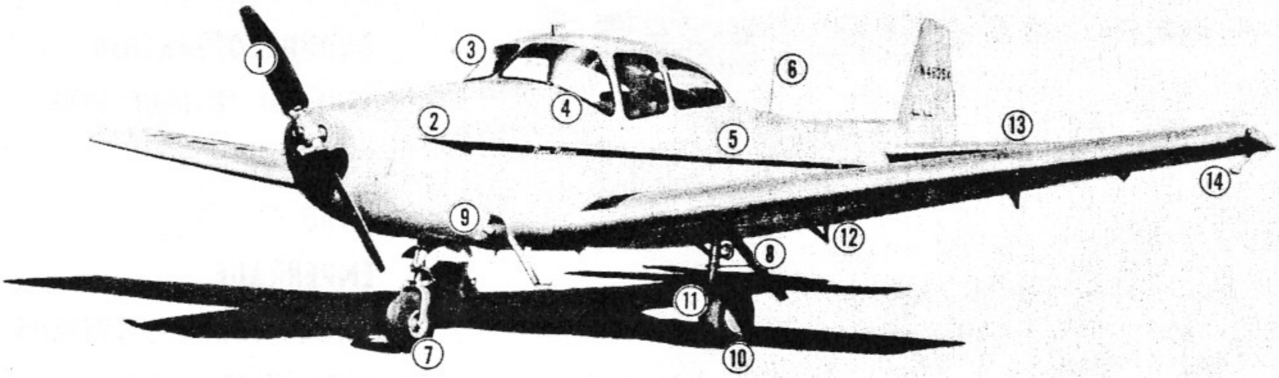

SERVICE MANUAL
1949



1 VARIABLE-PITCH PITCH PROPELLER
2 6-CYLINDER AIR-COOLED ENGINE
3 CLEAR-VISION CANOPY
4 DUAL CONTROLS
5 ALL-METAL CONSTRUCTION
6 V.H.F. ANTENNA
7 STEERABLE NOSE WHEEL
8 LANDING GEAR FAIRINGS
9 MUFFLER
10 HYDRAULICALLY RETRACTABLE TRICYCLE LANDING GEAR
11 HYDRAULIC BRAKES
12 WING FLAPS
13 DYNAMICALLY BALANCED ELEVATORS WITH ADJUSTABLE TRIM TABS
14 STATICALLY BALANCED AND DYNAMICALLY BALANCED AILERONS

Navion

SERVICE MANUAL

THIRD EDITION

1949 MODEL NAVION

APRIL 1, 1949

RYAN AERONAUTICAL COMPANY

Lindbergh Field, San Diego 12, California

GENERAL DESCRIPTION

IMPORTANT FEATURES, WEIGHTS, AND DIMENSIONS

The Navion is a four-place personal airplane, manufactured by Ryan Aeronautical Co. The Navion's distinguishing features are illustrated in figure 1. Weights and principal dimensions are shown on figure 2.

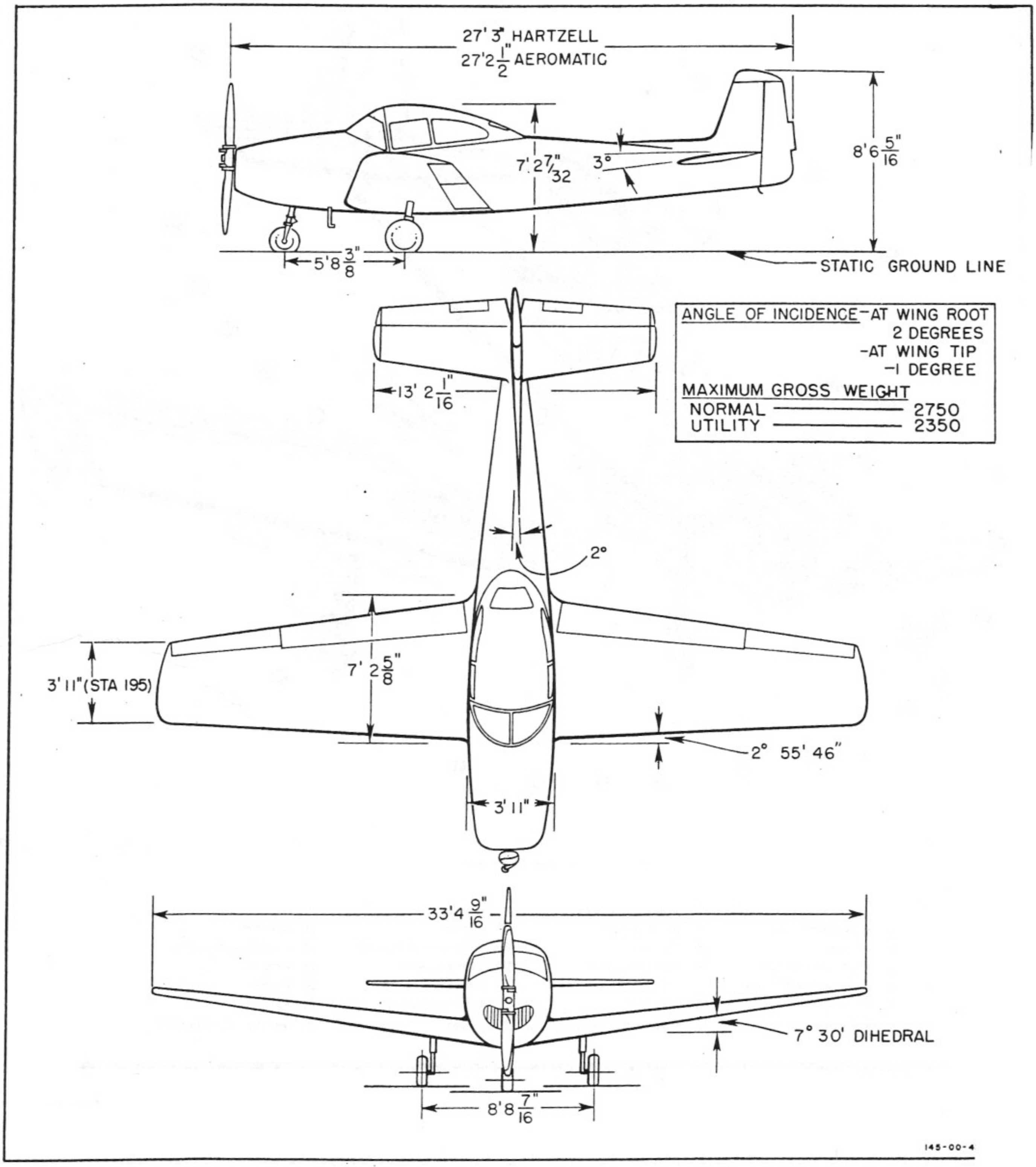
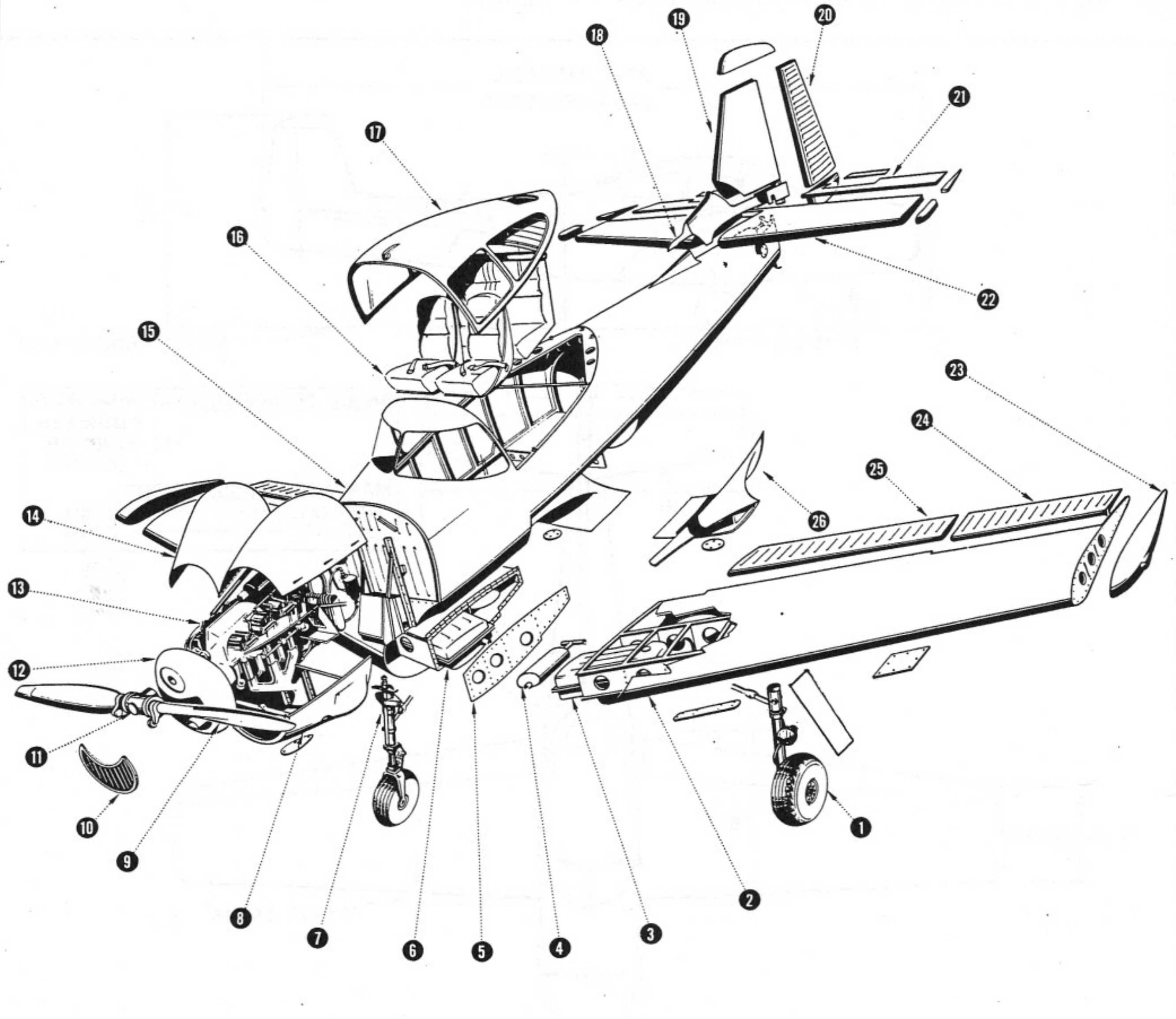


Figure 2 - PRINCIPAL DIMENSIONS



— KEY —

1	MAIN LANDING GEAR	7	NOSE LANDING GEAR	14	ENGINE COWL	21	ELEVATOR
2	LEFT WING	8	ENGINE MOUNT	15	FUSELAGE	22	HORIZONTAL STABILIZER
3	20-GALLON FUEL TANK	9	PROPELLER	16	FRONT AND REAR SEATS	23	WING TIP
4	ACCUMULATOR FUEL TANK	10	NOSE COWL GRILL	17	SLIDING CANOPY	24	AILERON
5	CENTER RIB	11	PROPELLER HUB	18	EMPENNAGE FILLETS	25	WING FLAP
6	20-GALLON FUEL TANK	12	NOSE COWL	19	VERTICAL STABILIZER	26	WING-TO-FUSELAGE FILLETS
		13	ENGINE AND ACCESSORIES	20	RUDDER		

Figure 3 - EXPLODED VIEW

SERVICING

SERVICING FUEL SYSTEM

Filling Fuel Tanks—The fuel tanks, having a total capacity of 39½ gallons, are serviced with 80 octane aviation fuel through a single filler in the right wing. *(See figure 4).* As an alternate, 90 octane fuel may be used. During transmission of fuel, the Navion must be grounded at the nose gear, or other convenient point. Fill the tanks to the top of the filler neck. To assure maximum fuel capacity, allow time for the fuel to transfer to the left tank. Install and secure filler cap.

WARNING

The following precautions should be observed:

Do not allow smoking, exposed flame, or sparks (such as sparks from energized electrical equipment) within 50 feet of the aircraft being refueled.

Stop the engine before refueling the airplane.

Make certain the airplane is grounded to the hose nozzle and gasoline container.

Wash off all the spilled gasoline to avoid vapor accumulation and gasoline pools.

Draining Fuel Tanks—A fitting at the forward end of the accumulator tank contains a combination fuel screen and tank drain. The fitting is accessible through the access hole in the skin under the wing, to the left of the center rib. To drain tanks *(figure 4),* cut safety wire, and remove drain plug and screen. The screen should be cleaned each time the tanks are drained. A petcock, adjacent to the drain plug, facilitates the daily requirement of draining accumulated water from the fuel tanks. A strainer on the front of the firewall is also provided with a petcock for draining accumulated water or sediment. The bowl of this strainer must be removed approximately every 50 hours for cleaning.

SERVICING OIL SYSTEM

Oil Specifications—Service the Navion with aviation oil of a grade based on the average ground temperature as follows:

Above 70°F	70°F to 20°F	Below 20°F
SAE 50	SAE 40	SAE 30

Checking Oil Level—Open the left section of the engine hinged cowling, remove the dip stick *(figure 4),* and check oil level against reference lines on the stick. The oil level should be maintained at the *full* mark.

Draining Engine Oil—The oil should be drained at the completion of each 25 hours engine time. Access to the drain plug is gained through an access door in the lower engine cowling. Remove the drain plug *(figure 4),* and allow the oil to drain from the engine; then replace and safety the oil plug. Complete the draining of the engine oil system by draining the oil system by draining the oil from the oil cooler. Remove the plug at the bottom of the oil cooler by-pass valve, and drain the oil into a container of approximately 2-quart capacity. Replace and safety the plug.

Refilling Oil System—When refilling the oil system after it has been drained, fill to capacity and run the engine briefly. Then replenish, to bring the oil up to the full level as indicated by the dip stick.

SERVICING HYDRAULIC SYSTEM

Checking Hydraulic Fluid Level—Raise engine hinged cowling on left side of engine. The hydraulic reservoir *(figure 4)* has a capacity of approximately 1/3 gallon. Remove dip stick *(attached to the filler cap),* and check the fluid level in relation to the marks on the stick. Should the fluid level be below the *full* mark, add fluid (Specification No. AN-VV-O-366 or or AN3580) through the dip stick opening. Replace dip stick.

Draining Hydraulic System—Position a fluid container (into which the fluid may drain), and disconnect the hydraulic line at the bottom of the reservoir. *(See figure 4.)* Drain fluid from the system lines by disconnecting several lines at a low point in the system. Connect the system lines, and the line to the bottom of the reservoir.

SERVICING MAIN LANDING GEAR TIRE

Maintain tire pressure of 25 psi.

SERVICING NOSE GEAR TIRE

Maintain tire pressure of 30 psi.

CAUTION

Do not install valve-core-remover type cap on valve stem—use only the short bonnet type.

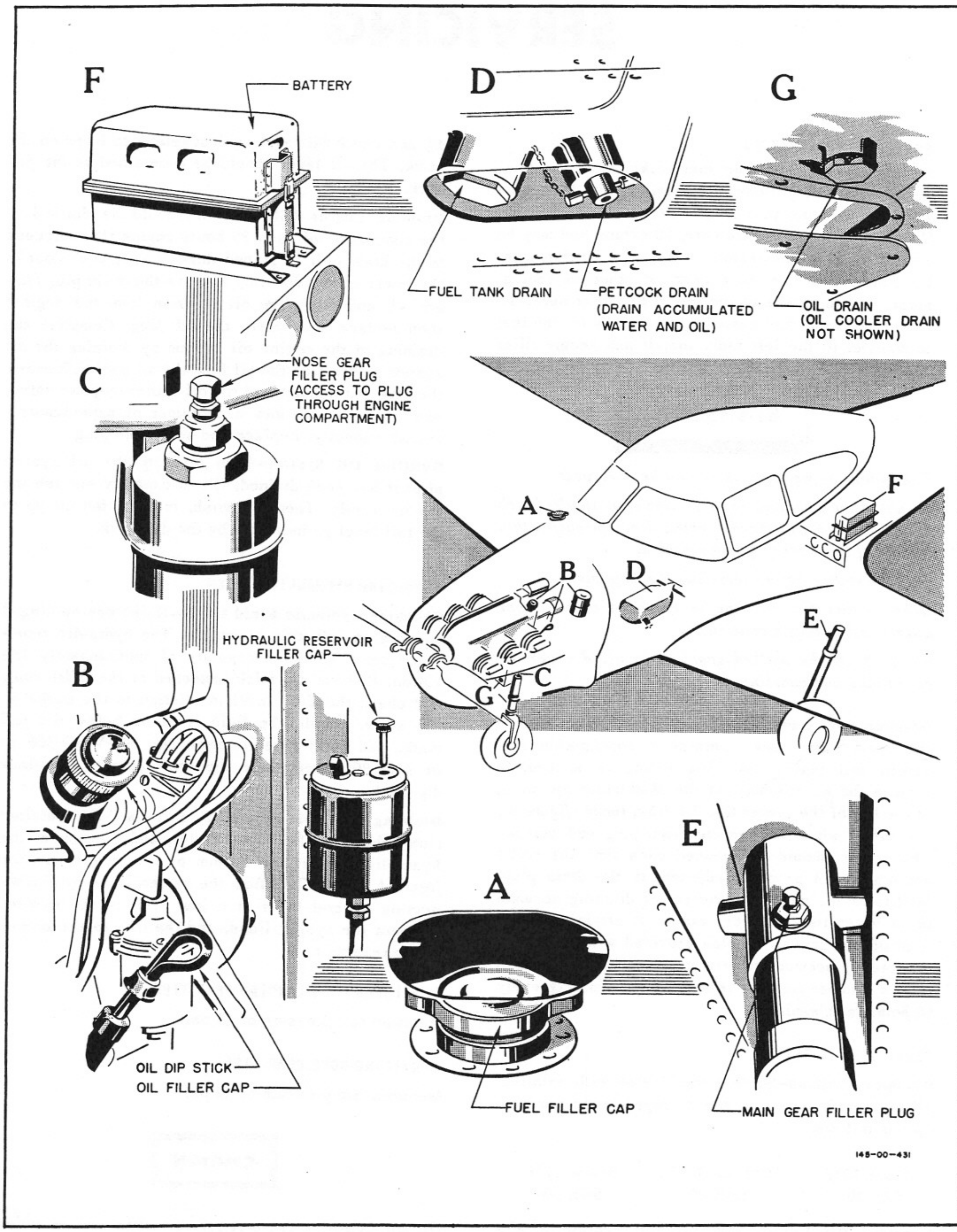


Figure 4 - SERVICING

SERVICING LANDING GEAR SHOCK STRUTS

Filling Landing Gear Shock Struts—Fill the shock struts *(figure 4)* with fluid (Specification No. AN-VV-O-366 or AN3580) as follows:

1. Jack the airplane, using the wing jacking points, until landing gear-tires are off ground.
2. Release air from strut by loosening filler plug.
3. Remove filler plug, and fully compress the strut.
4. Fill compressed strut with fluid.
5. Replace filler plug (finger-tight only); extend and compress strut several times to eliminate trapped air.
6. Compress strut, remove filler plug, and if necessary, add fluid to level of the filler plug hole.
7. Replace and securely tighten filler plug.

Inflating Landing Gear Shock Struts—Inflate the shock struts (airplane at approximate normal load) in the following manner:

1. Attach a high-pressure air hose to strut air valve.
2. Inflate strut until 1-5/16 inches (main gear) and 1½ inches (nose gear) of the polished piston can be seen between the packing nut and the strut piston shoulder.

NOTE

Small amounts of air can be removed from the strut by loosening the filler plug slightly, and then quickly tightening it. Do not depress the valve core to correct over-inflation.

3. Rock the airplane lightly by raising the wing of the corresponding strut. (This is to check the strut for possible sticking or binding.)
4. Recheck for proper strut dimensions.
5. Check the valve and filler plug for possible air leakage.
6. Install valve cap, which is a secondary seal, and tighten lightly with a wrench.

CAUTION

Excessive tightening of the cap will result in the seat of the cap depressing the valve core, allowing air to escape.

SERVICING LANDING GEAR BRAKES

Bleeding Landing Gear Brakes—Spongy or soft brake lever action may be caused by air bubbles in the brake system. To eliminate the air bubbles, bleed each brake as follows:

NOTE

During bleeding operation, fluid in hydraulic reservoir must be maintained as near the full level as possible.

1. Remove cap screw (located on the bleeder plug in the line to each brake), and attach a bleeder hose.
2. Place free end of bleeder hose in a partially filled can of hydraulic fluid so end of tube is submerged in fluid.
3. Apply brake pressure, loosen bleeder plug, and allow fluid to run until free of air bubbles.
4. Tighten bleeder plug, remove bleeder hose, and replace cap screw.

Bleeding Brake Lines—To bleed air from brake lines, proceed as follows:

1. Loosen fitting attaching nut in each main gear wheel well at point where flexible line attaches to rigid line in wing.
2. Apply brake pressure.
3. Disconnect fitting, allowing slight fluid seepage, until fluid is free of air bubbles; connect and tighten fitting.

SERVICING BATTERY

The battery *(figure 4)* should be checked at least every 10 hours. Warm climates require more frequent attention to the battery. Service battery as follows:

1. Remove battery cover.
2. Inspect water level within the battery.
3. Take hydrometer reading; recharge the battery if the gravity is below 1.240.
4. Add water if necessary.

CAUTION

When removing battery from airplane, remove battery and battery container together. This prevents the possibility of spilling acid on the airplane finish or upholstery.

LUBRICATION

GENERAL

Always lubricate carefully and thoroughly, as lubrication is most important for the continued operation of the Navion. Make sure the correct lubricants are used at the proper time. Apply lubricant sparingly, then wipe off excess grease. Oily surfaces collect dirt and grit which are detrimental to bearing surfaces because of their abrasive qualities. While lubricating the Navion, it is good practice to inspect the various parts closely, and test them for looseness and general wear. Specific lubrication points are illustrated in figure 5. When operating the airplane in extremely dusty conditions, clean and lubricate the parts more frequently.

SHIELDED AND SEALED BEARING LUBRICATION

Double shielded or sealed bearings are installed in all surface control pulleys, aileron bellcranks, and in aileron, rudder, and elevator hinge fittings, and do not require lubrication at normal check periods. They are prelubricated by the manufacturer.

BEARING SURFACE LUBRICATION

Excessive lubrication of bearing surfaces will attract dirt and grit. Therefore, bearing surfaces should be inspected to make sure only a thin film of oil is remaining after lubrication.

POINTS THAT REQUIRE NO LUBRICATION

Oilite bearings, control cables, and cockpit enclosure tracks, or other lightly loaded slides need not be lubricated unless protection against corrosion is necessary.

ENGINE ACCESSORY LUBRICATION

All engine accessories have prepacked bearings which do not require repacking until the overhaul period.

PROPELLER LUBRICATION

Aeromatic Propeller Lubrication—Check propeller for correct amount of lubricant at 50-hour intervals and add, as necessary, a special semifluid grease (Aeromatic Lubricant 7F). One-pound cans of this grease may be obtained from either a Navion dealer or the propeller manufacturer. Check lubricant level by turning propeller so that the 1/8-inch filler plug is on the bottom. While the propeller is in this position, remove No. 1 high-pitch stop bolt (stamped "1H"). Then remove the filler plug, and apply the approved lubricant through filler until grease comes out the high-pitch stop bolt hole. This method completely fills the propeller hub and avoids creating air pockets. *(See figure 5.)* For the first few hours of engine run-up or flight, white or gray streaks may appear on the propeller blade shanks. This condition does not indicate grease leekage, but is caused by assembly lubricant which is applied to the blade ferrules. Wipe grease streaks from blade with a soft, clean cloth.

CAUTION

Do not service propeller with a substitute grease, as serious damage may occur to the oil seals or bearings.

Hartzell Propeller Lubrication—Every 50 hours any of the following lubricants are recommended in the order of listing:

1. Stroma HT-1 (Z-801 Grease)
   Union Oil Company of California
2. Lubripate 630 AA
   Fiske Brothers, Toledo, Ohio
3. Stroma LT-1 (Z-815 Grease)
   Union Oil Company of California
4. Lubripate 707
   Fiske Brothers, Toledo, Ohio
5. Mobilgrease Aero. LO-H1 PD-535-5
   Socony Vacuum Oil Company

CAUTION

Do not service propeller with a substitute grease. Make sure propeller is not over-lubricated.

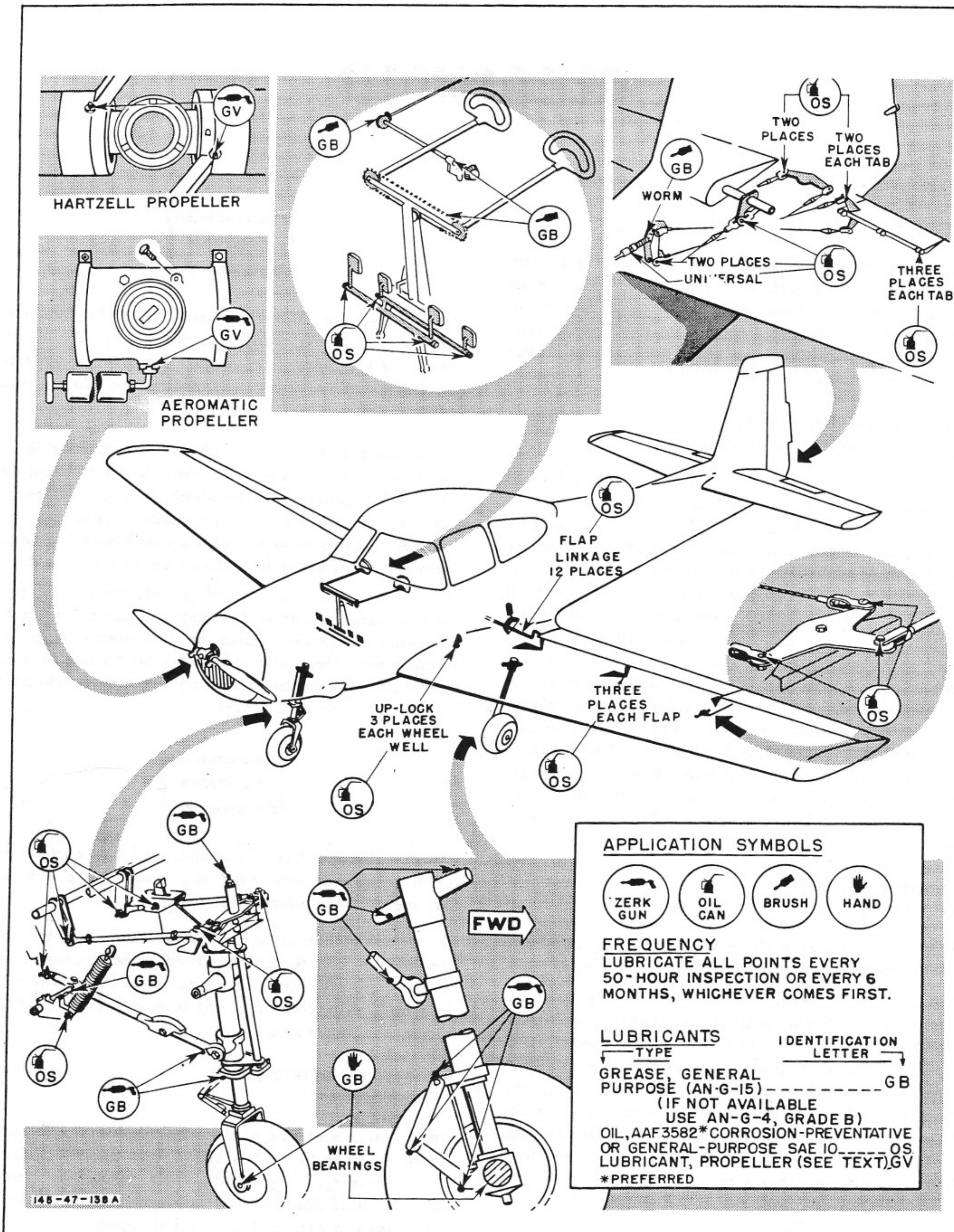


Figure 5 - LUBRICATION CHART

CLEANING

GENERAL

Keep the airplane clean and waxed, to help prevent corrosion. A clean airplane also offers less air resistance with a resultant increase in range and speed. Make sure the correct cleaners are used for the type of cleaning to be accomplished. Walk only in designated areas *(shown in figure 7C.)*

CLEANING AND MAINTAINING EXTERIOR SURFACES OF AIRPLANE

Close cowling and canopy securely. Apply a mild auto cleaner and water solution (such a cleaner should be either a neutral detergent of the soapless type con- :aining no alkali or other material which would corrode aluminum; or an alkaline silicate type obtainable from nanufacturers of industrial aluminum cleaners) to all ;urfaces, rubbing lightly with a sponge. Rinse sur- aces with clean, fresh water, drying with a soft, damp not wet) chamois. Inspect surfaces for oil stains, bug pots, etc., which do not respond to the cleaning so- ıtion, and remove them with a dry-cleaning solvent : kerosene. Whenever unpainted surfaces become dull, righten with a good grade of polish. Wax fuselage ıd wing surfaces, using a self-polishing liquid wax. etween wash jobs, dust may be removed from the sur- ces of the airplane by wiping lightly with a clean, ft cloth. Do not rub dusty surfaces.

EANING WINDSHIELD D CABIN WINDOWS

Flush plexiglas with clear water, using bare hand ıtly to feel and dislodge any dirt, salt, or mud.

Wash surface with an aluminum cleaning solution. fer to CLEANING AND MAINTAINING EXTERIOR RFACES OF AIRPLANE.) Make sure the water is : of dirt or other possible abrasives. A soft cloth, nge, or chamois may be used in washing, but uld only be used as a means of carrying water so- on to the plastic. Dry the surface, preferably with ean, damp chamois. However, a soft, clean cloth h as cotton flannelette) or soft tissues may be l, if care is taken not to continue rubbing the ic after it is dry.

emove oil and grease by rubbing lightly with a wet with kerosene.

CAUTION

Do not use the following materials on the windows: acetone, benzene, carbon tetrachloride, fire extinguisher fluids, gasoline, lacquer thinners, or window cleaning sprays. They may soften the plastic and cause crazing.

4. Do not rub the plastic with a dry cloth, as this is not only likely to cause scratches, but it also builds up an electrostatic charge which attracts dust particles to the surface. If the surface does become charged, patting or gently blotting with a clean, damp chamois will remove this charge as well as the dust.

5. If, after removing dirt and grease, the plastic surface is marred by scratches, apply a suitable scratch-removing compound (Parko or equivalent) by hand, using a soft, clean cloth to remove the polish. Several applications may be necessary to restore suitable clarity to the scratched area.

CAUTION

Do not attempt hand polishing until the surface is clean. The grit and sand may cause more serious damage than the original scratches.

6. After windshield and cabin windows are dry and free of dirt, wax them with a good grade of commercial wax to help prevent further scratching. Apply the wax in a thin, even coat and bring to a high polish with a clean, soft, dry cloth.

CLEANING AND MAINTAINING PAINTED SURFACES

The painted surfaces of the airplane are of a lacquer finish, and can be readily sanded and respotted whenever necessary. All painted surfaces should be cleaned with a mild auto cleaner and water solution, flushed with clean water, and then dried. Spots can be removed with a dry-cleaning solvent or kerosene. Keep a wax finish over the paint for best results.

CLEANING CHROME-PLATED PARTS

Chrome-plated parts should be kept polished and waxed. Should any blemishes appear, the part's appearance can be improved by cleaning the affected spots with ordinary household scouring powder. After scouring surface, apply wax coating.

CLEANING ENGINE SECTION

The engine section should be cleaned regularly to remove any collections of dirt and oil. The section is entirely accessible through the hinged cowling, and by removing the door in the lower surface of the fuselage under the engine. Remove dirt and oil with a dry-cleaning solvent or kerosene. Especially make sure that the engine cooling fins are clean, as dirty cooling fins can cause overheating of the engine.

CLEANING PROPELLER

All external metal parts of the propeller should be kept polished and waxed; remove any blemishes by using a scouring powder of a type that would be used to clean porcelain. The blade surfaces of the propeller are provided with a protective covering of plastic, and should be cleaned with a soap and water solution, and then flushed with clean water. Inspect blade surfaces for nicks or scratches, and repair surface if damaged. *Keep the blade surfaces smooth.* (A plastic repair kit for the Aeromatic propeller is obtainable from either a Navion distributor or the propeller manufacturer.) After making sure the blade surfaces are free from dirt, nicks, etc., apply a thin coat of self-polishing liquid wax.

CLEANING TIRES

Using a brush or cloth saturated in a soft soap and water solution, wipe surfaces clean; then rinse surfaces clean; then rinse surfaces thoroughly with tap water. After surface is thoroughly dry, apply a brush coat of thiokol tire paint, or rub surfaces with glycerine until a uniform appearance is obtained.

CLEANING LANDING GEAR AND HYDRAULIC ACTUATING CYLINDERS

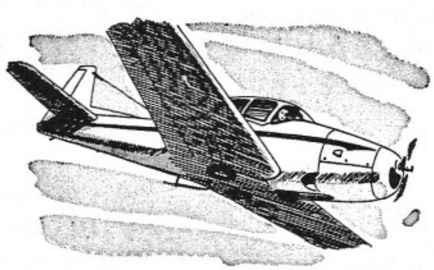
Keep the landing gears and hydraulic actuating cylinders clean, and well lubricated. Especially check the piston surfaces, as dirt and grit can cause leaks by cutting the strut seals. Remove dirt and oil with kerosene.

