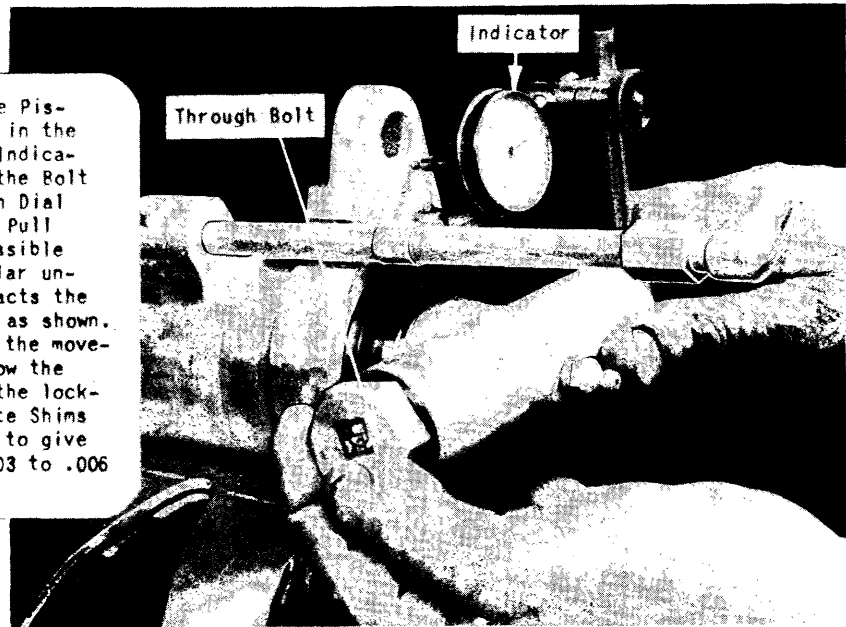


Figure 183 - Testing Backlash of Piston

(3) Wet the packing cups on the piston rod and slide the piston rod into the piston. Be careful not to foul the cups on the sharp edges of the square broached holes. Use a screw driver with a curved end or a similar tool and depress the edges of the cups as they slide past the broached holes. (See figure 178.)

(4) Wet the packing cups on the pawl and slide the pawl onto the piston rod and into the piston. Be sure that the collar on the pawl is outboard. Carefully guide the pawl cups through the square broached holes. (See figure 178.)

(5) If the cylinder cap pins and cups have been removed, wet the cups with hydraulic oil and insert them into the nut holes. Exercise extreme care in this operation so that the edges of the cups are not cut or scored by the threads in the nut holes. When the cups are properly seated, replace the pins in the nuts and screw the nuts into their respective openings. Lock-wire the nuts and the cylinder end is ready for installation on the piston rod.

(6) Do not push the piston rod all the way into the cylinder and insert the end in a wooden block clamp. Secure the clamp in a vise. Take the cylinder cap in one hand and drop the spring into the cap with the collar up. Line one of the slots on the spring up with the pin hole in the cap and install the snap ring. Screw the cap onto the piston rod and line up the pin holes on both assemblies. Insert the pin and tap it into place with a light hammer. Stake both ends of the pin.

(7) Release the piston rod from the wooden block clamp and wet the packing cups on the cap and piston with hydraulic oil, Specification No. 3586. Insert the piston assembly into the cylinder and turn the cylinder and piston up in a vertical position resting on the cap. This will keep the pawl in the proper location while the locks are inserted into the square broached holes in the piston. Insert the upper row of locking segments first and allow the cylinder to move down over this row of locks to retain them in place while the bottom locks are inserted in the broached holes. Carefully guide the piston over the lower row of locks. Start the cap into the cylinder and turn it up by hand as far as possible. If there was a shim on the cap in the original installation be sure that it is replaced. Be sure that the piston protrudes through the bearing at the opposite end of the cylinder.

(8) Place the cylinder in a wooden block clamp and secure the clamp in a vise. Turn the cap up tight with the handle of a spanner wrench or similar tool. (See figure 174.) Do not tighten excessively.

(9) Release the cylinder from the clamp and reverse the cylinder. Place the end of the piston in a wooden block clamp and secure the clamp in a vise. Thread the piston end onto the piston and tighten with a hard wooden block and light hammer. (See figure 175.)

(10) Install the lever on the cap with the clevis pin and safety the pin with a cotter. This lever must be installed as shown in figure 173, do not reverse.

(11) Release the piston from the wooden clamp and install the hydraulic line assembly to the forward end of the cylinder.

(12) Insert the cylinder in a vise with aluminum covered jaws. (See figure 183.) Replace the through bolt in the end assembly and attach an indicator. (See figure 183.) Be sure that the face on the dial is turned so that the indicator hand is at "ZERO." Pull the piston end out as far as possible and turn the ball and collar on the indicator to contact the cylinder. The indicator should show the extent of movement of the locks in their locked position. The locks should have a backlash of .003 to .006 in their locked position. Shims can be added or eliminated from the cap and the bearing to produce the required lock clearance in the locked position.

(13) Test the retracting strut for leaks before installing in the airplane. The strut must show no leaks at 2500 pounds per square inch. If the test shows no evidence of leakage the strut is ready to install in the wing.

#### e. To Install the Retracting Strut in the Wing.

(1) To install the retracting strut in the wing reverse the procedure outlined in b.(1) through (4).

#### 7. Tail Wheel Assembly.

a. General. - The tail wheel consists of a standard steerable knuckle unit, equipped with a wheel and a 12-1/2-inch diameter, four-ply rayon smooth contour casing, a retracting strut and a pneudraulic strut. The wheel disengages its steering splines at 30 degrees  $\pm$  2 degrees and will then castor through 360 degrees. Both the retracting and oleo strut may be removed from the fuselage for servicing without disturbing the drag link and tail wheel.

b. To Remove the Oleo Strut from the Fuselage. - To remove the oleo strut from the fuselage first unbutton the access door below the horizontal stabilizer and the inspection hole above and forward of the access door. Place a jack under the rear jack point to support the aft end of the airplane.

(1) Be sure the tail wheel is down. Work through the access door and remove the bolt attaching the lower end of the strut to the tail wheel drag link.

(2) Working through the hand hole remove the bolt attaching the oleo piston to the lug on the retracting strut.

(3) The oleo strut can now be removed through the access door.

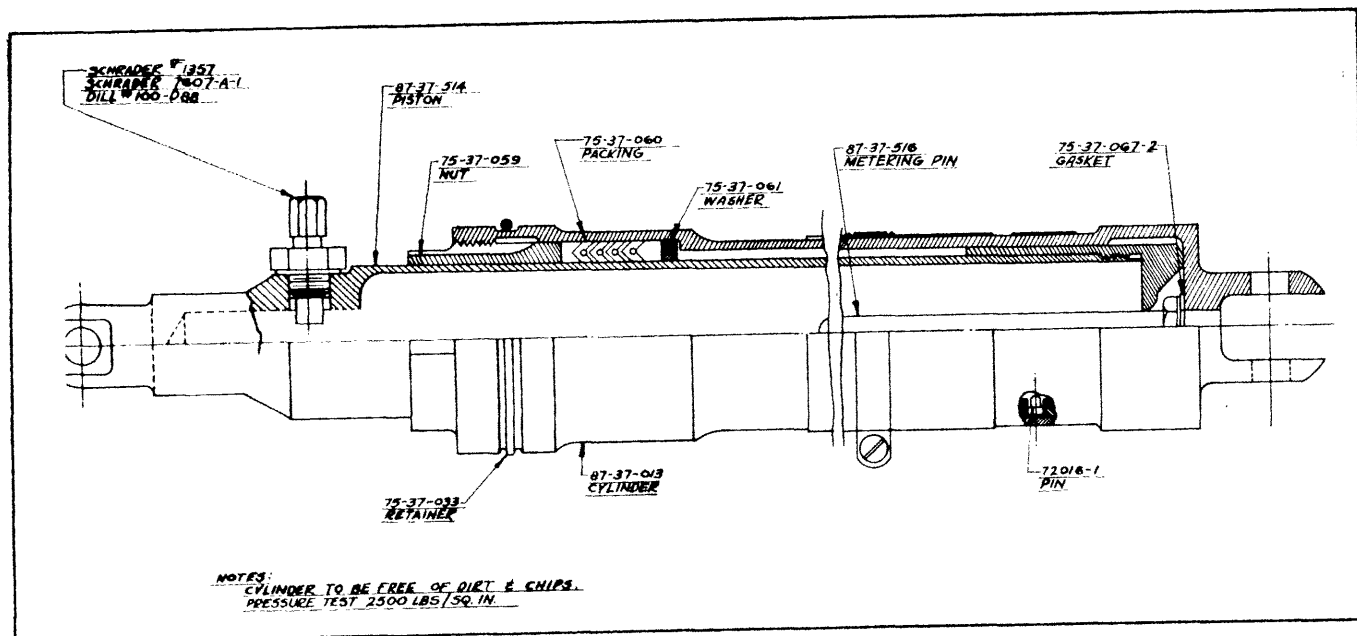


Figure 184 - Tail Wheel Oleo Strut

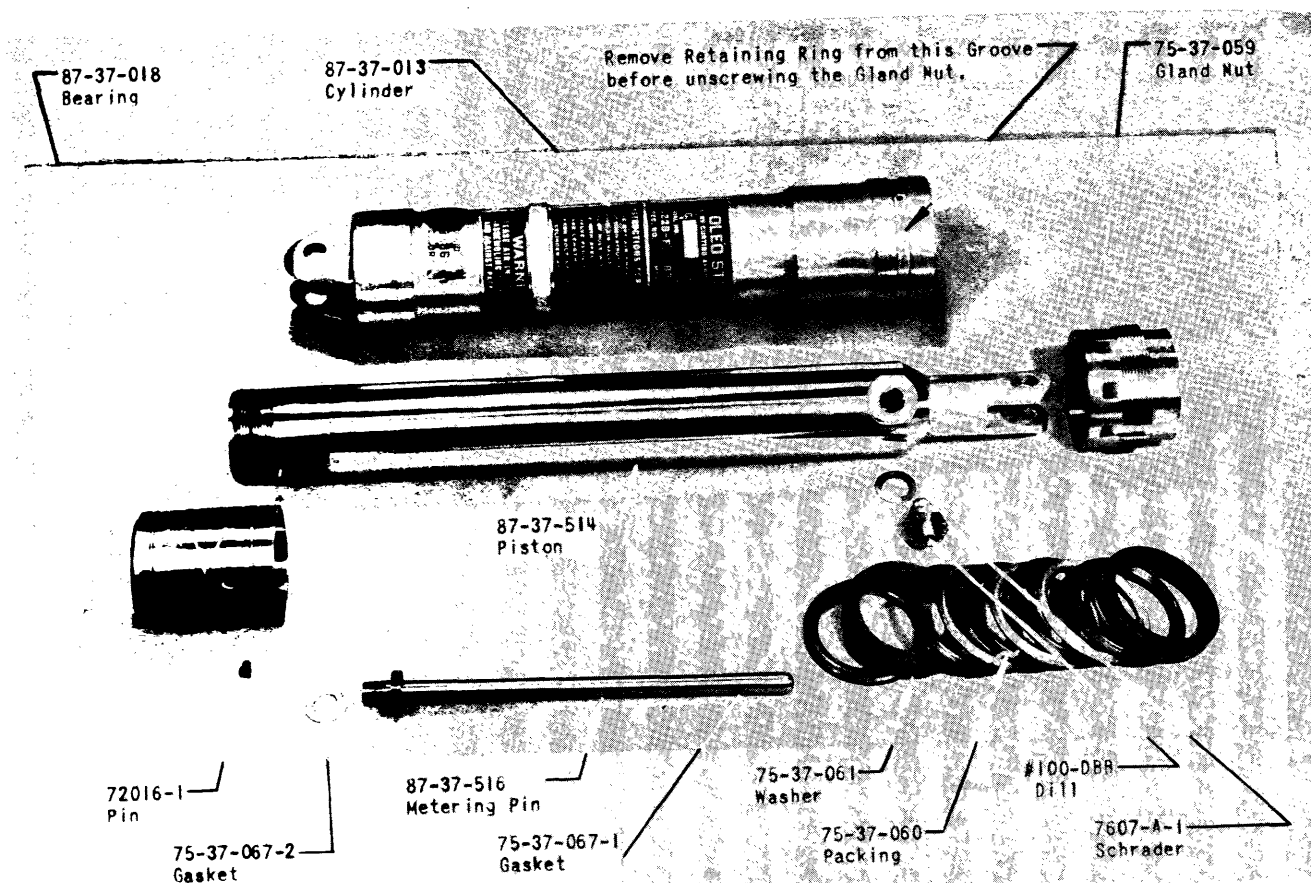


Figure 185 - Tail Wheel Oleo Strut Disassembled



c. To Disassemble the Oleo Strut.

- (1) Vent the air pressure and remove the Schrader plug to drain the fluid.
- (2) Place the oleo strut in a wooden block clamp and insert the clamp in a vise to keep the oleo cylinder from turning.
- (3) Force a screw driver or similar tool under the retaining ring on the cylinder and disengage the end of the ring from the hole in the cylinder. Expand the retainer ring and slide it off the cylinder.
- (4) Engage a spanner wrench on the gland nut and turn the nut out of the cylinder.
- (5) Pull the piston assembly from the cylinder and slide the washers and packing off the piston.
- (6) Place the piston in a wooden block clamp and tighten the clamp in a vise.
- (7) Remove the lockpin from the piston and piston bearing and unscrew the bearing from the piston.
- (8) With the cylinder held firmly in the wooden block clamp the metering pin may be removed, if desired, by using the metering-pin wrench (87-88-031) carried in the tool kit. When the metering pin is removed discard the copper gasket so that it will not be reinstalled. Never reinstall a used gasket on a metering pin.

d. To Assemble the Oleo Strut.

- (1) Before assembling the oleo strut be sure that all parts are thoroughly clean and free of chips. Clean with alcohol and blow out with compressed air if available. Inspect all packings and washers before installing them in the cylinder.
- (2) Place the cylinder in a wooden block clamp and secure the clamp in a vise. Install the metering pin in the cylinder and tighten with the metering-pin wrench (87-88-031). Be sure that a new copper gasket is installed with the metering pin. NEVER install a used gasket.
- (3) Place the piston in a wooden block clamp, screw on the piston bearing as far as it will go and line up the bearing lockpin hole with the hole in the piston. Screw the lockpin into the piston until it is tight.
- (4) Release the piston from the wooden block clamp. Install the cylinder in a wooden block clamp and secure the clamp in a vise with the cylinder in a vertical position.
- (5) Guide the piston bearing and piston into the cylinder, wet the packings and washers thoroughly with hydraulic oil, Specification No. 3586, and slide the first washer over the piston and into the cylinder. In-

stall the packings one at a time as on the original installation. The correct order of washer and packing installation is shown in figure 185. When the last washer and packing ring is installed slide the gland nut over the piston and tighten it into the cylinder. Never tighten this gland nut excessively.

(6) Insert the hooked end of the retainer ring into one of the two holes that line up with a slot in the gland nut. Expand the retainer and slide it on the cylinder until it engages in the groove on the cylinder. The hooked end on this retainer should extend far enough through the cylinder to engage the gland nut and lock it in position.

(7) With the Schrader plug removed, extend the piston as far as it will go. Stand the cylinder in a vertical position with the piston up and fill the piston at the plug hole with hydraulic oil, Specification No. 3586, until it overflows. Screw a pressure gage into the plug hole in the piston and subject the strut to a pressure of 2500 pounds per square inch for 10 minutes.

(8) Inspect the cylinder to determine if there is any evidence of leaks around the gland nut.

(9) If there is no evidence of leaks in the strut, release the pressure on the strut and remove the gage. Drain the oil from the strut and retract the strut into the cylinder as far as it will go. Stand the strut on end with the plug hole up and fill with hydraulic oil, Specification No. 3586, until the oil overflows and work the piston up and down several times to dispel any trapped air in the cylinder. Add additional fluid to bring the level up to the plug hole. Install the gasket and Schrader plug and inflate the strut with a high pressure hand pump to 347-1/2 pounds. Never use compressed air.

(10) The oleo strut is now completely assembled, tested and serviced with fluid and air for installation in the airplane.

e. To Install the Oleo Strut in the Airplane. - To install the oleo strut in the airplane reverse the procedure outlined in b.(1) through (3).

f. To Remove the Tail Wheel Retracting Strut from the Fuselage.

(1) The retracting strut is located on the center line of the airplane at the top of the fuselage between station No. 13 and No. 15 with a piston guide extending to station No. 12. The retracting strut is bolted to attachment fittings on station No. 13 and No. 14 bulkheads.

(2) Unbutton the access door and the two round inspection holes at the aft end of the fuselage on the left side. Unbutton the inspection door near the top of the fuselage on the right side.

(3) Place a jack under the rear jack point aft of the tail wheel doors to support the airplane.

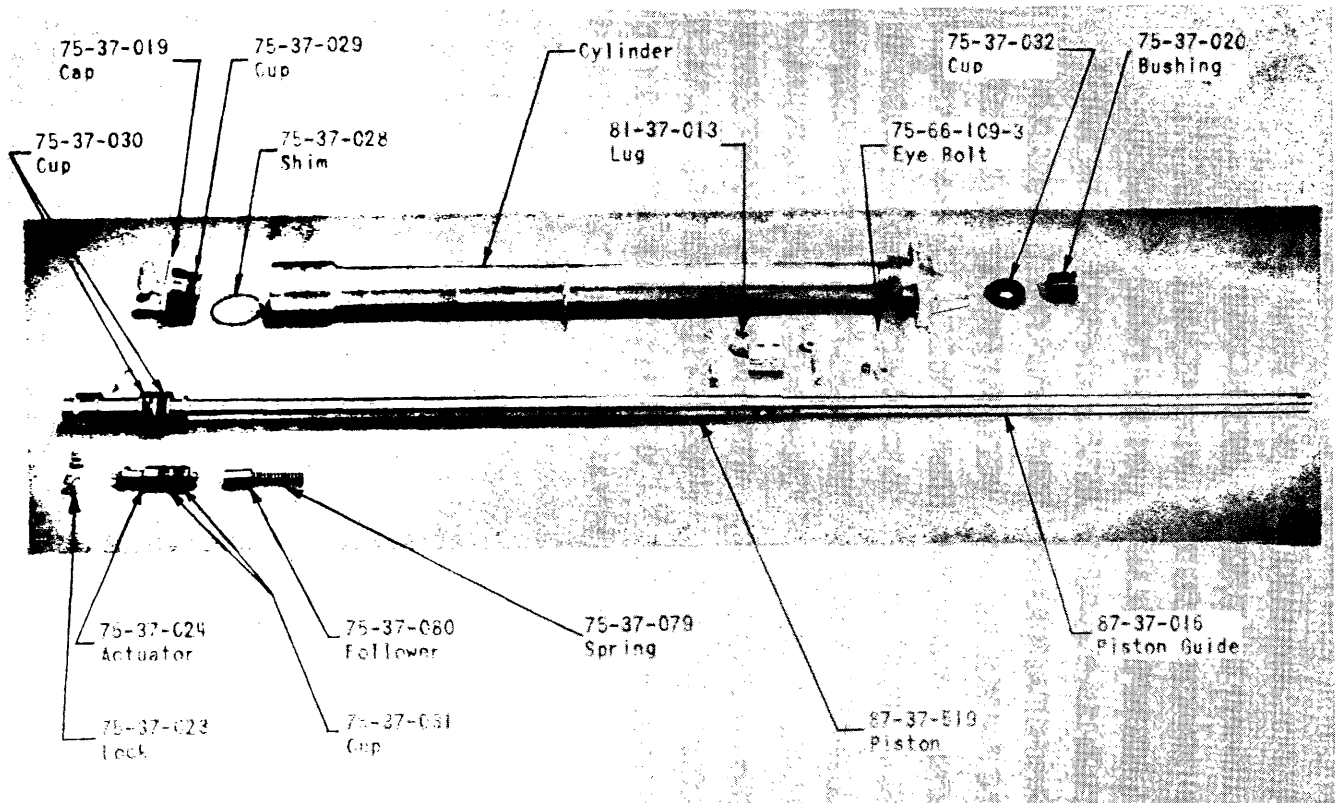


Figure 186 - Tail Wheel Retracting Strut Disassembled

(4) If the oleo strut is installed disconnect the oleo at the lug on the retracting strut piston.

(5) Disconnect the hydraulic line from the forward and aft end of the cylinder.