CLEANING AND CARE OF UPHOLSTERY

The upholstery is flame-resistant treated. The front and rear seats are designed so the upholstery can be removed and sent to be dry-cleaned; the cabin side panels are also removable for cleaning.

Fabric Upholstery and Carpeting—The fabric upholstery and all carpeting should be frequently cleaned with a whisk broom, clothes brush, or vacuum cleaner. Remove grease and oil stains by rubbing with a clean cloth wet with dry-cleaning solvent. Rubbing should be done with a circular motion starting outside the spot to be cleaned, and working toward the spot. A clean portion of the cloth should be used after every few strokes. Use the dry-cleaning solvent sparingly. Never pour the cleaning solvent on the spot to be cleaned. Do not use soap and water on fabric upholstery, as its flame-resisting qualities will be removed; dry-cleaning solvent does not affect the flame-resistance.

Artificial Leather (Vinyl-type) Upholstery—The vinyl-type artificial leather upholstery can be cleaned with soap and water, or dry-cleaning solvent. To remove film and grime, and to restore original luster, rub the surface of the upholstery briskly with a cloth slightly dampened with clean water and castile, or other soft soap. Next apply a cloth which has been moistened in clean water only, and finish be rubbing material dry with a clean, soft cloth. The friction produced by the dry cloth used in the last operation will restore the surface to its original brilliancy. A thin coat of self-polishing wax may be applied if desired.



GROUND HANDLING

GENERAL

Entrance to the cabin of the Navion is gained from the left side of the fuselage, just forward of the wing, by using the step provided. *(See figure 7C).* Walkway areas and handling points are also indicated in figure 7C. All access and inspection provisions are illustrated in figure 6.

HOISTING AIRPLANE

A special hoisting sling is available for hoisting the complete airplane or the fuselage, with or without the empennage. One of three rings on the sling is provided for each hoisting condition to ensure proper balance. For each condition, the landing gear should be retracted; otherwise, ballast weight will be required. Figure 7C shows use of sling for hoisting fuselage from wing. Complete instructions for use of sling are on sling spreader bar.

HOISTING ENGINE

The installation and removal procedures necessary prior to hoisting engine (such as removing hinged doors and disconnecting fuel lines, oil lines, etc.) and engine hoisting details are described in INSTALLING AND REMOVING ENGINE, page 52. The engine is hoisted by connecting a chain hoist hook to hoisting lug on the engine. *(See HOISTING ENGINE on figure 7C.)*

JACKING

General—There are four jacking points: a combination jacking and mooring fitting in each wing, just forward of the main landing gear; and one on each main landing gear strut.

Jacking Complete Airplane—Place a stand under the tail skid; make sure the tail skid is positioned properly. *(See JACKING COMPLETE AIRPLANE on figure 7C.)* Then place a jack stand, similar to the one shown in figure 7C, at each wing jacking point. Jack the airplane evenly, until each wheel is approximately 2 inches off the ground.

CAUTION

Before jacking, make sure jack is solidly engaged with wing fitting.

Jacking Main Landing Wheels—Raise the wheel off the ground *(as shown in JACKING MAIN LANDING WHEEL on figure 7C)*, using the combination uplock roller and intregral jack fitting on the main landing gear strut.

MOORING

A removable, combination jacking and mooring fitting is provided just forward of each main landing gear. The suggested method of mooring airplane is shown in figure 7A.

PUSHING AIRPLANE

The Navion is easily maneuvered and pushed, by one man, if the nose wheel is off the ground. The best position for pushing the airplane is to stand behind it and place one foot on the tail skid and push down till it is possible to grasp the leading edge of the horizontal stabilizer. The airplane may then be maneuvered as desired. When moving the airplane in a congested area, always station a man on each wing tip to make sure the tips clear all obstructions.

CAUTION

Do not push, pull, or lift airplane by aileron, elevators, or propeller.

LEVELING

Leveling Airplane Laterally (Airplane on Jacks)—*(See figure 7B.)* Open canopy and lay a straight bar across the upper fuselage longerons, at the junction of the windshield and canopy tracks. Place a leveling protractor on top portion of bar, and lower or raise one wing as required.

Leveling Airplane Longitudinally—*(See figure 7B.)* Level airplane longitudinally by placing a straight bar on the leveling lugs on the right side of the fuselage. Then place a leveling protractor on bar, and raise or lower tail of airplane as required.

DATUM POINT

The horizontal datum point is fuselage station 0. As station 0 is forward of the airplane, a reference jig point is established at the centerline of the forwardmost bolt in the lower wing attaching angle (fuselage station 93¼). *(See REFERENCE JIG POINT on figure 7B.)*

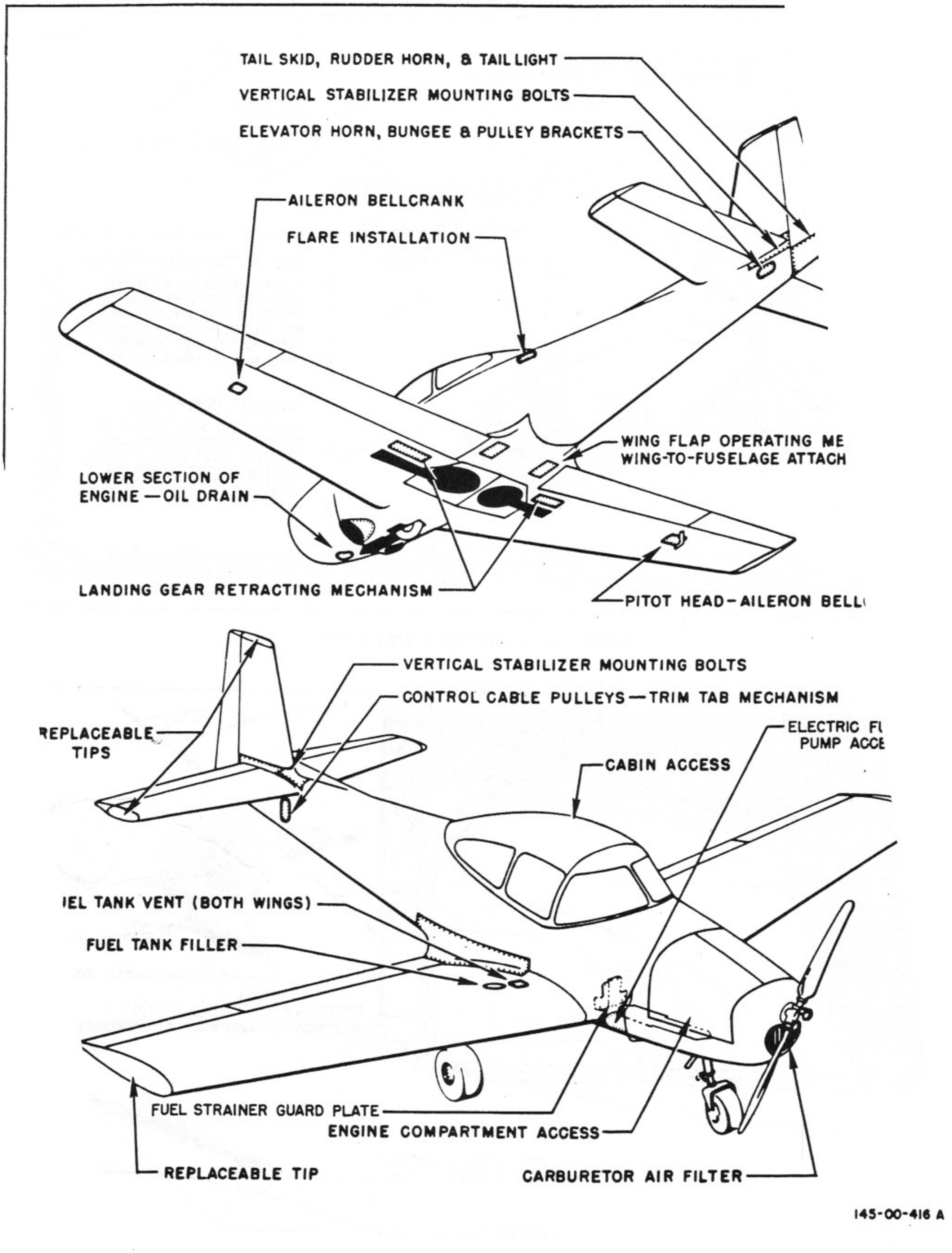


Figure 6 - ACCESS AND INSPECTION PROVISIONS

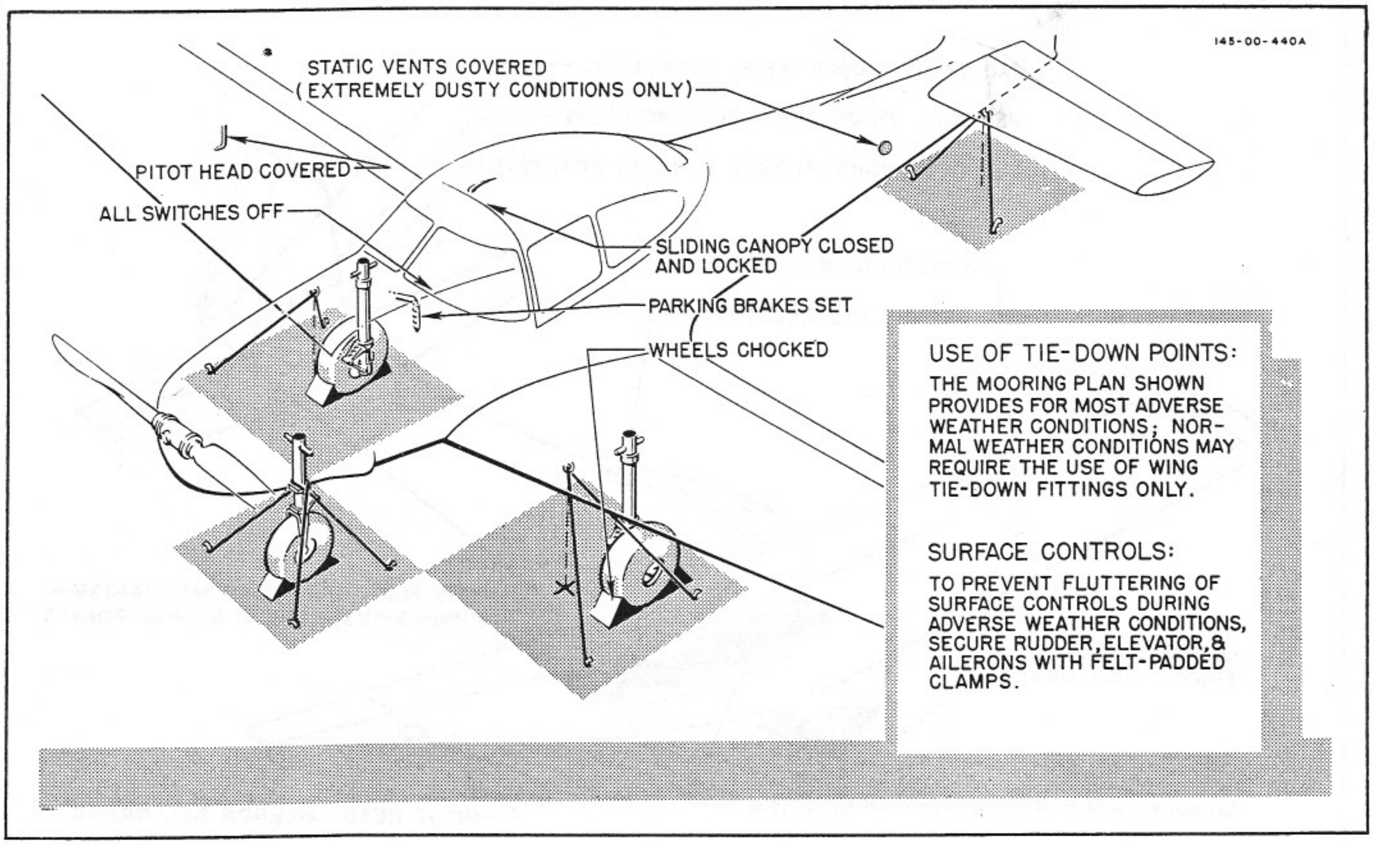


Figure 7A - MOORING AIRPLANE

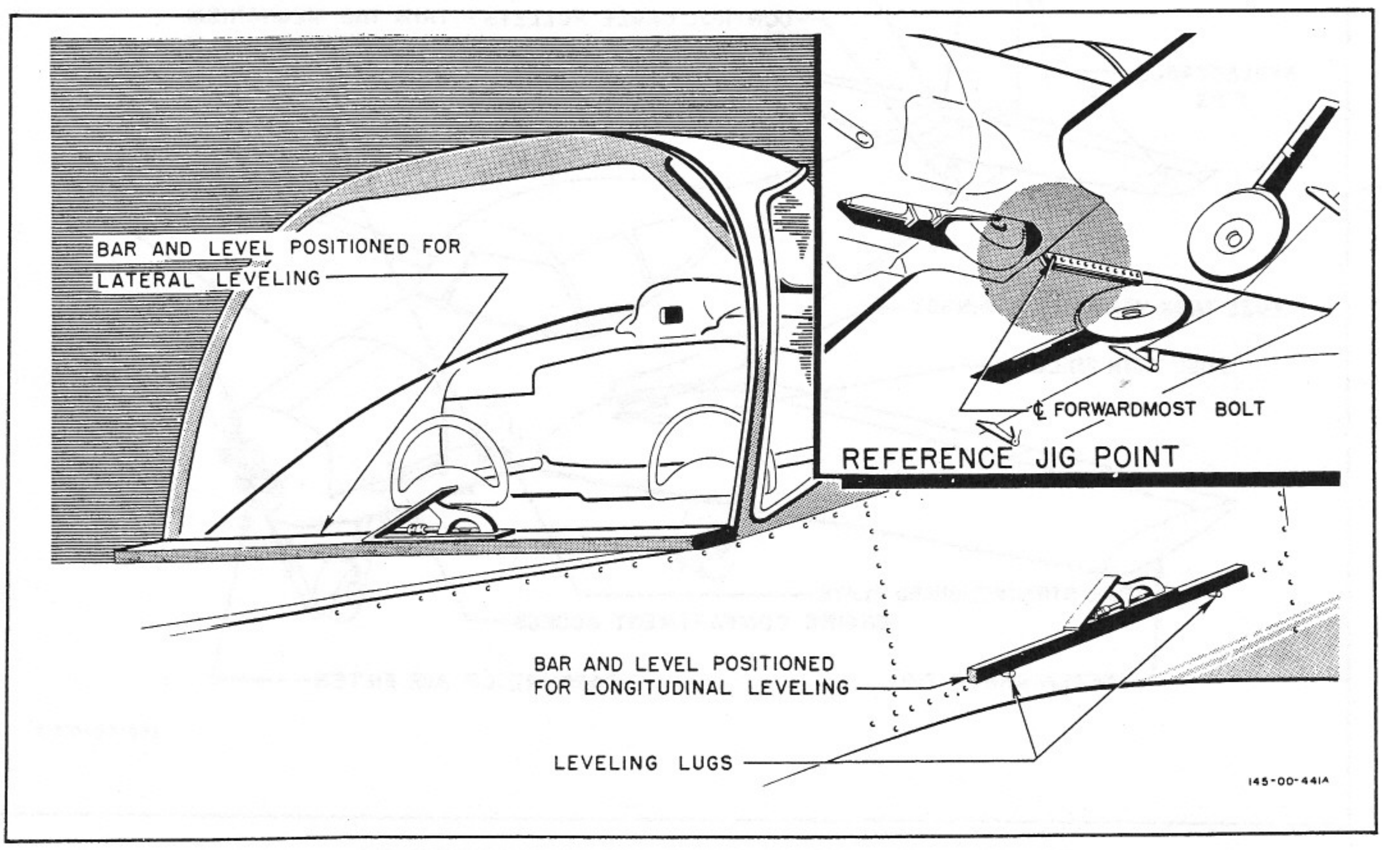


Figure 7B - LEVELING AIRPLANE

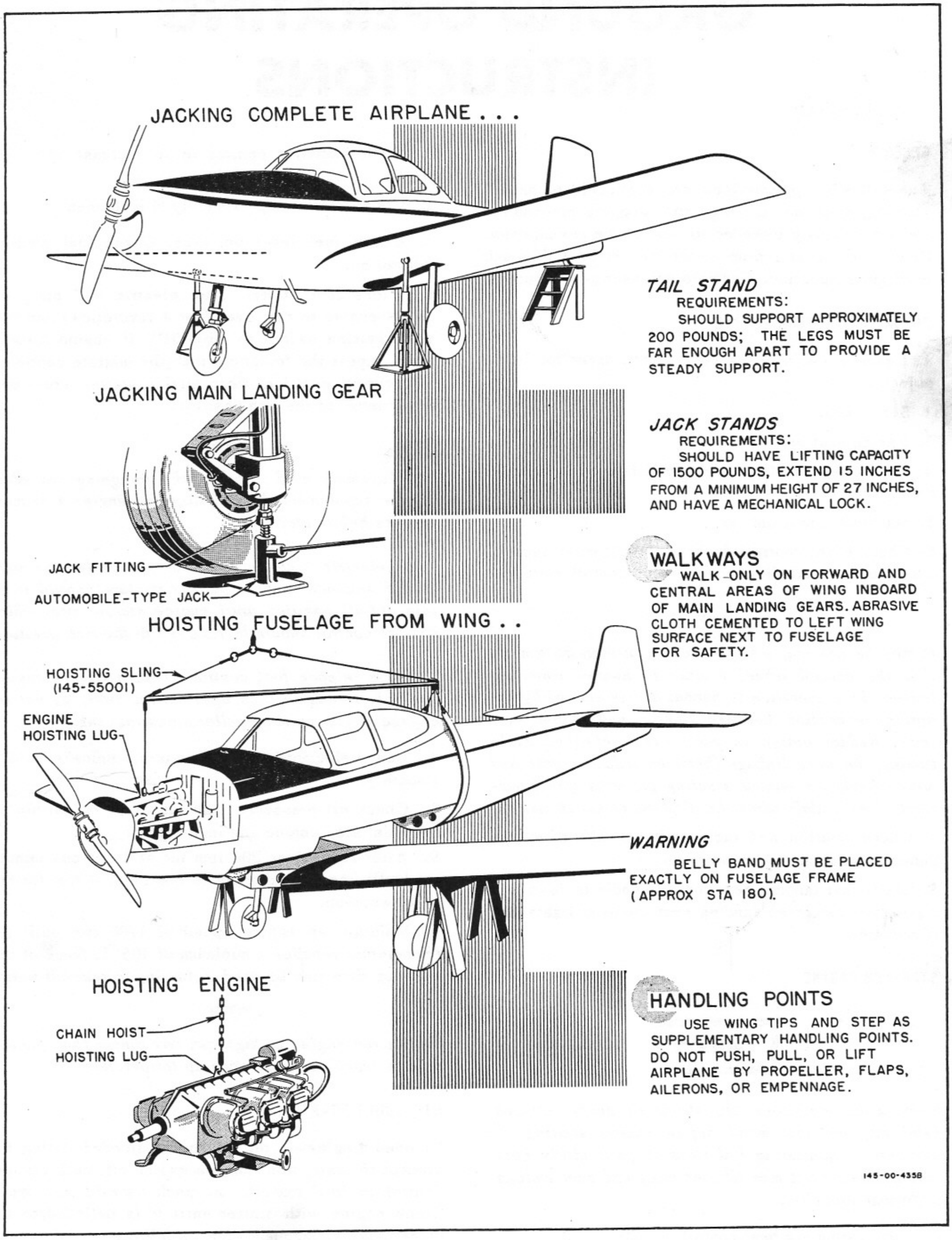


Figure 7C - GROUND HANDLING

GROUND OPERATING INSTRUCTIONS

GENERAL

The following instructions are applicable to normal starting, warm-up, taxiing, and stopping procedures, and are primarily intended for use of the ground crew. Prior to the first run-up of the day, make a thorough preflight inspection. Controls are shown on figure 8.

PRIOR TO STARTING ENGINE

1. Examine cabin & baggage compartment for loose objects.

2. Set brakes.

3. Fasten seat belt.

4. Adjust seat so that rudder pedals can be reached through full travel.

5. Set clock and altimeter.

6. Check flight controls for free and proper movement. Observe corresponding movement of control surfaces.

NOTE

It may be noticed, while checking aileron movement, that the control wheel returns to neutral when released. This condition is normal and is caused by the spring connection between aileron and rudder systems. Rudder action is more easily checked while taxiing, because linkage (between rudder pedals and nose wheel) for ground steering prevents free movement of the pedals when the airplane is not in motion.

7. Check ignition and radio switches off; then turn generator and battery switches on.

8. Check that landing gear control handle is down and make sure the green landing gear position lights are illuminated.

STARTING ENGINE

CAUTION

When wind conditions are strong or gusty, always head airplane into wind before engine starting or warm-up. A quartering tail wind is particularly hazardous, because it may lift one wing and gear enough to damage propeller.

1. Push carburetor heat control in *(off).*

2. Push mixture control in *(full rich).*

3. Push propeller control in to increase rpm *(low pitch).*

4. Crack throttle approximately ¼ inch open.

5. Check fuel level on gage. Check fuel shut-off control on.

6. Press foot starter. Turn electric fuel pump on. Allow engine to turn over 3 or 4 revolutions and then turn ignition switch to "BOTH". If engine fails to start, repeat the foregoing with the mixture control in idle cut-off position. When engine starts, return mixture control to the rich position.

NOTES

**In extremely cold weather, the foregoing procedure can be supplemented by priming the engine 4 or more strokes before starting.*

**The electric fuel pump should not be left on more than 5 seconds without pulling mixture control in to idle cut-off position until engine starts, after which mixture control should be returned to the rich position.*

**Always release foot control as soon as the engine catches. If engine dies after initial start, do not re-engage starter until propeller stops rotating.*

7. Leave electric fuel pump on until engine is running smoothly.

8. Check oil pressure. If not up to 10 psi within 30 seconds, stop engine and investigate.

9. After running at 800 rpm for at least one minute gradually increase throttle to obtain 1200 rpm for engine warm-up.

10. Maintain an engine speed of 1200 rpm until oil temperature reaches a minimum of 105°F. Some of the warm-up time may be used in taxiing to take-off point.

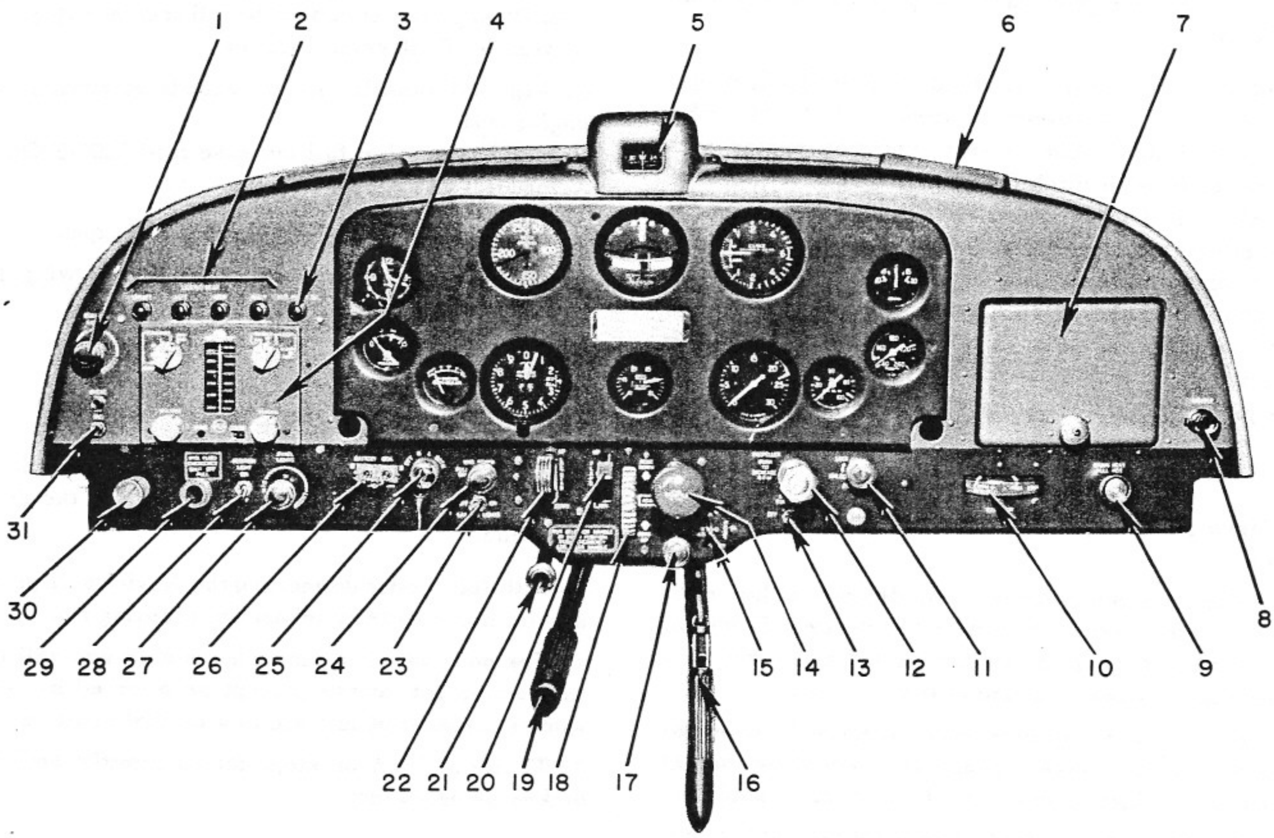
NOTE

Do not run engine at high rpm any longer than necessary to reach minimum warm-up temperature.

DIFFICULT STARTS

Flooded Engine—If the engine is flooded during an attempt to start, turn ignition switch off, pull mixture control to idle cut-off, and push throttle full open. Crank engine with starter until it is believed to be clear. Make subsequent start as follows:

1. Crack throttle approximately ¼ inch open.



1 GEAR INDICATOR LIGHTS CONTROL
2 GEAR POSITION INDICATORS
3 HYD. POWER INDICATOR LIGHT
4 RADIO
5 MAGNETIC COMPASS
6 WINDSHIELD DEFOGGING OUTLET
7 GLOVE COMPARTMENT
8 CIGARETTE LIGHTER
9 HEAT CONTROL
10 CABIN AIR CONTROL
11 MIXTURE CONTROL
12 PROPELLER CONTROL
13 ELECTRIC FUEL PUMP
14 THROTTLE
15 ELEVATOR TRIM INDICATOR
16 BRAKE CONTROL
17 CARBURETOR HEAT CONTROL
18 ELEVATOR TRIM CONTROL
19 HYDRAULIC HAND PUMP
20 FLAP CONTROL
21 LANDING GEAR EMERGENCY CONTROL
22 LANDING GEAR CONTROL
23 LANDING LIGHT SWITCH
24 HYDRAULIC POWER CONTROL
25 IGNITION SWITCH
26 BATTERY & GENERATOR SWITCHES
27 PANEL LIGHT SWITCH
28 POSITION LIGHT SWITCH
29 HYD. FLUID EMERG. SHUT-OFF CONTROL
30 FUEL PRIMER
31 RADIO JACKS

Figure 8 - CONTROLS

2. Push mixture control in *(full rich).*

3. Press foot starter, turn ignition switch to both.

4. Turn on electric fuel pump until engine runs smoothly.

Cold Weather Starting (Hartzell Propeller)—When operating under conditions of extreme cold (32°F or below), it is advisable to start and stop engine with propeller in high pitch (control full out). If propeller is left in low pitch under such conditions, oil in the propeller actuating cylinder may congeal before the next engine start, making it difficult for the propeller to change pitch. After starting in high pitch, wait until oil pressure reaches 40-50 psi and oil temperature indicates a definite rise before moving control to low pitch position.

TAXIING

1. Make sure wing flaps are up and hydraulic power is on.

2. Release parking brakes and depress either right or left rudder pedal to turn in the desired direction. With full rudder deflection, the Navion will pivot on a point about halfway inboard of the wing tip.

3. The nose wheel is inherently stable and will maintain a straight course (except as affected by torque) when the rudder pedals are in a neutral position.

4. To slow down or stop, retard throttle and apply brakes as necessary.

ENGINE WARM-UP AND GROUND TEST

1. Maintain an engine speed of 1200 rpm until oil temperature reaches a minimum of 105°F; then advance throttle to 1700 rpm (Hartzell propeller control in full increase rpm).

2. Check instruments for desired readings as shown by Instrument Dial Markings. Check ammeter for reading between 2 (minimum) and 23 (maximum) amps.

NOTE

Under certain operating conditions (when outside air temperatures are low, or heavier oil is used), the oil pressure may exceed the specified desired operating range without damage to the engine.

3. Check each magneto for drop-off (75 rpm maximum).

4. Check operation of carburetor heat system, by pulling control full out and noting drop in engine rpm with heat on, then push control in (off position).

5. Hartzell: Pull propeller control and note drop in rpm. Push propeller control to full increase rpm.
Aeromatic: Push control full in.

6. With full throttle (10-20 seconds maximum) check engine rpm.
Hartzell: (control at full increase rpm) 2200-2300.
Aeromatic: 2450-2550.

7. Retard throttle to approximately 1200 rpm.

8. Check hydraulic system by operating wing flaps through one complete cycle.

TAXIING

1. Make sure wing flaps are up.

2. Remove wheel chocks, and release brakes; depress either right or left rudder pedal to turn in the desired direction.

3. With full rudder deflection; the Navion will pivot on a point about halfway inboard of the wing tip.

4. The nose wheel is inherently stable, and will maintain a straight course (except as affected by torque) when the rudder pedals are in a neutral position.

5. To slow down or stop, retard throttle and apply brakes as necessary.

STOPPING ENGINE

1. Set brake.

2. Cool engine before shut-down, by idling at 700 to 900 rpm for 2 to 3 minutes.

3. To stop engine, pull mixture control to full out *(idle cut-off).* Leave mixture control in idle cut-off position until engine is again started.

4. When propeller stops spinning, turn off ignition, generator, and battery switches.

BEFORE LEAVING AIRPLANE

1. Make sure all switches are off.

2. After leaving cabin, close and lock canopy.

3. Chock wheels. (If brakes are hot, release handle after chocking wheels.)

4. Install cover on pitot tube head.

5. Moor airplane if necessary.

STORAGE INSTRUCTIONS

GENERAL

It is always a good policy to store aircraft in a dry hangar, particularly in areas where salt air or dust is present, or where the air is highly humid. Such conditions are highly conducive to corrosion of aluminum alloy materials. Under normal conditions, aluminum alloy materials are highly resistant to corrosion and will last indefinitely if kept clean. Should it become absolutely necessary to store the airplane outside, consult your Navion dealer on products available for protecting the aircraft against corrosion.

EXTENDED STORAGE OF AIRPLANE IN HANGAR

(Airplane not to be flown for 31 days or longer.)

The Navion can be stored indefinitely in a dry hangar if the engine, battery, and tires are adequately protected, and if outer surface of aircraft is cleaned and waxed occasionally. The storage treatment is as follows:

1. Preserve engine and propeller. (Refer to EXTENDED STORAGE OF ENGINE and EXTENDED STORAGE OF PROPELLER, pages 18 and 20 respectively.)

2. Remove battery, and store in as cool (not freezing) a place as possible. Recharge once each month in temperatures below 80°F, and every 2 weeks in temtemperatures above 80°F.

3. Jack airplane to relieve pressure from tires if airplane is to be stored for several months. (Refer to JACKING, page 10.) If airplane is not jacked, rotate wheels at least once every 30 days to change supporting points.

4. Clean any oil or grease from tires, and coat with tire preservative. (Refer to CLEANING TIRES, page 9.) Covers should be used to prevent grease and oil from contacting tires during storage.

5. Clean and wax airplane. (Refer to CLEANING AND MAINTAINING EXTERIOR OF AIRPLANE, page 8.)

6. Touch up any scratched or worn paint, especially around wheels, struts, and wheel wells.

7. Remove dust collections as frequently as possible during storage, and clean and wax as required.

8. At least once a month, inspect for corrosion. The first sign of corrosion on unpainted surfaces is in the form of whitish deposits or spots. Corrosion under painted surfaces is generally characterized by a scaly or blistered appearance, or sometimes by a discoloration of the paint.

TREATMENT OF ENGINE FOR STORAGE

To guard against engine corrosion, it is advisable to take certain precautions whenever engine is to remain idle for more than a day. This applies regardless of climatic conditions, and whether or not engine is sheltered from weather. Except when engine is to remain idle for more than 30 days, the work necessary to protect the engine is negligible, compared with the positive assurance it offers against corrosion. These instructions are applicable whether the engine is to remain in the airplane, or be removed. For instructions on preparing carburetor for use after storage, refer to PREPARING CARBURETOR FOR USE, page 56.

CAUTION

The corrosion-preventive mixture used to preserve engines is harmful to paint, and if sprayed or spilled on painted surfaces, should be wiped off immediately with a cloth.