(6) Disconnect the position transmitter linkage at the eyebolt on the piston lug.

(7) Remove the two attaching bolts at station No. 13 bulkhead.

(8) Remove the two attaching bolts at station No. 14 bulkhead and pull the retracting cylinder backwards until the piston guide is free of the support at station No. 12 bulkhead.

(9) Remove the retracting cylinder from the fuselage through the access door below the horizontal stabilizer.

g. To Disassemble the Retracting Strut.

(1) Place the cylinder in a wooden block clamp and insert the clamp in a vise.

(2) Remove the cotters, nuts, washers, and bolts attaching the lug to the piston. Slide the lug off the piston and piston guide.

(3) Remove the cylinder bushing with a spanner wrench.

(4) Move to the opposite end of the cylinder and remove the cap assembly 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 figure 186.

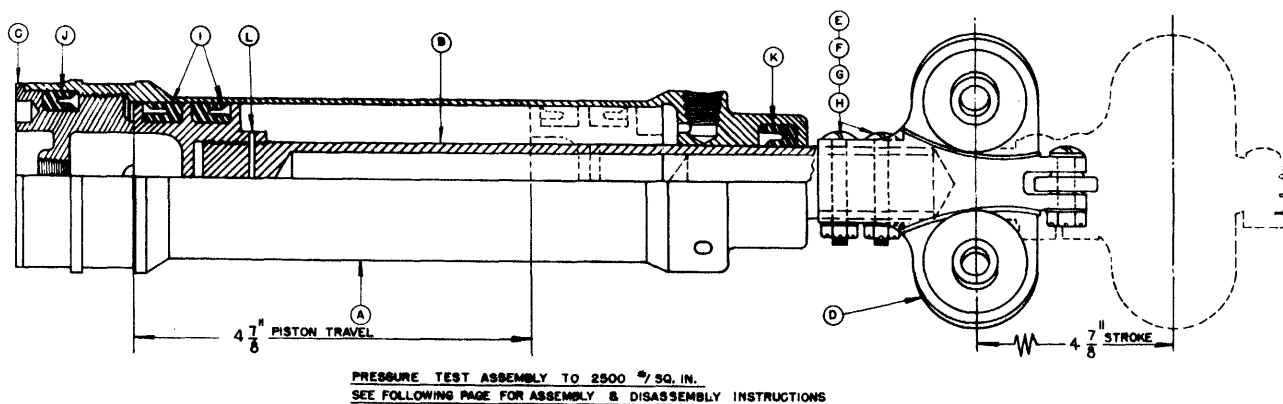
h. To Assemble the Retracting Strut.

(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.

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	AN23-23	BOLT	2	L	1060-1-20	PIN	1



PRESSURE TEST ASSEMBLY TO 2500 <sup>PSI</sup>/SQ. IN.  
SEE FOLLOWING PAGE FOR ASSEMBLY & DISASSEMBLY INSTRUCTIONS

REF. DWG. 87-64-004

Figure 187 - Wing Flap Actuating Cylinder

(4) Coat the cups on the actuator with hydraulic oil, Specification No. 3586, (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 backlash. 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.

(10) Slide the lug over the piston guide and onto the piston, line up the piston hole with those in the lug and insert the rear bolt. When the forward bolt is installed be sure to install the position transmitter link-

age eyebolt 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 hydraulic fluid, Specification No. 3586, 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 pounds per square inch. 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 f.(1) through (9).

(13) When the retracting strut has been reinstalled, it will be necessary to make adjustments to the position transmitter unit so that the indicator in the cockpit will show the correct position of the tail wheel at all times. To adjust the tail wheel position transmitter, hoist the aft end of the airplane so that the tail wheel can be raised and lowered. Put the tail wheel down and throw the battery switch to the "ON" position.

**WARNING:** Keep all personnel clear of the propeller when the battery switch is "ON." Adjust the turnbuckle on the lower linkage un-

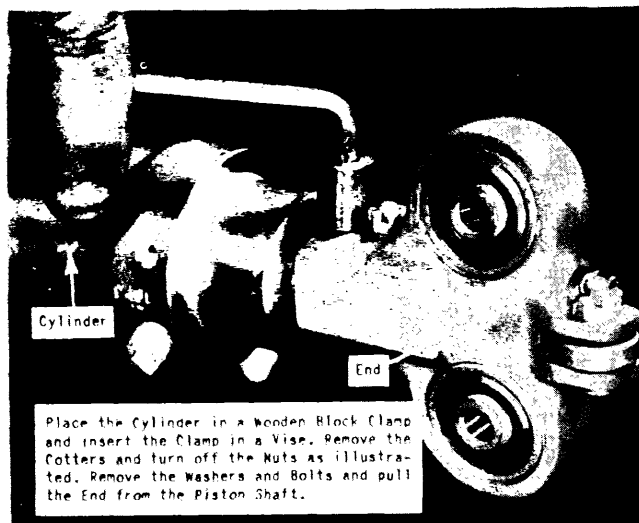


Figure 188 - Removing End on Piston Shaft

til the image on the indicator is in the "DOWN" position. Retract the tail wheel and check the position of the image. If it has overtraveled or undertraveled, correction can be made at the turnbuckle. Repeat this procedure until the setting is correct. These adjustments can be made through the inspection door on the right side of the fuselage just forward of the horizontal stabilizer.

#### 8. Wing Flap Hydraulic Actuating Cylinder.

a. General. - The hydraulic actuating cylinder is mounted on the center line bulkhead near the trailing edge of the wing. The cylinder operates the bell crank which is connected to a span-wise push-pull tube running the length of each flap. The actuating cylinder may be removed from the bulkhead by removing the two lower surface doors near the cylinder and the two hand holes immediately forward.

##### b. To Remove the Actuating Cylinder from the Wing.

- (1) Disconnect the two hydraulic lines at the cylinder.
- (2) Remove the two bolts attaching the bell-crank arms to the piston end.
- (3) Remove the four bolts, two in the forward and two in the aft clamp assemblies which attach the cylinder to the center line bulkhead.

(4) Remove the cylinder through one of the access doors.

##### c. To Disassemble the Actuating Cylinder.

- (1) Place the cylinder in a wooden block clamp and insert the clamp in a vise.

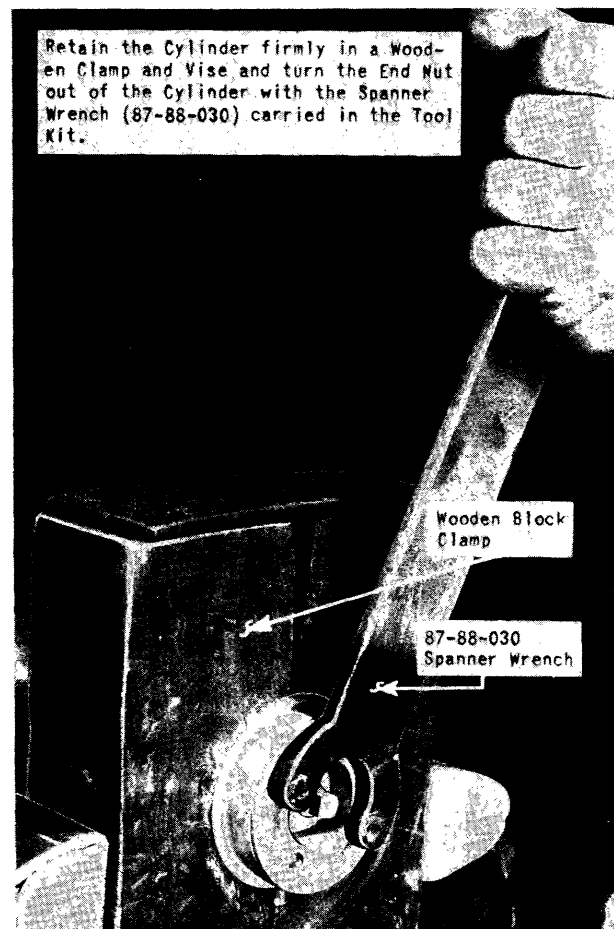


Figure 189 - Removing End Nut from Cylinder

(2) Remove the cotters, nuts, and washers from the two bolts attaching the end to the piston shaft. (See figure 188.)

(3) Unscrew the end nut with the spanner wrench (87-88-030) carried in the tool compartment on the duffle bag. (See figure 189.)

(4) Remove the piston assembly from the cylinder through the uncapped end.

(5) The rubber cups may now be removed from the end nut and the piston and the actuating strut is disassembled.

##### d. To Assemble the Actuating Cylinder.

(1) Clean and inspect all parts thoroughly. Blow out with compressed air, if available, to be sure that all chips, dirt, grit, or other foreign matter is not lodged on the parts. Replace all cups that are injured in any way.

(2) Insert the piston and shaft into the cylinder. Coat a film of hydraulic fluid (Lockheed No. 5) over the piston cups so that they will slide into the cylinder

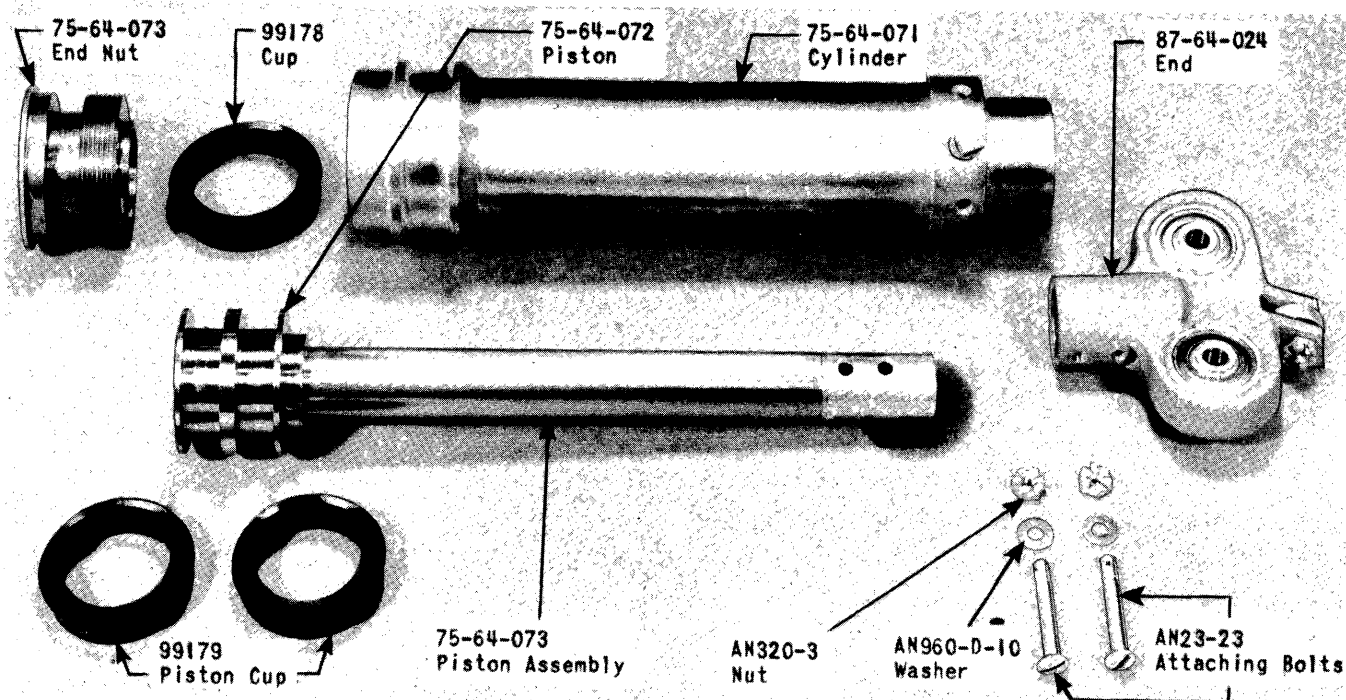


Figure 190 - Actuating Cylinder Disassembled

easily. Be very careful not to injure the edges of the cups as they enter the cylinder. Push the piston through until the shaft protrudes sufficiently from the other end to attach the end.

(3) Coat the cup on the end nut with hydraulic fluid (Lockheed No. 5) and screw the nut into the cylinder. With the cylinder held firmly in a wooden clamp tighten the end nut with the spanner wrench (87-88-030). (See figure 189.)

(4) Slip the end onto the piston shaft, line up the bolt holes on the end and piston shaft and insert the attaching bolts. Install the washers and nuts and tighten the nuts. Install cotters and the cylinder is reassembled.

e. To Install the Actuating Cylinder in the Wing.

(1) Installing the flap actuating cylinder in the wing is a reversal of the procedure outlined in b.(1) through (4).

9. Hydraulic Check Valve.

a. General. - An automatic check valve is installed in the pressure line from the electric motor-driven pump on the left side of the fuselage directly forward of station No. 9. (See figure 117.) The function of the check valve in the system is to prevent bypassing the hydraulic pressure through the electric hydro-pump when the auxiliary hand pump is operated.

b. To Disassemble the Check Valve.

(1) Insert the check valve in a vise with aluminum covered jaws at the nut face on the upper end of the valve body. Turn the stop nut off the valve with a suitable wrench.

(2) Pull the snap ring with a snap-ring wrench or a pair of light pliers.

(3) The bushing, spring, and valve will now fall out when the valve is released from the vise and turned bottom side up. (See figure 191.)

c. To Assemble the Check Valve.

(1) Inspect the valve body and other parts for grit, dirt, or other foreign matter. Clean the valve and parts thoroughly with alcohol and blow out with compressed air, if available.

(2) Replace the valve, spring, bushing, and snap ring in the valve body.

(3) Screw the stop nut on the valve body and tighten.

10. Hydraulic Shuttle Valve.

a. General. - A shuttle valve is installed between each landing gear retracting strut and the main hydraulic system. This valve permits the bypassing of the main hydraulic system when the emergency hand pump is operated. The valve is located inside the wheel pocket, aft of the landing gear position transmitter.

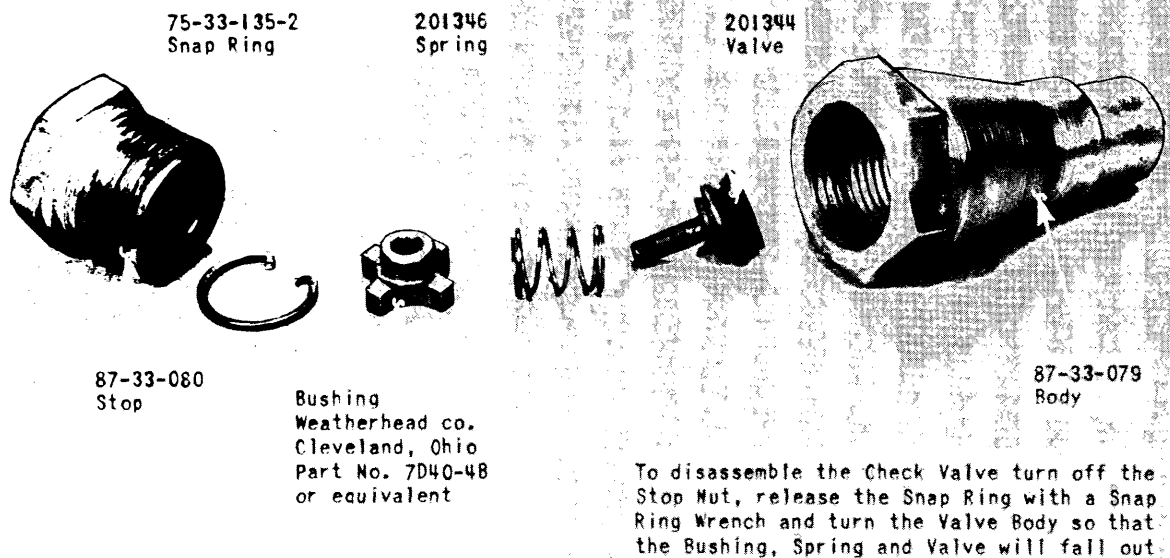


Figure 191 - Hydraulic Check Valve Disassembled

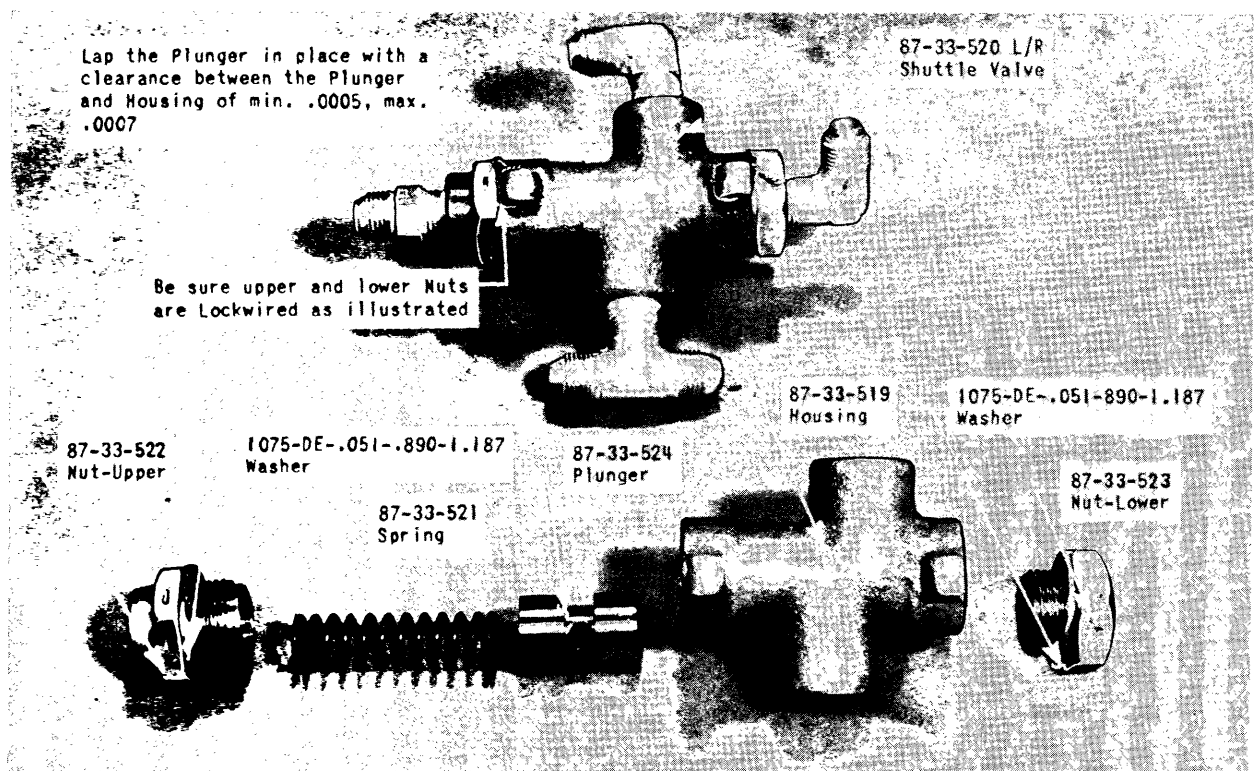


Figure 192 - Shuttle Valve Assembled and Disassembled

**b. To Disassemble the Shuttle Valve.**

(1) Place the valve assembly in a vise with aluminum covered jaws so that the upper end nut is free. Cut the lock wire on the end nut and remove the nut with a suitable wrench.

(2) The spring and plunger may now be dropped from the valve housing.

(3) Reverse the valve in the vise and cut the lock wire on the lower nut. Remove the nut with a suitable wrench. (See figure 192.)

**c. To Assemble the Shuttle Valve.**

(1) Wash all parts in alcohol and be sure that all grit, dirt, or foreign matter is expelled from the housing and parts by applying compressed air pressure.

(2) On the original installation the plunger was lapped into place in the housing with a clearance between the housing and plunger of minimum .005 and maximum .007. If a new plunger is installed lap the plunger in as on the original installation.

(3) Install the lower nut gasket and lockwire the nut.

(4) Install the spring and screw in the upper nut. Be sure that the gasket is installed on the nut. Lockwire the nut to the lug on the housing. (See figure 192.)

**11. Hydraulic Relief Valves.**

**a. General.** - One single relief valve for the hydraulic auxiliary hand pump (87-33-066) and one twin relief valve for the landing gear and flap controls are located in the lower left side of the fuselage forward of the access door. Another twin relief valve (87-33-069) is located in the lines to the control valve midway between the control valve and cockpit floor.

**b. To disassemble the twin relief valve** disconnect the hydraulic lines to the valve and remove the valve from the airplane and proceed as follows:

(1) Loosen the two lock nuts and turn out the screws.

(2) After the setscrews are removed the two springs and plungers will drop out.

**c. To Assemble the Twin Relief Valve.**

(1) Clean the valve thoroughly with alcohol and blow out with compressed air if available. Inspect the needle points on the plungers to be sure that they have not been dropped on the points or damaged in some other manner.

(2) Drop the plungers into the valve first and then the springs.

(3) Insert the setscrews with gaskets and lock nuts and tighten the setscrews. Lock the setscrews with the lock nuts. Set the valve to bypass at 1800 to 2000 pounds per square inch.

(4) Reinstall the relief valve in the airplane and connect the hydraulic lines.

(5) Test the relief valve as follows: Install a test gage on the forward side of the auxiliary hand pump. Tighten down the hand pump relief valve for 2000 pounds per square inch and pump up the system with the auxiliary hand pump. Place the landing gear control handle in neutral and the flap control handle in the "UP" position. Test the flap relief valve for 1500 pounds per square inch. Repeat this test with the landing gear control handle in "NEUTRAL" and the flap control in the "DOWN" position. Repeat this procedure with the flap control handle in the "NEUTRAL" position and the landing gear in both the "UP" and "DOWN" positions. Test the landing gear relief valve for 1500 pounds per square inch.

**d. To disassemble the auxiliary hand pump relief valve** disconnect the hydraulic lines and remove the valve from the airplane.

(1) Loosen the lock nut and turn out the setscrew. The gasket will be removed with the setscrew.

(2) The spring and plunger will now drop out of the valve body.

**e. To assemble the auxiliary hand pump valve,** clean the valve thoroughly in alcohol and blow out with compressed air if available.

(1) Be sure that the needle point on the plunger has not been damaged in any way.

(2) Drop the plunger and spring into the valve body and screw the setscrew with gasket and lock nut into the valve body.

(3) Set the relief valve to bypass at 1500 pounds per square inch and install the valve in the airplane.

**12. Hydraulic Brake System.**

**a. General.** (See figure 194.) - The airplane is equipped with reversible hydraulic brakes of the internal expanding type. The brakes are actuated by Warner aircraft hydraulic cylinders mounted on the armor plate at station No. 2A and connected to the brake treadles in the cockpit. The brakes and cylinders are connected by flexible rubber tubing and 5/16-inch OD "Everdur" tubing. Whenever the brake system does not function properly the entire system should be inspected for leaks. If no leaks are evident in the system the master brake cylinder should be removed and disassembled for servicing.

**b. Servicing of the Master Cylinder Unit.** - With the brakes applied, check the operation of the brake



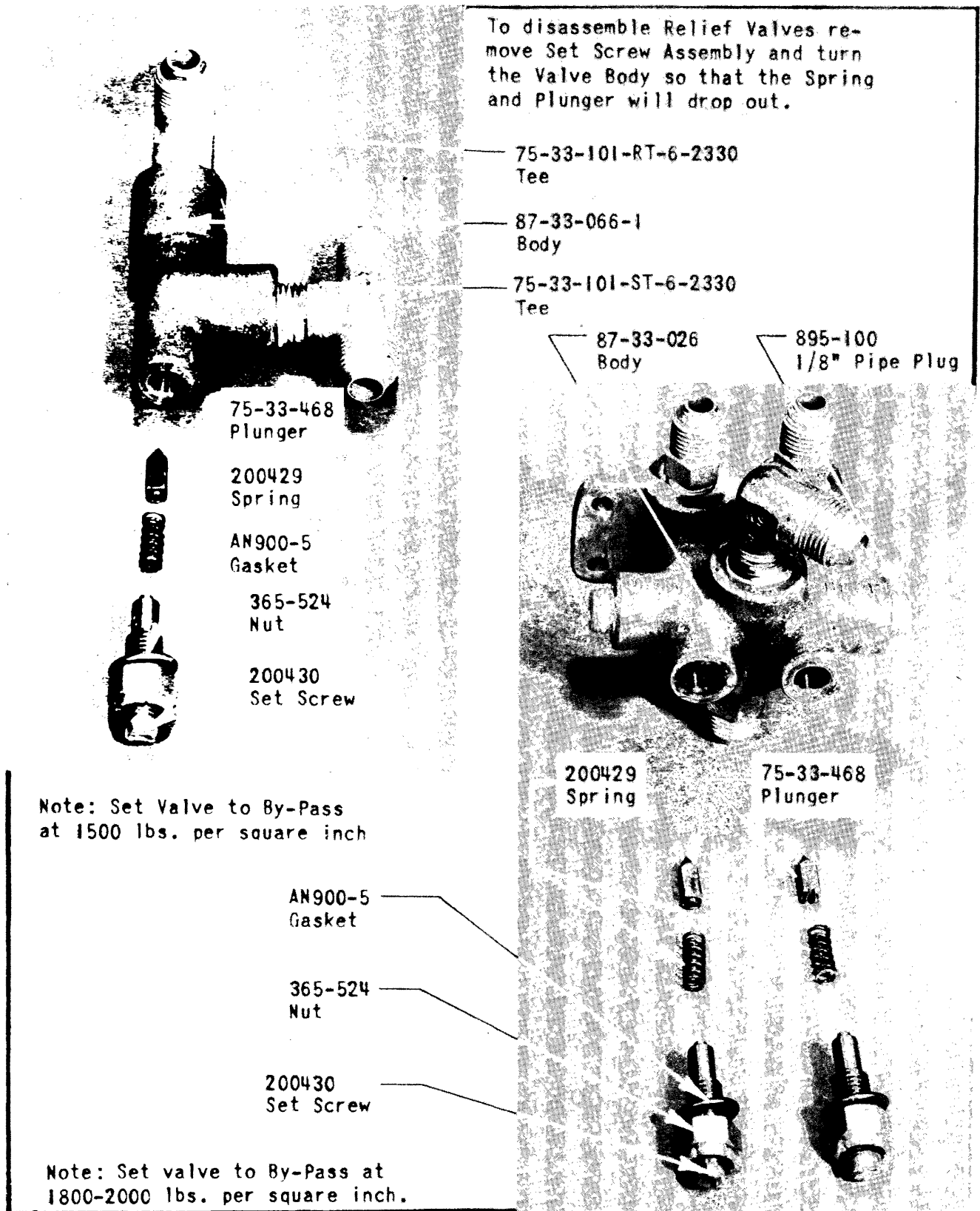


Figure 193 - Relief Valves Disassembled

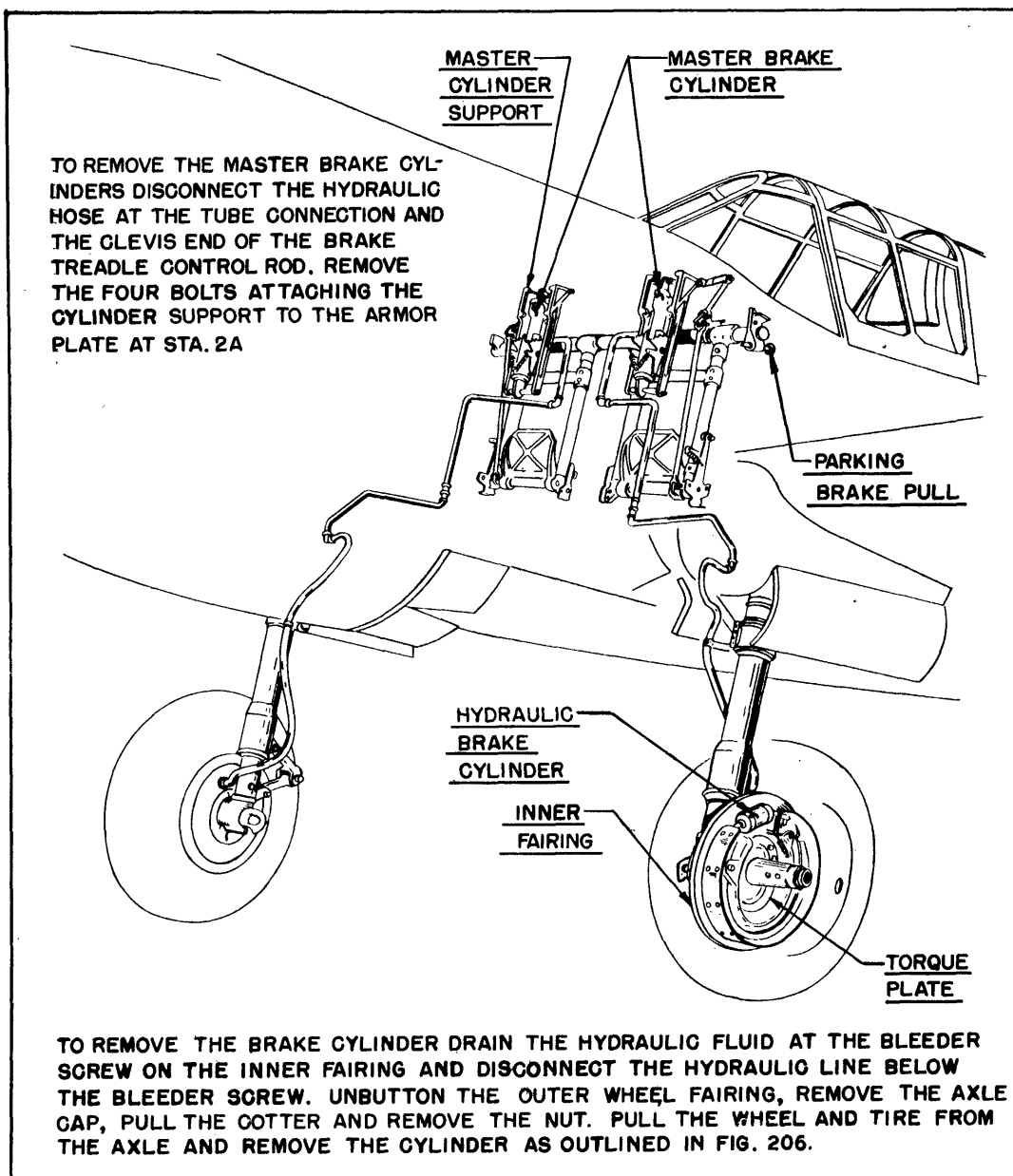


Figure 194 - Hydraulic Brake System

system. Malfunctioning of the brake system in this condition may be due to any of the following reasons.

(1) 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 in the brake pedals, due to the compression of trapped air.

(2) The gasket under the transfer valve not holding tight due to the valve not being tightened sufficiently or some dirt lodged on the gasket.

(3) Dirt or chips held on the compensating valve holding it open. The presence of a slight leak as described in (2) and (3) can be determined by the fact

that the brake treadle feels solid when the brake is fully applied, but with continued pressure the treadle gives slowly, due to the fluid being forced through the leak. Under normal conditions these leakages cannot be detected from the outside since the fluid in either case returns to the reserve chamber.

A leaking gasket under the transfer valve assembly can be easily determined as follows: With the brakes off, remove the lower level-indicating screw and allow the fluid in the reserve chamber to come down to this level. Replace the lower level-indicating screw and remove the upper level-indicating screw. Move the rudder pedal either forward or aft as far as it will go, apply the brake and if there is any leakage past the transfer valve gasket fluid

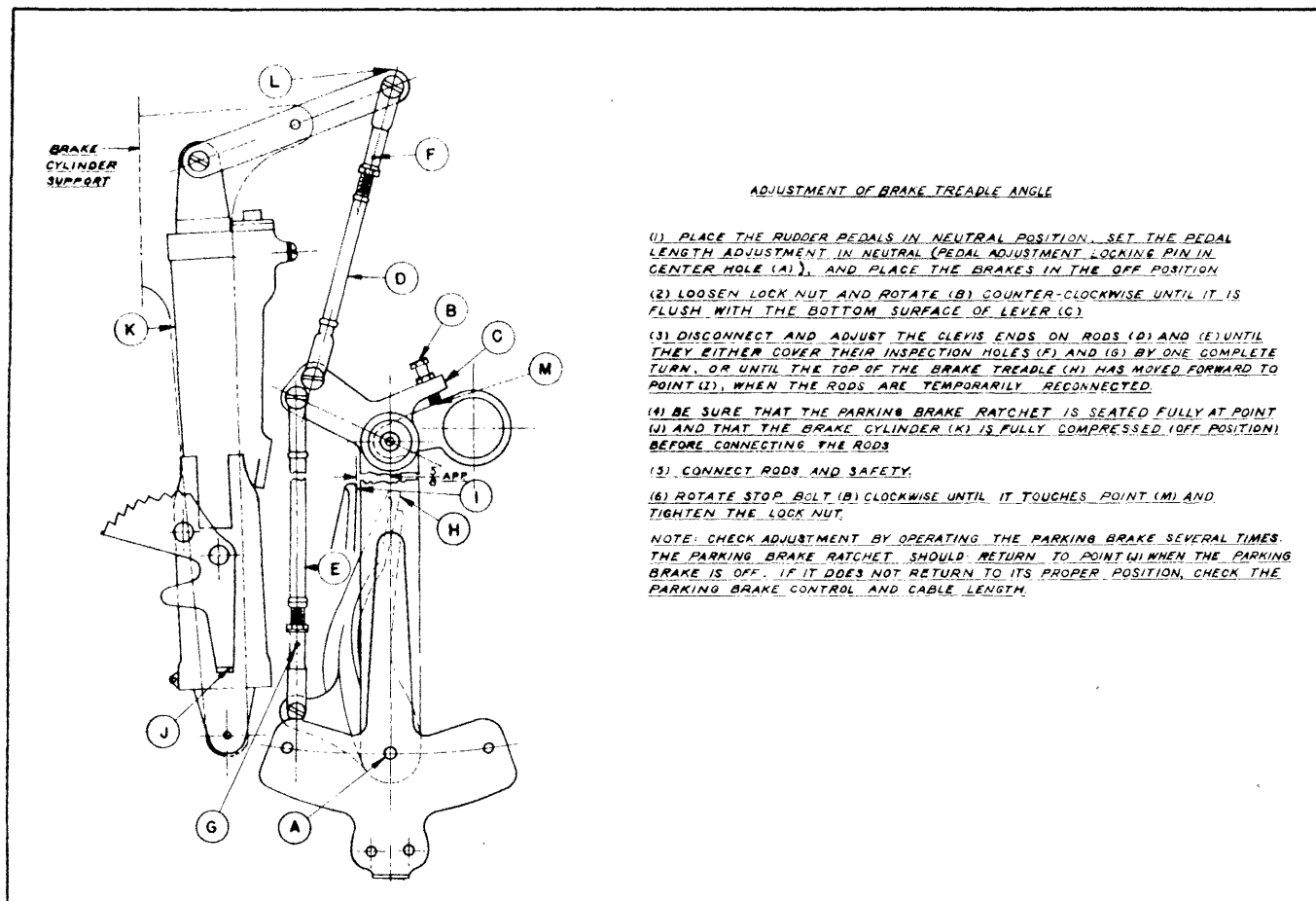


Figure 195 - Brake Treadle Adjustment

will run out the upper level-indicating hole which in the full fore or aft position of the rudder pedal is lower than the passage to the reserve chamber. If this test indicates that the gasket is tight and there is no evidence of leaks in the line or at the wheel cylinder, it is apparent that some dirt is lodged on the compensating valve seat inside the unit. This will necessitate the disassembling and cleaning of the unit as per instructions in this section.

With the brakes parked, the condition inside the cylinder is the same as when pressure is applied on the brake treadle. The force applying the brake is maintained by the parking spring and ratchet instead of pressure on the brake treadle. The throw of the treadle is short and the parking brake usually will engage only in the first notch on the ratchet. The amount of parking spring deflection can be determined by the gap between the yoke and the lower end fitting. This gap will vary with the expansion and contraction of the fluid and with fluid losses due to leaks in the system. After a brake has been parked for some time and the ratchet jumps to the "OFF" position it is an indication that there is a leak in the system which has released the entire reserve provided by the parking spring deflection. If there is no evidence

of leaks elsewhere in the system, this leak may be traced to any of the conditions outlined above. (See figure 196.)

If there is evidence of leaks in the master brake cylinder, the unit may be removed from the airplane for disassembly by disconnecting the flexible hose, the clevis end of the brake treadle control rod, and removing the four bolts attaching the cylinder mounting support to the armor plate at station No. 2A. (See figure 194.) Remove the cylinder and support assembly from the airplane and remove the through bolt at the top and bottom of the support assembly. Pull the support apart and the cylinder is ready for disassembly.

#### c. To Disassemble the Master Brake Cylinder.

(1) Remove either plug on the top of the cylinder, and turn the cylinder upside down to drain the hydraulic fluid.

(2) Remove the lock screws, one in the upper and one in the lower end fitting. (See figure 198.) In the manufacture of the unit the end fittings are lined up and machined with the housing or cylinder to which they belong. Therefore, if disassembling

**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, WITHOUT 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

more than one unit at a time, it is very important to keep the parts of the different units separate.

(3) Place the cylinder in a vise with aluminum covered jaws (figure 199) and turn off the lower end fitting.

(4) Turn the cylinder around in the vise so that the lower end is up and remove the cotter and nut on this end. After the nut has been removed, the two halves of the unit can be pulled apart. (See figure 200.) The lower half is the "Housing-Complete Assembly" containing the parking spring and ratchet. The upper half is the "Cylinder-Complete Assembly" and "Transfer Valve Assembly" containing all parts necessary for the hydraulic operation of the unit.

(5) Reverse the cylinder in the vise and turn off the upper end fitting. (See figure 201.)

(6) Push gently on the piston rod protruding from the cylinder assembly until it is free of the cylinder. The lower rubber cup may either come out with the piston rod or remain in the cylinder.

(7) Remove the two screws securing the "U" retainer on the bottom of the cylinder and remove the retainer.

(8) The lower cylinder nut can now be removed with a spanner wrench and the lower spring washer and cut removed from the cylinder. (See figure 202.)

(9) The transfer valve assembly may now be removed by unscrewing the nut at the top of the transfer valve assembly.

(10) Normally it will not be found necessary to remove the parking spring from the "Housing-Complete Assembly," but, if it is desired to remove the spring, proceed as follows:

(a) Place a 1-5/8 inch or 1-1/2 inch diameter bar approximately 2 inches 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, therefore, will take the load, when applied, instead of the slender guides on the housing assembly.

Figure 196 - Operation-  
Brake Master Cylinder

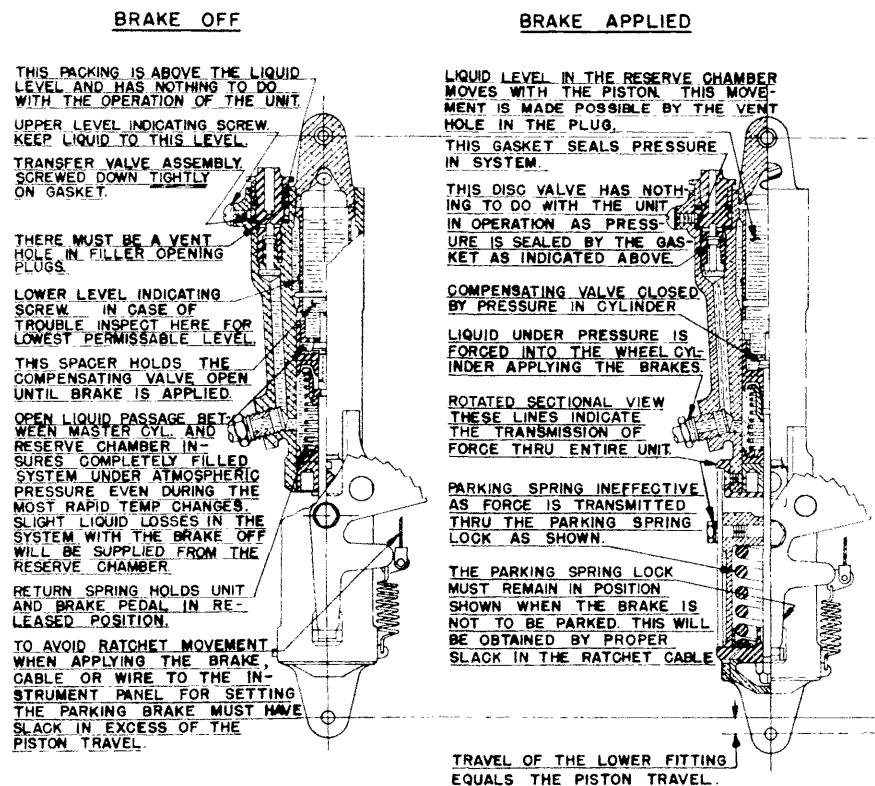


Figure 196 - (Continued)

(b) Cut a piece of tubing of 1-1/2 inch to 1-5/8 inch diameter and approximately 3 inches long. Cut two 3/4-inch slots about 1 inch deep opposite each other on one end of the tubing. (See figure 204.)