MATERIALS REQUIRED TO PREPARE ENGINE FOR STORAGE

MATERIAL	DESCRIPTION OR USE	SPECIFICATION
Corrosion-preventive Compound	Use undiluted on external unpainted parts only, of engine and propeller.	AN-C-52, Type 1
Fuel	Unleaded gasoline.	AN-F-24
Dry-cleaning Solvent		P-S-661
Engine Oil	Use to service engine.	*
Engine Oil	Use to flush carburetor only, regardless of temperature.	AN-VV-O-446, Grade 1065 (SAE 30)
Corrosion-preventive Mixture	Use to spray engine interior.	AN-VV-C-576, Type 2**

MATERIAL	DESCRIPTION OR USE	SPECIFICATION
Tape	Moisture-resistant noncorrosive.	AN-T-12
Paper	Greaseproof, noncorrosive.	AN-P-12, Grade A

*Use grade normally used to service engine according to prevailing temperature. (Refer to OIL SPECIFICATIONS, page 3

**If AN-VV-C-576, Type 2, is not available, it can be made by mixing 25 per cent by volume of AN-VV-C-576, Type 1, with 75 per cent by volume of engine oil.

SHORT STORAGE OF ENGINE

(Engine not to be operated from 1 to 7 days)

1. Every other day, warm up engine until desired oil temperature (110°F to 175°F) is reached.

NOTE

Do not exceed desired oil temperature.

2. On intervening alternate days, rotate propeller at least four revolutions by hand.

TEMPORARY STORAGE OF ENGINE

(Engine not to be operated for 8 to 30 days)

CAUTION

The temporary storage period should not be extended or repeated. If the engine has been temporarily stored for 30 days and will be stored for a longer period, the engine should be considered to be in extended storage status, and the treatment directed in the following paragraph, EXTENDED STORAGE OF ENGINE, must be accomplished.

1. Disconnect the left hot air inlet duct from carburetor air mixing chamber.

2. Place hot air control in full out position.

3. Start engine, and run it until normal operating temperatures are obtained.

4. Operate engine at maximum idling speed and introduce approximately one quart of corrosion-preventive mixture into the induction system. This is accomplished by discharging the vaporized mixture into the mixing chamber as close as possible to the carburetor throttle valve.

5. Reconnect the left hot air inlet duct to air mixing chamber.

EXTENDED STORAGE OF ENGINE

(Engine not to be operated for 31 days or longer)

1. Drain engine oil system.

2. Place a minimum of 6 quarts of corrosion-preventive mixture in sump.

3. Disconnect left hot air inlet duct at carburetor air mixing chamber.

4. Place hot air control in full out position.

5. Run engine on unleaded gasoline for approximately ½ hour at 1000 rpm.

6. Just before completing the ½-hour running period, spray one quart of corrosion-preventive mixture into the induction system. Discharge the vaporized mixture as close as possible to the carburetor throttle valve, with engine operating at maximum idling speed.

7. As soon as practical after completing the ½-hour running period, remove spark plugs to allow vapors to escape.

8. Drain corrosion-preventive mixture, and remove oil screen, located on rear of engine at right-hand side.

9. If airplane is to be stored inside hangar, drain fuel from tanks. Do not remove fuel filler cap.

10. Prepare carburetor for storage. (Refer to EXTENDED STORAGE OF CARBURETOR, page 19.)

11. Lightly coat the magneto cam, springs, and all steel parts of the breaker mechanism with engine oil.

CAUTION

Use extreme care so that no oil reaches the breaker points.

12. Seal all external openings of the magneto with tape.

13. Spray the accessory drive gear section with corrosion-preventive mixture while the propeller is being turned. Insert spray nozzle into oil filler neck opening, and spray for at least 12 seconds to assure thorough coverage.

14. Dip carburetor air filter, oil sump plug, oil screen, and oil filler cap in corrosion-preventive mixture, and reinstall.

15. Spray cylinders with corrosion-preventive mixture through the top spark plug holes. Place each piston on the bottom of the suction stroke before operating sprayer. Be sure that spray reaches all parts of cylinder and top of piston. Rotate crankshaft at least two revolutions (stop Aeromatic propeller with filler cap upright); then respray the cylinder space above each piston. After this treatment, do not rotate propeller.

16. Placard propeller, "DO NOT ROTATE PROPELLER."

17. Spray all spark plugs with corrosion-preventive mixture, and reinstall.

18. Apply corrosion-preventive compound on all external, unpainted steel parts, and cover or wrap with greaseproof paper, secured with tape.

19. If the propeller is to be removed and stored separately, coat exterior of shaft with corrosion-preventive compound. Cover threads of the propeller shaft with a thread protector, wrap the shaft with a greaseproof wrapper, cover with oilcloth, and tape securely.

20. If airplane is stored outside, disconnect hot air inlets at mixing chamber. Then cover the carburetor air scoop, exhaust pipe outlets, and hot air inlets at mixing chamber with a suitably anchored double thickness of oilcloth.

PREPARATION OF ENGINE FOR SERVICE AFTER SHORT STORAGE

Engines in short storage require no preparation for service.

PREPARATION OF ENGINE FOR SERVICE AFTER TEMPORARY STORAGE

1. Turn propeller slowly by hand at least four or five revolutions to determine that cylinders are free of any accumulations of water, oil, or fuel, and that the valves operate freely. If any valves are found to be sticking, lubricate the stems with a mixture of gasoline and lubricating oil. Make sure that all valves are free before the engine is placed in service.

2. Clean spark plugs.

3. Run up engine.

PREPARATION OF ENGINE FOR SERVICE AFTER EXTENDED STORAGE

1. Remove all plugs and covers from openings, and wipe corrosion-preventive mixture from external steel parts with a rag.

2. Wipe breaker mechanism of magnetos; then lubricate.

3. Remove oil sump and oil cooler drain plugs. Drain oil and replace plugs.

4. Remove oil screen, and clean thoroughly in gasoline.

5. Slowly rotate crankshaft four or five revolutions by hand, and check for proper operation of the valve mechanism before installing the spark plugs. Make sure that excessive corrosion-preventive mixture is not present in the cylinders. Remove any excess mixture with a hand-pump, or by draining.

6. If any valves are found to be sticking, lubricate the stems with a mixture of oil and gasoline. Make sure that all valves are free before the engine is placed in service.

7. Check spark plug adjustment, and install spark plugs.

8. Prepare carburetor for use. (Refer to page 56.)

9. Prepare engine for initial run-up. (Refer to page 54.)

EXTENDED STORAGE OF CARBURETOR

See figure 37 to identify parts referred to in the following text.

1. Remove filler plug located below, and to the left of, the main metering jet plug.

2. Remove the 1/8-inch pipe plug at bottom of regulator cover.

3. Remove fuel strainer assembly.

4. Allow fuel in carburetor to drain thoroughly.

5. After carburetor has drained, replace plugs and a fuel strainer.

6. Remove the 1/8-inch pipe plug from end of manual mixture control assembly, and allow any moisture present to drain. Replace plug immediately.

7. Place mixture control lever in *full rich* position, and throttle lever in *full open* position.

8. Connect an oil supply line to the carburetor fuel inlet, and inject engine oil (Specification No. AN-VV-O-446, Grade 1065 (SAE 30)), into the carburetor at 5 psi pressure. Continue to inject oil until a flow of oil from the discharge nozzle is noted, This flow need not be excessive.

CAUTION

The oil used to flush carburetor must not be allowed to enter the air section of the regulator.

9. Disconnect oil supply line, and plug fuel inlet opening with suitable plug, allowing oil to remain in carburetor.

EXTENDED STORAGE OF ELECTRIC FUEL PUMP

1. Disconnect inlet fuel line at pump.

2. Inject a small amount of engine oil (Spec. No. AN-VV-O-446, Grade 1065, (SAE 30)), into pump.

3. Reinstall fuel inlet line.

EXTENDED STORAGE OF PROPELLER

(31 days or longer)

Under normal conditions, neither the Aeromatic nor

Hartzell propeller requires special treatment when storage is not to exceed 30 days. If propeller is removed and the airplane is stored outside, the exterior of the propeller shaft should be coated with exterior surface corrosion-preventive compound (Specification No. AN-C-52, Type I). The threads of the propeller shaft should be covered with a thread protector, and the shaft wrapped with a greaseproof wrapper, covered with oilcloth, and securely taped. The following procedure applies to both propellers, except as noted.

1. Before storing the Aeromatic propeller, place the hub with the oil filler plug upright, and fill the hub completely with oil. (Use special oil, listed in PROPELLER LUBRICATION, page 6.) Replace plug securely.

NOTE

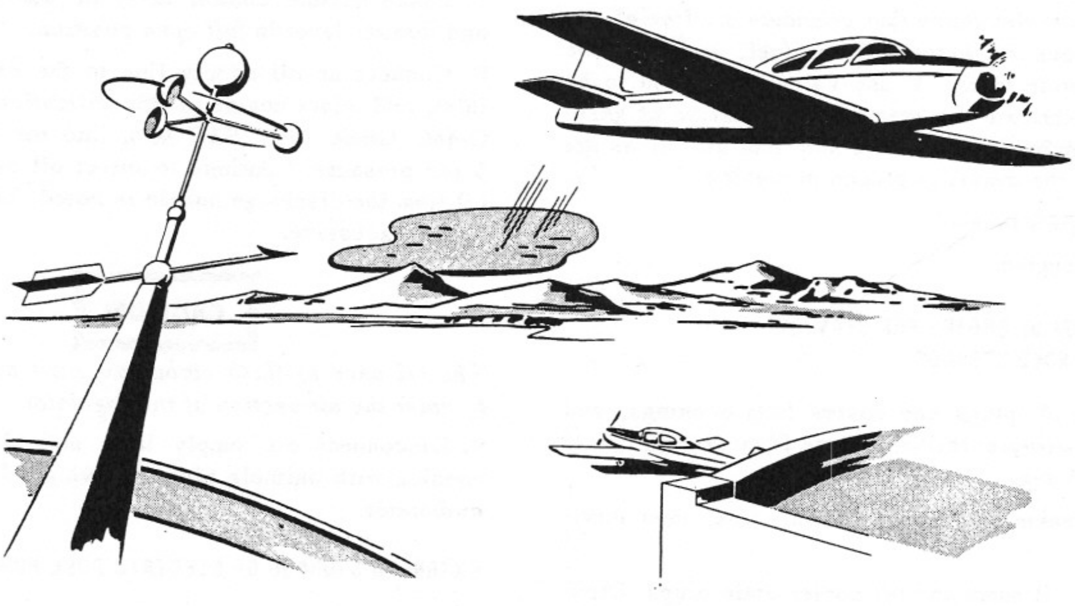
Aeromatic propellers should be rotated twice each month to slush internal parts with oil. This does not apply if propeller is installed on engine that has been treated for storage.

2. Protect all external metal surfaces of propeller with a coating of corrosion-preventive compound (Specification No. AN-C-52, Type I). The Hartzell propeller blades should be placed in high-pitch position before the coating is applied.

NOTE

Do not coat the propeller blades with corrosion-preventive compounds.

3. Propeller blades should be inspected for breaks in the plastic covering, and necessary repairs made. If plastic covering is intact, exposure to weather will have no adverse effect on the blades.



FUSELAGE

GENERAL

The fuselage is a semi-monocoque structure consisting of the main section and a nose section. The main section includes firewall, windshield, sliding canopy, space for cabin, cabin floor covers, cabin side panels, tail section, and nose wheel bay. The nose section comprises the engine mount assembly, hinged engine cowl, and fixed nose cowl. For structural details, refer to AIRPLANE STRUCTURE, page 105.

Installing and Removing Fuselage—See figure 9.

WINDSHIELD

The windshield consists of a formed alclad frame riveted to the fuselage structure, and two formed plastic panels which are held in the frame by rubber extrusions.

Installing and Removing Windshield Panel—See figure 10.

SLIDING CANOPY

The cabin sliding canopy consists of a formed aluminum sheet with plastic windows on each side and in the aft end. The windows are held in place by rubber extrusions. The canopy is mounted on rollers, and has a cylinder-type lock for use while airplane is on ground. A cable, running from the locking handle down the left side to a pin assembly, makes it possible to lock the canopy in several open positions. An opening mechanism makes it possible for the pilot to open the canopy to obtain clear vision during flight. *(See figure 11A.)* The inside of the canopy is covered with upholstery, held in place with spring wires along the top, and cemented on the sides.

Installing and Removing Sliding Canopy—See figure 11.

CABIN FLOOR COVERS AND SIDE PANELS

The cabin floor and scuff boards are covered with carpeting, which is secured with snap-down fasteners. The side panels, which are secured to the airplane with snaps, are covered with flame resistant barkweave and broadcloth with a nogahyde trim.

ENGINE MOUNT ASSEMBLY

The engine mount assembly is semimonocoque in construction, and is attached to the fuselage main section, at the firewall, by four torqued bolts. The assembly consists of engine mount structure, which supports the engine; an intake duct, which supplies air to the carburetor and oil cooler; and an outer skin which acts as lower cowling for the engine. An access cover in the bottom affords access to the bottom of the engine for draining oil.

Installing and Removing Engine Mount Assembly—The parts necessary to attach or detach the engine mount assembly are shown in figure 12.

ENGINE COWLING

The engine cowling consists of a left and right hinged cowl that covers the top of the engine, and a nose cowl which is bolted to the engine mount assembly. A grill is fitted into the air intake cutout of the nose cowl.

Installing and Removing Engine Cowling—The parts necessary to attach or detach the engine cowling are shown in figure 12.

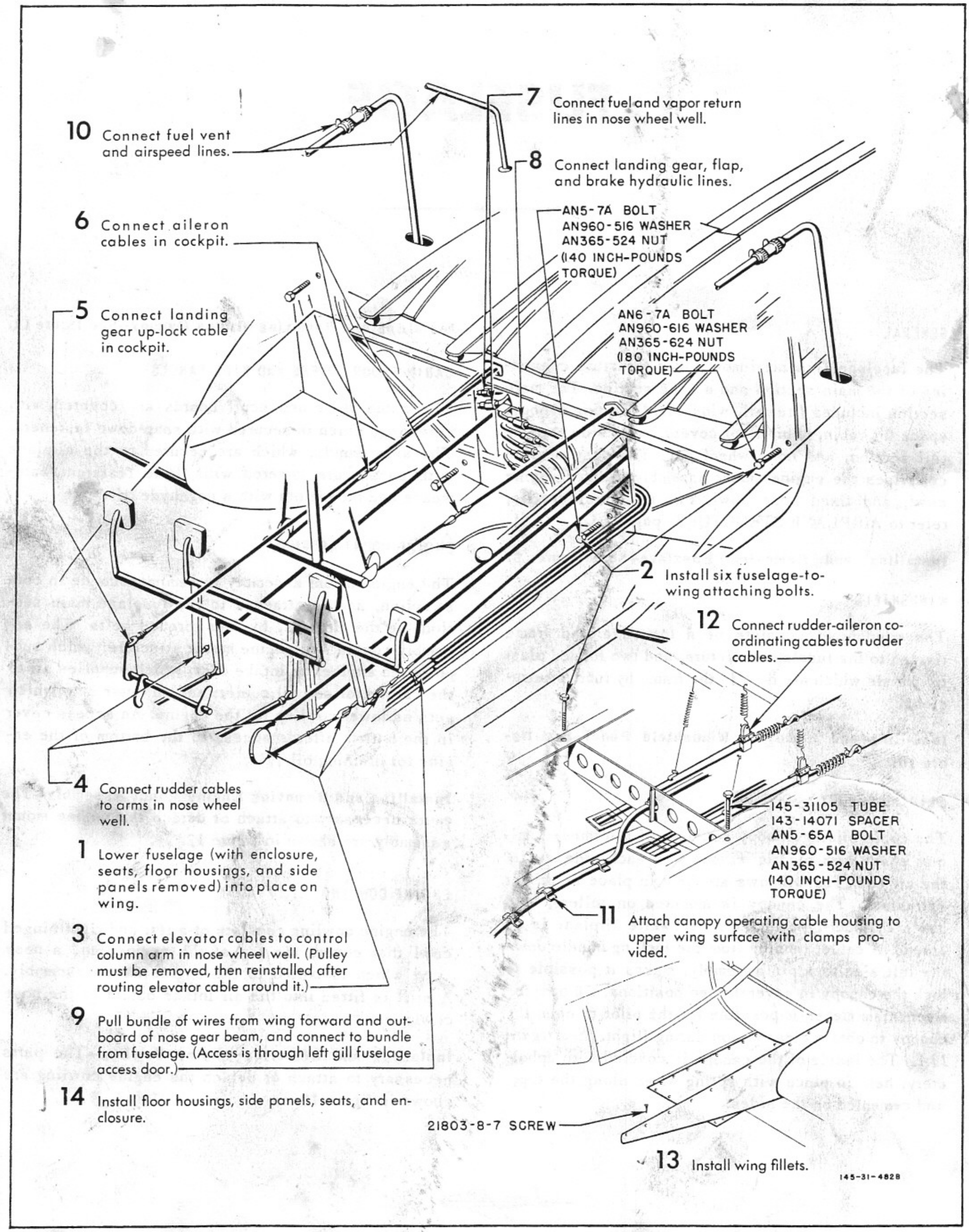


Figure 9 - FUSELAGE INSTALLATION

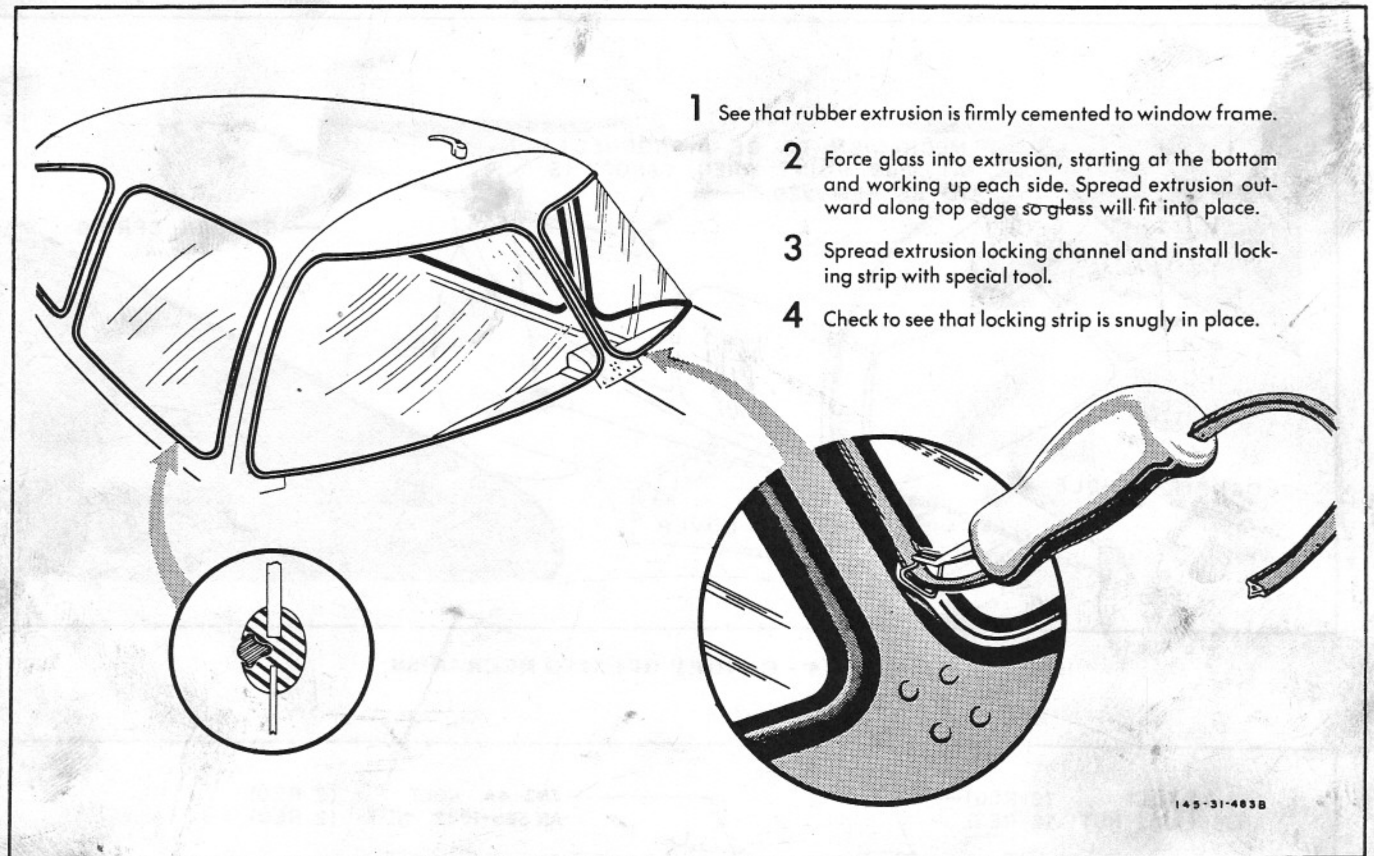


Figure 10 - INSTALLING AND REMOVING WINDOW PANELS

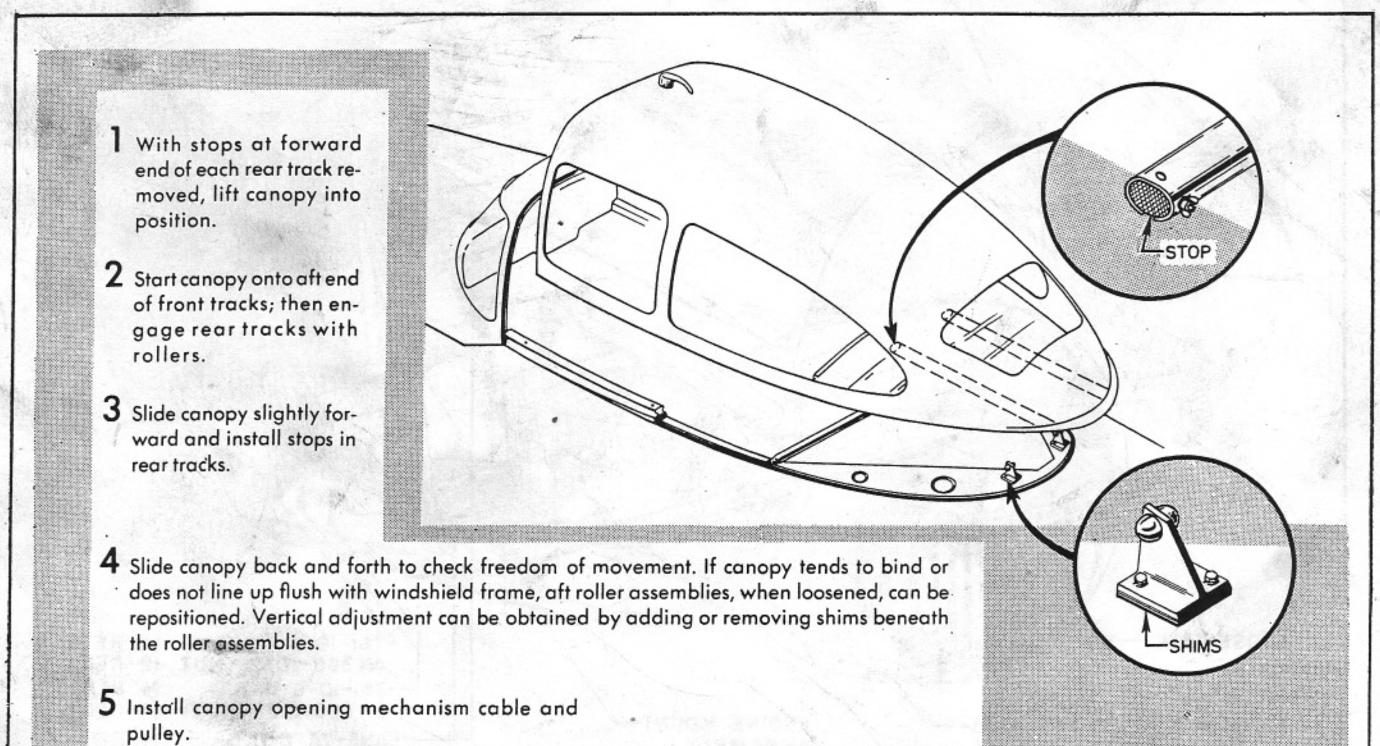


Figure 11 - INSTALLING AND REMOVING WINDOW PANELS

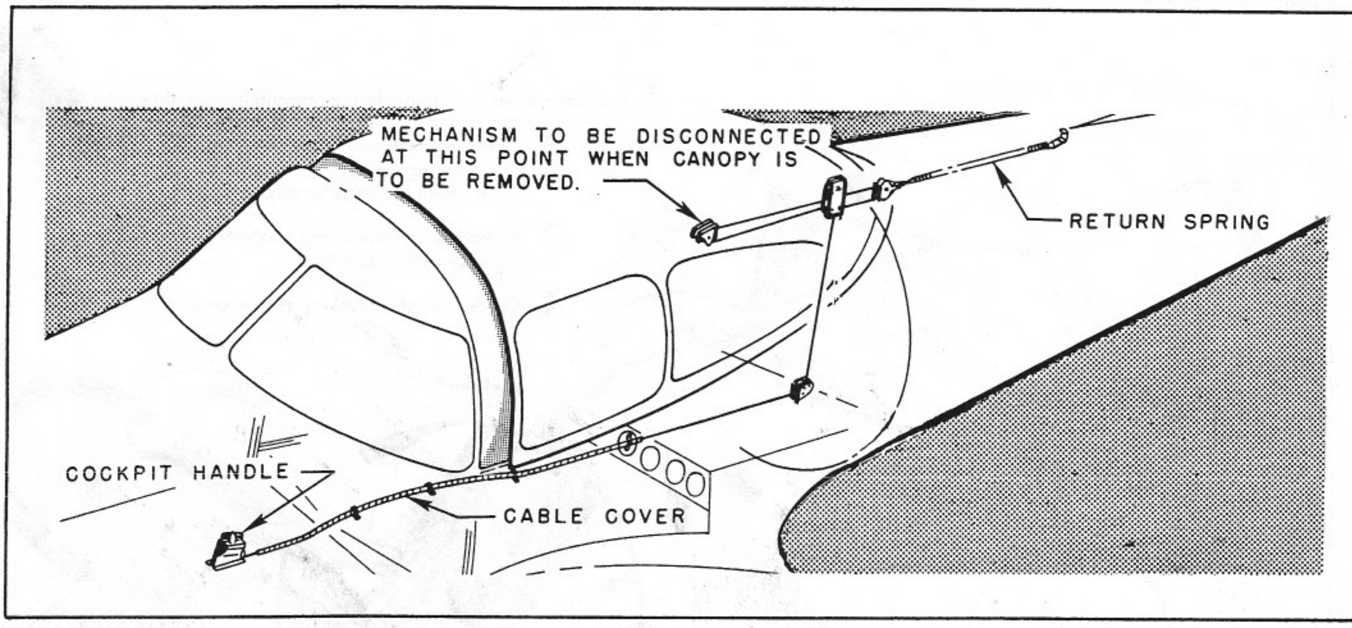


Figure 11A - CANOPY OPENING MECHANISM

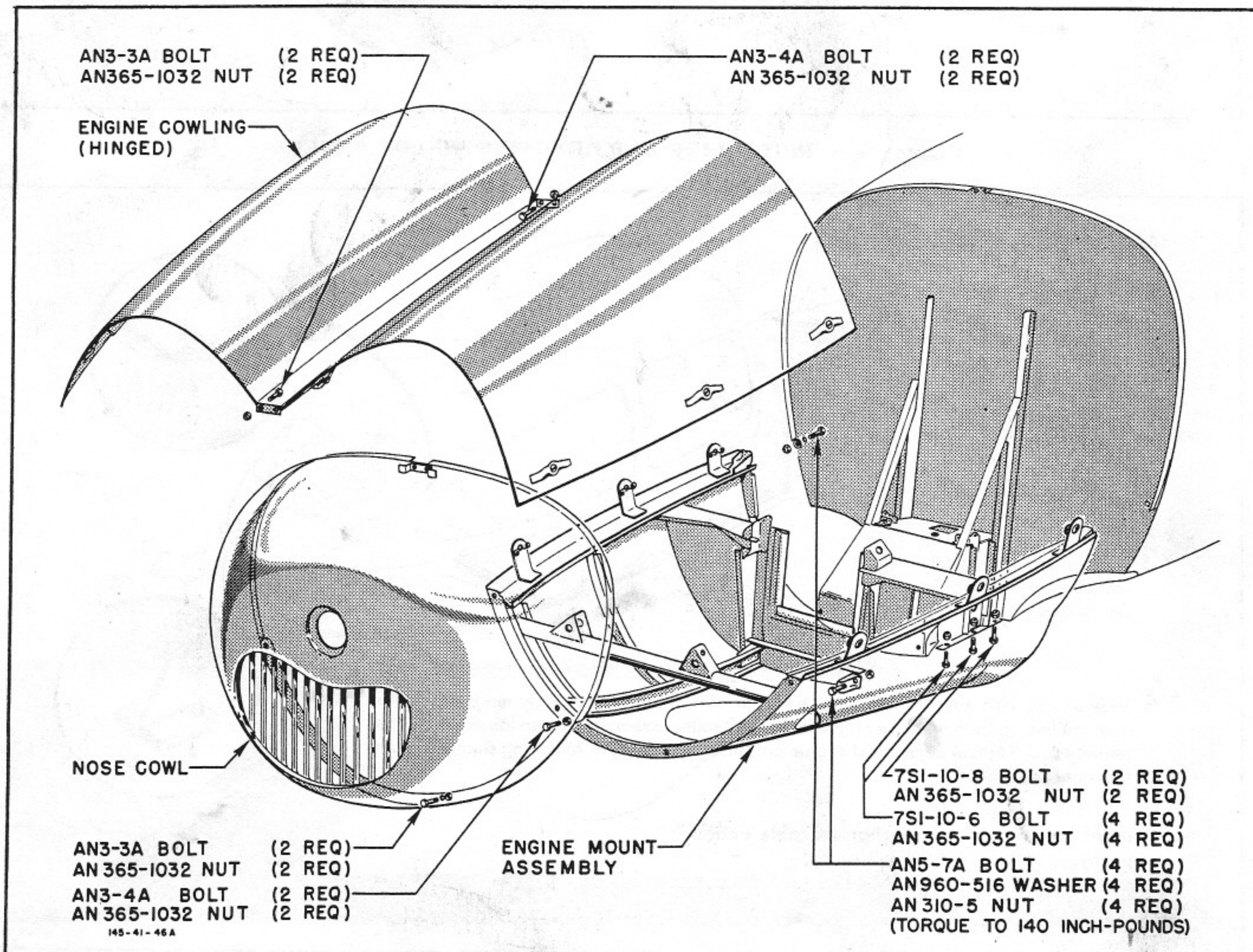


Figure 12 - ENGINE MOUNT AND ENGINE COWLING INSTALLATION

WING

GENERAL

The wing is a full-cantilever type consisting essentially of a right and left wing panel with removable tips, ailerons, and wing flaps. For structural details, refer to AIRPLANE STRUCTURE, page 105.

WING PANELS

The wing panels are bolted together at the airplane centerline with a full rib between them. Fuel tanks within each wing root are accessible only after the panels have been separated. The metal wing tips are attached with screws. Although the wing panels are lightweight, supporting stands or cradles should be provided when the panels are to be separated or joined.

Separating and Joining Wing Panels—See figure 14.

AILERONS

The Frise-type metal ailerons are hinged at three points by brackets bolted to the wing rear spar. The angular travel is 25 degrees up and 17½ degrees down from neutral.

Installing and Removing Ailerons—The parts necessary to attach or detach the ailerons are shown in figure 13.

WING FLAPS

A metal-covered, slotted-type wing flap is installed on the trailing edge of each wing panel between the fuselage and aileron. The right and left wing flap assemblies are interconnected by a torque tube. The flaps are raised or lowered hydraulically and have a maximum travel of 45 degrees in the full down position.

Installing and Removing Wing Flaps—The parts necessary to attach or detach the wing flaps are shown in figure 13.

Adjusting Wing Flaps—See figure 29.