(c) Place the slotted tubing on the spring guide with the slots straddling the yoke. Pull the ratchet out to allow the yoke to move down when pressure is applied with the arbor press. Apply enough pressure to deflect the 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. (See figure 204.)

(d) Hold the spring in this position and lift the yoke to clear the spring guide and pull it out of the housing through the window. The spring and guide can now be removed by releasing the pressure on the arbor press. (See figure 205.)

(e) If an arbor press is not available a vise that will open far enough can be used to apply pressure horizontally.

d. To Assemble the Master Brake Cylinder.

(1) Before starting to reassemble the master brake cylinder examine each part thoroughly and replace all worn parts.

(2) Reassemble the transfer valve as follows: Hold the transfer valve upside down, drop in the disc and make sure that it lies flat on its seat to avoid damaging the disc when the retainer is screwed into place. Be sure that the gasket is in place at the bottom of the well in the cylinder and that it is in perfect shape, before installing the transfer valve assembly. This gasket has no function to perform during the filling and bleeding of the system but it

**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 PSI 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 PSI 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

IF THERE IS A LEAK ANYWHERE IN THE SYSTEM IT MANIFESTS ITSELF BY A DOWNWARD MOVEMENT OF THE YOKE. A DOWNWARD MOVEMENT OF APPROXIMATELY 1/16" MAY BE NOTICED IMMEDIATELY AFTER FILLING AND BLEEDING. IF THE SYSTEM IS PARKED FOR 12 HOURS OR MORE A MOVEMENT OF 1/16" TO 1/8" IS TO BE EXPECTED, IF THERE IS NO EXPANSION OR CONTRACTION DUE TO TEMPERATURE CHANGES. IF AN EXTERNAL LEAK IS DISCOVERED IT SHOULD BE ELIMINATED AS SOON AS POSSIBLE AND LIQUID SHOULD BE ADDED TO BRING IT TO THE PROPER LEVEL IN THE RESERVE CHAMBER.

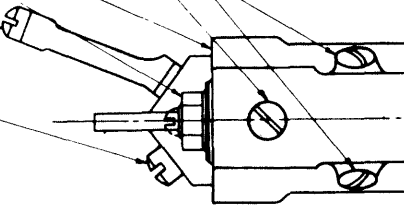
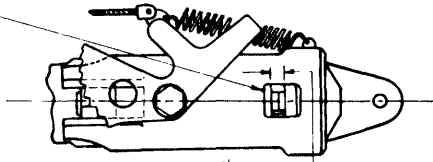


Figure 197 - Hydraulic Brake Control Unit Service Instructions

Remove these Nuts and pull Bolts to free the Master Cylinder from its support

To remove the Master Brake Cylinder from its Support Assembly, pull the Cotters and remove the Nuts from the upper and lower Through Bolts. Pull the Through Bolts out and the Support Assembly will separate at the center line.

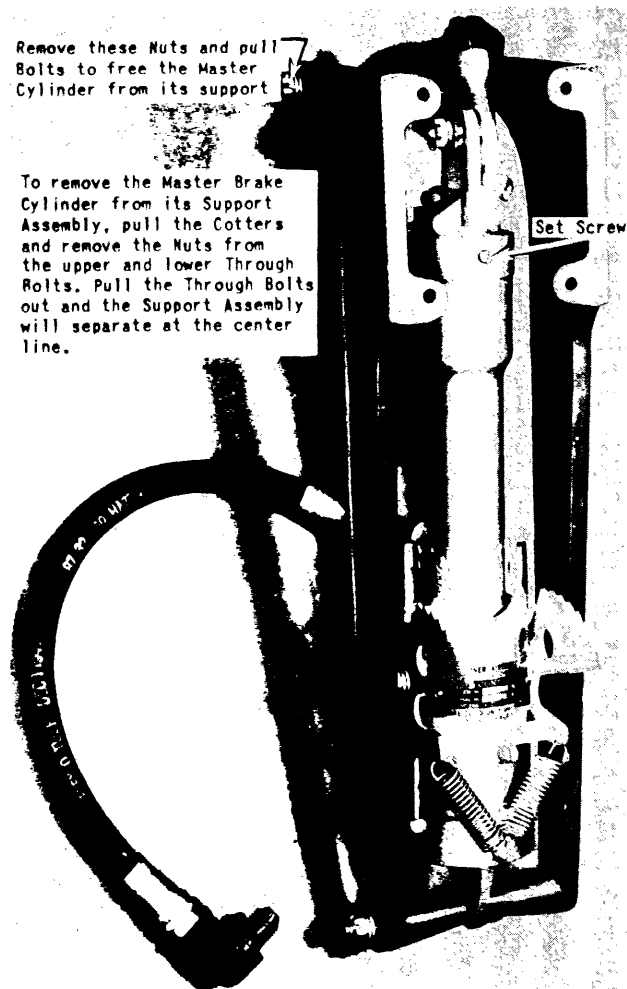


Figure 198 - Master Brake Cylinder and Support Assembly

Remove the two Set Screws, one in the Upper and the other in the Lower End Fitting. Place the Master Cylinder Unit in a Vise with aluminum covered Jaws and turn the Cylinder off of the Lower End Fitting as illustrated.

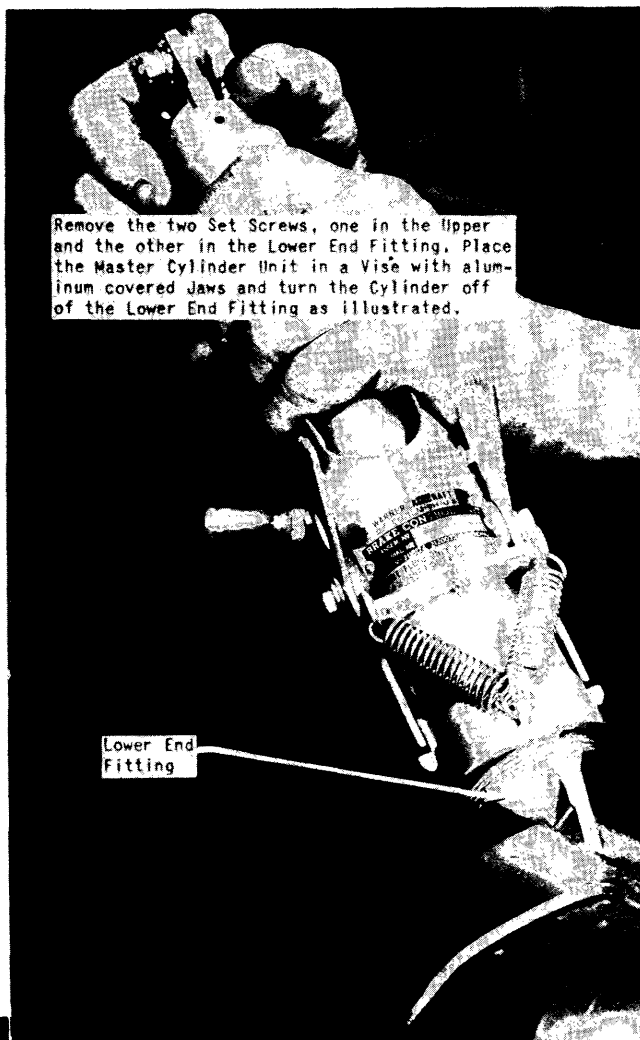


Figure 199 - Removing Lower End Fitting

Remove the Cotter and Nut on the Lower End and separate the Housing-Complete Assembly from the Cylinder-Complete Assembly and transfer Valve Assembly as illustrated.

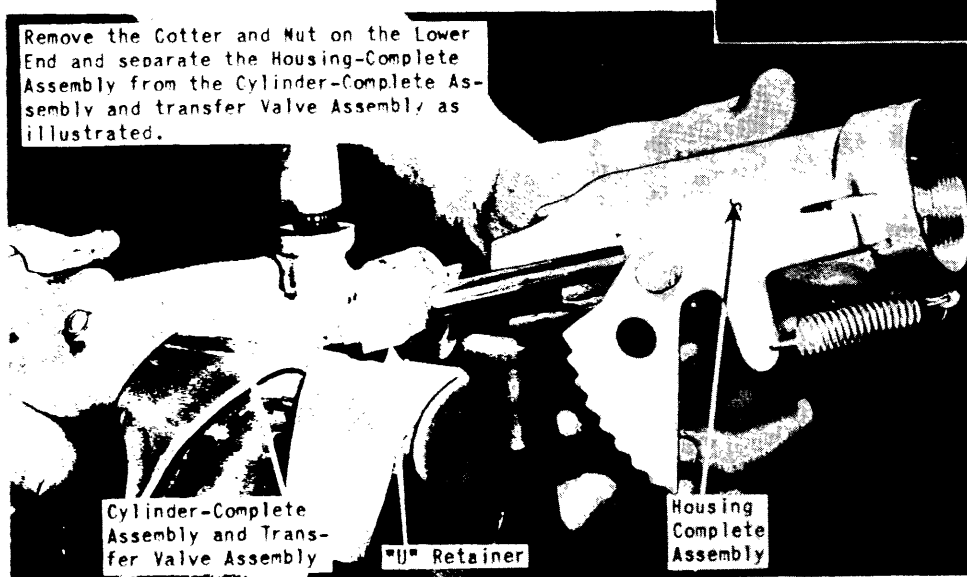


Figure 200 - Removing Housing Assembly from Cylinder Assembly



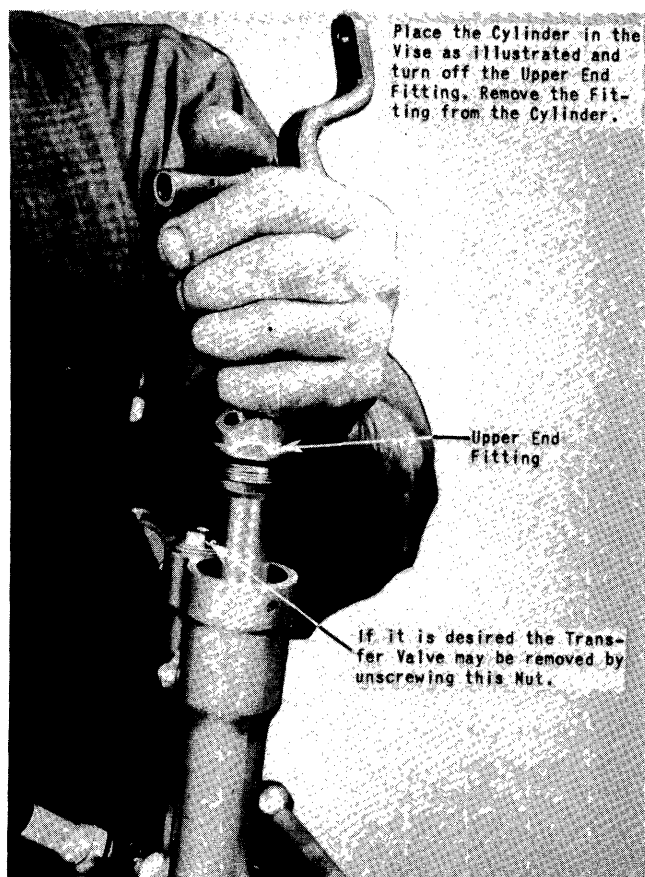


Figure 201 - Removing Upper End Fitting from Cylinder

must hold tight against the pressure in the system when the unit is in operation. It may be found easier to reinstall the valve assembly if the gland and two packings are removed from the valve. Screw the valve in part way so that the start of the thread is approximately flush with the top surface. Install the two packings into the well one at a time and screw the gland on.

(3) Before reassembling the housing, grease the entire inner surface of the housing with a heavy grease of high melting point, preferably a rocker arm lubricant for corrosion protection. When installing the parking spring be extremely careful not to let the spring snap up against the light bridge on the yoke as it may cause serious damage to the yoke.

(a) To reassemble the housing reverse the procedure outlined in (10)(a) through (e). Do not install the housing end until the housing and cylinder are assembled together.

(4) To reassemble the cylinder reverse the procedure outlined in (1) through (9). Wet all cups with hydraulic brake fluid to facilitate their entrance into the cylinder. Do not install the upper end fitting until after the housing and cylinder have been assembled together.



Figure 202 - Removing Piston and Piston Rod from Cylinder

(5) Assemble the housing to the cylinder by slipping the housing assembly over the piston rod protruding from the cylinder assembly. Insert a clean wooden hammer handle into the open upper end of the cylinder and push the piston down until the rod has protruded far enough through the yoke on the bottom of the housing to engage the nut on the threaded end of the rod. Turn up the nut so that the rod threads do not protrude through the nut more than  $1/32$  inch to  $3/64$  inch to insure that the rod will not foul the end fitting. Install the cotter in the nut.

(a) Grease the threads on the lower end fitting and the thread face of the housing assembly with a heavy grease and screw the end fitting on the housing assembly. The last few turns will produce considerable drag as the heavy parking spring is being depressed. Line up the locking screw hole on the housing and end fitting and insert the lock screw.

(b) Grease the threads on the upper end fitting to protect the threads against corrosion and seal against slight seepage during the filling and bleeding operation. If it is desired, a non-hardening sealing compound such as key paste may be used. Apply the sealing compound sparingly so that it will not mix with the brake fluid which is in contact with the upper end fitting.

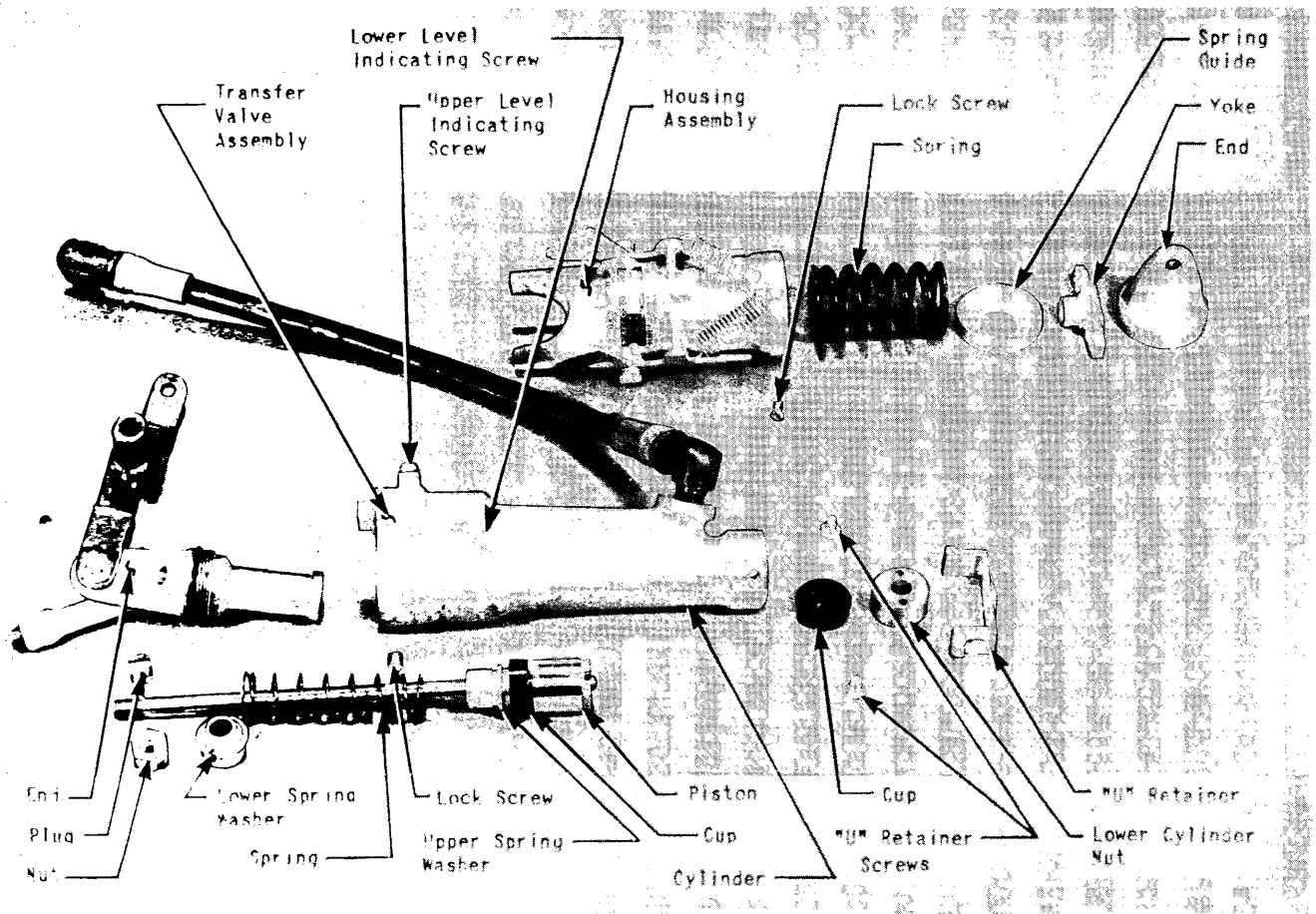


Figure 203 - Master Brake Cylinder Disassembled

(c) If the nipple on the elbow installed in the 1/4-inch pipe tapped hole in the cylinder has been removed, or a new replacement fitting is being installed, use thread lubricant to seal the connection.

e. To Disassemble the Hydraulic Brake Cylinder. -  
(See figures 206 and 207.)

(1) General. - The double end hydraulic cylinder is mounted near the top of the torque plate by two cap screws. The cylinder is attached to the brake shoe at each end by levers attached to the two cylinder piston rods. To remove the brake cylinder from the torque plate proceed as follows:

(a) Unbutton the four Dzus fasteners attaching the outer fairing to the wheel.

(b) Pull the cotter and remove the nut on the end of the axle.

(c) Pull the wheel and tire assembly from the axle exposing the brake shoe and torque plate.

(d) Remove the bleeder screw on the rear of the cylinder and drain the fluid from the hydraulic line and cylinder.

(e) Disconnect the brake hose at the fitting on the inner fairing.

(f) Pull the cotters and remove the bolts attaching the two levers, one at each end of the cylinder to the two cylinder piston rods.

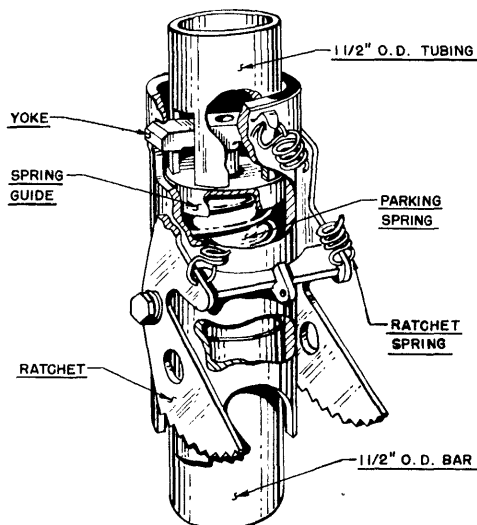
(g) Cut the lock wire on the cap screws at the base of the cylinder and remove the cap screws. This will free the brake cylinder from the torque plate and the cylinder can now be disassembled.

(h) To disassemble the brake cylinder proceed as follows:

1. Remove the rubber boots at either end of the cylinder. This will allow the piston rod, piston, and piston cup to be removed from both ends of the cylinder. The piston cup spring may now be removed and the cylinder is completely disassembled.

(i) To Assemble the Brake Cylinder. - Before assembly, the cylinder should be washed with alcohol and the pistons and cups lubricated with hydraulic brake fluid. Do not use mineral oil.

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.

Figure 204 - Removing Yoke from Housing Assembly

1. Insert the spring in the cylinder and then the piston cups, one from either end to fit over the spring.
2. Next install the two pistons, one on either end.
3. Install the rubber boots which will hold the pistons, cups, etc., in the cylinder.
4. Attach the brake cylinder to the torque plate with the two cap screws and safety wire the screws. (See figure 206.)
5. Insert the piston rods into the holes in the boots and attach them to the brake shoe levers with the proper bolts. Safety the bolts in place with cotters.
6. Connect the hydraulic hose to the cylinder fitting on the back of the inner fairing.