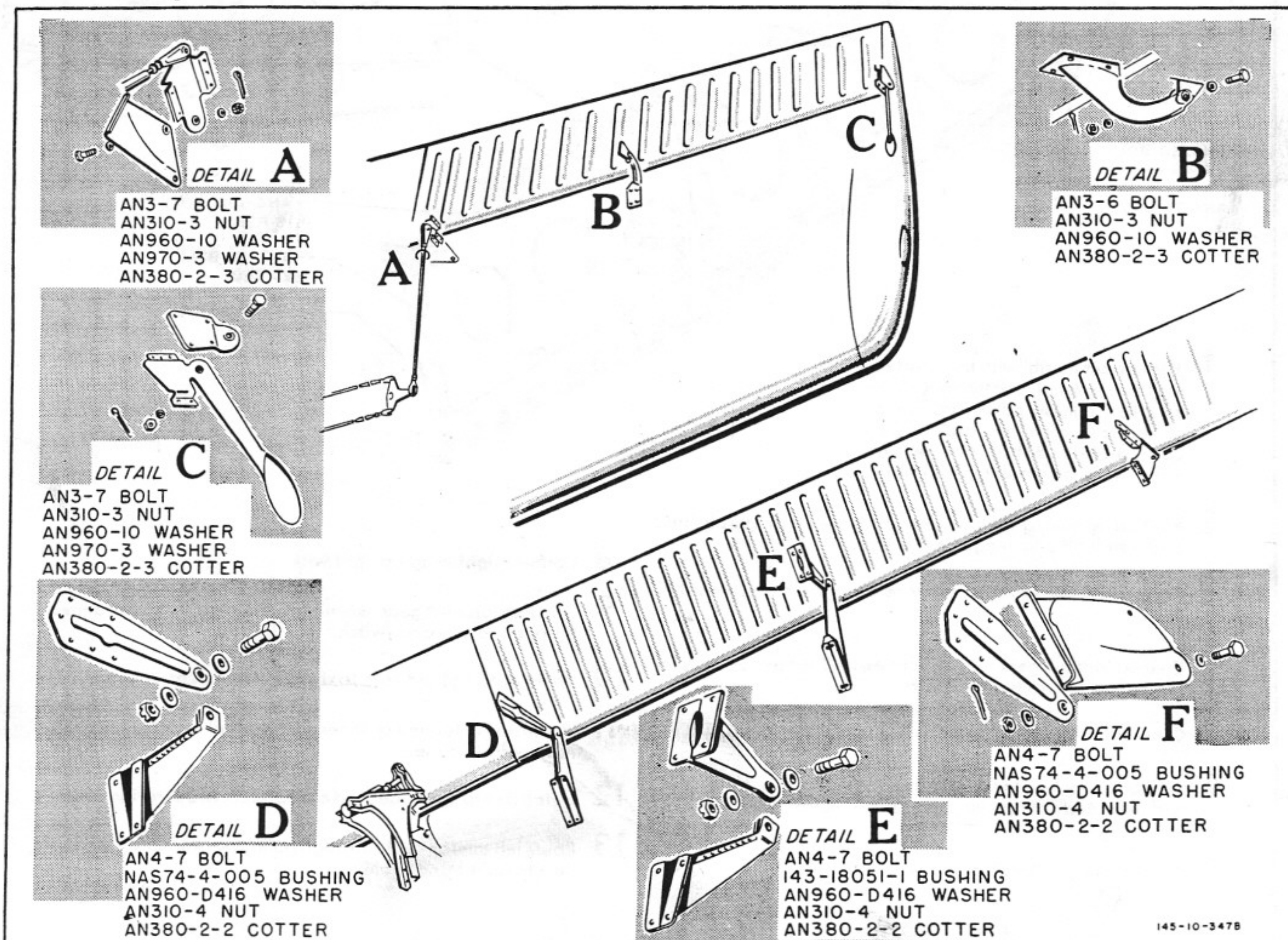
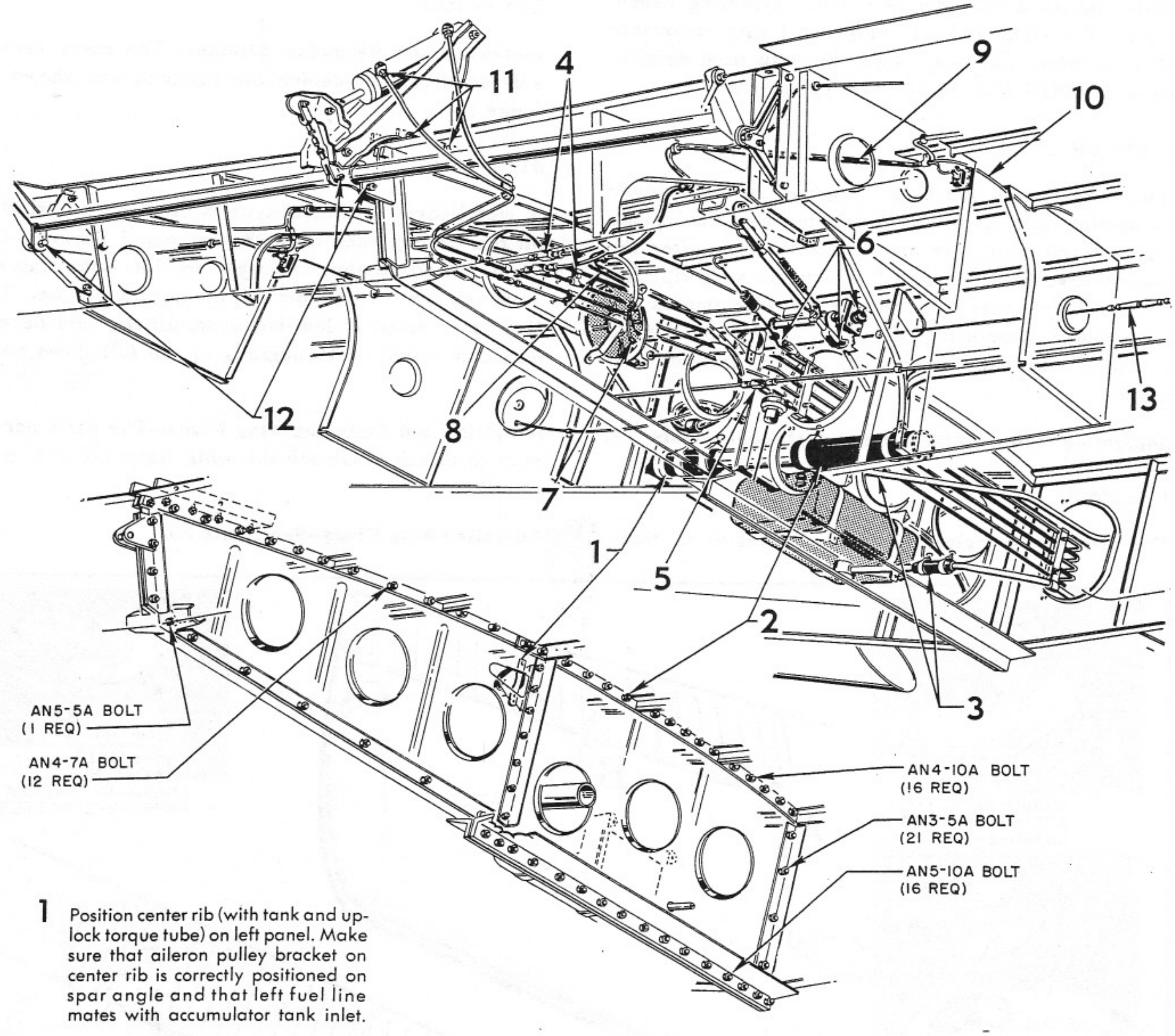


Figure 13 - WING FLAP AND AILERON INSTALLATION



1 Position center rib (with tank and up-lock torque tube) on left panel. Make sure that aileron pulley bracket on center rib is correctly positioned on spar angle and that left fuel line mates with accumulator tank inlet.

2 Position right wing panel; connect right fuel tank supply line, and install all attaching angle bolts.

3 Connect fuel supply and vapor return lines to accumulator tank.

4 Connect landing gear hydraulic lines, and secure to rib. Also secure flap hydraulic lines to rib.

5 Connect brake line, and attach adjuster valve to rib.

6 Position up-lock torque tube in supports, install cotter pins at each end, and connect up-lock cable, links, and springs.

7 Connect wires to landing gear warning horn.

8 Connect right wing tip light wire.

9 Connect landing gear warning system wires at disconnect fittings and inboard switch.

10 Route landing light wire to disconnect at gear.

11 Install flap actuating cylinder and bracket on wing, and connect hydraulic lines.

12 Install flap torque tube, and connect link to operating arm.

13 Route left aileron cable through pulley on center rib, and connect to right-hand cable.

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Figure 14 - SEPARATING AND JOINING WING PANELS

EMPENNAGE

GENERAL

The empennage consists of a horizontal stabilizer, with attaching elevators, a vertical stabilizer, the rudder asesmbly, and fuselage-to-empennage fairings. A dorsal fin completes the stream-lining between horizontal stabilizer and fuselage. Elevators and rudder are cable-controlled. For structural details, refer to AIRPLANE STRUCTURE, page 105.

HORIZONTAL STABILIZER

The horizontal stabilizer is of the full-cantilever type. It is covered with alclad sheet and incorporates a full-span spar and ribs. The removable stabilizer tips are attached by screws.

Installing and Removing Horizontal Stabilizer with Fairing—The parts necessary to attach or detach the horizontal stabilizer are shown in figure 15.

ELEVATORS

The elevators, containing a spar and forming ribs, are of all-metal construction. Removable tips, attached by screws, are incorporated, and controllable trim tabs are attached to each elevator. Both right and left elevators are of identical construction, allowing interchangeability. Each elevator is hinged to the horizontal stabilizer at three points, the angular travel being 20 degrees down and 30 degrees up from neutral. Operation of elevators is afforded by a torque tube, on the inboard end of each elevator, joined by a horn assembly connecting to the control cables.

Installing and Removing Elevators—The parts necessary to attach or detach the elevators are shown in figure 15.

VERTICAL STABILIZER

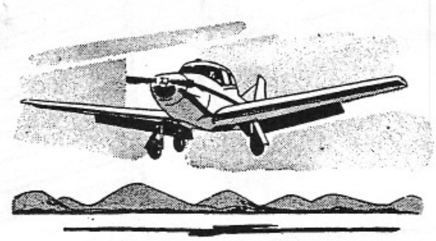
The full-cantilever vertical stabilizer consists of a single spar, forming ribs, and stringers covered with alclad skin. The vertical stabilizer incorporates a removable tip attached by screws.

Installing and Removing Vertical Stabilizer with Fairing—The parts necessary to attach or detach the vertical stabilizer are shown in figure 16.

RUDDER

The all-metal rudder, containing a spar and forming ribs, has a beaded metal skin covering. Hinged to the vertical stabilizer at three points, the rudder has an angular travel of 20 degrees either side of neutral. The arm assembly at the lower hinge point affords connections for control cables.

Installing and Removing Rudder—The parts necessary to attach or detach the rudder are shown in figure 16.



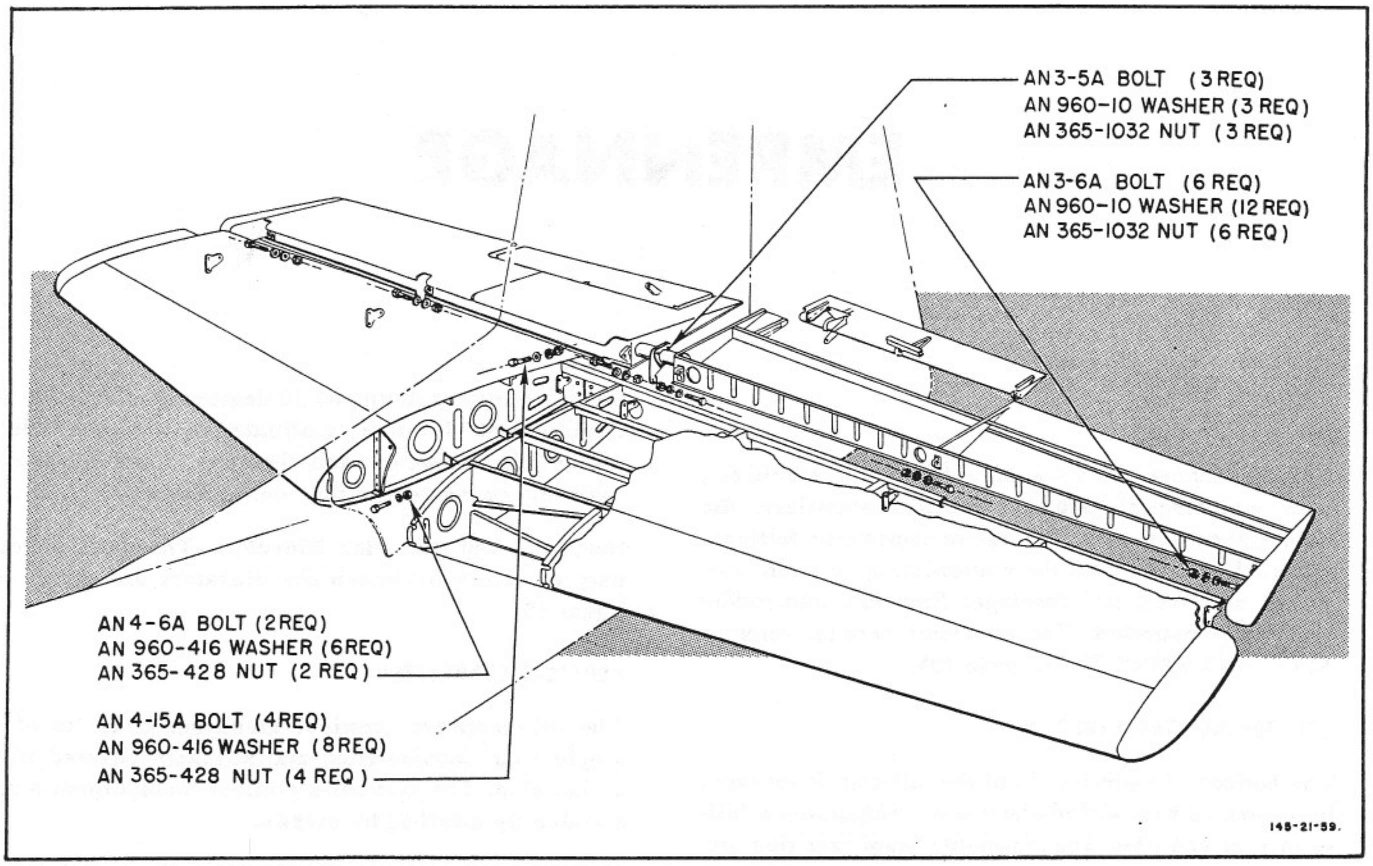


Figure 15 - HORIZONTAL STABILIZER AND ELEVATOR INSTALLATION

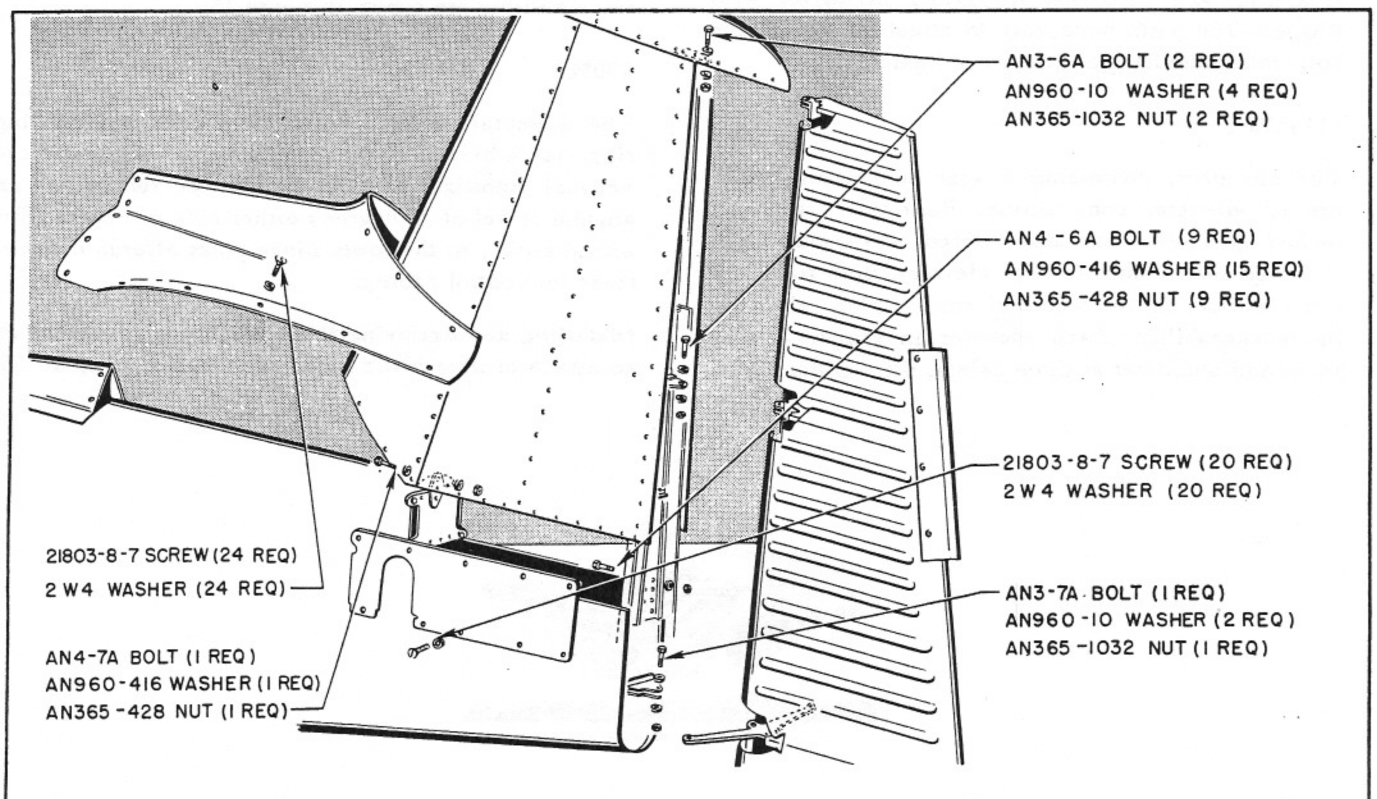


Figure 16 - VERTICAL STABILIZER AND RUDDER INSTALLATION

FLIGHT CONTROL SYSTEMS

GENERAL

The conventional flight control systems consist of two sets of rudder pedals, two wheels for elevator and aileron control, and cables and linkage connected to the respective control surfaces. *(See figures 17 through 21.)* Trim tabs, controllable from the cabin, are installed on each elevator. The aileron and rudder systems are interconnected by a coordinating cable and spring mechanism which is a safety feature designed to impart a feeling of lateral stability in the airplane during certain maneuvers. For structural details, refer to AIRPLANE STRUCTURE, page 105.

CONTROL COLUMN

The control column, to which the control wheel shafts (through universal joints) are attached, pivots at the base to permit fore and aft movement. Sprockets on the forward end of each control wheel shaft are interconnected by a chain, the ends of which attach to cables routed through pulleys at the top and bottom of the column. The control wheel and shaft on either side can be removed when only one set of controls is desired. *(See figure 22.)*

RUDDER PEDAL ASSEMBLIES

The rudder pedal assemblies, consisting of two left pedals connected by a torque tube, and two right pedals also connected by a torque tube, are hinged to the floor. *(See figure 18.)* The rudder pedals on either side can be removed when only one set of controls is desired. *(See figure 22.)*

AILERON CONTROL SYSTEM

The ailerons are controlled by a combination linkage and cable system. *(See figure 17.)* Disconnect fittings are located within the control cable guard box on the pilot's floor, and turnbuckles are located at each bellcrank. A balance cable interconnects the bellcrank in each wing, and has a turnbuckle located in the right wheel well. Adjustable rods connect the bellcranks to the ailerons. *(See figure 17.)*

Installing and Removing Aileron Control System—For information pertinent to installing and removing aileron control system, see figure 17.

Adjusting Aileron Control System—See figure 17.

RUDDER CONTROL SYSTEM

The rudder control system consists of two cable assemblies, connected to rudder pedal torque tube arms, and running aft to the rudder horns. Two rods, extending forward from the pedals to the bellcrank for nose wheel steering, serve as a balance cable for the system. *(See figure 18.)*

Installing and Removing Rudder Control System—For information pertinent to installing and removing rudder control system, see figure 18.

Adjusting Rudder Control System—See figure 18.

RUDDER-AILERON COORDINATING SYSTEM

The coordination system includes two cable and spring assemblies, interconnecting the rudder and aileron cables on each side of the airplane. *(See figure 21.)* At the rudder cable end of each coordinating cable is a large coiled spring, through which the rudder cable passes. A fairlead, secured to the coordinating cable and sliding over the rudder cable, prevents the spring from riding on the rudder cable. In addition to these springs, light tension springs on each side take up coordinating cable slack which exists under certain conditions. Steel balls, swaged onto the cables at fixed positions, provide the interconnecting points, except at the aft end of the coordinating cables. There, threaded cable fittings connect to a clip engaging the large springs.

Adjusting Rudder-Aileron Coordinating System-See figure 21.

ELEVATOR CONTROL SYSTEM

The elevator control system consists of two cable assemblies, connecting the control column arm with the elevator horn. *(See figure 19.)*

Installing and Removing Elevator Control System—For information pertinent to installing and removing elevator control system, see figure 19.

Adjusting Elevator Control System—See figure 19.

ELEVATOR TRIM TAB CONTROL SYSTEM

The elevator trim tab control system consists of a control wheel and indicator on the control panel, and a pair of bevel gears, which drive a torque shaft connected to a jackscrew bellcrank to which trim tab cables are attached. *(See figure 20.)*

Installing and Removing Elevator Trim Tab Control System—For information pertinent to installing and removing elevator trim tab control system, see figure 20.

Adjusting Elevator Trim Tab Control System—See figure 20.

NOTE:

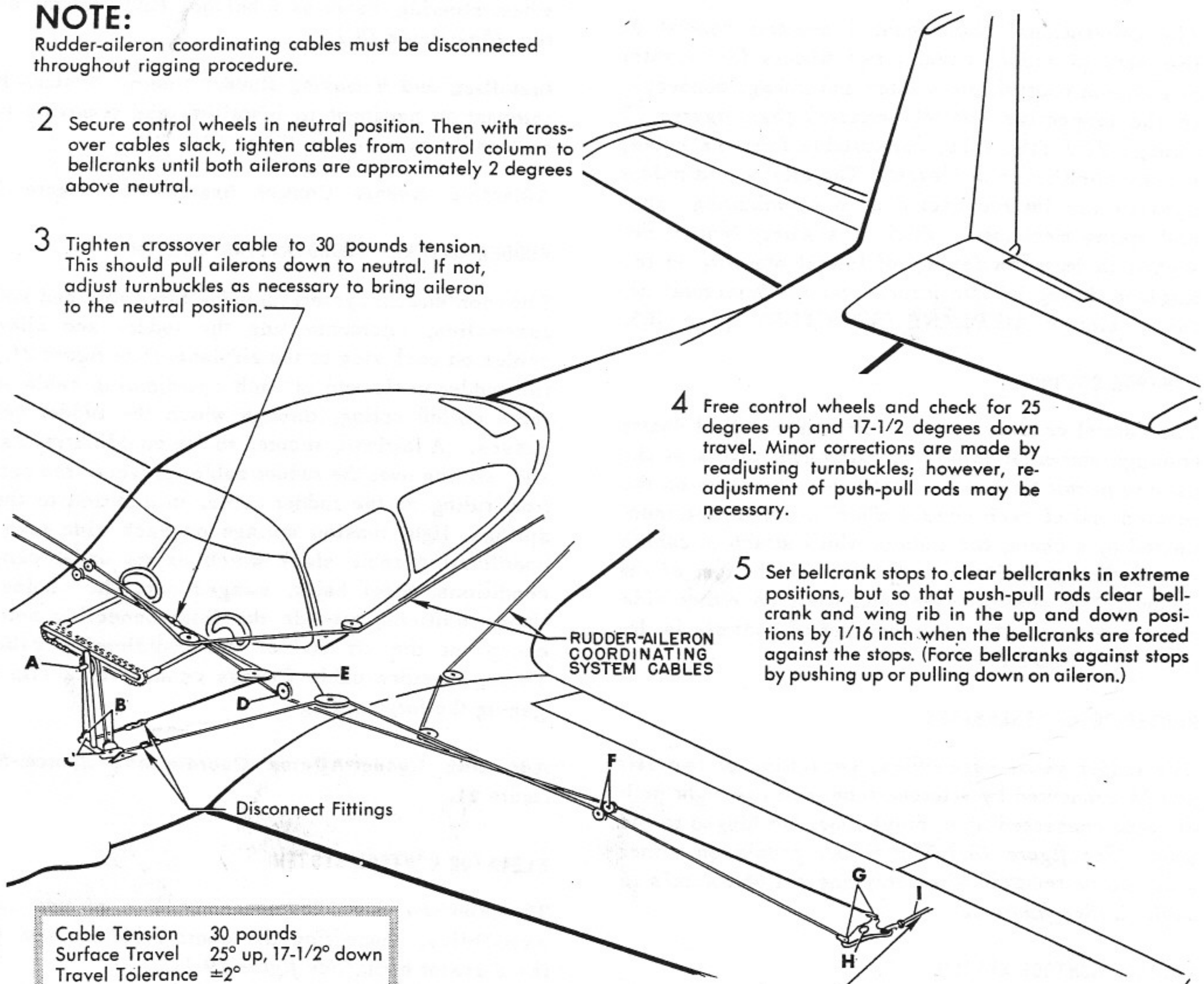
Rudder-aileron coordinating cables must be disconnected throughout rigging procedure.

2 Secure control wheels in neutral position. Then with cross-over cables slack, tighten cables from control column to bellcranks until both ailerons are approximately 2 degrees above neutral.

3 Tighten crossover cable to 30 pounds tension. This should pull ailerons down to neutral. If not, adjust turnbuckles as necessary to bring aileron to the neutral position.

4 Free control wheels and check for 25 degrees up and 17-1/2 degrees down travel. Minor corrections are made by readjusting turnbuckles; however, re-adjustment of push-pull rods may be necessary.

5 Set bellcrank stops to clear bellcranks in extreme positions, but so that push-pull rods clear bell-crank and wing rib in the up and down positions by 1/16 inch when the bellcranks are forced against the stops. (Force bellcranks against stops by pushing up or pulling down on aileron.)



Cable Tension	30 pounds
Surface Travel	25° up, 17-1/2° down
Travel Tolerance	±2°

1 With related aileron 25 degrees up, adjust push-pull rods on each side so that aft cable attachment bellcrank arm clears push-pull rod by 1/8 inch.

6 Check entire system for 30 pounds tension.

A AN210-4A Pulley (2 Req)
AN4-34 Bolt (1 Req)
AN310-4 Nut (1 Req)
AN380-2-3 Cotter (1 Req)

B AN210-4A Pulley (2 Req)
AN4-7 Bolt (2 Req)
AN310-4 Nut (2 Req)
AN380-2-3 Cotter (2 Req)

C AN3-6 Bolt (2 Req)
AN310-3 Nut (2 Req)
AN380-2-3 Cotter (2 Req)

D AN210-3A-4DR7-3/4 Pulley (1 Req)
AN4-10 Bolt (1 Req)
AN310-4 Nut (1 Req)
AN380-2-2 Cotter (1 Req)

E AN210-4A-4DR7-3/4 Pulley (2 Req)
AN4-10 Bolt (2 Req)
AN310-4 Nut (2 Req)
AN380-2-2 Cotter (2 Req)

F AN3-14 Bolt (4 Req)
AN310-3 Nut (4 Req)
AN960-10L Washer (4 Req)
AN380-2-2 Cotter (4 Req)
4S3-10-19 Spacer (4 Req)
145-52301 Roller (4 Req)

G AN23-12 Bolt (4 Req)
AN310-3 Nut (4 Req)
AN960-10L Washer (4 Req)
AN380-2-2 Cotter (4 Req)

H AN4-9 Bolt (2 Req)
AN310-3 Nut (2 Req)
AN380-C2-3 Cotter (2 Req)

I AN4-12 Bolt (4 Req)
AN310-4 Nut (4 Req)
AN960-416 Washer (4 Req)
AN380-2-2 Cotter (4 Req)

NOTE:

Check alignment of flap and aileron trailing edges. If trailing edges are over 1/4 inch out of alignment, adjust aileron and flap rigging equally to align edges within the 1/4-inch tolerance.

145-15-66C

Figure 17 - ADJUSTING AILERON CONTROL SYSTEM

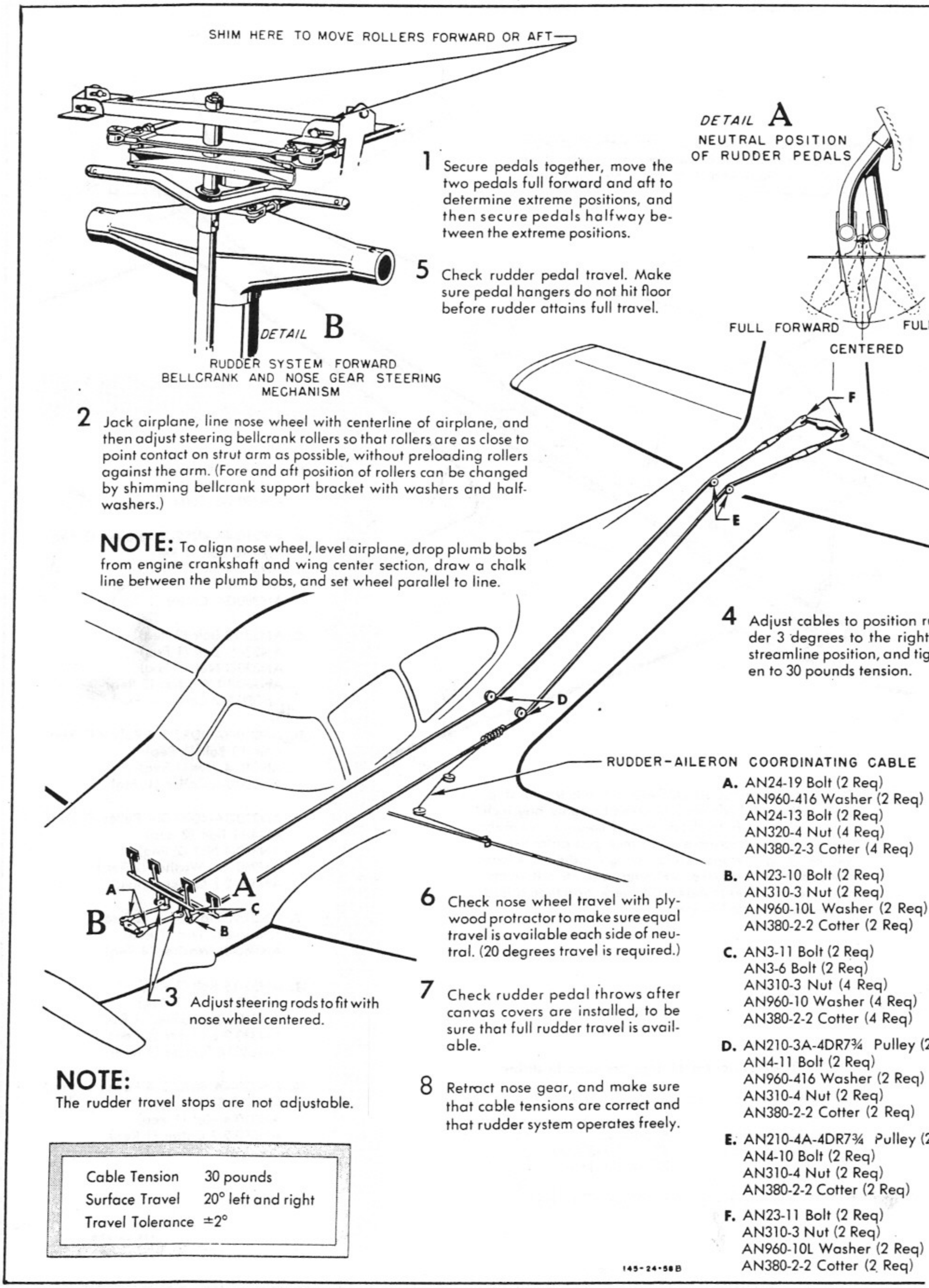
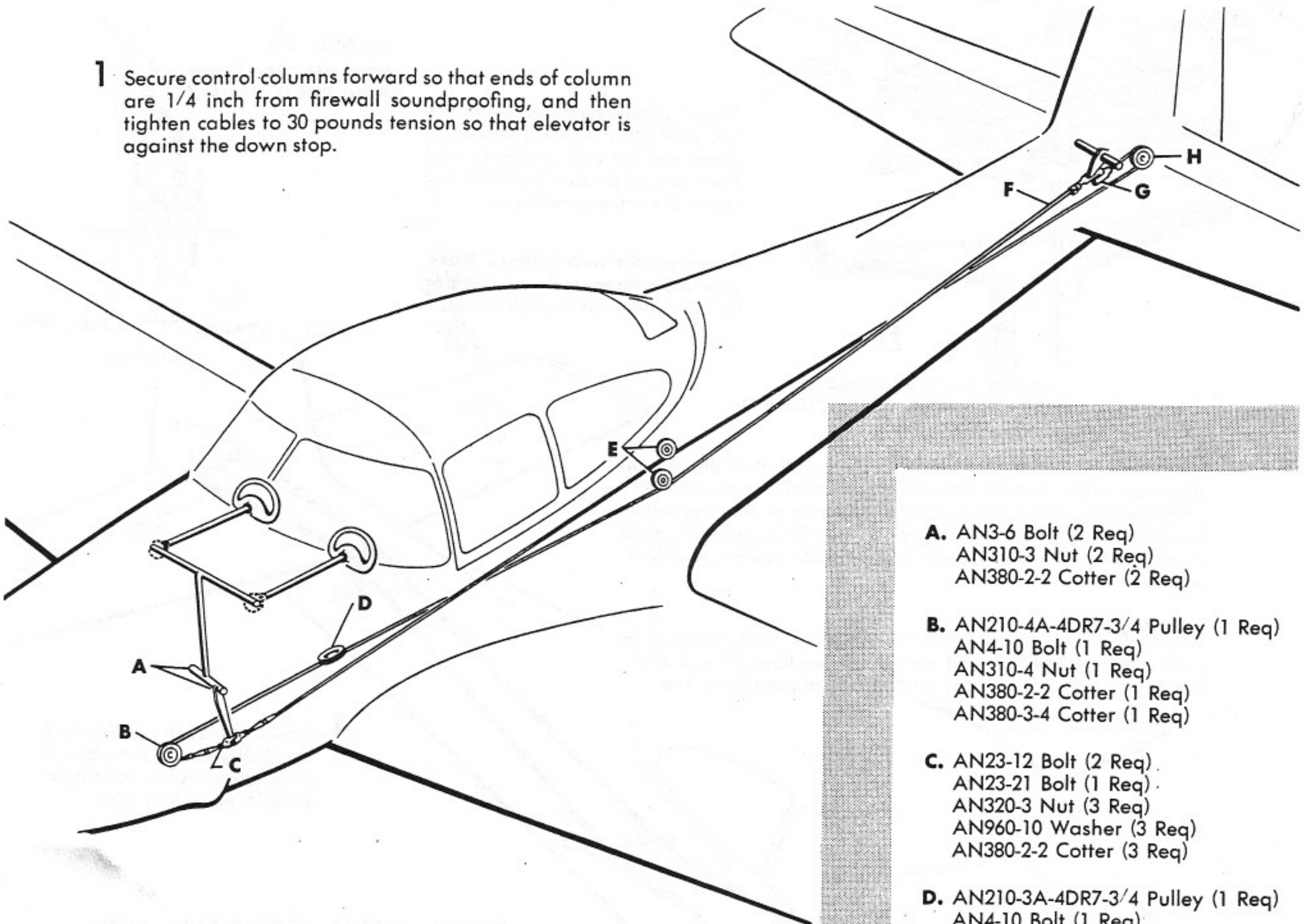


Figure 18 - ADJUSTING RUDDER CONTROL SYSTEM



1 Secure control columns forward so that ends of column are 1/4 inch from firewall soundproofing, and then tighten cables to 30 pounds tension so that elevator is against the down stop.