The brake system must now be serviced with fluid. The correct filling and bleeding procedure is outlined in figure 197, and should be followed to assure the efficient operation of the brake system.

When the Spring is deflected sufficiently as illustrated in Fig. 204, 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.

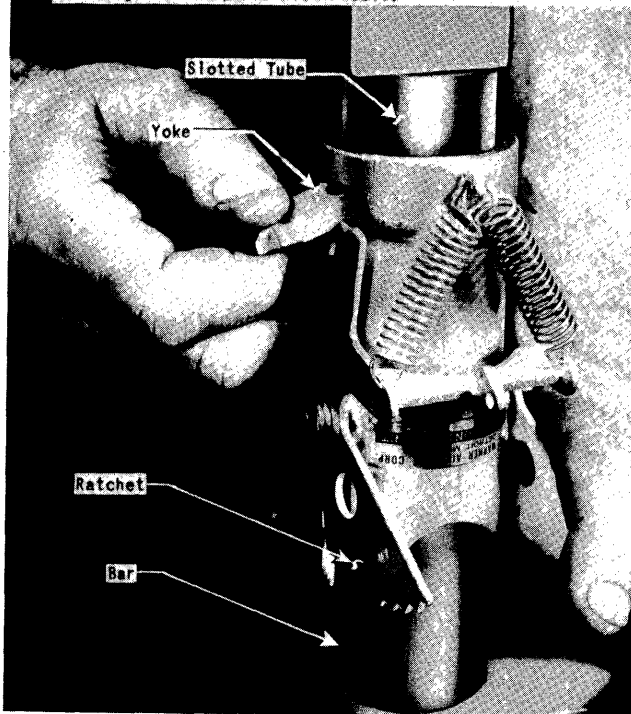


Figure 205 - Removing Yoke from Housing Assembly

After the brake system has been properly filled and bled, it may be found necessary to adjust the brake treadle to gain the maximum breaking efficiency of the system. If the treadle adjustment is necessary follow the procedure outlined in figure 195.

### 13. Bendix Hydraulic Gun Charger Cylinder and Charger Valve.

a. General. - 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.

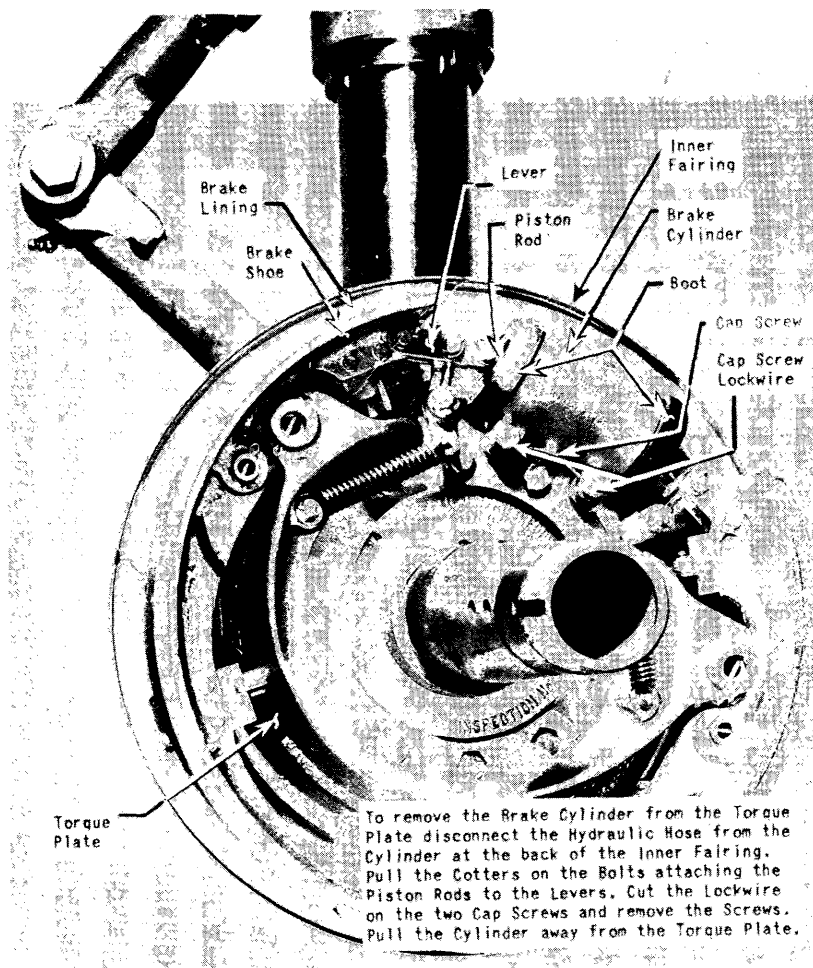
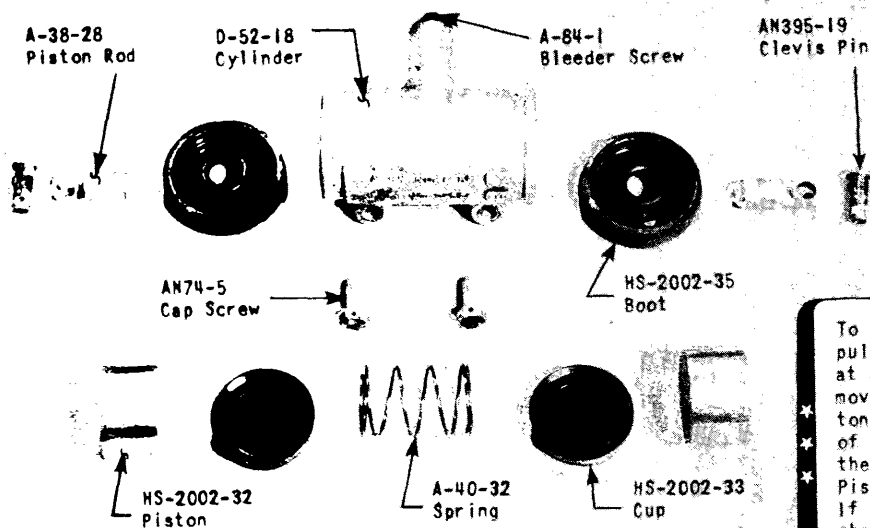


Figure 206 - Hydraulic Brake and Torque Plate Assembly



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.

Figure 207 - Brake Cylinder Disassembled

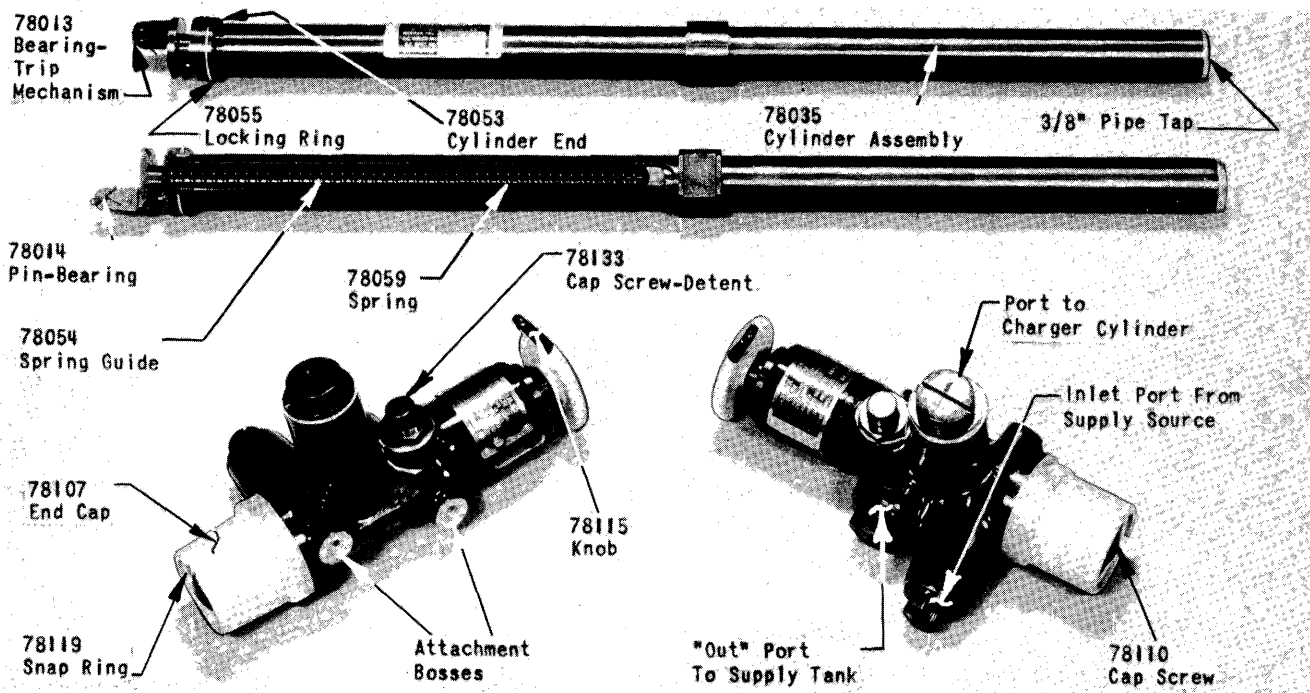


Figure 208 - Hydraulic Charging Cylinder and Charging Valve

**b. To Disassemble the Charger Cylinder.**

- (1) If the charger cylinder leaks excessively around the piston, the piston cup should be replaced.
- (2) Remove the charger cylinder from the brackets on the outboard side of the gun and disconnect the flexible hose connection.
- (3) Remove the locking ring on the spring end of the cylinder.
- (4) Secure the cylinder in a wooden block clamp and unscrew the cylinder end.
- (5) The spring and piston assembly can now be pulled from the cylinder chamber and the piston cup replaced.
- (6) When a charger cylinder is disassembled extreme care should be exercised not to damage the cylinder by careless handling.

**c. To Assemble the Charger Cylinder.**

- (1) Before reassembling the cylinder clean all parts, except the cup packing, with a good grade of cleaning gasoline. Thoroughly dry the parts with air and be sure all parts are free of dirt and chips.
- (2) Install a new cup packing on the piston and push the piston and spring assembly into the cylinder. Special care should be exercised to guide the cup seal into the cylinder chamber past the end of the

cylinder slot. If the sharp sealing edge of the cup is cut or damaged during assembly in the cylinder, leakage will occur at low pressures in the cylinder.

- (3) Screw the cylinder end into the cylinder and reinstall the locking ring. (See figure 208.)

**d. To Disassemble the Charger Valve.**

- (1) If the charger valve requires a pronounced increase in effort to actuate, or does not kick out fully on the return stroke, it should be disassembled and thoroughly cleaned. Disconnect all hydraulic lines to the valve, cut the lock wire and remove the two attaching cap screws.

- (2) To disassemble the charger valve, push the charger valve knob detent in slightly and pull out the locking pin.

- (3) This will free the knob, the knob detent, and the spring.

- (4) The detent cap screw (78133) should now be removed releasing the detent spring and detent plunger. (See figure 208.)

- (5) Working through the cylinder port (figure 208), unscrew the spring pilot and the spring, ball, and pin will drop out.

- (6) Working through the inlet port (figure 208), unscrew the spring pilot and the spring, ball, and pin may be removed from the inlet port.

(7) Remove the snap ring (78119), unscrew the end cap (78107) from the valve body (figure 208), and the valve plunger may be pulled out of the valve housing.

(8) The valve plunger can be disassembled further by removing the cap screw, the spring adjustment screw, the spring, the stop, and the release valve plunger. The valve is now completely disassembled for cleaning and inspection.

e. To Assemble the Charger Valve.

(1) All parts should be carefully cleaned and inspected for burrs and score marks caused by the presence of dirt or abrasive matter in the system.

(2) If burrs are found on any of the moving parts, they should be stoned off until the part again moves freely.

(3) If deep score marks are found in the valve body bore, the valve body should be replaced.

(4) Reassemble the valve plunger and install the plunger assembly in the valve body.

**IMPORTANT:** The valve plunger should never be assembled in the valve body or in the end cap without employing a nose piece to guide the seal into the cylinder without marring its sharp sealing edge. This nose piece will be furnished by the manufacturer of the valve on order.

(5) Reassemble the remainder of the valve by reversing the steps outlined in d.(1) through (7).

(6) After the valve has been completely reassembled the release valve spring in the plunger assembly will require adjustment. This can be accomplished by employing either a hand pump or a power operated pump with an adjustable relief valve. The control valve should be placed in the "OPEN" position and the pressure gradually increased until the valve plunger kicks out. The spring should be adjusted by turning the adjusting screw inside the plunger cap screw, in or out as required until a kick-out pressure of 750 pounds per square inch is reached. If the seal in either the end cap or valve body leaks excessively during this adjustment of the relief valve the seals should be replaced. After testing the valve and adjusting the relief valve spring, stake the screws in the outlet port to the charger cylinder and the inlet port from the hydraulic pump.

(7) Replace the valve in the airplane and complete all hydraulic connections. After a gun charging installation has been made, the hydraulic line fitting at the hose connection to the hydraulic charger cylinder should be loosened two or three turns and the control

valve and hydraulic motor switch actuated. When fluid, free of air, begins to flow at the loosened connection, tighten the connection and the line is free again. Lockwire all mounting screws furnished with wire holes and stake all flathead screws at the screw driver slot before the gun is fired. A good light mineral oil should be used to lubricate the working parts of the charges.

**NOTE:** It is recommended that, wherever possible, all hydraulic gun charger valves and charger cylinders that malfunction be returned to the manufacturer for service repairs and new valves and cylinders be installed in the airplane. However, if replacement stocks are low and service depots are far removed from the manufacturer the charger valves and cylinders may be disassembled and assembled by service personnel as outlined in this chapter.

**IMPORTANT:** It has been found that due to improper actuating of the charger valves by pilots that it has been impossible to charge the guns on some airplanes. It is therefore, recommended that the following procedure be employed to charge all guns.

1 Turn all valve handles clockwise 140 degrees from the red marker on the panel.

2 Actuate only one charger valve at a time.

3 Push the charger valve handle all the way in.

4 Actuate the hydraulic electric motor switch on the control stick, below the handgrip, until the valve handle pops out.

5 Repeat these operations on the remaining charger valves and all guns are charged.

f. To Lock the Guns Rearward.

(1) Match the red points on the valve handles with the red markers on the panel.

(2) Actuate one charger valve at a time.

(3) Push the charger valve handle all the way in.

(4) Actuate the hydraulic electric motor switch on the control stick, below the handgrip, until the valve handle pops out.

(5) Repeat these operations on the remaining charger valves and all guns are locked. If it is desired to charge the guns again, after they have been locked, turn the valve handles 140 degrees clockwise from the red markers on the panel and the guns are charged and ready to fire.

SECTION VIIFUSELAGE FUEL TANK1. To Remove the Fuselage Fuel Tank.

a. General. - The fuselage fuel tank assembly is designed to utilize the available space for the maximum fuel capacity as well as providing enough clearance to remove or install the tank through the cockpit and station No. 5 bulkhead. The tank removal through the cockpit may appear to be impossible at first glance, however, if the correct procedure is followed and extreme care is used in handling, the removal of the tank is a comparatively easy service operation. Two men should be able to handle this assignment competently.

b. To Drain Fuselage Fuel Tank Prior to Removal.

(1) Unbutton the aft section of the keel fairing and remove the fairing exposing the fuselage tank drain.

(2) Place a jack under the rear jack point, aft of the tail wheel doors, to raise the fuselage enough to accommodate a drain tank. (See figure 209.)

(3) Have at least two fire extinguishers available in case of fire. (See figure 209.)

(4) Insert a large funnel in the drain tank (figure 209) and remove the fuselage tank drain plug with a suitable wrench. After all fuel has drained from the tank replace the drain plug and remove the drain tank from under the fuselage.

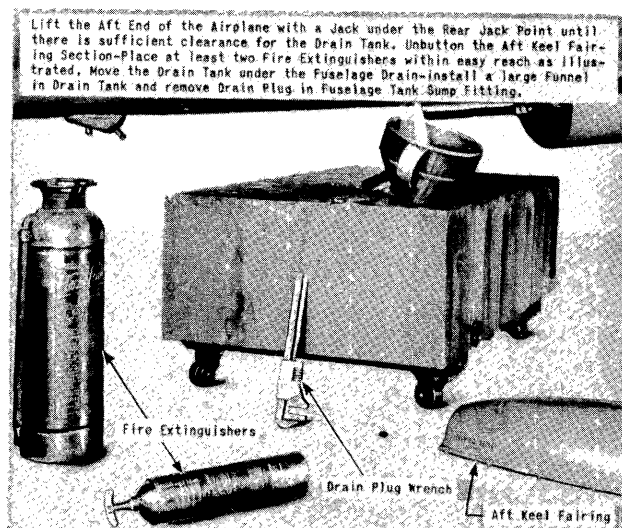


Figure 209 - Draining Fuselage Fuel Tank

c. To Remove the Fuselage Fuel Tank.

(1) Working through the access door in the fuselage remove the duffle bag. Remove the two radio transmitters from the top shelf forward of the access door. (See figure 210.) Remove the top radio shelf by withdrawing the retaining bolts at the four corners of the shelf attaching the shelf to station No. 8 and No. 9 bulkheads. Remove the three radio receiver units from the center shelf. If a radio receiver and transmitter set is installed on the shelf aft of the access door, remove this unit also to provide additional room for a man to climb inside the fuselage.

(2) By climbing into the fuselage through the access door and leaning over the center radio shelf, forward of the access door, a man can remove the fuel supply line at the bottom rear of the tank, at the sump connection, by loosening the clamp fitting and pulling the connection free. Disconnect the rear vent line on top of the tank and break the lock wire on the rear tie-down strap turnbuckle. Unscrew the turnbuckle and swing the straps to the sides of the fuselage. (See figure 211.) Also disconnect the bonding tab at the nut plate on the tank to the right of the sump assembly.

(3) Break the hose connections on the vent lines aft of the tank. (See figure 211.)

(4) Cut the lock wire on the aft tie-down strap turnbuckle and release the turnbuckle as shown in figure 211.

(5) Working from within the cockpit, remove the two bolts at the top of the pilot's seat support tubes and remove the seat from the cockpit. (See figure 212.)

(6) On all P-40E-1 airplanes remove the oxygen economizer from the left side of the pilot's seat by unscrewing the one bolt through the longeron and the two bolts through the trim tab mechanism guard plate. Disconnect the oxygen line to the regulator and remove the mouthpiece tube with the economizer unit.

(7) Remove the four bolts attaching the headrest to the armor plate and remove the headrest.