2 Pull control columns aft until elevator hits the up stop; then pull control wheels 3 degrees (roughly one inch travel) further aft to check control column assembly clearance. This overtravel clearance guarantees there will be no interference under flying conditions where the cables are slack (i.e., extreme cold, etc). If necessary, loosen cables to make this check, and then adjust cables as instructed in step 1.

NOTE: The elevator travel stops are not adjustable.

Cable Tension	30 pounds
Surface Travel	30° (+ 2°/-0°) up 20° (± 2°) down

A. AN3-6 Bolt (2 Req)
AN310-3 Nut (2 Req)
AN380-2-2 Cotter (2 Req)

B. AN210-4A-4DR7-3/4 Pulley (1 Req)
AN4-10 Bolt (1 Req)
AN310-4 Nut (1 Req)
AN380-2-2 Cotter (1 Req)
AN380-3-4 Cotter (1 Req)

C. AN23-12 Bolt (2 Req)
AN23-21 Bolt (1 Req)
AN320-3 Nut (3 Req)
AN960-10 Washer (3 Req)
AN380-2-2 Cotter (3 Req)

D. AN210-3A-4DR7-3/4 Pulley (1 Req)
AN4-10 Bolt (1 Req)
AN310-4 Nut (1 Req)
AN380-2-2 Cotter (1 Req)

E. AN210-3A-4DR7-3/4 Pulley (2 Req)
AN4-11 Bolt (2 Req)
AN310-4 Nut (2 Req)
AN960-416 Washer (2 Req)
AN380-2-2 Cotter (2 Req)

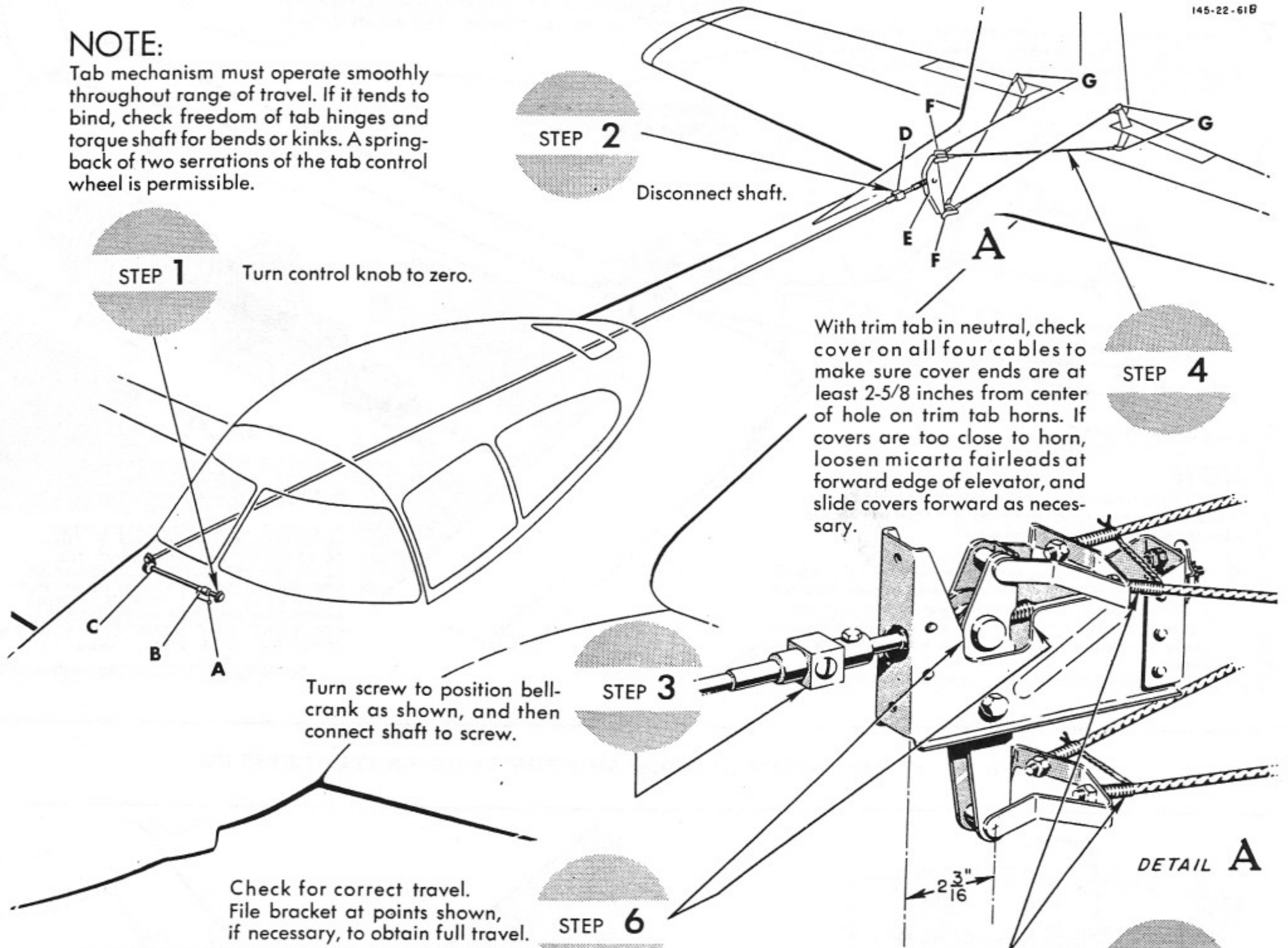
F. AN515-8R16 Screw (2 Req)
AN365-832 Nut (2 Req)
AN960-8L Washer (4 Req)

G. AN23-15 Bolt (1 Req)
AN310-3 Nut (1 Req)
AN960-10L Washer (1 Req)
AN380-2-2 Cotter (1 Req)
145-52214 Spacer (1 Req)

H. AN210-4A-4DR7-3/4 Pulley (1 Req)
AN4-10 Bolt (1 Req)
AN310-4 Nut (1 Req)
AN380-2-2 Cotter (1 Req)

145-22-608

Figure 19 - ADJUSTING ELEVATOR CONTROL SYSTEM



Cable Tension	15^{+5}_{-0} pounds
Surface Travel	23° (±2°) up, 32° (+2°-0°) down

A. 7S1B-10-7 Screw (2 Req)
AN365-1032 Nut (2 Req)

B. AN392-13 Pin (1 Req)
AN380-2-2 Cotter (1 Req)

C. 7S1-10-7 Screw (3 Req)
AN365-1032 Nut (3 Req)

D. AN3-7 Bolt (1 Req)
AN365-1032 Nut (1 Req)

E. AN4-16 Bolt (1 Req)
AN310-4 Nut (1 Req)
4S4-4-30 Spacer (1 Req)
AN960-416 Washer (1 Req)
AN393-35 Pin (2 Req)
4S3-4-30 Spacer (1 Req)
AN380-2-2 Cotter (3 Req)

F. AN23-16 Bolt (2 Req)
AN310-3 Nut (2 Req)
AN960-10 Washer (2 Req)
AN380-2-2 Cotter (2 Req)

G. AN23-9 Bolt (4 Req)
AN310-3 Nut (4 Req)
AN960-8 Washer (4 Req)
AN380-2-2 Cotter (4 Req)

Figure 20 - ADJUSTING ELEVATOR TRIM TAB CONTROL SYSTEM

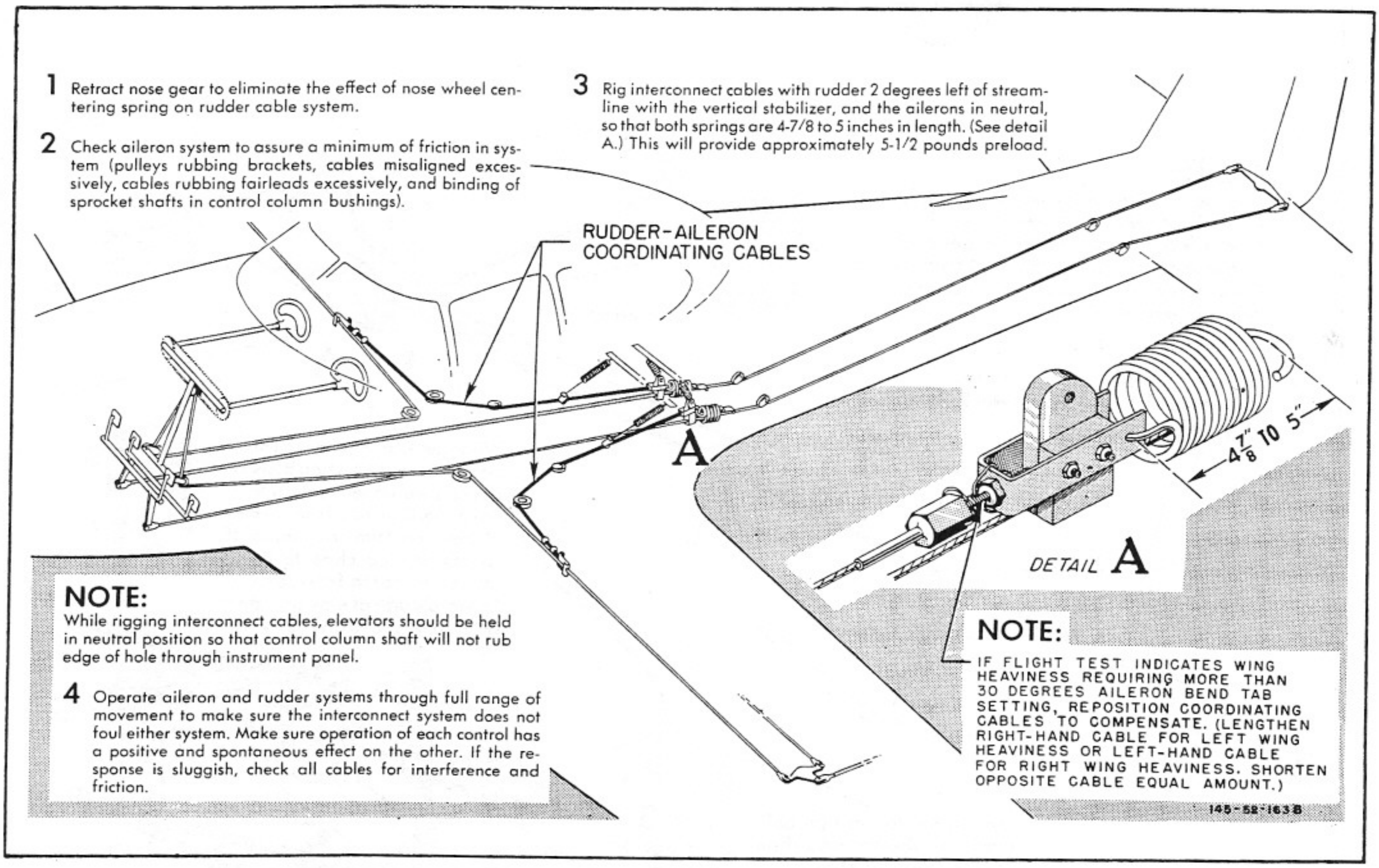


Figure 21 - ADJUSTING RUDDER-AILERON COORDINATING SYSTEM

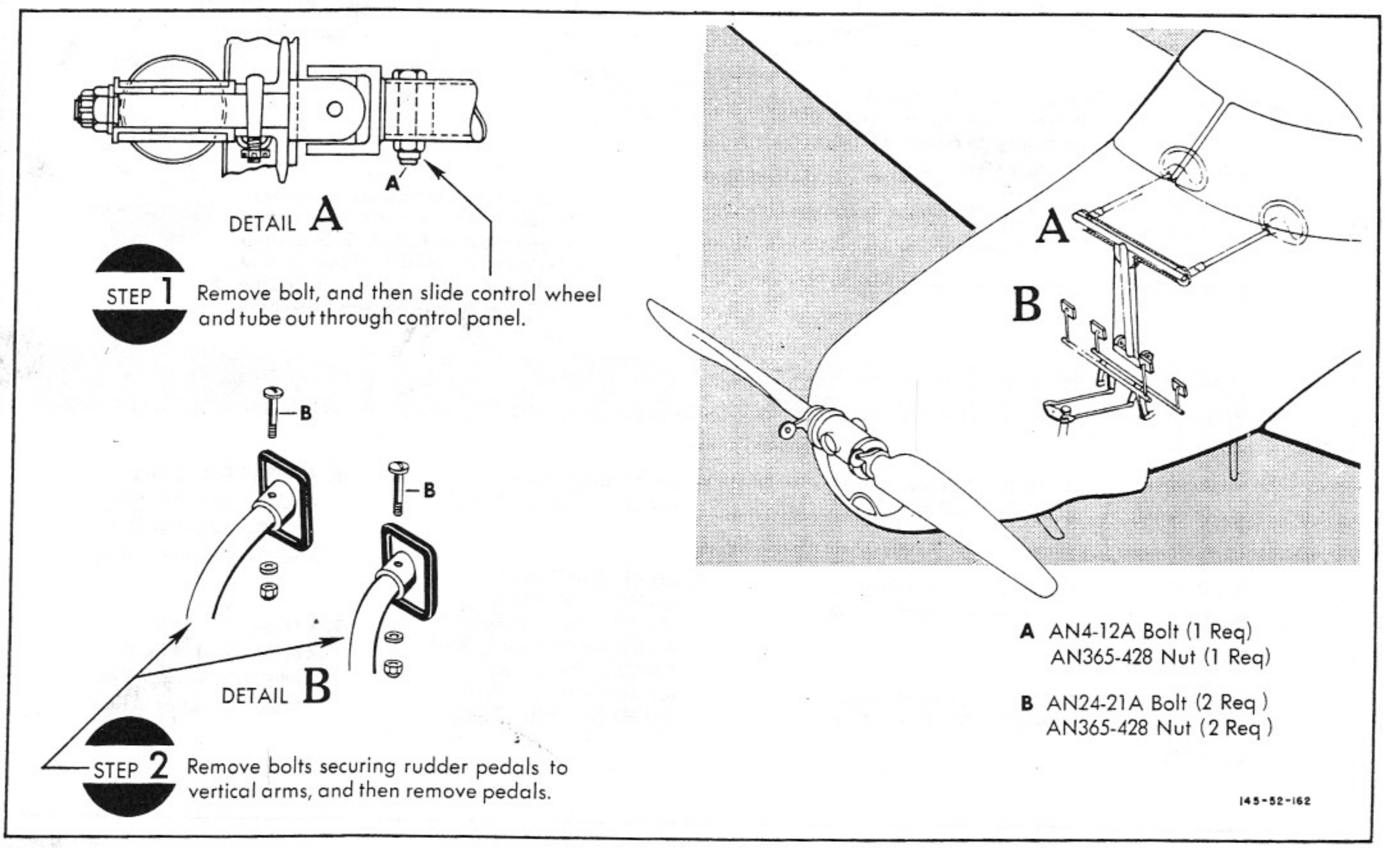


Figure 22 - REMOVING ONE SET OF CONTROLS

HYDRAULIC SYSTEM

GENERAL

The hydraulic system is divided into the power system, the landing gear system, and the wing flap system. The power system supplies pressures up to 1150 psi to operate the landing gear and wing flap systems. A relief valve, manually controlled by a knob on the control panel, permits either free flow or pressure for operation of landing gear or flaps. An amber light on the control panel illuminates when the power control knob is pulled out, indicating that relief valve is closed. A hand-pump is built into the master control valve to permit manual operation of the systems while airplane is on the ground and the engine is not running. The hand-pump also affords emergency lowering of the wing flaps should the engine-driven pump fail during flight. An emergency shut-off valve is provided in the fluid supply line just below the reservoir. This makes it possible to shut off fluid supply in case of engine fire. The valve is controlled by a lever on the control panel.

GENERAL INSTRUCTIONS FOR
HANDLING HYDRAULIC EQUIPMENT

Removing and Disassembling Hydraulic System Units—When disconnecting hydraulic lines, plug the ends to prevent loss of fluid and to keep out foreign matter. When disassembling a unit of the hydraulic system, work in as clean a place as possible, as small particles of dirt are injurious to the unit. Thoroughly clean component parts immediately after disassembly.

Cleaning Hydraulic Parts—Parts must be clean before assembly. Clean metal parts and subassemblies by washing them in a suitable solvent. Use a brush when necessary to remove caked dirt, gum, rust-preventive coating, or paint. Be sure the brush used will not mar or scratch finishes, or sealing ring grooves, pistons, piston rods, valve faces, slide valves, sealing surfaces, etc. Remove the paint from all surfaces inside the assembly. Do not use solvents to clean sealing rings or packing; use dry air, or clean, lint-free rags. Never use rags that have been around a machine shop, because of the possibility of metal chips being in the rags. To prevent oxidation, keep parts as free from moisture as possible. Do not leave steel unplated parts unprotected long enough to start rusting.

Removing Surface Blemishes From Hydraulic Parts—When removing rust or rust stains from interior honed surfaces, use only suitable abrasives such as buffing compound or crocus cloth. Be sure to rub lengthwise when removing mars or nicks.

Inspecting Hydraulic Parts—Threads and sharp edges must be free from burrs. All passages must be free of material which might break loose and get into interior of assemblies. Make sure plated surfaces are not damaged to the extent that they could cause leakage or binding Examine bores, ring grooves, etc., for flaws and roughness. Make sure that all surfaces which come in contact with nonmetallic packing rings, or parts made of synthetic rubber, are free from burrs, nicks, scratches, tool marks, and roughness.

Lubricating Hydraulic Parts—All parts should be lubricated before assembly. Apply lubricant sparingly and wipe off excess, as too much oil will collect dirt and grit, and cause malfunctioning of the assembly. Lubrication of external seals, O rings, threads, bearings, and retainers, provides easier assembly and eliminates galling of the threads and slide fits. It is advisable to lubricate external seals, threads, bearings, and retainers with petrolatum jelly or equivalent, so that when external tests are made, no hydraulic fluid is visible, unless it has leaked from the inside. Lubricate internal and moving surfaces such as pistons, O rings, rods, shafts, etc., with hydraulic fluid.

Assembling Hydraulic System Units—Refer to prints at all times during assembly, and accomplish one operation at a time. Always use proper assembly tools so that parts will not be damaged. Use tapered sleeves and fixtures where necessary to facilitate assembly. Install O rings and gaskets carefully, and make sure they are the proper size and in the proper place.

Assembling Hydraulic Operating Cylinders—When installing O rings on piston, do not use tools with sharp corners, sharp edges, or rough surfaces. Keep mold flash of O ring in one plane to ensure against twisting. When ring is in its groove, make sure it is evenly stretched around its circumference. When sliding piston into cylinder, check closely to make sure there are no fine particles shaved from the piston or O ring. Do not insert piston any further than necessary

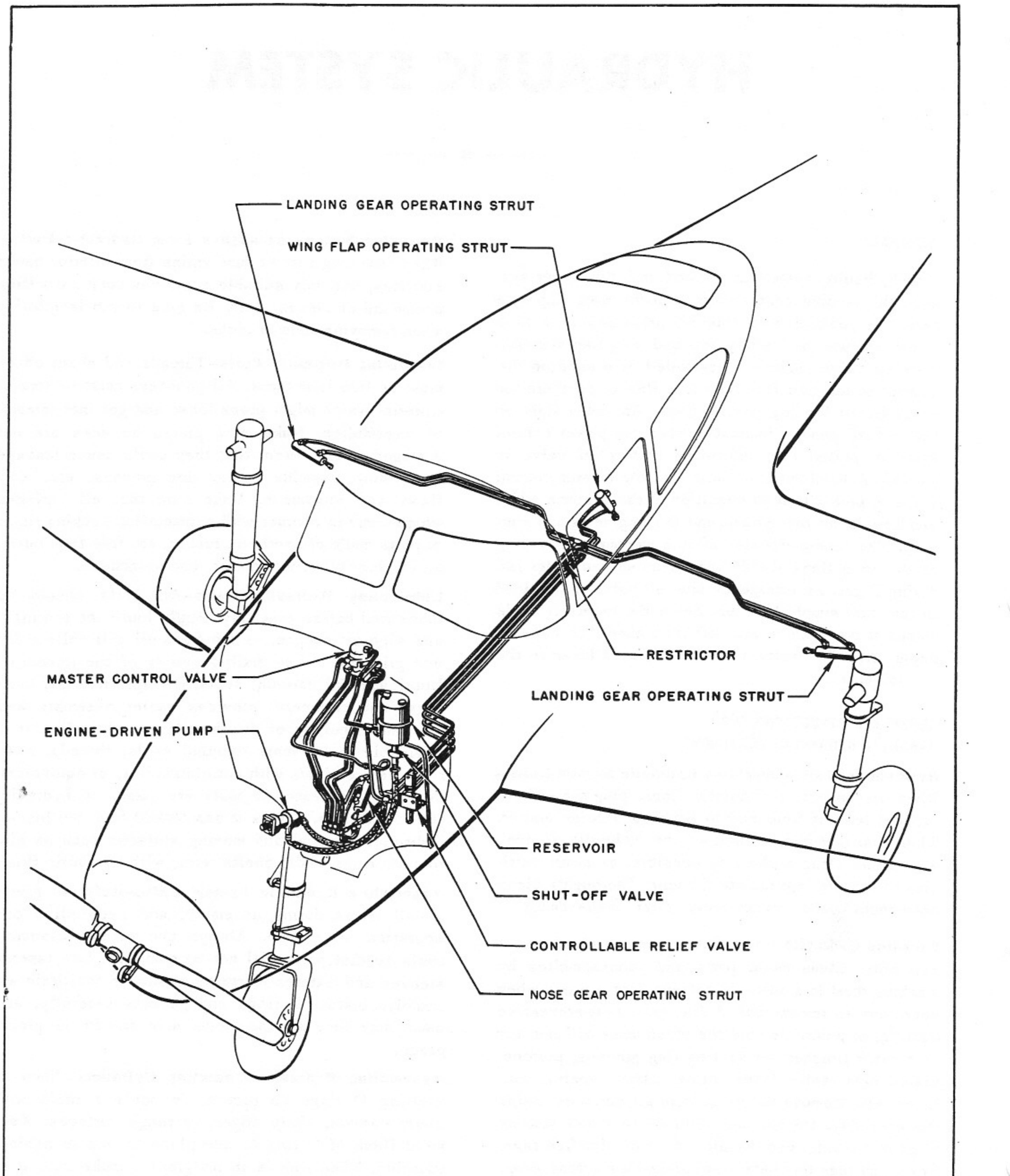


Figure 23 - HYDRAULIC SYSTEM

to install cylinder end. (This precaution will eliminate cocking the piston in the cylinder, which might cause damage to both cylinder and piston.) After assembly piston must move in and out freely by hand, while being rotated at least one complete turn in each direction. There should be no scratching or metallic drag.

Assembly Hydraulic Valves—Inspect valves, valve bores, and chrome plating for burrs, nicks, pits, and sharp edges. Make sure springs and valves are free-acting, and do not bind or stick in the bores. Check slide valves for bent shafts, nicks, and scratches on sealing diameters. Slide valve bores are to be honed or lapped, and selectively fitted to shafts to meet leakage requirements. Make sure each part which has been lapped or fitted with another part, is placed in its correct position when assembled. All parts honed or lapped are to be kept together at all times, and are not to be interchanged unless they are relapped or rehoned. When staking is required to secure an adjustment, do not stake until after parts have been tested and properly adjusted. Use caution when installing O rings and packings. Keep mold flash of O ring in one plane to ensure against twisting. When O ring is in its groove, make sure it is evenly stretched around its circumference. Sleeves, valves, and pistons with O rings must be carefully inserted, using only enough pressure to overcome friction. Test valve shafts and valve actuating pins to make sure they are not binding. Operate by hand to check proper spring return.

Testing Hydraulic System Units After Assembly—All hydraulic units must be tested within 24 hours after assembly as a protection against corrosion. Completed assemblies may be washed externally only, with carbon tetrachloride. Do not use any other cleaning fluid, as damage to seal rings may result.

Preparing Hydraulic Tubing for Installation—Remove seal cap from all tubing assemblies that have been in storage. All tubing should have color-codeband (light blue, yellow, light blue), and part number should be rubber-stamped on each tube. Before installation, inspect tubes for cracks, burrs, sharp edges. Check tubing for dents, scratches; if such defects are not too deep, remove them with buffing compound or crocus cloth. Blow all dirt from inside of tubing with clean, dry, compressed air.

Installing Hydraulic Tubing—If necessary, fittings may be lubricated with hydraulic fluid or petrolatum. Care must be taken that no lubrication enters the tubing or fitting during installation, as it will cause sticking of valves and malfunctioning of units. Place the tube in position, making sure it is not scratched while being installed. Be sure the tube flares meet the fittings squarely and fully. Never use the nut to draw tube flare to fitting, as flare will be damaged. Always use fingers to start tubing nut on fitting and to tighten nut firmly into position. After the nut is firmly in place, tighten with wrench. The following torque values in inch-pounds should be used.

	ALUMINUM ALLOY		STEEL	
	Min	Max	Min	Max
1/4″ Tubing	40	65	50	90
3/8″ Tubing	75	125	90	150

Be very careful not to tighten the nuts too tightly, as this will damage the flare. Tubing should be preformed by proper bending equipment and should require only minimum hand pressure to fit in proper place when being installed. All hydraulic lines must be supported by clamps of proper size. Never tighten a tube fitting when there is pressure in the system.

Bleeding Hydraulic Systems—The landing gear, wing flap and power systems will bleed themselves after three or four operating cycles, provided the hydraulic reservoir is full of oil.

Checking Hydraulic System Operation

1. Determine that all lubrication points on the main and nose gear have been properly lubricated.

2. Connect test stand. (Test stand pressure connection on early airplanes is made at tee on bottom of relief valve. On late airplanes connection is made at cross on bottom of relief valve filter. Supply line connection is made at bottom of flow regulator. Test stand output should not exceed ½ gallon per minute, unless provided with individual relief valve set for 1500 psi. Test stand should also be provided with a shut-off valve to prevent supply from test stand reservoir when airplane reservoir is full and a line connecting the vent of the airplane reservoir with the test stand reservoir. Fluid from the test stand reservoir must flow through a filter to safeguard the units of the airplane.)

3. Pull hydraulic power control out, and operate gear and flaps through several cycles to bleed system of air. This may be done with either the test stand or hand-pump. However, to check hand-pump operation, one complete cycle of both gear and flap operation must be made. Then check relief valve setting by use of hand-pump and reference to test stand gage. Crackling pressure should be 1125 (+25/-0) psi. With test stand running at full flow, pressure should not exceed 1200 psi.

4. Operate landing gear to the up position, and check linkage adjustments and proper engagement of uplocks as shown in figures 30 and 31. Then hang 12-pound weight on each wheel, and retract gear. Gear should retract and lock.

NOTE

After completion of any operation cycle, power con-

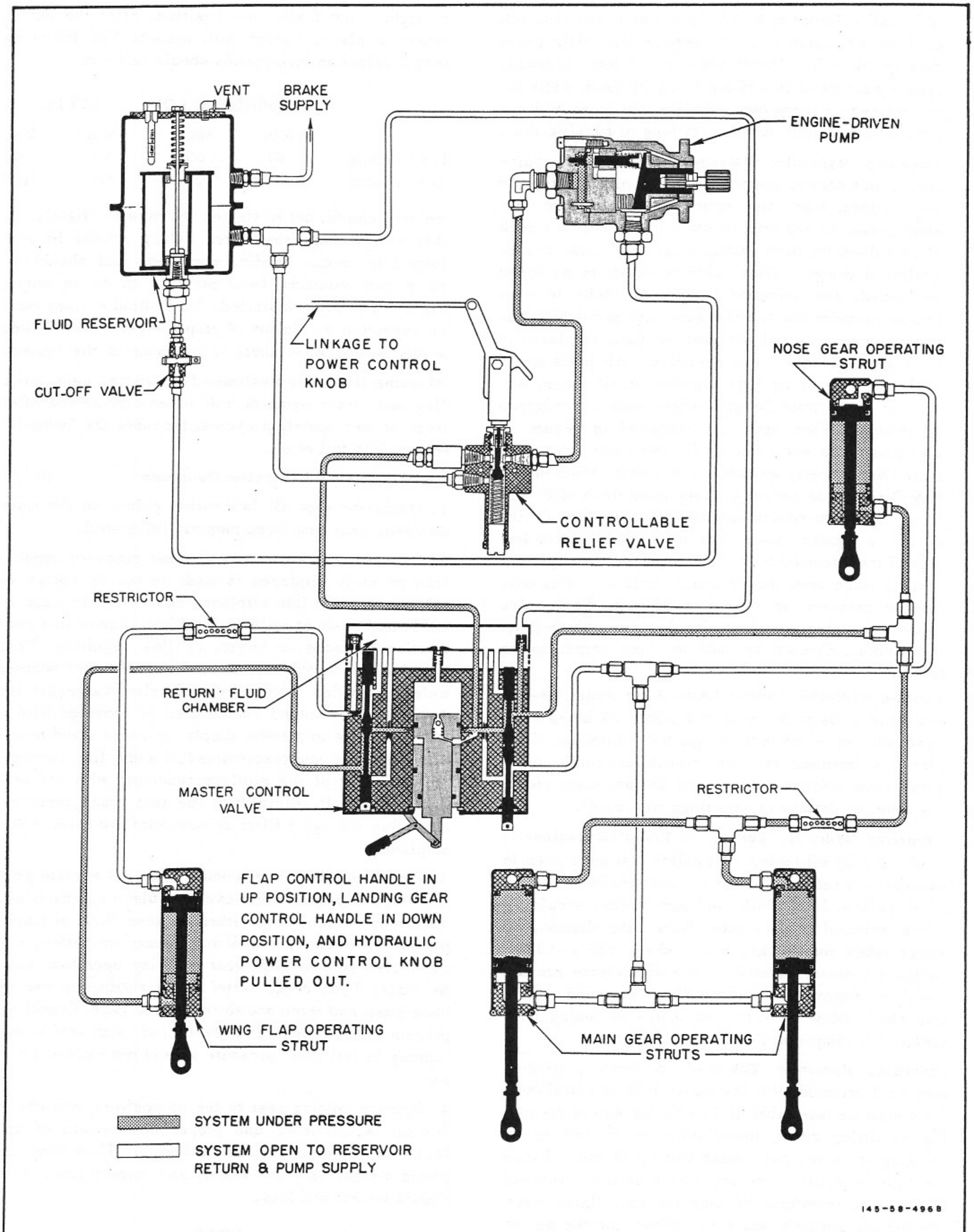


Figure 24 - HYDRAULIC SYSTEM FLOW CHART

trol knob should be pushed in to relieve pump and relief valve of continuous operation against pressure.

5. Operate landing gear to the *down* position and check for proper down-locking as shown in figures 30 and 31.

6. With test stand operating, retract gear and disconnect up-lock cable from control valve. Then place control handle in down position and pull emergency release lever. Locks should release and allow gear to extend. Check for any damage to control linkage.

7. Operate wing flaps and check adjustments as shown in figure 29. Flaps should operate up or down in 9 to 12 seconds.

NOTE

If proper operation is not obtained after adjustment, check system for internal leakage.

HYDRAULIC POWER SYSTEM

The power system consists of an engine-driven pump, fluid reservoir, controllable relief valve, master control valve (which incorporates the hand-pump, check valve, and thermal relief valve), and necessary lines to carry the fluid under pressure to the master control valve, and return fluid to the reservoir. The operation of the power system is as follows: Fluid from the reservoir flows through the emergency shut-off valve to the engine-driven pump. The pump forces fluid to a tee on the controllable relief valve. When the knob for the controllable relief valve is pulled out, the relief valve is closed, allowing the pump to build up pressure. Then, when the master control valve is positioned to operate gear or flaps, fluid flows from the tee to the master control valve. At the completion of the operational cycle, pressure builds up to approximately 1125 psi and the relief valve opens, allowing fluid to flow from the tee, through the relief valve and to the reservoir. When the power control knob is pushed in, the relief valve is held fully open, permitting free flow from the pump to the reservoir. This open-center power system relieves the pump of continuous operation against pressure, and provides a continuous flow of fluid through the relief valve, thus preventing accumulation of any foreign particles that may damage relief valve.

LANDING GEAR HYDRAULIC SYSTEM

The landing gear hydraulic system consists of an operational control shaft, and a by-pass check valve (incorporated in the master control valve), two main gear operating struts, a nose gear operating strut, and necessary tubing to carry the fluid to and from the operating struts, The landing gear control handle must be left in the desired up or down position at all times, as there is no neutral position. When the control handle is moved to the down position, mechanical linkage from the handle pulls the up-locks and moves the landing gear control shaft (in the master control valve) to direct pressure to the down side of the gear operating struts. Because the gear is forced down by spring bungees faster than pump can supply fluid, a check valve in the master control valve, between return and down pressure lines, allows return fluid to be drawn into the down line. Return fluid from the up side of the operating struts is directed to the return line. When the control handle is moved to the up position, the gear up-locks are moved to the locked position, and the control shaft is moved to direct pressure to the up side of the operating struts. Return fluid from the down side of the operating struts is directed to the return line. A restrictor valve in the landing gear down line prevents the gear from retracting or extending fast enough to cause strain on the surrounding structure.

WING FLAP HYDRAULIC SYSTEM

The wing flap hydraulic system consists of a control valve, an operating strut, and necessary tubing to carry the hydraulic fluid to and from the operating strut. The control valve (incorporated in the master control valve) consists of an operating control shaft, two poppet check valves, and two thermal relief valves. The flap control handle may be in either the up or down position to activate the flaps. Or, if desired, the control handle may be placed in neutral position when the flap is to be left in a partially down position. When the flap control handle is moved to the up or down position, mechanical linkage from the handle moves the control shaft to direct fluid pressure to the indicated side of the operating strut. Return fluid from the strut is directed thru the master control valve to the reservoir. A restrictor valve in the flap down line prevents excessive speed in retraction or extension of the flaps.

ENGINE-DRIVEN HYDRAULIC PUMP

An engine-driven hydraulic pump *(figure 25)* is located on the lower right side of the engine accessory drive section, and is held in place by four bolts. The pump is of the multiple piston type with cam-type piston movement. The pump is lubricated by the oil passing through, and has O ring seals to prevent external leakage. The output of the pump is approximately ½ gpm at approximately 2150 rpm of engine (approximately 3000 rpm of pump).

HYDRAULIC SYSTEM FLUID RESERVOIR

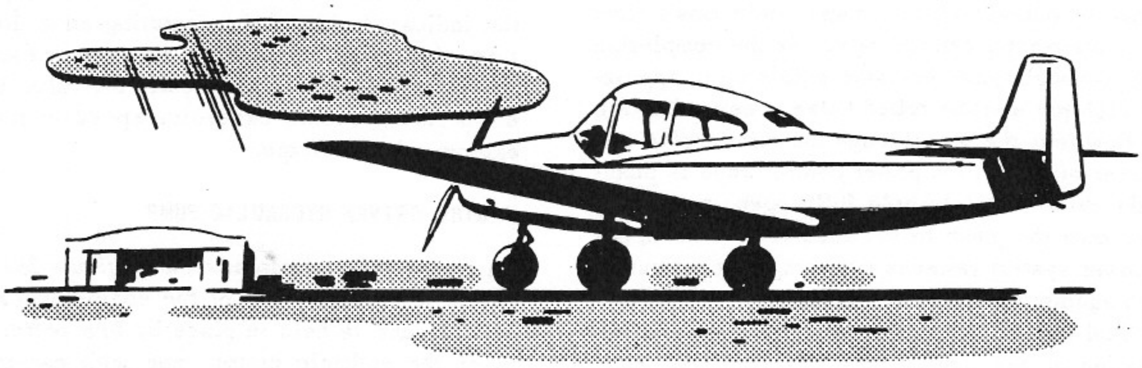
The hydraulic fluid reservoir *(figure 26)* is attached by four bolts to the forward left side of the firewall. The reservoir incorporates a filler cap and dip stick, ports for pump and brake supply, a system return port, a vent port, and a filter unit. The filter unit is easily replaced by removing center bolt, and lifting top from reservoir. When replacing filter, be sure gaskets are installed properly. Reservoir has a fluid capacity of approximately 1/3 gallon when filled to full mark.

MASTER CONTROL VALVE

The master control valve is located on the forward side of the control panel, midway between the sides, and is held in place by three bolts. The valve incorporates a hand-pump, control shafts for landing gear and wing flaps, check valves, and thermal relief valves for the flap system. *(See figure 27.)* Pressure from the engine-driven pump enters the pressure chamber for the hand-pump, and from there is routed to the control shafts. The control shafts direct pressure to their respective systems, and return fluid back to the reservoir. A fluid return chamber in the top of the valve provides the hand-pump with fluid during operation. Check valves between the fluid return chamber and the pressure chamber keep system pressure from entering the return chamber. The control shafts are hone-fitted into the valve body. O ring seals are used to prevent external leakage. *(For details of valve interior, see figure 27.)*

CONTROLLABLE RELIEF VALVE

The controllable relief valve *(figure 28)* is a spring-loaded poppet-type valve having a plunger and lever mechanism connected by rod linkage to the power control knob on the control panel. It is located on the firewall just below the hydraulic reservoir. The valve incorporates a removable seat and is adjusted to open automatically at 1125 (+25/-0) psi by increasing or decreasing the valve spring tension. The lever mechanism overrides the valve spring tension when the pressure control knob is pushed in so the valve relieves all pump pressure.



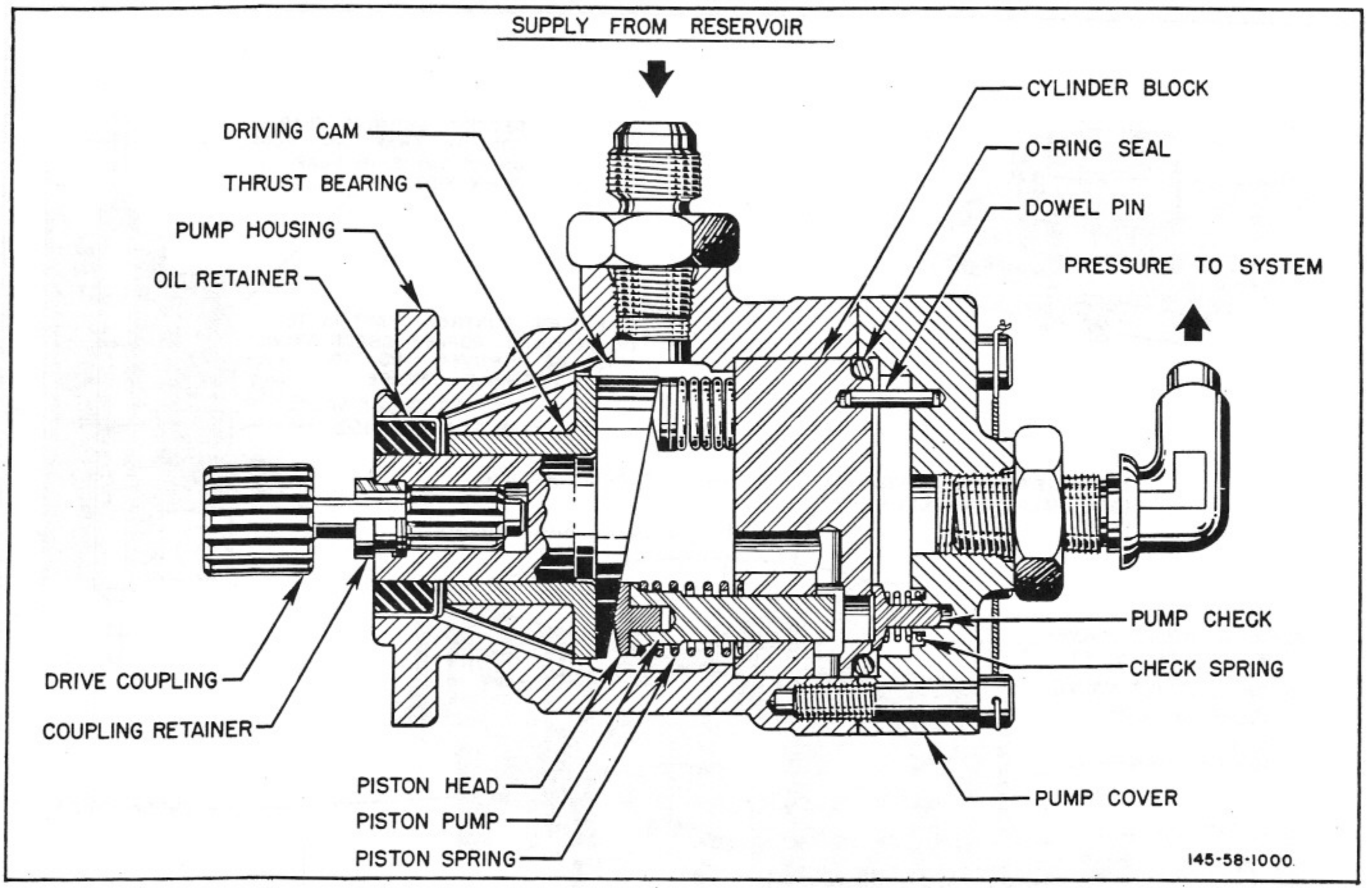


Figure 25 - HYDRAULIC SYSTEM ENGINE-DRIVEN PUMP

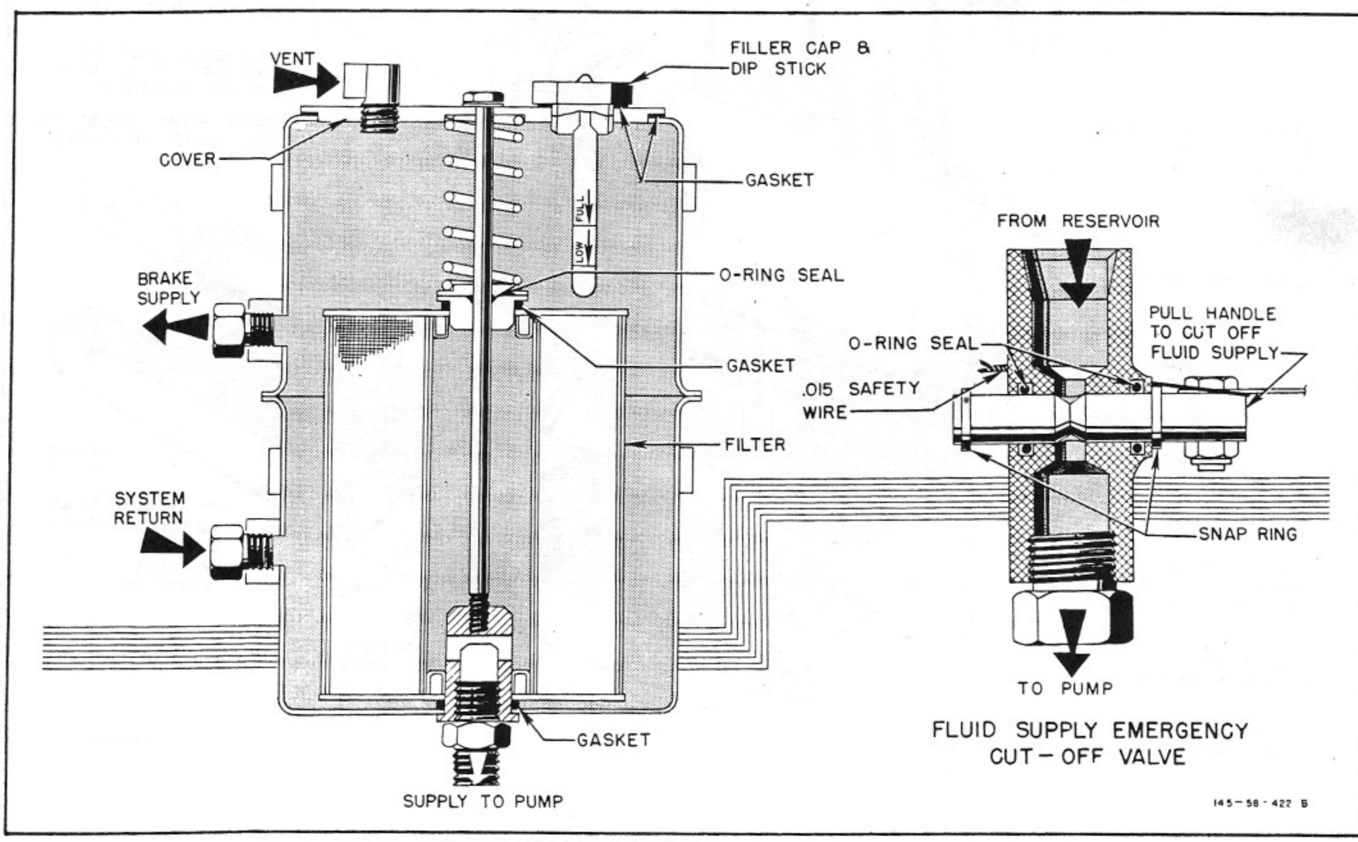


Figure 26 - HYDRAULIC SYSTEM FLUID RESERVOIR AND SHUT-OFF VALVE

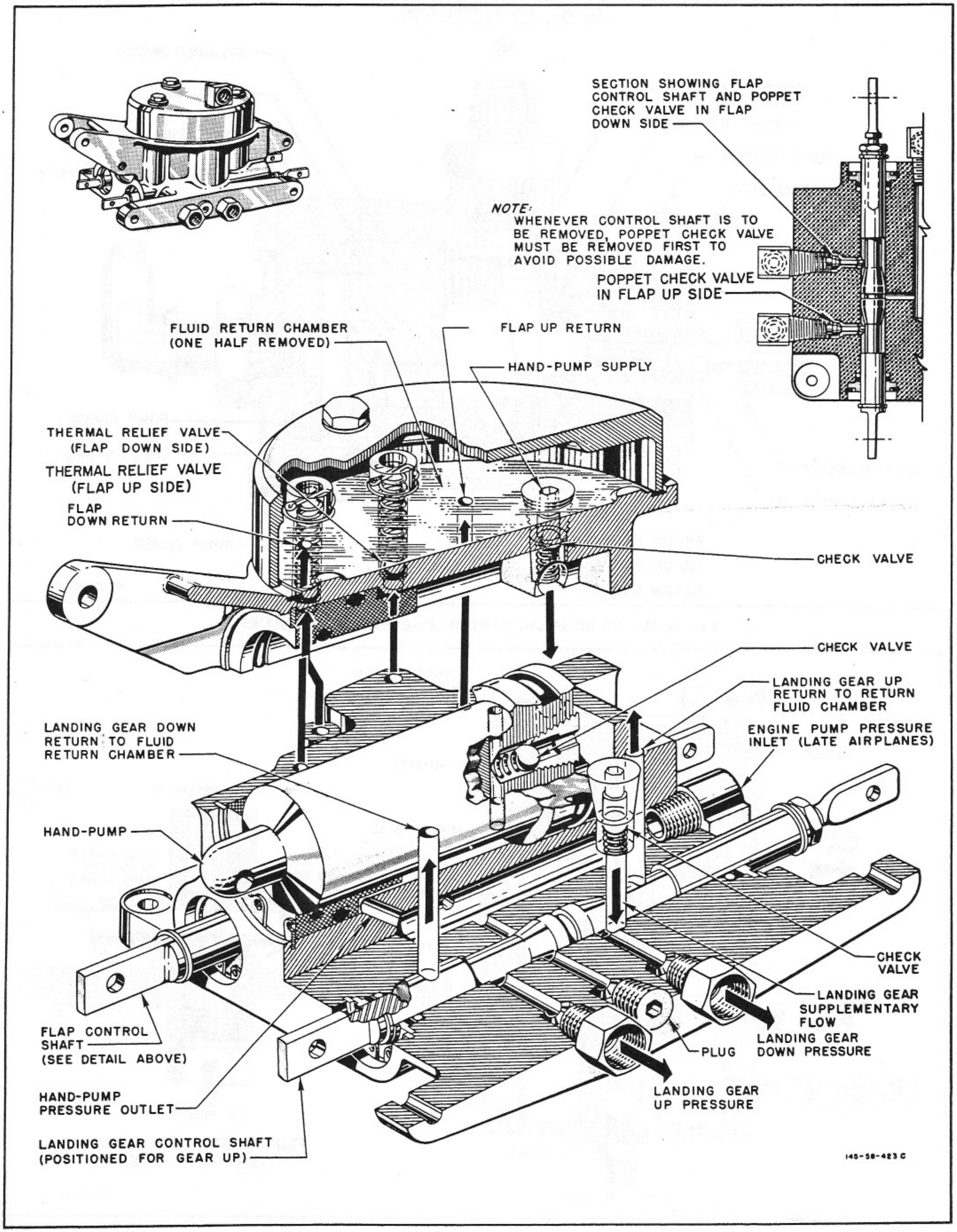


Figure 27 - HYDRAULIC SYSTEM MASTER CONTROL VALVE

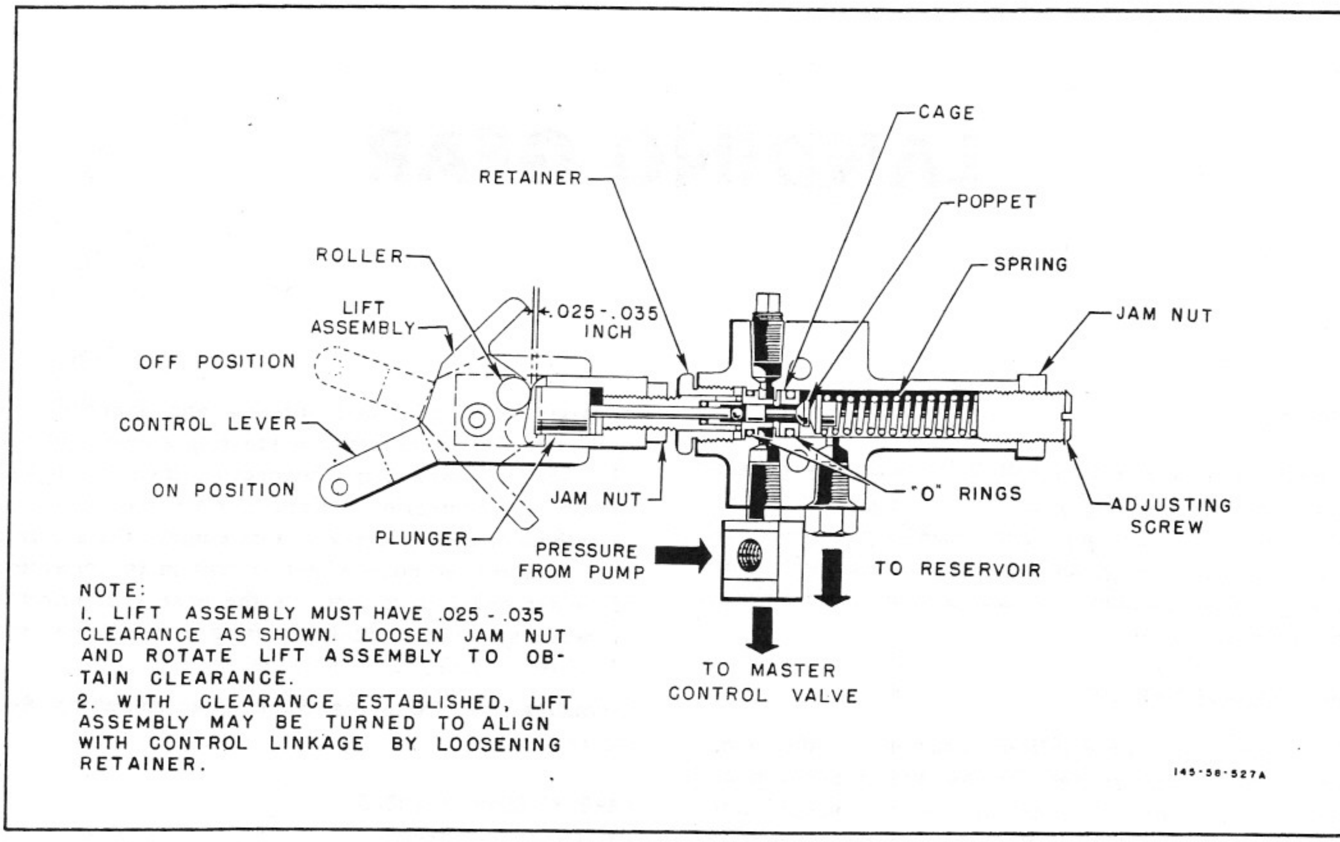


Figure 28 - HYDRAULIC SYSTEM CONTROLLABLE RELIEF VALVE

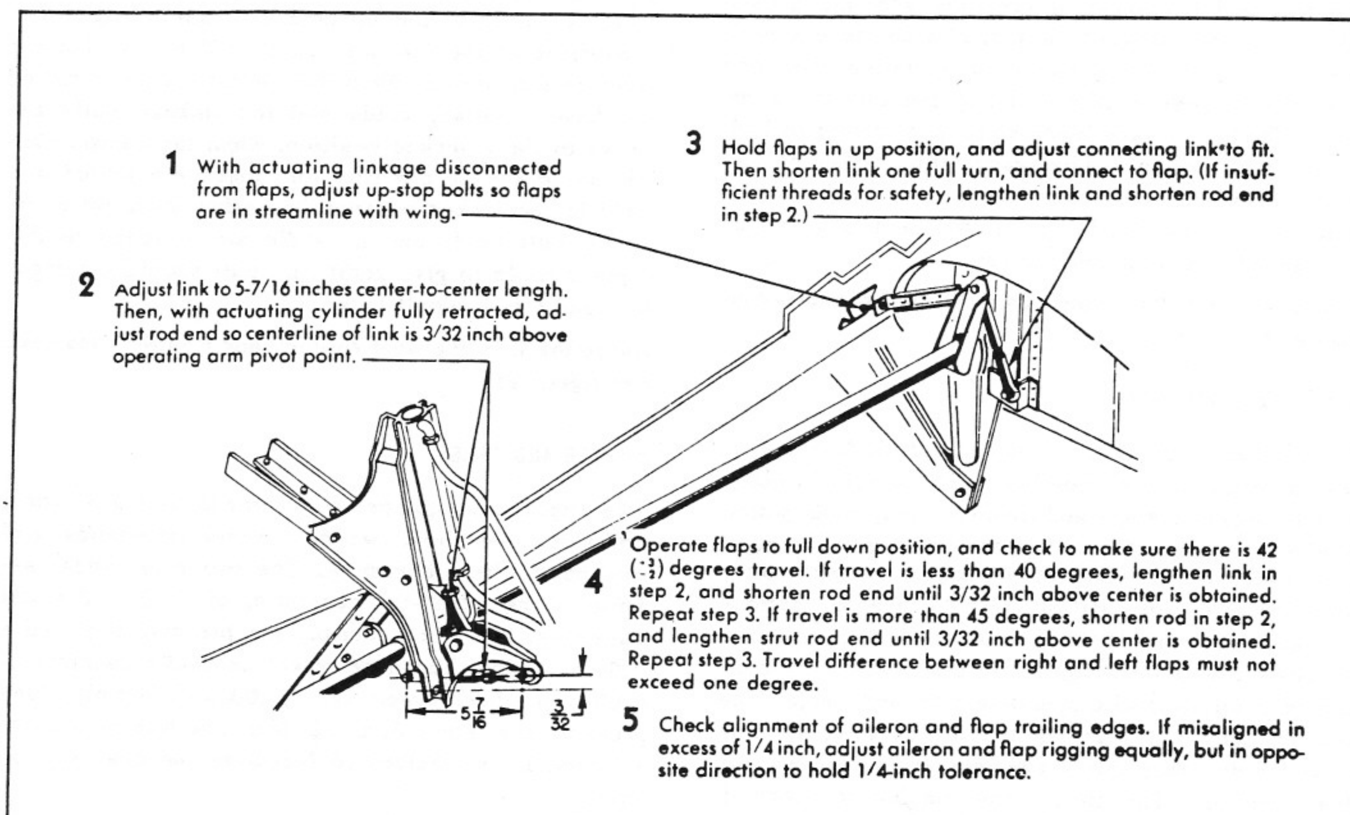


Figure 29 - ADJUSTING WING FLAP OPERATING MECHANISM

LANDING GEAR

GENERAL

The Navion is equipped with a hydraulically retractable tricycle landing gear, consisting of two main gear assemblies, a nose gear assembly, wheels and tires for each gear, up-locks with normal and emergency control linkage, and fairing doors for the shock struts of each gear.

MAIN GEAR ASSEMBLIES

The main gear assemblies, attached to the wing structure by ball-socket fittings and trunnion pins, pivot on the trunnion pins, and retract inboard into the wing panels. Each main gear assembly consists of a shock strut assembly and side brace linkage. Retraction and extension of the main gear are accomplished by movement of the hinged side brace assembly, connected to the hydraulic operating strut and bungee; the gear is held in the up position by an up-lock. The hinged side brace stops past center to lock in the down position. The shock strut, having an air-fluid combination for cushioning, absorbs the shock caused by sudden loads against the landing gear during take-off, landing, and taxiing.

Installing and Removing Main Gear Assembly—See figure 30.

NOSE GEAR ASSEMBLY

Attached to support box in the nose of the fuselage at the firewall, the nose gear assembly is held in place by ball-socket fittings and trunnion pins, about which it pivots aft into the well in the fuselage. The nose gear assembly consists of a shock strut assembly, drag brace linkage, and steering mechanism. Retraction and extension of the nose gear are accomplished by movement of the hinged drag brace assembly connected to the hydraulic operating strut and bungee; the gear is held in the up position by an up-lock. The hinged side brace drops past center to lock in the down position. The shock strut, having an air-fluid combination for cushioning, absorbs the shock caused by sudden loads against the landing gear during take-off, landing and taxiing. The steering mechanism consists of a tube and steering arm assembly attached to the shock strut, a steering support assembly, and rod assemblies connecting from the rudder pedals to the steering bellcrank. When the nose gear is extended, the bellcrank rollers contact the steering arm, causing the nose wheel to turn in the direction of rudder pedal movement. As the nose gear retracts or extends, a mechanical centering device keeps the wheel from turning to either side.

Installing and Removing Nose Gear Assembly—See figure 31.

LANDING GEAR UP-LOCKS AND CONTROL LINKAGE

The up-locks, located in each respective wheel well, hold the gear in the up position during flight. The movement of the locks is controlled by the landing gear control handle. When the control handle is moved to *down* position, cable and rod linkage pulls the locks to the unlocked position. When the control handle is in the *up* position, the locks are pulled and held in the locked position by spring load. An emergency pull cable and a handle are attached to the regular cable to give additional pull should the regular handle fail to pull locks.

Adjusting Landing Gear Up-lock and Control Linkage—See figure 32.

WHEELS AND TIRES

The airplane is equipped with three landing gear wheel and tire assemblies, two main wheel assemblies, and one nose wheel assembly. The two main wheel assemblies are identical, consisting of a 6.50 x 8 wheel assembly, a 7.00 x 8 four-ply low-pressure tire, and a 7.00 x 8 tube. The nose wheel assembly consists of 6.00 x 6 wheel assembly, a 6.00 x 6 four-ply, low-pressure tire, and a 6.00 x 6 tube. The wheels are constructed in two halves to facilitate the changing of tires.

Installing and Removing Wheels and Tires—See figure 33.