(8) Using a ratchet wrench, remove all the bolts attaching the armor plate to station No. 5 bulkhead. The small installation of 5/16-inch armor plate aft of the pilot's headrest should be removed first. Remove the name plate on the left side of the armor plate. This plate contains valuable data including model and serial numbers. Be sure to reinstall this plate when the armor plate is reassembled in the cockpit. With one man on each side of the cockpit



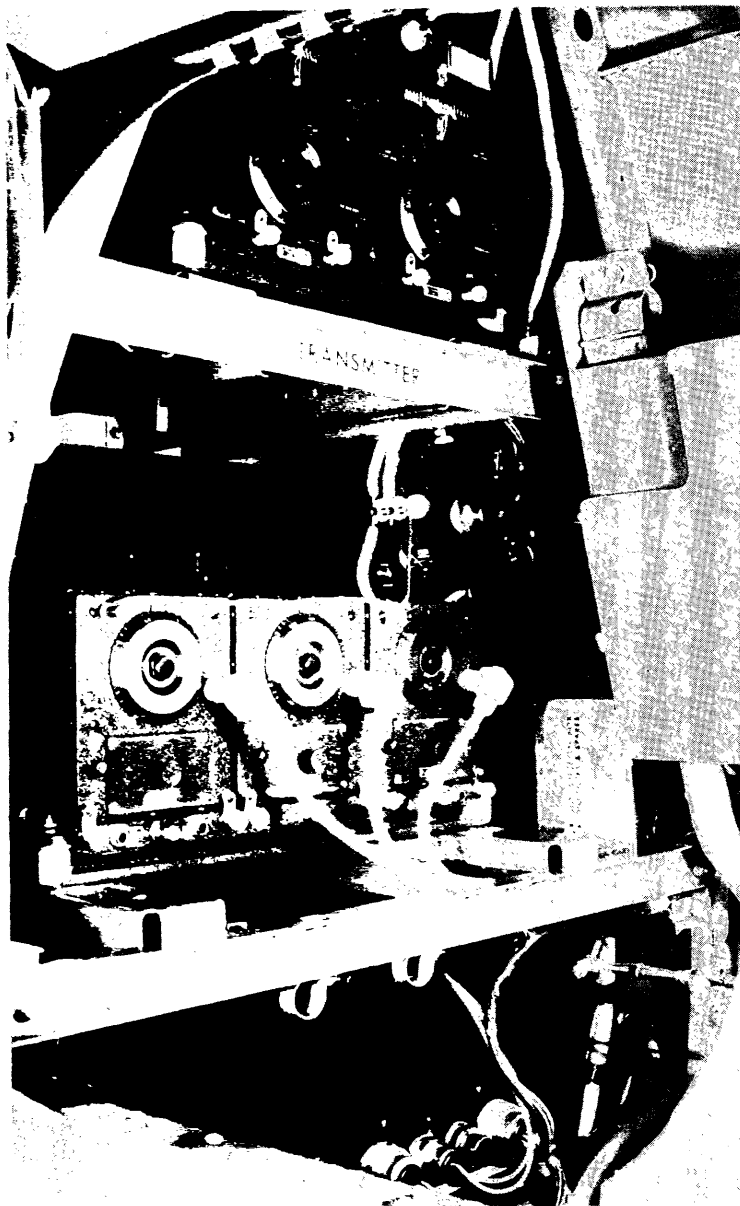


Figure 210 - Radio Equipment  
Prior to Removal

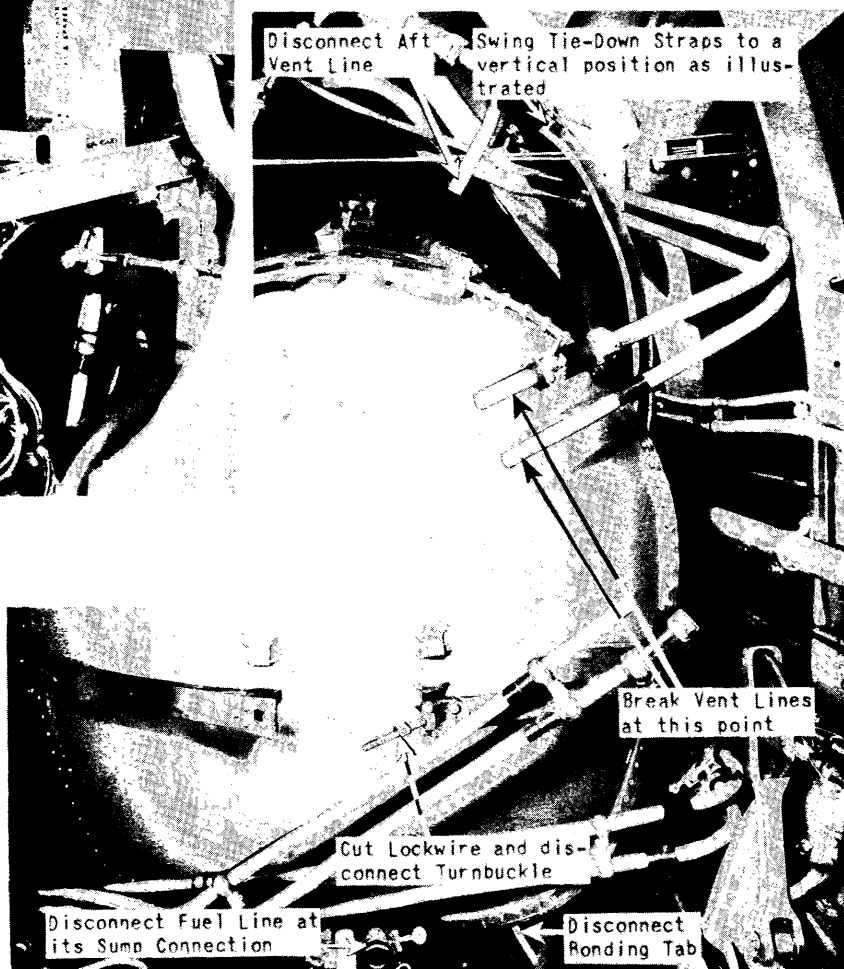


Figure 211 - Aft End of Fuselage  
Fuel Tank Ready for Removal

Unscrew these Bolts on both sides of the Headrest to remove the Headrest from Armor Plate.

Be sure to reinstall this Name Plate. It contains the Serial and Model Numbers of the Airplane.

Remove these two Bolts to free Pilot's Seat from Armor Plate.

Figure 212 - Armor Plate and Attachments Prior to Disassembly



Figure 213 - Removing Pilot's Seat from the Cockpit

Figure 214 - Removing Armor Plate from Station No. 5 Bulkhead



Figure 215 - Removal of Electric Cable Connection to the Fuel Quantity Transmitter

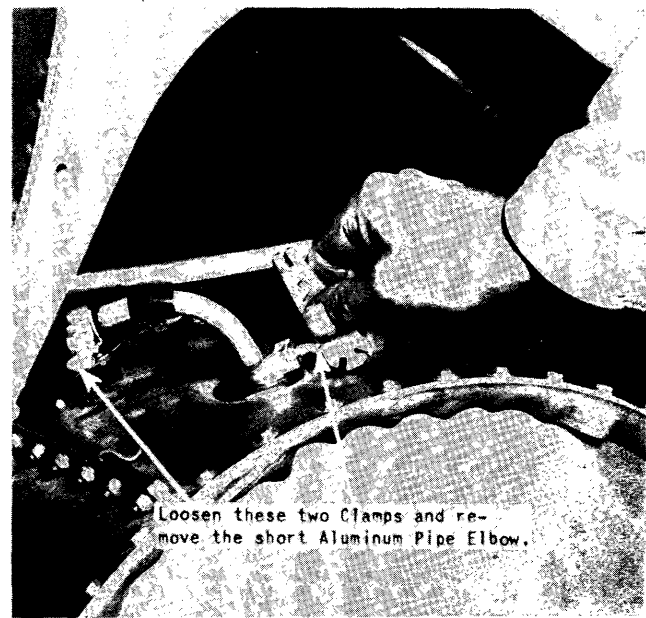


Figure 216 - Forward Vent Line Clamp Fittings

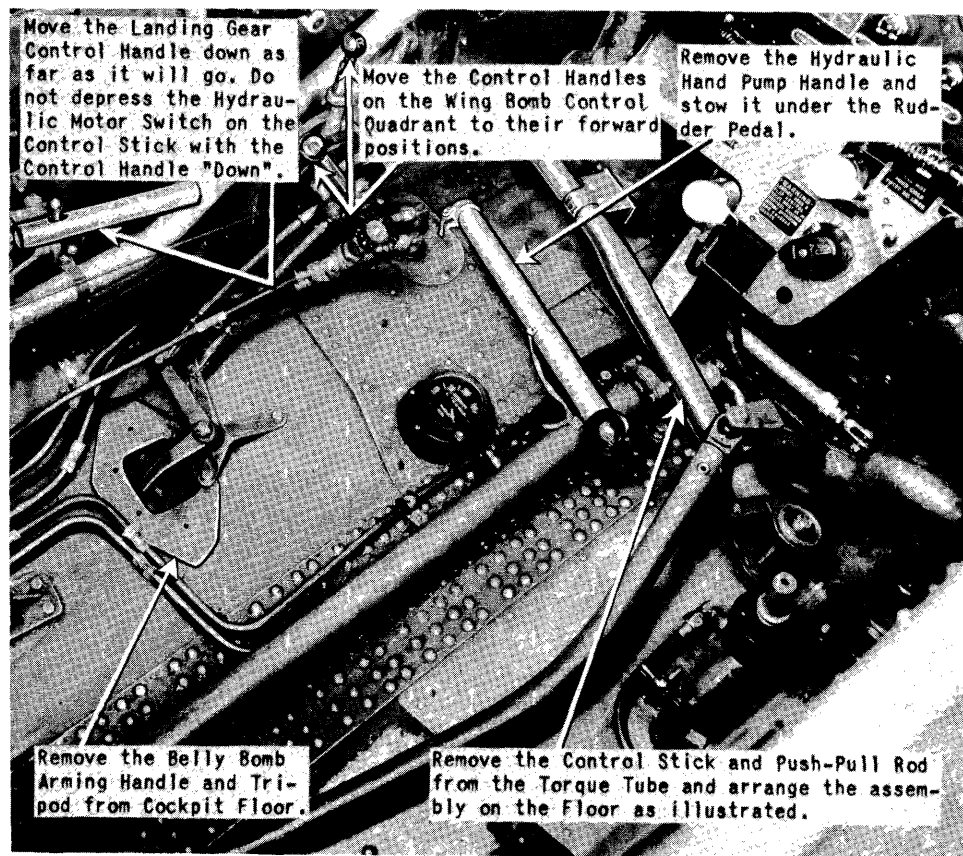


Figure 217 - Preparation of the Cockpit Prior to the Tank Removal

raise the armor plate straight up until it clears all controls and other obstacles in the cockpit. Start to move the armor plate upward with extreme care so that fingers and hands of service personnel will not be pinched or crushed by the heavy plate. Lift the armor plate over the side of the cockpit as illustrated in figure 214, and place it on the floor of the hangar or depot. Do not leave it on the wing of the airplane as it may slide off causing injuries to personnel and damage to the armor plate and wing skin.

(9) Remove the bonding tabs, one on the right side of the tank and the other on the synthetic rubber filler neck. (See figure 227.) Screw bonding tab attaching screws into the attaching nut plates so that they will not be lost. (See figure 227.)

(10) Remove the electric conduit disconnect plug at the gage transmitter unit. (See figure 215.)

(11) Cut the lock wires on the forward tie-down strap and forward retaining strap turnbuckle and loosen the turnbuckles. Place the tie-down straps in a vertical position and push the retainer straps out of the way.

(12) Loosen the clamps on the forward vent connection and remove the short pipe elbow from the vent line. Release the Adel clamp on the left side

of the fuselage at station No. 7 so that the vent lines may be swung upward to prevent them fouling the tank on removal. (See figure 216.)

(13) Loosen the two clamps on the synthetic rubber filler neck and remove the filler neck cap and adapter on the left side of the fuselage. Remove the seven screws around the circumference of the filler neck on the outside of the fuselage and remove the nut plate and the filler neck from the inside of the fuselage.

(14) Remove the hydraulic hand pump handle and stow it under the rudder pedal.

(15) On all P-40E-1 airplanes remove the damped rate control bracket from between the hydraulic hand pumps.

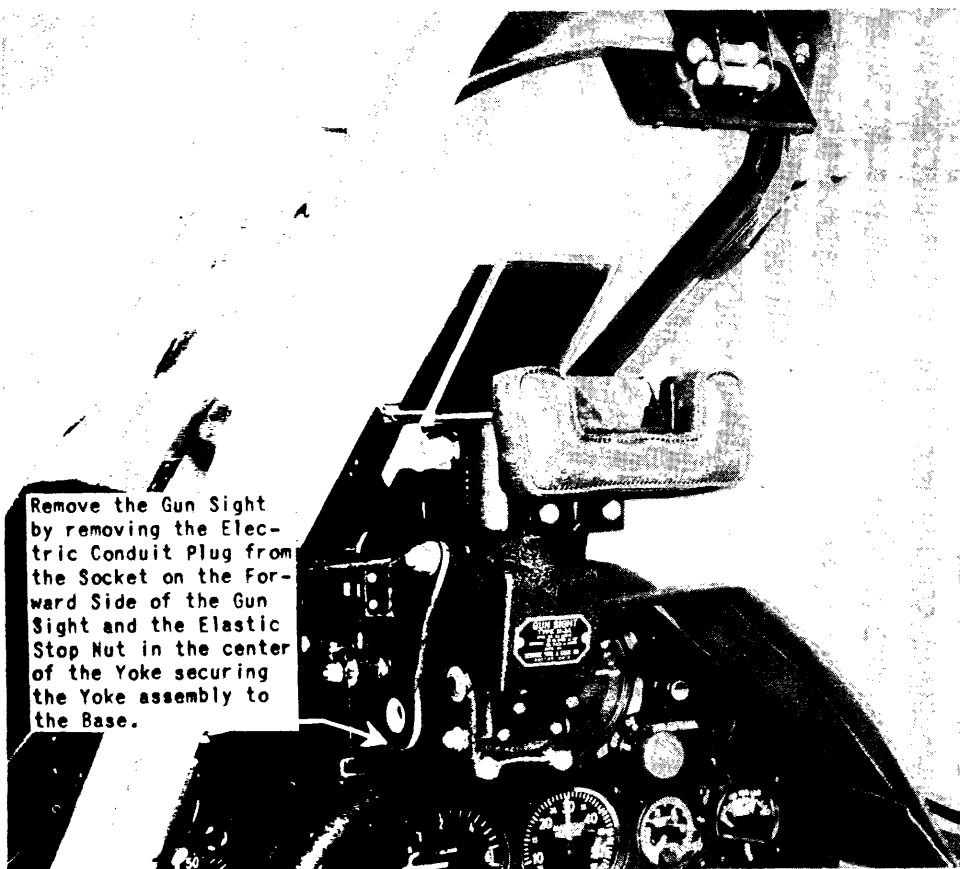
(16) Remove the control stick attaching bolt at the base of the stick and at the aft end of the elevator control push-pull rod and lay the control stick assembly on the floor of the cockpit. (See figure 217.)

(17) Remove the handle on the cabin canopy control on the right side of cockpit. To remove the handle, turn the crank handle up above the sill and grip the nut on the inboard end of the bolt with a thin wall socket wrench while retaining the outboard end of the bolt from turning with an offset screw driver.



Remove the Handle and Spacer on the Control Crank by holding the Screw Head on the Outboard End of the Bolt and turning the Nut on the Inboard End with a thin wall-ed Socket Wrench as illustrated.

Figure 218 - Removal of Cabin Control Crank Handle



Remove the Gun Sight by removing the Electric Conduit Plug from the Socket on the Forward Side of the Gun Sight and the Elastic Stop Nut in the center of the Yoke securing the Yoke assembly to the Base.

Figure 219 - Removal of Gun Sight

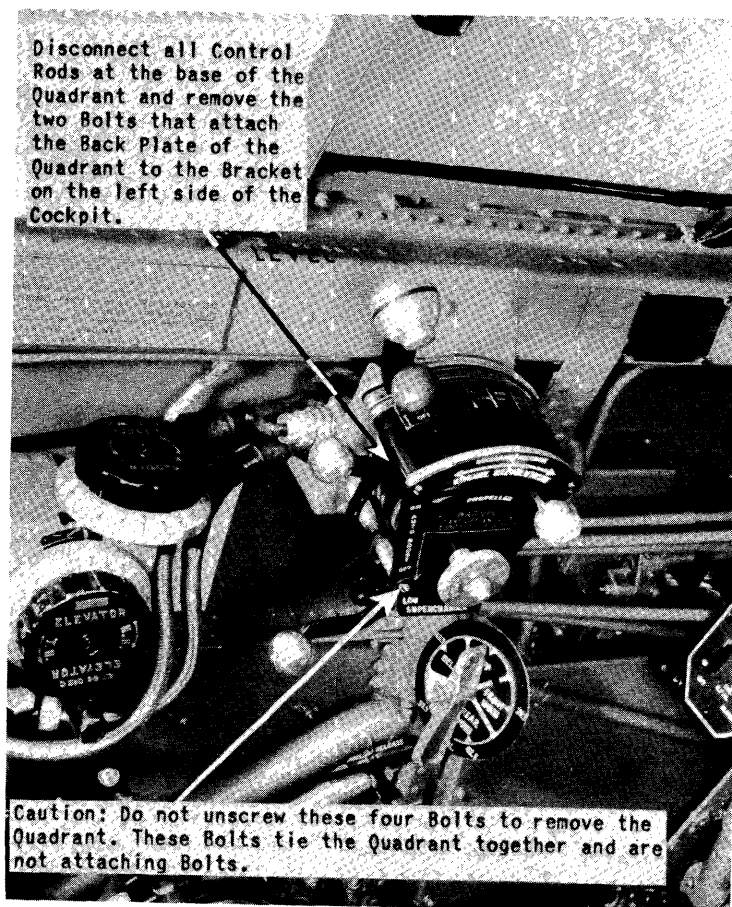
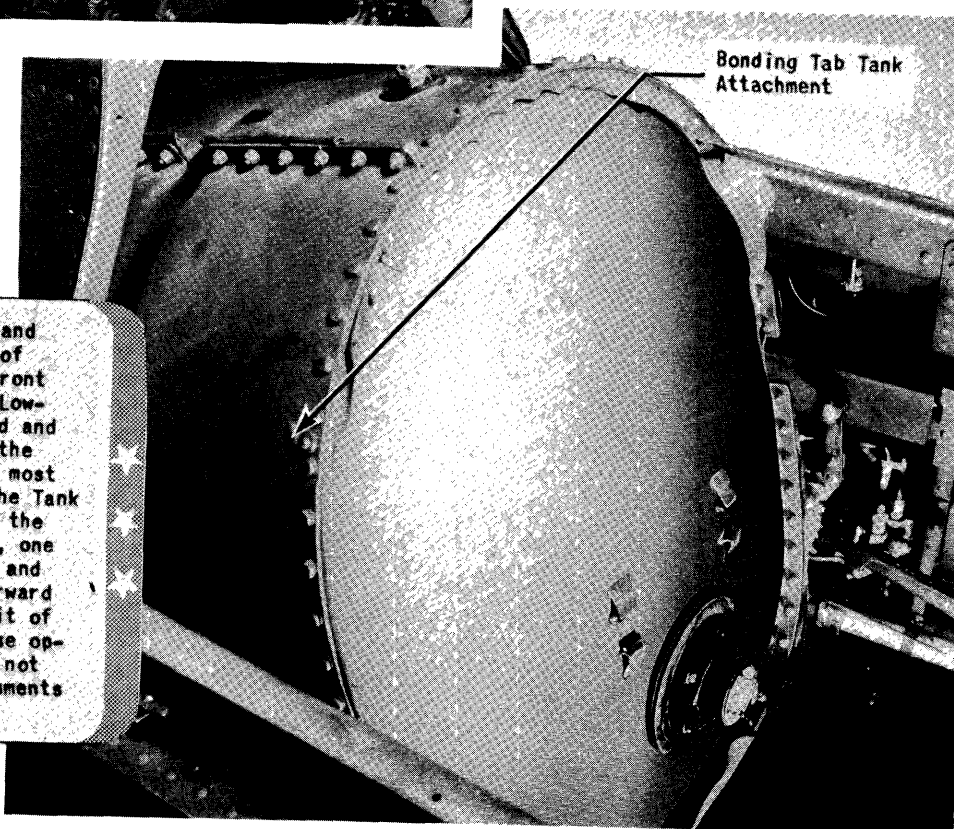


Figure 220 - Engine Controls Quadrant Removal for P-40F Airplanes

Figure 221 - Fuselage Fuel Tank Moved Forward into the Cockpit



With one man in the Cockpit and another in the Fuselage Aft of the Fuselage Tank lift the Front of the Tank up to clear the Lower Section of Sta.#5 Bulkhead and slide the Tank forward with the man in the Fuselage applying most of the forward force. When the Tank is well out into the Cockpit the men should take their places, one on each side of the Cockpit, and continue to move the Tank forward until it has reached the limit of forward movement. During these operations use extreme caution not to damage Controls and Instruments in the Cockpit.





One man, by straddling the Tank with his feet firmly placed on the Cockpit Sills and grasping the Tank Shell Flanges as illustrated, can work the Aft End up about midway on Sta.#5 Bulkhead. The man straddling the Tank should now step down on the Wing and with the aid of the second man on the opposite side of the Cockpit the Aft End of the Tank may be worked up until the Tank is resting on its Forward End in the Cockpit. Be sure that all Oil, Grease or Water is wiped from the soles of the Shoes and Cockpit Sills to safeguard against slipping from the Sill when working the Tank forward in this position.

Figure 222 - Correct Method for Starting the Tank's Removal from the Cockpit

(See figure 218.) The nut and bolt have been peened so that it may require an additional torque on the nut to start it. After the nut has been removed, pull the handle from the spacer and remove the spacer from the bolt. The bolt may now be pushed outboard and removed from the crank arm.