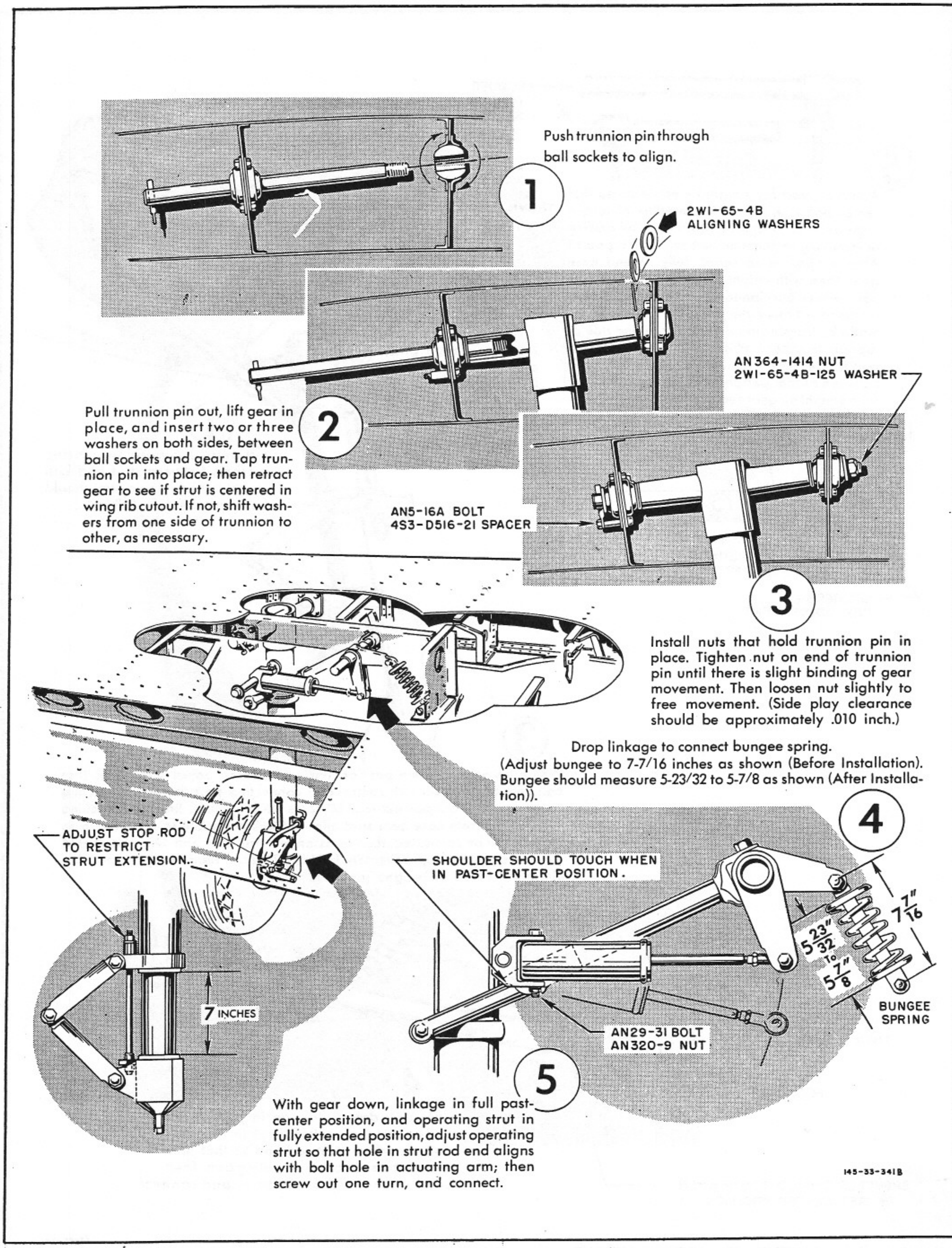


Figure 30 - INSTALLING AND REMOVING MAIN GEAR ASSEMBLY

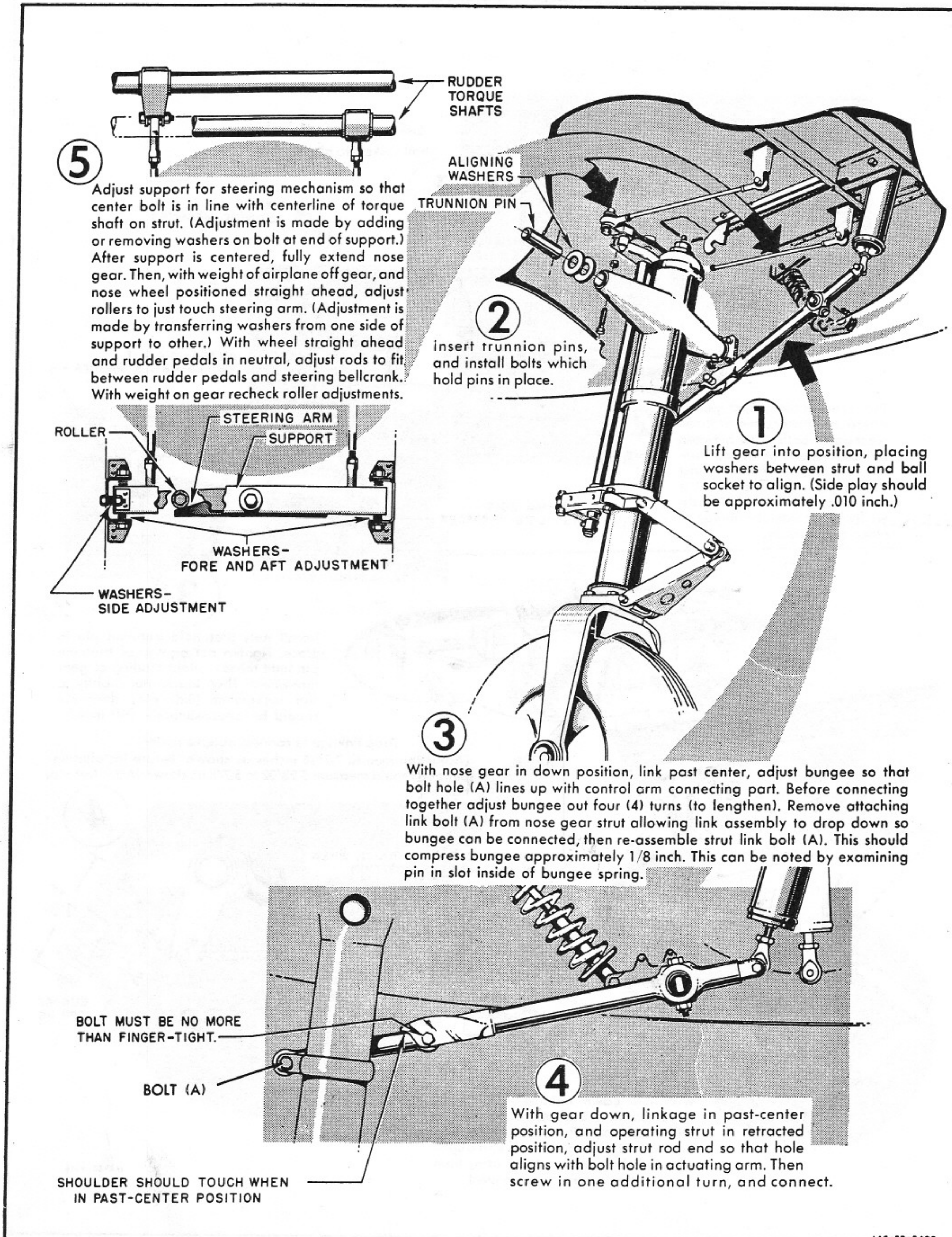


Figure 31 - INSTALLING AND REMOVING NOSE GEAR ASSEMBLY

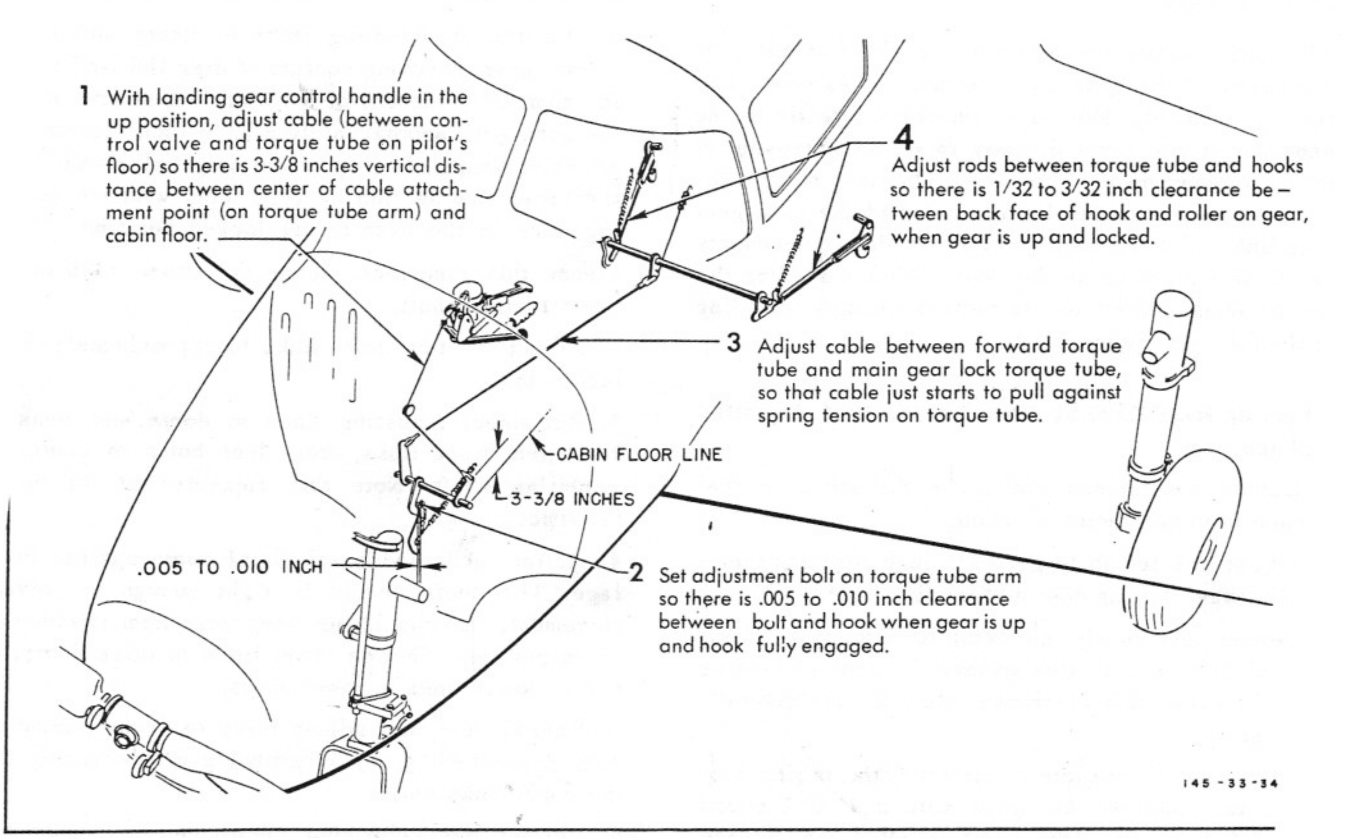


Figure 32 - LANDING GEAR UP-LOCK AND CONTROL LINKAGE ADJUSTMENTS

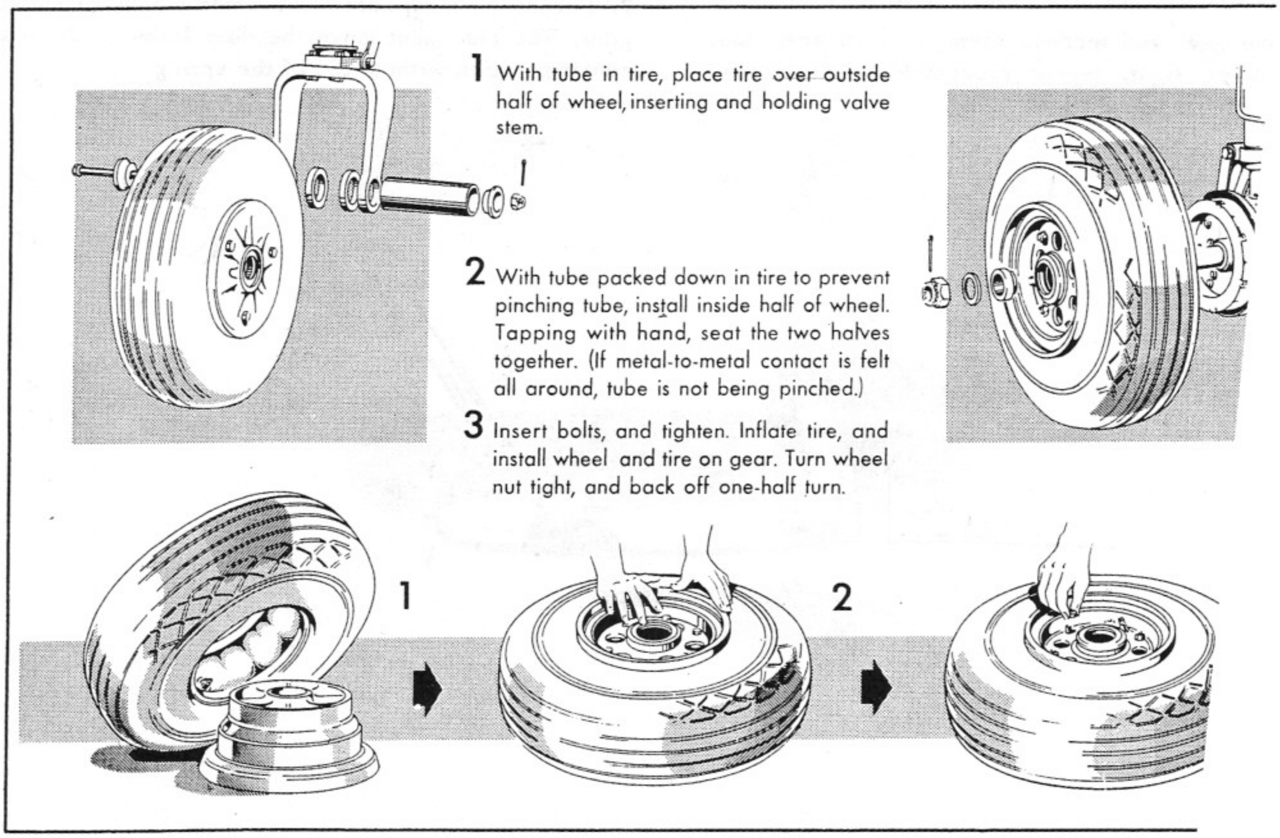


Figure 33 - INSTALLING AND REMOVING WHEELS AND TIRES

FAIRING DOORS

The fairing doors are actuated, to close or open, by movement of the gear as it retracts or extends. The main gear fairing doors are connected directly to the shock strut and pivot directly to follow extension or retraction movement of the gear. The nose wheel fairing doors are actuated by movement of the nose gear drag link which moves a cam to provide the necessary power to open or close the doors. When installing the fairing doors adjust the retraction linkage according to the following procedures:

Adjusting Main Landing Gear Fairing Door Actuating Linkage

1. Locate the linkage clamp, on the strut, so that linkage is in horizontal position.

2. Adjust link length to give 1/8 inch minimum clearance between fairing door and landing light.

3. Retract gear slowly, checking for a minimum clearance of 1/8 inch as link passes in front of landing light. To adjust this clearance rotate the clamp on the shock strut.

4. When gear is completely retracted, the fairing door should rest against the stops with a 1 to 2 pound load. To move the door position slide the linkage clamp up or down on the shock strut. Moving the clamp down pulls the door closer to the stops.

5. Lower gear and recheck clearances between door and landing light; repeat procedure as necessary.

Adjusting Nose Gear Fairing Doors Actuating Linkage

1. Disconnect actuating links at doors and slowly retract gear, checking contact of drag link and actuating cam. Only the end of the drag link should bear on the cam, with approximately a 1/16 inch clearance at all other points. The tip of the drag link should clear the lower cam section by 1/16 inch; with the actuating arms in the over center locked position. To increase this clearance, screw the upper links out of the actuating shaft.

2. Adjust the two lower links to approximately 5-3/8 inches long.

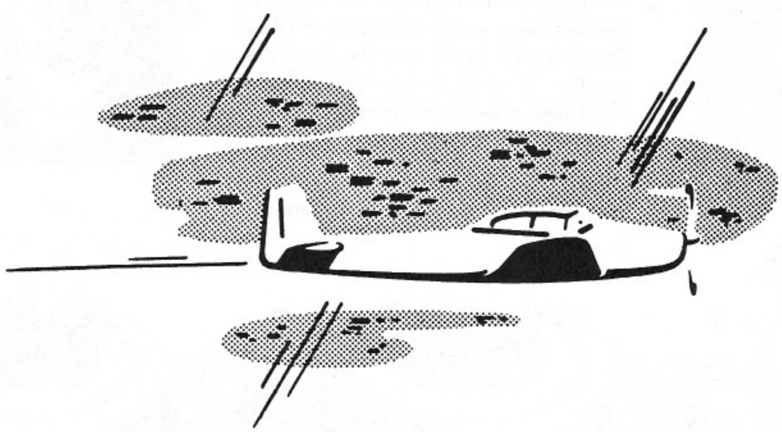
3. Reconnect actuating links at doors and measure total length of links, from door bolts to center of actuating shaft. Note this measurement for future reference.

4. Retract gear and check fit of doors against fuselage. The doors should fit tight enough to prevent movement, but should not keep gear from latching in in up position. Shorten lower links to raise doors, or extend lower links to lower doors.

5. Extend gear and adjust links to length noted in step 3 preceeding, by lengthening or shortening the the upper links only.

6. Retract gear checking clearances and door fit. Adjust as necessary.

7. For final check, hold doors while slowly extending gear. The cam must move the door links to the over center position without aid of the spring.



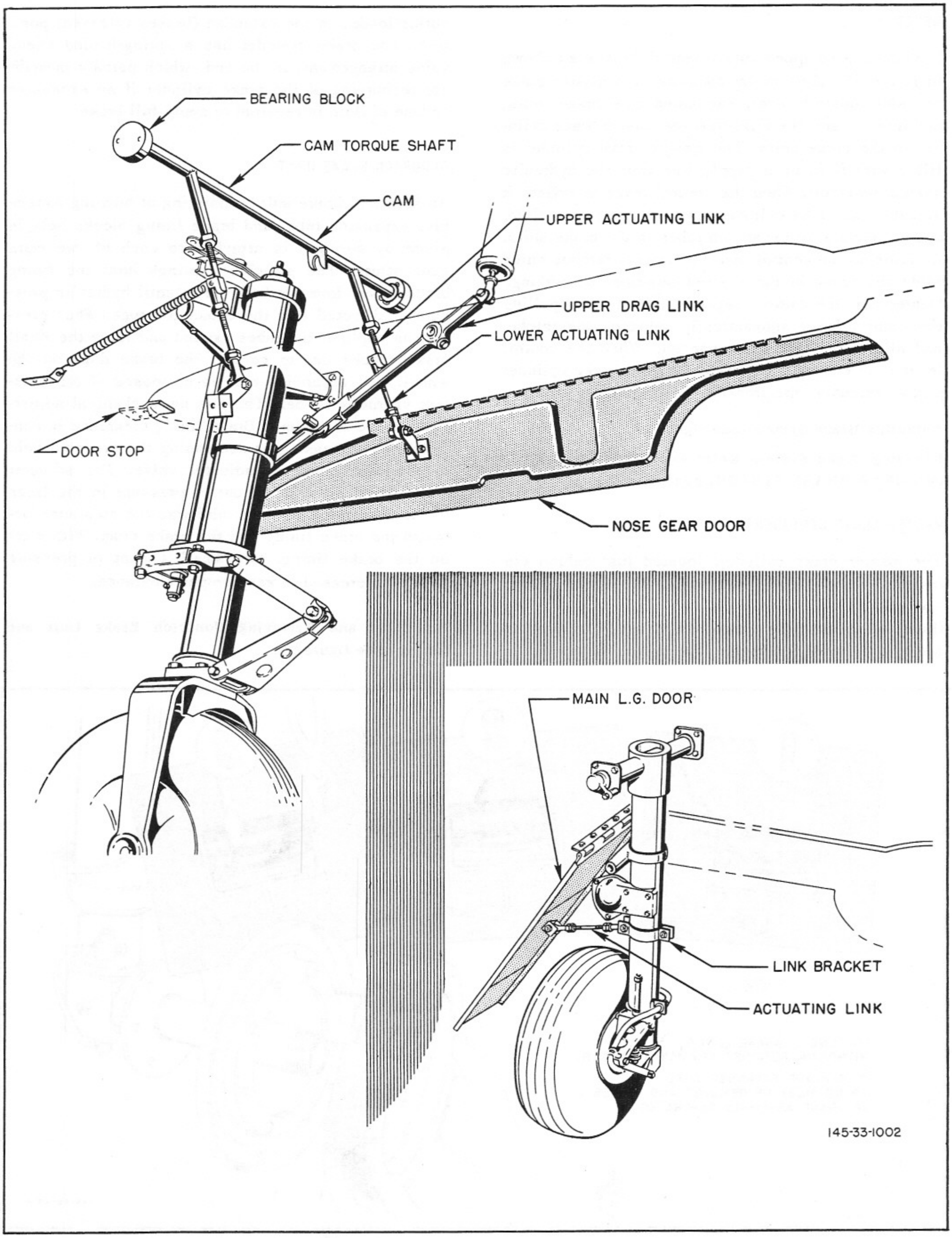


Figure 34 - LANDING GEAR FAIRING INSTALLATION AND REMOVAL

BRAKE SYSTEM

GENERAL

Navions are equipped with Goodrich brakes as shown in figure 35. The system consists of a master brake cylinder, control lever, expansion-type brake units, and line to carry the fluid from the master brake cylinder to the brake units. The master brake cylinder is filled with fluid by a supply line from the hydraulic system reservoir. When the control lever is pulled, it actuates the brake cylinder piston which forces fluid, under pressure, to expansion tubes in the brake units. A button on the control lever actuates a ratchet which holds the lever in the desired position for parking. Depressing the button engages the ratchet; pulling the control lever automatically releases the ratchet and allows the button to snap out. When the control lever is released, it returns the master brake cylinder piston, releasing the pressure on the fluid.

Adjusting Brake System—See figure 36.

Bleeding Brake System—Refer to SERVICING LANDING GEAR BRAKE SYSTEM, page 5.

MASTER BRAKE CYLINDER

The master brake cylinder, located just behind the instrument panel, is a piston type. The piston assembly incorporates a neoprene cup seal for preventing fluid leakage past the piston. O ring seals are used to prevent external leakage. The piston assembly is spring-loaded in the extended (brakes released) position. The brake cylinder has a spring-loaded check valve arrangement, in the end, which permits immediate recharging of the brake cylinder if an excessive volume of fluid is required to apply full brake.

GOODRICH BRAKE UNIT

An identical brake unit (consisting of housing assembly, expansion tube, and brake lining blocks held in place by springs) is attached to each of two main gear struts. The attaching springs hold the lining blocks away from the brake drum until hydraulic pressure is directed into the expansion tube. When pressure is applied, the tubes expand and force the small brake blocks out to contact the brake drum on the wheel. The expansion tube is composed of oil-resistant synthetic rubber. There is no mechanical adjustment on the brake unit. Brake lining clearance is controlled by increasing or decreasing the pressure held in expansion tube by adjuster valve. The adjuster valve holds a small amount of pressure in the lines to the brake unit so as to minimize the clearance between the brake lining and the brake drum. With wear on the brake lining, this small amount of pressure must be increased to keep proper clearance.

Installing and Removing Goodrich Brake Unit and Lining—See figure 35.

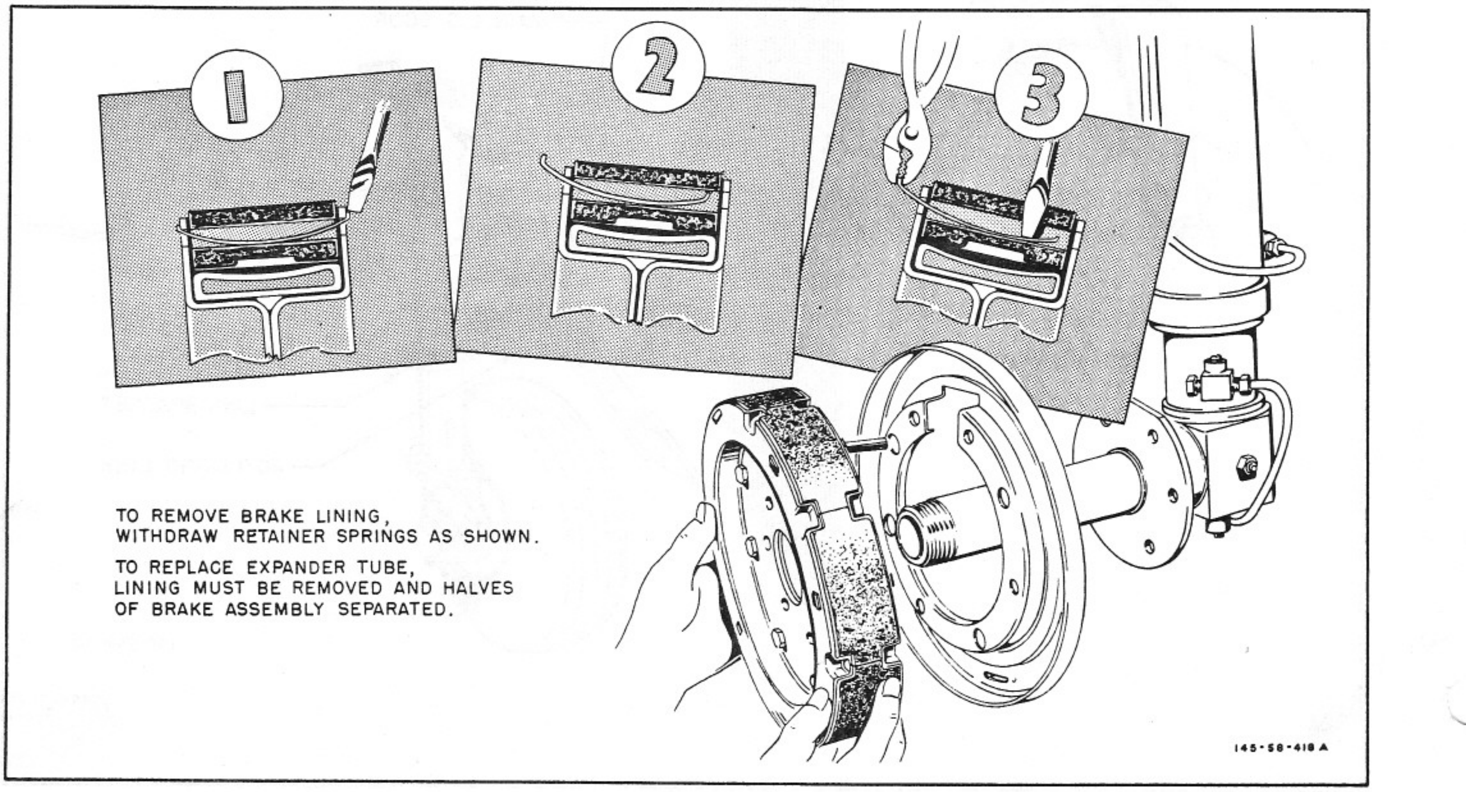


Figure 35 - INSTALLING AND REMOVING GOODRICH BRAKE UNIT AND LINING

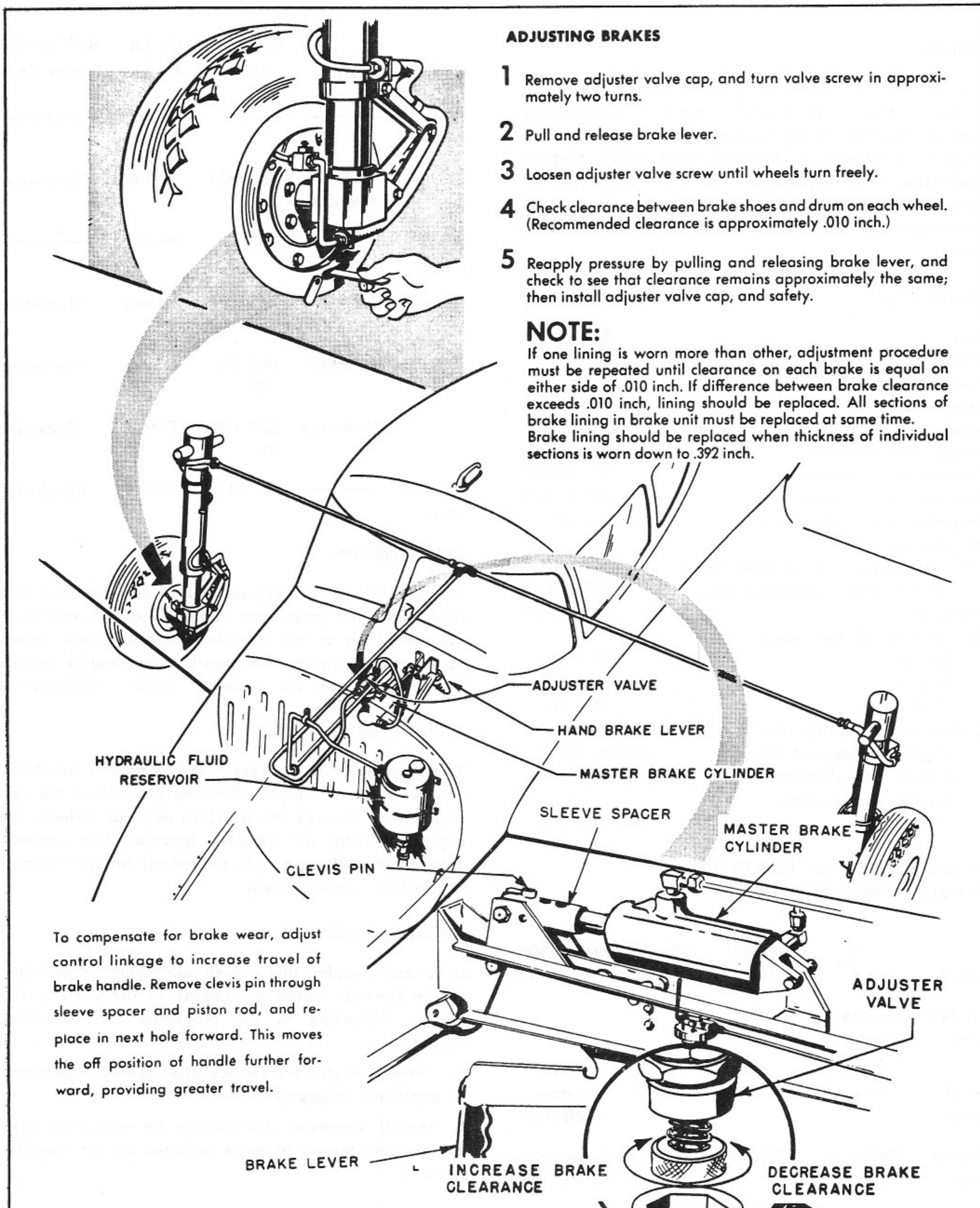


Figure 36 - BRAKE SYSTEM AND GOODRICH BRAKE ADJUSTMENT

ENGINE

GENERAL

The Navion is powered by a six-cylinder, over-head-valve, air-cooled, horizontally opposed, direct-drive, Continental (Type E-185) engine. *(See figure 37.)* The engine, incorporating hydraulic-type valve tappets which require no adjustment, has a sea level take-off power rating of 205 bhp at 2600 rpm, for one-minute. Continuous operation power rating is 185 bhp at 2300 rpm.

ENGINE DATA

Bore	5.00 in.
Stroke	4.00 in.
Piston displacement	471 cu in.
Compression ratio	7:1
Intake valve (opens)	15° B.T.C.
Intake valve (closes)	60° A.B.C.
Exhaust valve (opens)	55° B.B.C.
Exhaust valve (closes)	15° A.T.C.
Propeller shaft spline size	No. 20
Magneto timing	
Left magneto (lower spark plugs)	26° B.T.C.
Right magneto (top spark plugs)	26° B.T.C.
Firing order	1-6-3-2-5-4
Engine over-all dimensions	
Length	46.7 in.
Height	25.0 in.
Width	33.5 in.
Engine weight details (dry)	
Engine without accessories	approx 335 lb
Engine and accessories	approx 371 lb
Engine, accessories, and mount	approx 390 lb

ENGINE ACCESSORIES, GEAR RATIOS, AND DIRECTION OF ROTATION

UNIT	MAKE	MODEL NO.	GEAR RATIO	ROTATION (Drive End)
Carburetor	Bendix-Stromberg	PS-5C	----------	------------
Fuel pump	Romec	RD7790	1.667:1	Counter-clockwise
Generator	Delco-Remy	1101879	2.250:1	Counter-clockwise
Hydraulic pump	New York Air Brake	67AB025	1.364:1	Clockwise
Starter	Delco-Remy	1109660	35.77:1	Clockwise
Tachometer	----------	---------	0.500:1	Clockwise
Magnetos	Bendix-Scintilla	S6LN-21	1.500:1	Clockwise
Spark plugs	BG	706S	---------	-------------
Propellers	Hartzell	HC-12x20-7	Direct	Clockwise
	Aeromatic	Hub No. 220	Direct	Clockwise
	Aeromatic	220-1/0-85	Direct	Clockwise
Vacuum pump	-----------	AN-6110-1	1.67:1	Clockwise

ENGINE COOLING

An air-pressure-type system of air deflectors and baffling, installed around the engine, directs a sufficient volume of air to the cylinder barrels, heads, spark plugs, and oil cooler to maintain proper engine operating temperatures for maximum engine efficiency.

ENGINE EXHAUST SYSTEM

The exhaust system consists of two muffler manifolds and two extension pipes. Exhaust gases from the cylinders flow through the mufflers and out through the engine cooling air exhaust louvres. The shrouds around the mufflers supply heated air for the carburetor, and for cabin heating.

INSTALLING ENGINE

It is recommended that the engine mount be attached to the firewall before the engine is installed in the mount. Following is the procedure for installing engine:

1. Prepare engine for service after storage treatment, as explained on page 19.

2. Install necessary accessories on engine to make up full complement of units required by the specific airplane.

NOTE

When a new or drained carburetor is being installed, it must be filled, flushed of shipping oil, vented, and the diaphragms soaked for an 8-hour period before the

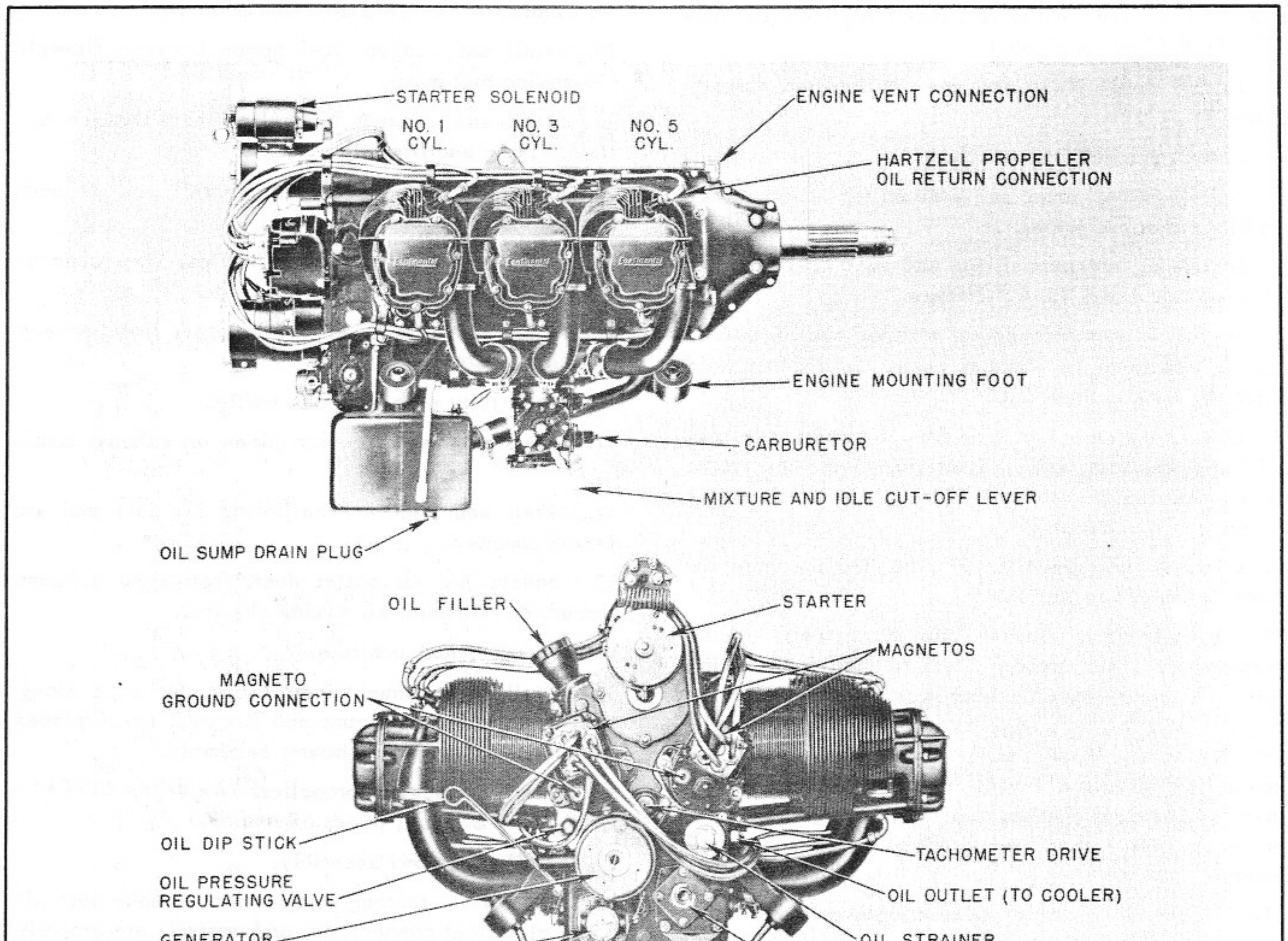


Figure 37 - E-185 CONTINENTAL ENGINE

engine is started. (Refer to PREPARING CARBURETOR FOR USE, page 56.)

3. Install spark plugs and connect ignition harness leads.

4. Install cylinder head baffles.

5. Install primer fitting and hose on top of left intake manifold near carburetor.

6. Install oil pressure fitting and hose on crankcase between No. 4 and No. 6 cylinders.

7. Install heater shrouds on exhaust manifolds and attach manifolds to exhaust ports. Torque manifold mounting nuts to 80-90 inch-pounds.

8. Check engine mount assembly to make sure that all lines, controls, and units are installed, and are so positioned that no interference will occur when engine is lowered into mount.

9. Connect fuel vapor return, and fuel pressure fittings and hoses to carburetor.

10. Carefully lower engine into mount until engine mounting feet are approximately ¼ inch from engine mount fittings. Install rubber washer and end plate on each side of each engine foot; then install engine retainer bolts. Install engine bonding braids under heads of front bolts. Lower engine until bolts can be inserted in mount bosses; then install washer and nut on each bolt, torque to 450-500 inch-pounds, and safety.