(18) Remove the gun sight by removing the electric conduit plug from the socket on the forward side of the gun sight and removing the one nut in the center of the yoke which secures the sight and yoke assembly to the base. (See figure 219.) Removal of the gun sight in this manner will not change the adjustment. Be sure to remove the sight from the cockpit so that no damage to the sight will result.

(19) Place the landing gear control handle in the "DOWN" position. Be careful not to actuate the hydraulic electric motor switch on the control stick during removal operations and return the control

to its "NEUTRAL" position as soon as these operations are completed.

(20) Place the two-wing bomb quadrant handles in their forward positions.

(21) Remove the three attaching bolts on the feet of the arming handle tripod. Release the clevis attaching the arming control handle to the control cable and remove the arming control assembly from the cockpit.

(22) Place the "throttle" and "mixture" controls in their "FORWARD" positions on the control quadrant.

**NOTE:** On all P-40F airplanes it will be necessary to remove the engine control quadrant to gain enough clearance for the tank removal. To remove the quadrant, detach all control rods to the quadrant controls and unscrew the two bolts which attach the quadrant to its mount. (See figure 220.)



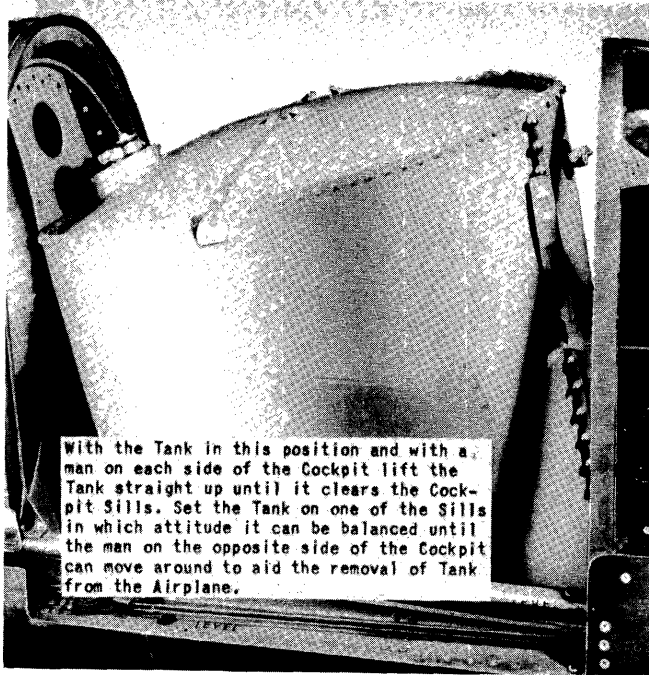


Figure 223 - Fuselage Tank Ready for Removal from the Cockpit

(23) On all P-40E-1 airplanes place the cowl shutter control in the "OPEN" position.

(24) Place a pad on the floor of the cockpit to act as a skid and protect the control stick push-pull rod as well as the torque tube.

(25) Be sure that the cabin enclosure is in its "FULL OPEN" position.

(26) Place one man in the cockpit facing the fuselage tank and the second man in the baggage compartment in the fuselage. The man in the cockpit by grasping the tank at the transmitter unit with one hand and the top of the tank with the other can lift the tank over station No. 5 bulkhead and guide it through the opening. The man in the rear will apply the force to push the tank forward as far as he can reach. When the tank is well out into the cockpit (figure 221) the two men should station themselves one on each side of the cockpit and, by grasping the bottom and top of the tank, pull the tank into the cockpit until the windshield blocks further progress in this direction. One man can now move the tank to its most forward position by straddling the tank with his feet on the sills and grasping the tank. (See figure 222.)

**CAUTION:** Be sure that the soles of the shoes and cockpit sills are wiped dry of any oil, water, or grease so that the possibilities of slipping when straddling the tank will be reduced to a minimum.

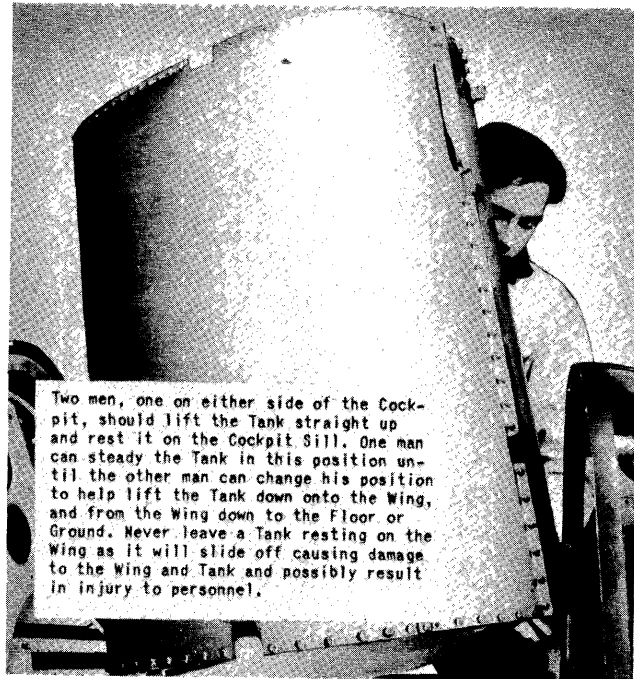


Figure 224 - Tank Resting on Cockpit Sill Ready for Removal from the Airplane

(27) When the tank has been moved forward as far as it will go, start to raise the aft end of the tank. After the aft end has been raised about a foot off the cockpit floor, two men working from either side of the cockpit can work the aft end of the tank upwards by raising the aft end while pushing the forward end back until the tank is in an upright position. (See figure 223.) The tank should now be raised straight up until it can be rested on the cockpit sill. (See figure 224.) One man can now steady the tank while the other man moves around the airplane to help him lift the tank down on the wing. Remove the tank from the wing to the floor or ground.

**NOTE:** Throughout this removal procedure it is extremely important that the utmost caution is employed so that damage to the tank and cockpit equipment will not result.

## 2. To Remove the Fuselage Fuel Cell from the Shell.

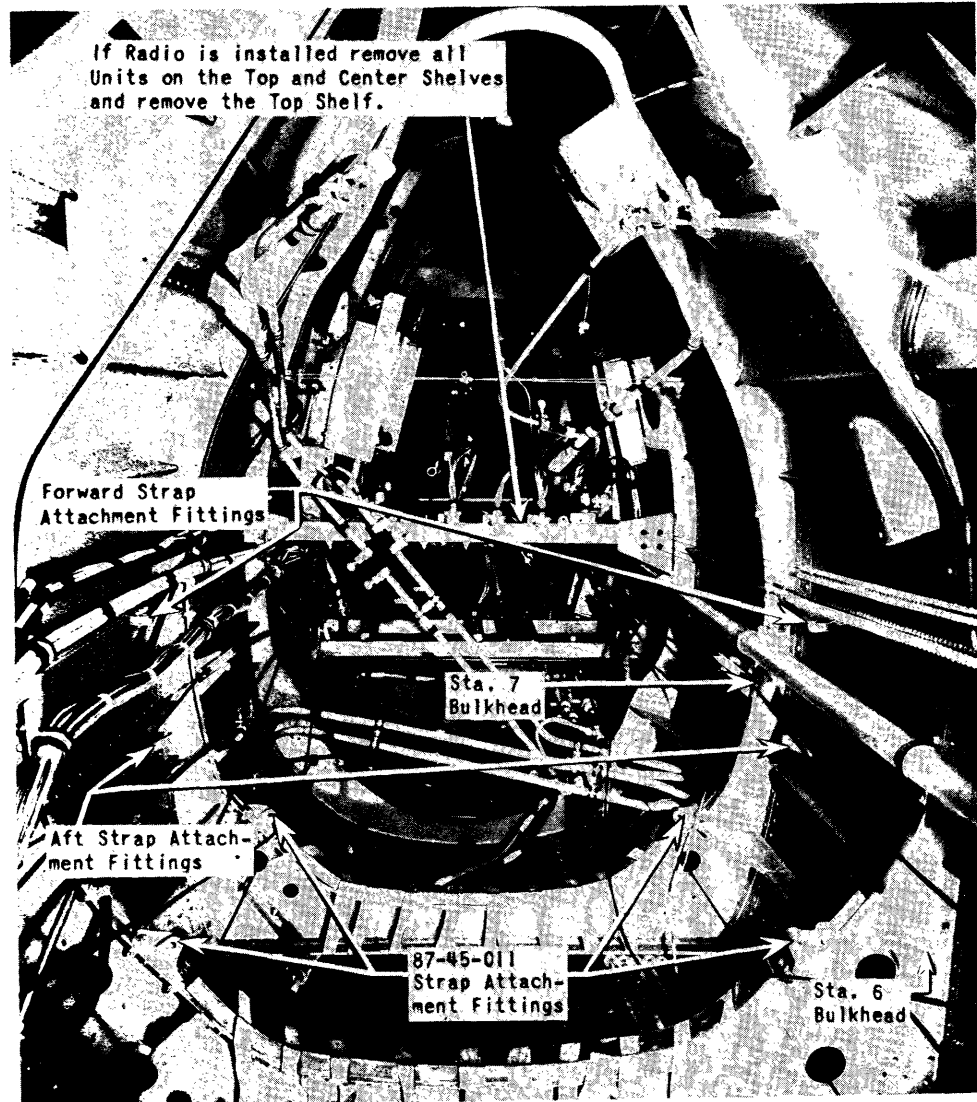
a. Remove all bolts through the flanges attaching the top segment to the remainder of the shell.

b. Remove the segment taking care not to damage the fore and aft vent line fittings on the cell.

c. Remove all bolts attaching the front end of the shell and remove the end carefully so that the gage fitting will not be damaged.

d. Remove the fuel cell from the remainder of the shell using extreme care not to damage any of the fittings.

Figure 225 - Fuselage Prior to Installing Tank Straps



3. To Install the Fuselage Fuel Cell in the Shell.

To install the fuselage fuel cell in the shell, employ extreme care in handling and reverse the procedure outlined in this section, 2.a. through d.

4. To Install the Fuselage Fuel Tank.

a. General. - The installation of the fuselage tank should be handled with extreme care so that no damage to the tank assembly, the cockpit controls, and pipe fittings in the fuselage will result. Two men should be able to install the tank competently if the following instructions are adhered to.

b. Preparation of the Cockpit Prior to Installation.

(1) Be sure that the control stick and push-pull rod are placed on the cockpit floor as illustrated in figure 217.

(2) Stow the hydraulic hand pump handle under the rudder pedal.

(3) Be sure the oxygen economizer is removed from the left side of the cockpit just forward of station No. 5 on all P-40E-1 airplanes.

(4) Make sure that the belly bomb arming handle and tripod are removed from the floor on the left side of the cockpit. The installation of the arming control will start on P-40E-1 airplanes with AAF Serial No. 41-24946.

(5) Be sure that the cabin control crank handle is removed as illustrated in figure 218.

(6) On all P-40F airplanes remove the engine control quadrant as illustrated in figure 220 and on all other airplanes be sure that all the controls are placed in their "FORWARD" position.

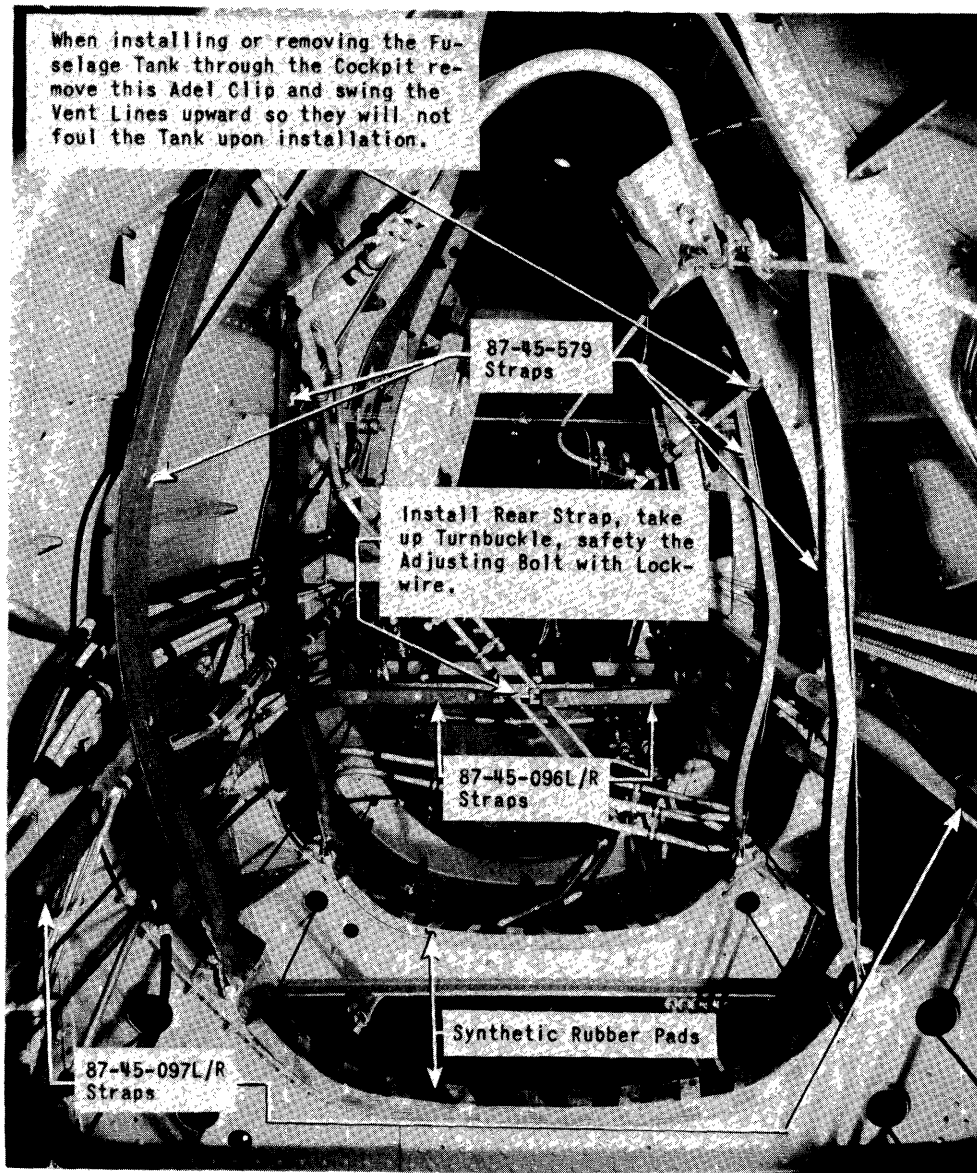


Figure 226 - Fuselage Ready for Tank Installation

(7) Be sure that the wing bomb control handles are in their "FORWARD" position.

(8) On all P-40E-1 airplanes be sure that the cowl shutter control handle is in the "OPEN" position.

(9) Place the landing gear control handle in the "DOWN" position, and be careful not to actuate the hydraulic electric motor control switch during the installation proceedings and as soon as the tank is installed in the fuselage cradle return the landing gear control to its "NEUTRAL" position.

(10) Be sure that the gun sight is removed.

(11) On all P-40E-1 airplanes be sure that the damped rate control bracket is removed from between the hydraulic hand pumps.

c. To Prepare the Fuselage Prior to the Tank Installation.

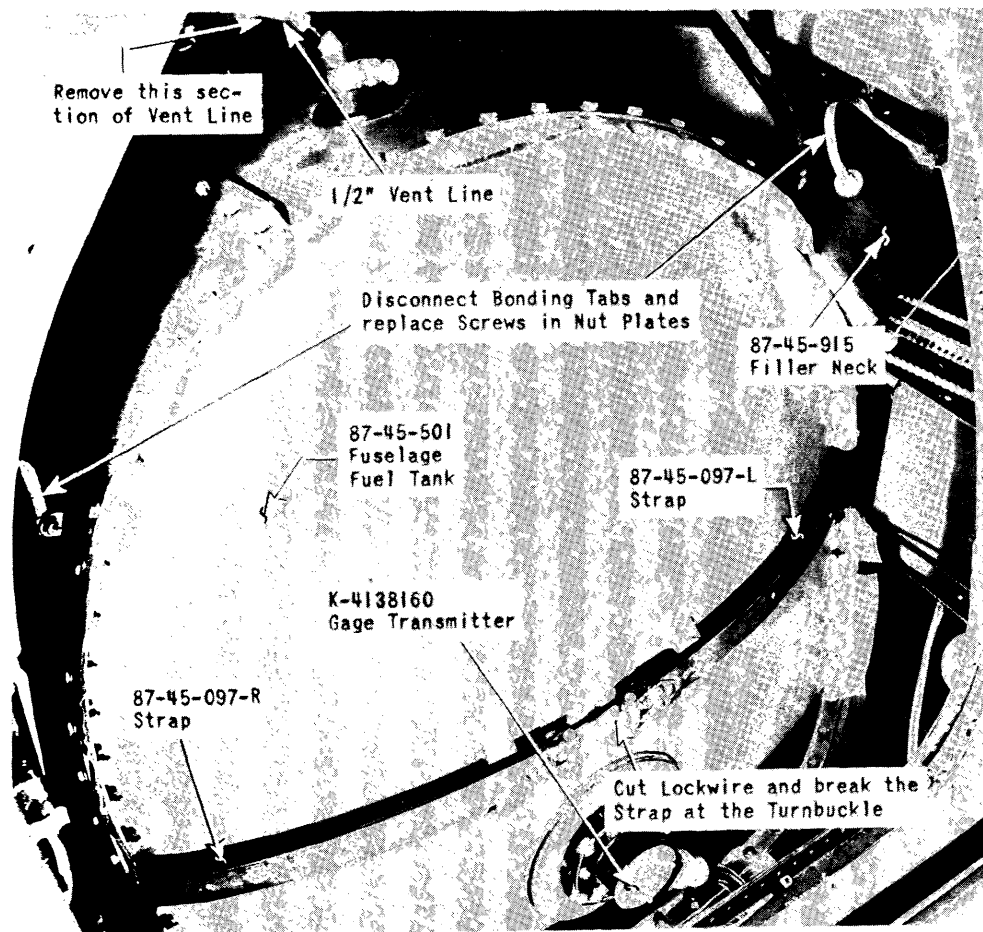
(1) The fuselage tank is designed to rest in the cradle formed by the lower sections of station No. 6 and No. 7 bulkheads. (See figure 225.)

(2) Be sure that the radio equipment on the top and center shelves forward of the fuselage access door is removed. (See figure 210.) Also remove the top shelf.

(3) Thoroughly inspect all control cables, pulleys, electric conduit, and other installations in the fore part of the fuselage before the tank is installed. (See figure 225.)

(4) Be sure that the synthetic rubber pads on the bottom section of station No. 6 and No. 7 bulkheads

Figure 227 - Fuselage Fuel Tank Installed



are in place. (See figure 225.) If these pads are worn, replace them.

(5) Inspect all straps, before installing the tank, for worn synthetic rubber pads, worn bolt fittings, stripped threads on the turnbuckles, and the general condition of the straps. If new straps are to be installed, insert a strap bolt in each tie-down fitting to test the fit of the bolt. If the bolt does not fit freely use a punch and hammer and spread the fittings so that the bolts will fit freely but not loosely before attempting to install the straps on their fuselage fittings.

(6) Install the straps as illustrated in figures 225 and 226. Bend the rear strap to fit the tank and install the turnbuckle bolt. Take up the turnbuckle and install a lock wire. (See figure 227.)

d. To Install the Fuselage Tank.

(1) Raise the tank to the walkway on the wing and move it up even with the cockpit opening.

(2) With two men on the wing, tip the tank so that the forward end is down and raise the tank up until it rests on the cockpit sill. (See figure 224.) One man can now balance the tank while the other takes his place on the opposite side of the cockpit.

(3) Lift the tank off the sill and allow it to lower into the cockpit with the tank still in a vertical position until it rests on the torque tube and push-pull rod assemblies on the cockpit floor. (See figure 223.)

(4) Grasp the forward end of the tank, resting on the cockpit floor with one hand and the flange on the aft end with the other hand, and lift up slightly on the tank while turning the aft end downward. Keep on working the tank to a horizontal position being extremely careful not to foul any of the controls or instruments in the cockpit.

(5) After the tank is about halfway down, one man should straddle the tank and grasp the tank both fore and aft. (See figure 222.) In this position, one man can work the tank down to a horizontal position.

**CAUTION:** Be sure that all oil, grease, and water is wiped from the soles of the shoes and cockpit sills so that injuries from slipping will be held to a minimum.

(6) The man straddling the tank can now start the tank backward into the fuselage through station No. 5 bulkhead.

(7) The man straddling the tank should now move down onto the wing and with the other man on the opposite side of the cockpit, work the tank back into the fuselage until there is room in the cockpit for one man. One man should now station himself in the cockpit facing the tank while the other man crawls through the fuselage access door and, by working over the center radio shelf, raises the tank to clear the pad on station No. 7 bulkhead while the man in the cockpit pushes the tank into the fuselage until it rests in its cradle. The man in the fuselage should guide the aft strap between the retaining lugs on the aft end of the tank shell.

(8) While the man is in the fuselage he should fasten the rear tie-down strap by its turnbuckle, take the turnbuckle up and lockwire it. Connect the rear vent line to the fitting on top of the tank and tighten the clamp. Connect the two vent lines at the hose fittings aft of the tank and connect the fuel outlet line to the sump fitting at the bottom rear of the tank. Also connect the bonding tab from the fuselage floor to the nut plate on the tank to the right of the sump assembly.

(9) Move the Adel clamp at station No. 7 bulkhead down to its normal position which will lower the vent lines.

(10) The man in the cockpit should connect the front strap and take up the turnbuckle. (See figure 227.) Then connect the front tie-down strap and take up on the turnbuckle. Lockwire all turnbuckle bolts. (See figure 227.)

(11) Insert the short pipe elbow in the front vent line connection and connect the other end to the tank vent fitting. (See figure 216.) Tighten the two clamps.

(12) Connect the electric conduit disconnect plug to the fuel quantity transmitter as illustrated in figure 215.

e. To Install the Fuselage Tank Filler Neck. - After the tank is installed and all connections secured, the next step is to install the synthetic rubber filler neck. The installation of this filler neck will be greatly facilitated if the following directions are followed.

(1) Before installing the filler neck, inspect it for breaks and deterioration. If, after inspection, it is deemed necessary to install a new filler neck, the neck's inboard end must first be trimmed with a knife. Grasp the filler neck (figure 228) and start the cut as shown. Increase the depth of the cut until opposite the starting point and then decrease the depth of the cut for the remainder of the circumference of the neck. The depth of the cut should never exceed 1/2 inch. The old filler neck may be used as a guide for making this trim.

(2) Brush a generous coating of a dissolved mild soap flakes and water mixture on both the inside and

outside surface of the inboard end of the filler neck. (See figure 229.) This will allow the clamps to slide on over the end easily and also the filler neck to slide onto the tank filler opening flange freely.

NOTE: Do not brush the soap mixture on the outboard end of the filler neck or the clamp may not retain the cap adapter securely when installed.

(3) Install the two clamps on the filler neck, sliding the larger one on first over the inboard end of the neck. (See figure 230.)

(4) Squeeze the outboard end of the filler neck in the hands (figure 230) and insert the neck through the round opening in the fuselage skin. Guide the inboard end of the neck onto the tank flange and push the filler neck completely through the fuselage hole.

(5) Insert a wooden plug in the filler neck opening (figure 232) to keep screws and tools from accidentally falling into the tank.

(6) Install the nut plate on the filler neck and back up the flange on the filler neck with the nut plate. (See figure 231.)

(7) Insert an awl or punch in one of the holes in the fuselage skin to line up the holes with those in the nut plate. (See figure 232.) Insert the top screw and work around the opening until all screws are inserted. Tighten all screws, but do not tighten excessively.

(8) Insert the cap and adapter assembly. (See figure 233.) Push the cap in until it is flush with the fuselage skin and turn the cap handle so that it parallels the line of thrust.

(9) Tighten the two clamps inside the fuselage. One to retain the filler neck on the tank and the other to lock the adapter in the neck. (See figure 234.)

(10) Remove the two screws from the bonding tab nut plates, one on the right side of the tank (figure 227) and one on the left side of Station No. 5 bulkhead (figure 227). Attach the bonding tab from the right side of the fuselage to the tank and tighten the screw. Attach the bonding tab from the filler neck to the nut plate on station No. 5 bulkhead. (See figure 227.)

f. To Install the Armor Plate at Station No. 5.

(1) Lift the armor plate over the side of the cockpit and rest it on the two cockpit sills as illustrated in figure 214. With one man on each side of the cockpit grasp the armor plate at the bottom and top and allow the plate to lower straight down into the cockpit. All personnel should use extreme caution not to pinch or crush their fingers under the armor plate.

★ Whenever a new Filler Neck is installed it will be necessary to trim the end to insure a good fit on the Tank Filler Neck Flange. Start the cut on the Neoprene Neck as illustrated and cut around the circumference of the Neck increasing the depth of the cut until opposite the starting point. Then begin to decrease the depth of the cut until the remainder of the circumference has been cut away.

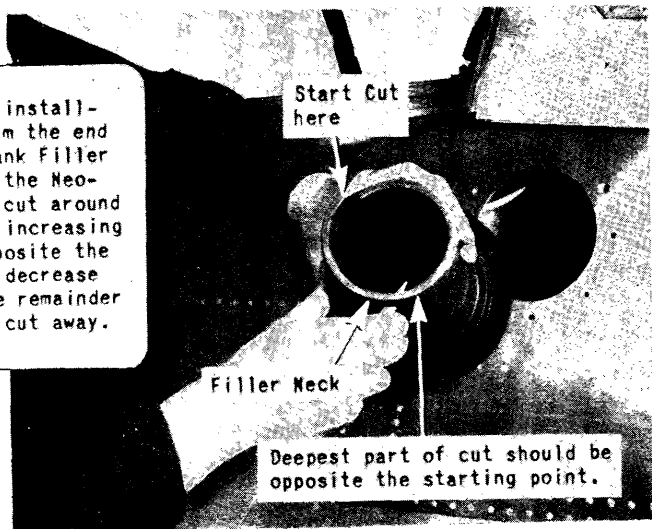


Figure 228 - Trimming Filler Neck Prior to Installation

★ Employing a mixture of Ivory Soap Flakes and Water, or equivalent, brush a generous coating on both the inside and outside of the Inboard End of the Filler Neck as illustrated. This will facilitate the installation of the Filler Neck on the Tank Flange and the Clamps on the Filler Neck.

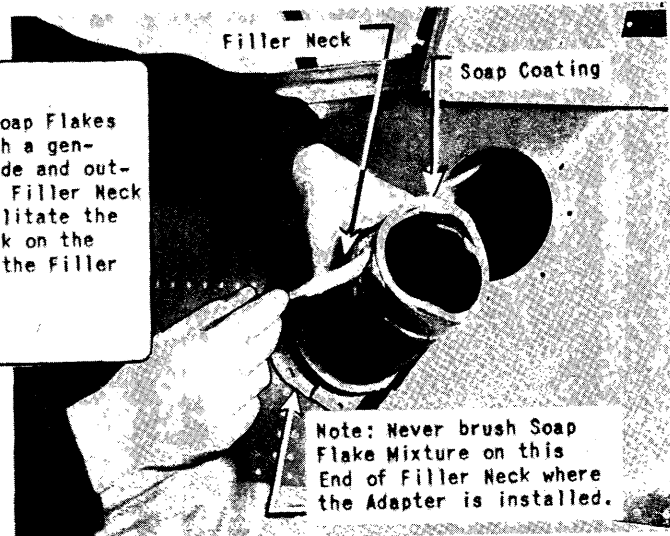


Figure 229 - Applying Soap Mixture to the Filler Neck before Installation

★ Slip the two Clamp Fittings on the Neoprene Filler Neck. Squeeze the Flange End of the Neck together as illustrated and insert the Neck through the Fuselage Access Hole. Guide the Filler Neck onto the Tank Neck Flange and push the Filler Neck Flange through the Fuselage Opening.



Figure 230 - Inserting Filler Neck Through Fuselage Opening



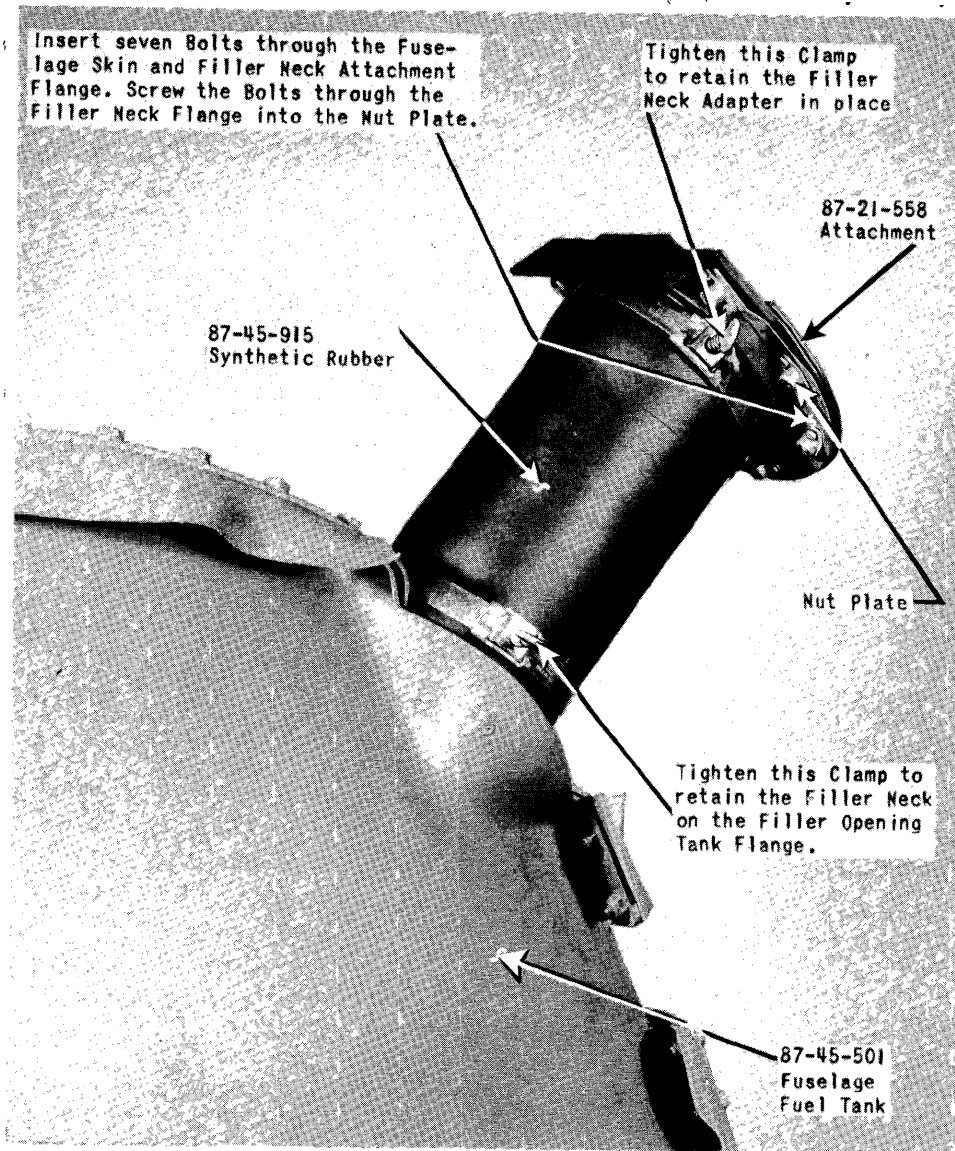


Figure 231 - Assembly of Filler Neck and Retainers

(2) When the plate is lowered into position secure it with two bolts.

(3) Install the small section of armor plate between the pilot's headrest and the large armor plate.

(4) Install the pilot's headrest.

(5) Install the name plate on the left side of the pilot's seat. (See figure 212.)

(6) After all bolts are installed tighten them evenly.

g. Complete the reassembly of the cockpit after the tank is installed as follows:

(1) Replace the belly bomb arming handle and tripod base.

(2) On all P-40E-1 airplanes replace the oxygen economizer and connect the line to the oxygen regulator.

(3) On all P-40F airplanes reinstall the engine control quadrant and connect all control rods to their proper controls.

(4) Reinstall the control stick and push-pull rod on the torque tube.

(5) Replace the damped rate control bracket between the hydraulic hand pumps and secure the bracket to the floor. This bracket will be installed only on P-40E-1 airplanes.

(6) Install the cockpit enclosure control crank by reversing the procedure outlined in figures 218 and 219.



★ Insert Wooden Plug in Filler Neck as illustrated to prevent Screws or Tools from accidentally falling into the Tank. Back up the Filler Neck Flange with the Nut Plate. Use an Awl or Punch to line up the Nut Plate Holes with those in the Fuselage Skin and insert the Seven Bolts around the circumference of the Filler Neck Hole.

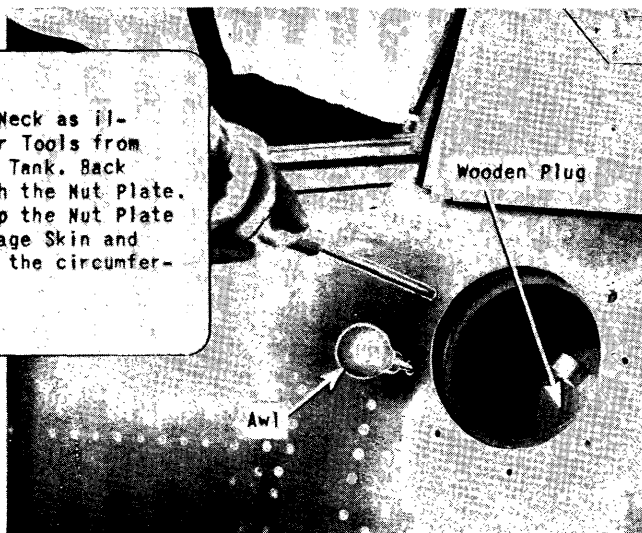


Figure 232 - Bolting Filler Neck in Place Through Fuselage Skin

★ Remove Wooden Plug in Filler Neck and insert the Cap and Adapter Assembly into the Filler Neck as illustrated. Push the Cap in until it is flush with the wing Skin and locate the handle on the Cap parallel with the thrust line of the Airplane.

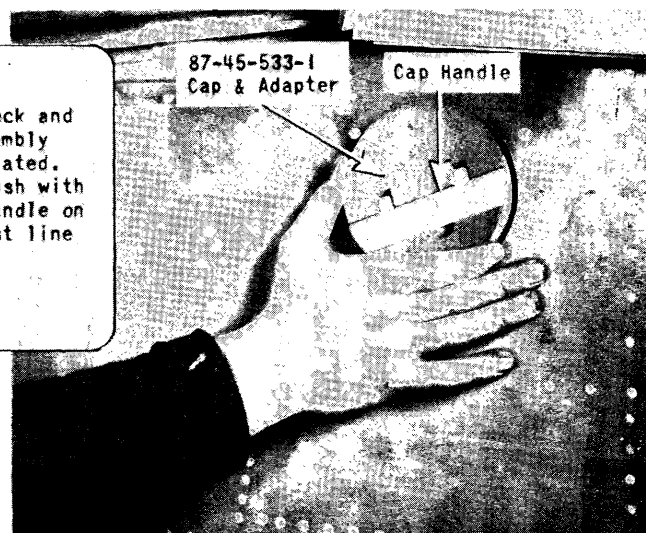


Figure 233 - Installing Cap and Adapter Assembly in Filler Neck

★ Tighten the two Clamps to securely retain the Cap Adapter in the Filler Neck and the Filler Neck on the Tank Flange. Connect the Bonding Tab to the Nut Plate on the aft side of Station #5 Bulkhead.

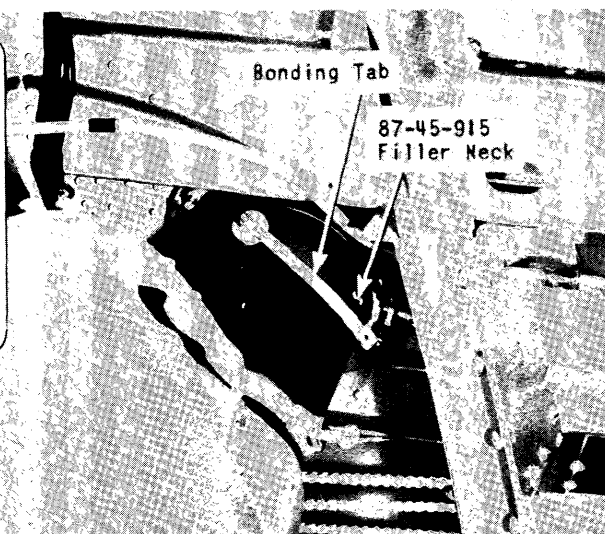


Figure 234 - Filler Neck Installation - Fuselage Fuel Tank

(7) Replace the hydraulic hand pump handle on the outboard pump.

(8) Return all control handles to their proper positions.

(9) Reinstall the type N-3A gun sight and complete the electrical connection to the sight.

#### h. To Install the Pilot's Seat.

(1) Lift the seat into the cockpit (figure 213) and lower it to the cockpit floor. Engage the seat support tubes into the two fittings on the cockpit floor.

(2) Insert the two bolts through the lugs on the armor plate and the top of the seat support tubes and tighten the bolts. (See figure 212.)

i. Inspect the fuselage tank drain nut for security, install the aft keel fairing section and the fuselage tank is installed and ready for refueling.

#### 5. To Install the Fuselage Fuel Tank with the Wing Panel Removed.

a. General. - The preparation of the fuselage prior to the tank installation is the same as outlined for the installation of the tank through the cockpit. With the wing panel removed the preparation of the cockpit prior to installation will be extremely simple. The only installation to be removed in the cockpit will be the oxygen economizer installed on P-40E-1 airplanes. After the preparations are completed install the fuselage fuel tank as follows:

(1) Move the tank under the fuselage and place it directly under the cockpit opening and turn the tank up on its forward end.

(2) Two men grasping the tank, one on either side, can now raise the tank up and start to tip it aft so that as the tank clears station No. 5 bulkhead it will start to enter the fuselage. Continue to raise the tank to a horizontal position and at the same time keep moving it into the fuselage through station No. 5 bulkhead.

(3) As the tank nears station No. 7 bulkhead one man can move aft under the fuselage opening and lift the aft end of the tank to clear the bulkhead. With the man at the forward end of the tank applying the force to move the tank into the fuselage, the man under the tank should lift the tank at every movement of the tank to clear the neoprene bulkhead pads and allow free movement of the tank into the fuselage cradle. Keep working the tank into the fuselage in this manner until it contacts the rear strap.

(4) One man can now take his place in the fuselage aft of the tank and complete all hose connections, fasten and safety wire the aft tie-down strap, connect the bonding tab at the rear of the tank and move the Adel clamp on the left side of station No. 7 bulkhead down to its original position.

(5) The man at the front of the tank should connect the conduit to the fuel quantity transmitter, fasten the forward retaining and tie-down straps by their turnbuckles, and safety wire the turnbuckles; connect the forward vent line, install the filler neck, and connect the bonding tabs from the filler neck to the fuselage and from the tank to the fuselage.

(6) The tank is now installed in the fuselage and a thorough inspection should be made to be sure that the installation is complete with all straps tight and secured with safety wire, all vent connections secured at their clamp fittings, all Adel clamps securely in place, and all bonding tabs connected to their nut plates.

#### 6. To Remove the Fuselage Fuel Tank with the Wing Panel Removed.

a. Preparation for the removal of the fuselage fuel tank with the wing panel removed should proceed step by step as outlined for removal of the tank through the cockpit. However, there should be no necessity to remove any controls from the cockpit except the oxygen economizer installed on P-40E-1 airplanes.

b. When the tank is ready for removal one man should station himself at the forward end of the tank just aft of station No. 5 bulkhead. The other man should be in the fuselage aft of the tank and by working over the center radio shelf he can apply force to move the tank forward while the man under the forward end of the tank will lift the tank to clear station No. 5 bulkhead. In this manner work the tank forward as far as possible. The man in the fuselage should now remove himself through the access door and station himself below the cockpit, and while the man at the rear of the tank tips the aft end up and slides it forward the man forward can guide the sliding tank down through the cockpit opening until it is in a vertical position. Then both men can grasp the tank, one on either side and lower it to the floor or ground. Remove the tank from under the fuselage. The removal of the tank whether through the top or bottom of the fuselage should proceed with extreme caution so that no damage will occur to the tank fittings, fuselage installations, or cockpit instruments and controls.