11. Connect air mixing chamber adapter to carburetor.

12. Connect air duct, from left heater shroud, to carburetor air mixing chamber.

13. Connect and adjust throttle and mixture controls to carburetor.

14. Connect electrical leads to throttle warning switch on carburetor.

15. Connect tachometer shaft to engine.

16. Connect electrical leads and air blast hose to generator.

17. Connect ground wire to each magneto.

18. Connect fuel vapor return line, and fuel pressure line connections on forward right side of engine mount bulkhead.

19. Connect electrical leads to starter.

20. Connect and adjust control cable to starter control arm.

21. Connect fuel supply lines between carburetor and engine fuel pump.

22. Connect oil pressure hose connection on forward left side of engine mount bulkhead.

23. Install and connect oil hoses between engine and oil cooler radiator.

24. Connect oil temperature bulb at oil cooler.

25. Install and connect fuel hoses between firewall and engine fuel pump.

26. Install and connect hydraulic lines between hydraulic pump and firewall.

27. On airplanes so equipped, install and connect vacuum lines.

28. Install left side bulkhead baffles; then connect primer hose and line forward of baffle.

29. Install and connect engine breather line between engine and firewall.

30. Install right side bulkhead baffle.

31. Install exhaust extension pipes on exhaust manifolds.

32. Install and connect ventilating air duct and air mixing chamber.

33. Connect hot air outlet duct, from right exhaust shroud, to ventilator air mixing chamber.

34. Connect heater controls.

35. Install and connect ventilating air duct along right side of engine mount and firewall. On airplanes so equipped, install gas heater assembly.

36. Install applicable propeller. *(Refer to INSTALLING PROPELLER, pages 65 and 69.)*

37. Install nose cowl assembly.

38. Make a final thorough inspection to make sure all lines, electrical connections, and controls are properly and tightly connected, and adjusted.

PREPARING ENGINE FOR INITIAL GROUND RUN-UP

1. Fill fuel tank with 5 gallons of proper grade fuel.

2. Make sure carburetor has been filled and diaphragms soaked with fuel. *(Refer to PREPARING CARBURETOR FOR USE, page 56.)* Remove and clean fuel inlet screen.

3. Place 4 quarts of required oil in oil sump.

4. Drain fuel accumulator water trap.

5. Check starter and primer operation, and security of all ignition wiring.

6. Inspect carburetor air scoop for foreign matter.

ENGINE INITIAL RUN-UP

1. Start engine according to instructions on page 14.

2. Run engine at 800 rpm. (If oil pressure is not up to 10 psi within 30 seconds, stop engine and investigate.)

3. After running engine for approximately one minute, stop engine and inspect for fuel and oil leaks.

4. Again start engine and warm up slowly at 1200 rpm until 105°F oil temperature is obtained. At 1700 rpm, check magneto drop and required instrument readings.

5. At 1700 rpm, on airplane with Hartzell propellers, pull propeller control full out *(decrease rpm).* Note that rpm drops; then return control to full increase rpm position. Pull carburetor heat control out and note rpm drop. Push control in to turn off heat.

6. Adjust engine idling. *(Refer to ADJUSTING CARBURETOR, page 56).*

7. Check engine for good acceleration.

8. Stop engine and drain oil sump; clean oil screens; then refill oil sump with new oil (capacity 10 quarts).

9. Remove and clean all fuel strainers (fuel tank, main fuel strainer, fuel pumps, carburetor, and relief valve strainers).

10. Replenish fuel supply.

11. Install hinged cowling.

REMOVING ENGINE FROM MOUNT

1. Turn ignition switch to *off* position.

2. Turn fuel control off and turn hydraulic shut-off control to *off* positions in the cockpit. This will shut off the fuel and hydraulic supplies, and make it unnecessary to drain the complete fuel and hydraulic systems. Have a suitable container at hand to catch liquid remaining in the lines when the engine is being disconnected.

3. Remove propeller.

4. Remove access door on bottom of engine mount assembly, and drain oil system at engine sump and at oil cooler. Replace drain plugs.

5. Remove hinged cowling door assembly and nose cowl.

6. Remove heater or cockpit ventilating air intake duct.

7. Disconnect hot air duct leading from right exhaust shroud to ventilating air mixing chamber.

8. Disconnect and remove exhaust manifold extension pipes from mufflers.

9. Disconnect fuel supply line at carburetor and at engine fuel pump outlet.

NOTE

This line passes through engine mount bulkhead, and will remain with mount when engine is removed.

10. Disconnect fuel vapor return and fuel pressure indicator line at connections located on forward right side of engine mount bulkhead.

11. Disconnect starter wiring at starter.

12. Disconnect electrical wiring at generator terminals.

13. Disconnect ground wires to magnetos.

14. Disconnect engine vent line at firewall connection.

15. Disconnect air blast hose at generator.

16. Disconnect primer hose connection located forward of the left bulkhead baffle; then remove baffle.

17. Disconnect oil pressure hose connection located on forward left side of engine mount bulkhead.

18. Disconnect oil inlet hose, at top of cooler radiator, and oil return hose *(to engine)* from fitting on left side of engine.

19. Disconnect fuel inlet hose *(to engine fuel pump)* at firewall connections.

20. Disconnect hydraulic pressure hose at firewall connection, and hydraulic suction hose at connection on bottom of hydraulic reservoir.

21. Disconnect tachometer shaft at engine.

22. Disconnect vacuum lines if airplane is so equipped.

23. Disconnect throttle and mixture controls at carburetor.

NOTE

It is not necessary to disconnect the carburetor air control, as the air mixing chamber remains on the engine mount when engine is removed.

24. Disconnect electrical wiring to landing gear warning switch mounted on carburetor.

25. Disconnect air mixing chamber adapter from bottom of carburetor.

26. Place a suitable stand under tail skid to support airplane when it is relieved of engine weight.

27. Attach hoist to fitting on top of engine, and manipulate hoist to relieve engine weight from the mount.

28. Remove the four bolts securing engine to mount.

29. Make a final thorough inspection to make certain all engine-to-mount and engine-to-firewall connections have been disconnected; then slowly hoist engine straight up. Steady engine while it is being hoisted, to avoid damaging closely fitted or projecting parts. When engine is clear of mount, swing engine away from airplane and remove exhaust manifolds, cylinder baffles, lines, and all accessories as necessary.

30. Install engine on suitable stand or in shipping box.

FUEL-AIR INDUCTION SYSTEM

GENERAL

The fuel and air induction system *(figure 38)* consists of a "PS" series Bendix-Stromberg carburetor, an air duct (containing an air filter), an air mixing chamber, and an exhaust muffler shroud which provides heated air. Cold filtered air or hot air is directed in desired proportion to the carburetor by an air mixing chamber. An air valve in the air mixing chamber is controlled by a push-pull control in the cabin, for selection of filtered ram air through the air duct, or hot air from the shrouds around the exhaust manifolds. A riser is installed between the air mixing chamber and the carburetor. The riser straightens the air flow through the carburetor to provide best carburetor performance. The air filter must always be in place during operation of airplanes equipped with this riser.

CARBURETOR

The PS-5C carburetor *(figure 39)* is a single barrel, updraft, injection type, incorporating a regulated pressure discharge nozzle, a mechanically operated enrichment valve, a manual mixture control, and an idle cut-off mechanism. The carburetor also incorporates a vacuum-operated, single-diaphragm accelerating pump. The main body of the carburetor contains a manually controlled butterfly-type throttle valve for controlling airflow, and a venturi tube for obtaining venturi pressure differential to afford a means of measuring the airflow through the carburetor. The venturi pressure differential is a measure of mass airflow, and is applied to the air diaphragm in the regulator section of the carburetor, to regulate the fuel pressure across the fixed metering jet in the regulator fuel section. This regulation of pressure is in porportion to the mass airflow through the carburetor. Fuel enters through the strainer, passes through the diaphragm-controlled poppet valve to one side of the fuel diaphragm in the regulator fuel section, and then passes to the metering jet. The fuel then flows through the idle and power enrichment needle valve, and to the discharge nozzle, which opens when the fuel pressure, acting upon the discharge nozzle diaphragm, is great enough to overcome the force of the discharge nozzle spring, and sprays fuel under positive pressure into the engine intake manifold.

Preparing Carburetor for Use—Before starting the engine after the installation of a new carburetor, or one that has been previously drained, proceed as follows to fill, flush, and vent the carburetors, and to soak the diaphragms:

1. Connect an outside source fuel (or Stoddard solvent to reduce fire hazard) supply line to carburetor fuel inlet.
2. Remove the 1/8-inch drain plug located at the bottom of the regulator cover.
3. Open carburetor throttle lever about halfway, and move the mixture control level to *full rich* position.
4. Introduce fuel slowly through the carburetor, until the fuel flowing from drain plug is free of oil.
5. Replace drain plug and continue pumping fuel until a small amount of fuel discharges from the discharge nozzle.
6. Place the mixture control lever in the *idle cut-off* position. Because the carburetor has a closed fuel system, it will remain full of fuel as long as the lever is in the *idle cut-off* position.
7. Disconnect external fuel supply line, and connect airplane fuel supply lines.
8. Let carburetor stand for an 8-hour period before starting engine.

NOTE

This is important because the carburetor was originally calibrated with its diaphragms thoroughly soaked with fuel, and these diaphragms must be restored to this condition before the carburetor can be expected to function properly. If desired, the soaking operation may be performed prior to the installation of the carburetor on the engine.

Adjusting Carburetor—Special testing equipment, such as a flow bench, must be used to calibrate the carburetor and to obtain a definite and accurate check of the performance which the carburetor will provide under flight conditions. The only adjustment that can be made without a flow bench test, is the idle-mixture adjustment, which is made as follows:

1. Start and warm up engine until oil temperature is normal.
2. Check for proper magneto operation.
3. Close throttle completely to idle engine at approximately 600 rpm.
4. When the idling speed has stabilized, move cockpit mixture momentarily, but with a smooth, steady pull, into the *idle cut-off* position, and observe tachometer for any change during the "leaning" process; then return control to *full rich* position before rpm can drop to a point where engine cuts out. Rpm increase should be a minimum of 5 or a maximum of 10. An increase of over 10 rpm during "leaning" process is indicative of an excessively rich idle mixture;

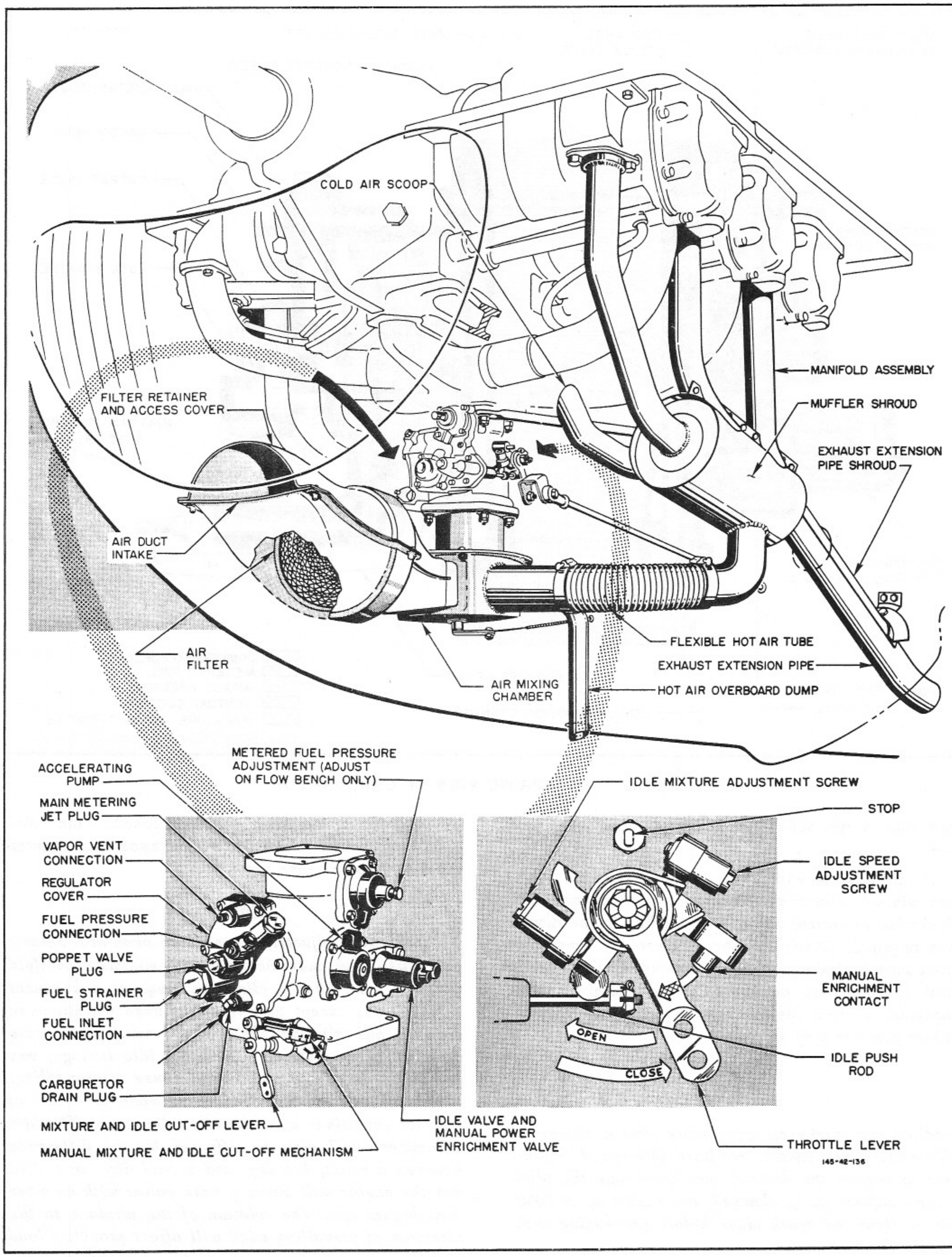


Figure 38 - FUEL-AIR INDUCTION AND ENGINE EXHAUST SYSTEMS

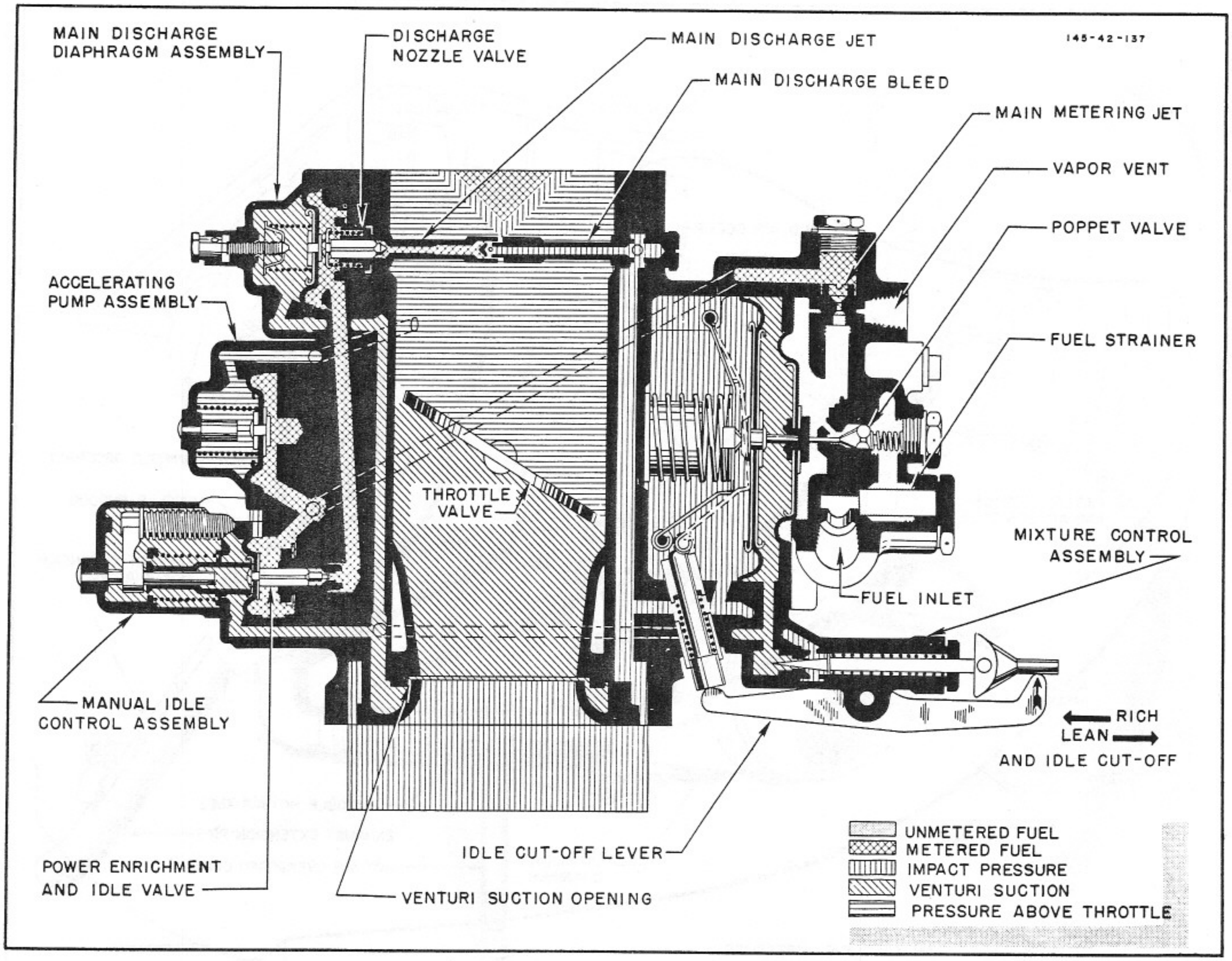


Figure 39 - SCHEMATIC VIEW OF CARBURETOR

less than 5 rpm indicates an excessively lean mixture.

5. If idle mixture adjustment is too rich or too lean, turn mixture adjustment (clockwise to lean, counterclockwise to enrich) one or two notches in the direction required. Check adjustment made, by repeating procedure 4. Make additional checks if necessary, until a momentary pick-up of approximately 5 rpm (maximum 10 rpm) results when repeating check procedure given in step 4.

NOTE

If idling rpm increases appreciably after a change in idle-mixture adjustment, readjust idle-speed adjustment to restore the desired rpm. Each time the idle-mixture adjustment is changed, run engine up to 2000 rpm to clear the spark plugs before proceeding with the rpm check.

6. Make final idle-speed adjustment to obtain the desired idling rpm with throttle closed. Turn idle-speed adjustment clockwise to increase rpm; counterclockwise to decrease rpm.

NOTE

The preceding adjustment procedure aims at a setting that will obtain maximum rpm with minimum manifold pressure, and should eliminate frequent subsequent adjustments, except to correct for wide variations in weather and altitude changes. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for effect of weather conditions upon the idle adjustment. The idle adjustment will also be affected by the difference between a moist, hot day, and a cold day; on a cold day the engine will develop more power with an attendant higher rpm. The relation of the airplane to the direction of prevailing wind will affect propeller load and thus its rpm; hence it may be advisable to make the idle adjustment with the airplane cross-wind.

Cleaning Carburetor Air Filter–The air filter should be removed from the airplane and cleaned as follows:

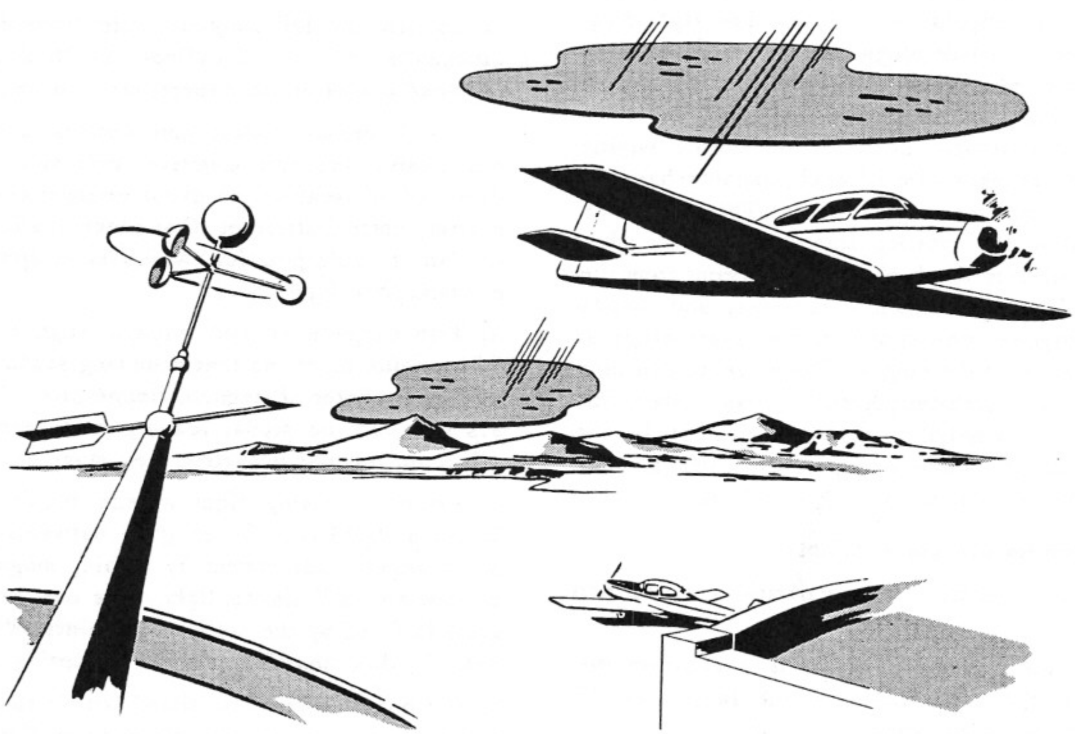
1. Immerse filter, dirty side down, in unleaded gasoline or other suitable cleaning fluid. While cleaning, rock filter or agitate cleaning fluid to remove dirt from the innermost part of the filter element.

2. Dry the filter thoroughly. When dry, immerse filter in engine oil (Grade SAE 20 or 30) for a period of 2 to 5 minutes.

NOTE

Make sure filter element is thoroughly dry bef mersing in oil; otherwise, the filter will not be ly coated, resulting in impaired cleaning effi

3. Drain the filter from 2 to 4 hours prior to in tion to remove excess oil. If filters are too h lubricated, clogging may result.



IGNITION AND STARTING SYSTEM

GENERAL

The ignition system consists of two impulse-drive type magnetos, radio-shielded ignition wiring, 12 spark plugs, and an ignition switch. The ignition switch stops operation of the magnetos by grounding the magneto primary coils at the breaker assemblies. The starter system includes a 12-volt, direct-cranking starter motor, mounting a solenoid switch. The starter solenoid switch is actuated by a foot switch mounted on the cockpit side of the firewall. The starter is wired through the battery-disconnect relay which must be turned on before the starter will be operable.

MAGNETOS

The magnetos (Bendix-Scintilla S6LN-21) are single, flanged-mounted, impulse-drive type. The right magneto fires the top spark plugs; the left magneto fires the lower spark plugs. The magnetos incorporate impulse drives that give an intensified spark for eady starting, and automatic spark retard during engine cranking. The breaker cam of each magneto has two lobes on the rotating magnet shaft. The distributor rotor, driven by the rotating magnet shaft through a fiber gear, conducts the high-tension current from the coil to the distributor cover electrodes, and thence through the high-tension cables to the spark plugs at the firing interval of the engine. The magneto bearings are packed with high-temperature grease when the magnetos are assembled. Further lubrication is not necessary, except at overhaul periods. The gap setting for the breaker points is .020 (±.002) inch.

Adjusting Magneto Breaker Assembly

1. Remove the breaker cover and timing inspection plug.
2. Look into the timing inspection hole and turn the magneto until the white tooth on the large gear is lined up with the timing pointer.
3. With the timing marks lined up, the breaker should be just starting to open.
4. If the points do not break at this position, loosen the screw in the slotted hole of the breaker assembly and shift the breaker slightly so that the points just break contact when the timing marks are lined up.

NOTES

**If the breaker points are oily, they can be cleaned with a little clear gasoline. Avoid getting any gasoline on the breaker cam, as it is impregnated with lubricant which would be washed away with gasoline or solvent.*

**If the breaker points are burned or worn excessively, remove and test the condenser.*

**Do not try to redress the contact surfaces. If the points are in unsatisfactory condition, install a complete new breaker assembly.*

CAUTION

DO NOT under any circumstances remove the five screws which hold the two sections of the magneto together, while the magneto is on the engine. To do so would disengage the distributor gears, causing the distributor timing to be "lost" and necessitating complete removal and retiming of the magneto.

Timing Magnetos to Engine

1. To time the left magneto, turn crankshaft counterclockwise until No. 1 cylinder is 26 degrees before top dead center on its compression stroke.
2. Check breaker point gap setting and adjust, if necessary; then turn magneto rotor shaft opposite to direction of rotation, to avoid engagement of impulse starter, until distributor rotor electrode is centered in the No. 1 cable position, which is at approximately 7 o'clock. *(See figure 40.)*
3. With magneto so set, engage magneto drive shaft with engine drive, so that mounting studs are approximately in center of magneto flange slots. Install washers and nuts on studs, leaving nuts loose enough to allow for angular adjustment on magneto flange pilot.
4. Attach a timing light across breaker points, or insert a .0015-inch feeler gage between points; then make angular adjustment by turning magneto counterclockwise until timing light dims out, or until feeler gage is freed by the separating points. With the magneto in this position, tighten mounting flange nuts.
5. If magneto cannot be timed within range of flange slots, remove and reindex magneto on flange to obtain maximum amount of angular adjustment in direction required.
6. To time right magneto, turn engine crankshaft until No. 1 cylinder is 26 degrees before top dead center and on its compression stroke; then proceed to time magneto to engine as explained in steps 2 through 5.

SPARK PLUGS

Each cylinder is fired by two radio-shielded 18mm Champion spark plugs. The cylinder heads are fitted with threaded aluminum bronze spark plug inserts which are screwed and pinned in place to receive the spark plug.

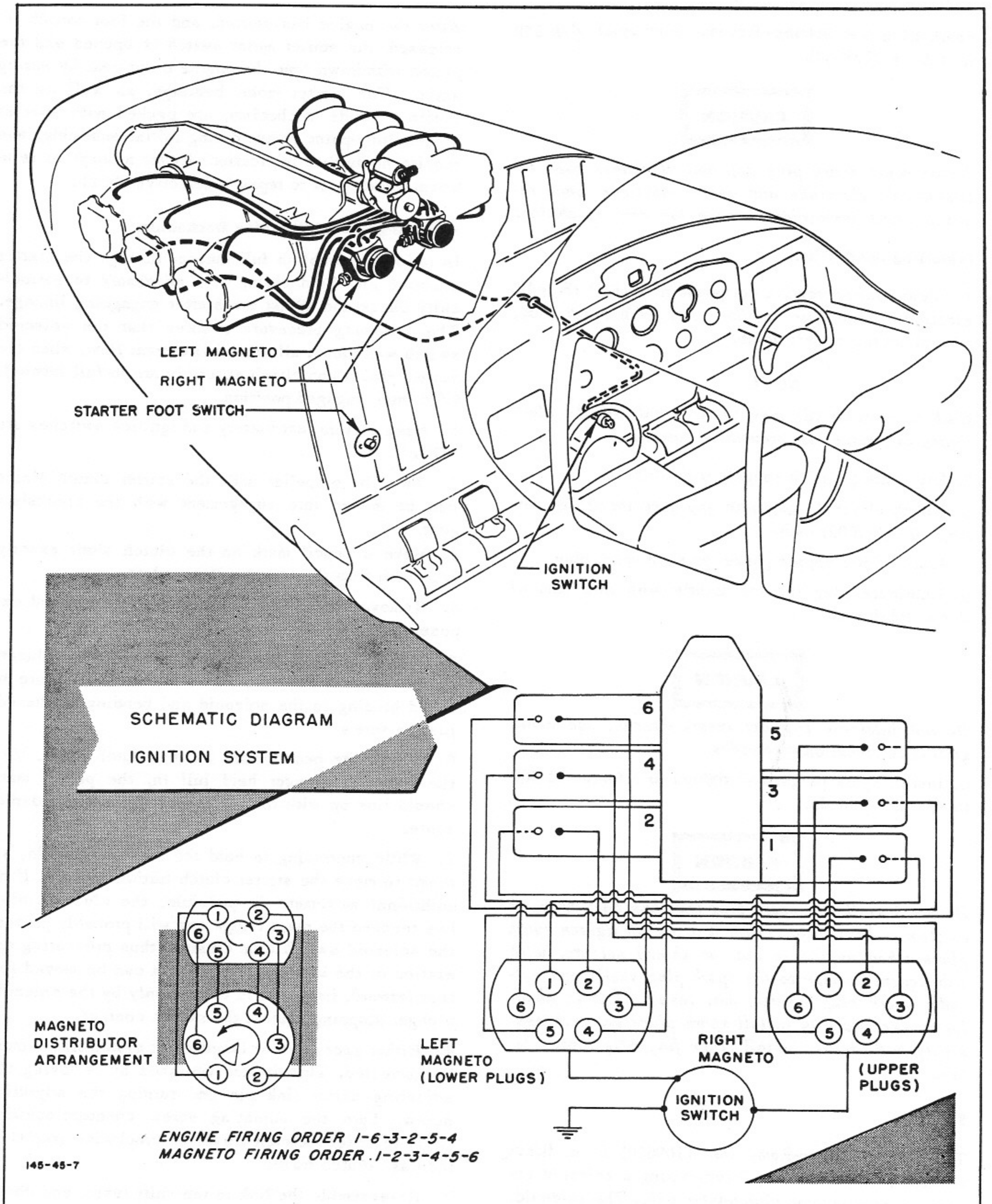


Figure 40 - IGNITION AND STARTER SYSTEM

Spark Plug Gap Setting—Recommended spark plug gap is .020 (±.002) inch.

CAUTION

Never reset spark plug gap with thickness gage between side electrode and center electrode. Such resetting will invariably damage the core insulation.

Installing Spark Plugs

1. Clean rust-preventive compound from shell threads, electrodes, and core insulation of each spark plug, with clean rag or soft brush.

NOTE

Carbon tetrachloride may be used only on the shell thread to remove rust-preventive compound.

2. Dry spark plugs thoroughly with air blast.

3. Check electrode gap with gap gage for proper setting, .020 (±.002) inch.

4. Install solid copper gasket on each spark plug.

5. Lubricate plug threads lightly with thin film of thread lubricant.

CAUTION

Do not lubricate cylinder insert threads, and avoid getting lubricant on electrodes.

6. Install spark plugs, and tighten to a torque of 300 to 360 inch-pounds.

CAUTION

Do not install any spark plug that has been dropped on floor or hard surface. Do not install or tighten spark plugs when engine is hot, as thread seizure, with subsequent damage to the spark plug shells and cylinder spark plug inserts, may result. If it is absolutely necessary to install spark plugs on an excessively hot engine, install plugs finger-tight plus ½ turn.

STARTER

The starter (Delco-Remy No. 1109660) is a direct cranking, electric motor, incorporating a solenoid engageing, overrunning, clutch-type drive. The solenoid, controlled by a foot-switch in the cockpit, moves the clutch assembly on the spline shaft, shifting the pinion into mesh with the engine drive gear. As the solenoid reaches its limit of travel it closes the starter motor switch contacts, and starting takes place.

After the engine has started, and the foot switch is released, the starter motor switch is opened and the pinion withdrawn from the engine drive gear by spring action. The starter motor bearings, as well as the clutch override mechanism, are packed with special high-melting-point grease during initial assembly, and require no further lubrication. Never attempt to relubricate starter, or to repair a defective clutch.

Adjusting Starter Engaging Mechanism

In order to establish full current through the starter armature and field coils, it is necessary to periodically check and adjust the starter engageing linkage. The following procedure assures that the solenoid switch will close, allowing full current flow, when the starter pinion and clutch assembly are in full forward, 9/16 inch, engaged position.

1. Make certain that battery and ignition switches are "OFF".

2. Turn the propeller until the starter clutch pinion can be moved into engagement with the crankshaft gear.

3. Make a pencil mark on the clutch shaft exactly 9/16 inch from the starter adapter plate.

4. Remove the solenoid plunger rubber boot and expose the plunger.

5. With a ¼-inch diameter brass bar, push the plunger as far as possible into the solenoid. Take care to avoid binding in the solenoid and bending of the adjusting screw.

6. Check the pencil mark on the clutch shaft. With the solenoid plunger held full in, the pencil mark should line up with the surface of the starter adapter plate.

7. While continuing to hold the solenoid full in, attempt to move the starter clutch further forward. If no additional movement is possible, the clutch pinion has touched the pivot flange and will probably prevent the solenoid switch from closing, thus preventing operation of the starter. If the clutch can be moved further forward, its travel is limited only by the solenoid plunger stopping against the switch contact.

8. Either excessive or insufficient clutch travel must be corrected. This is accomplished by removing the adjusting screw link pin and turning the adjusting screw. Turn the adjusting screw counterclockwise (left) to reduce clutch travel or clockwise (right) to increase clutch travel.

9. Re-assemble the link to the shift lever, and check piston travel again. When the pencil mark on the clutch exactly reaches the adapter plate as the solenoid switch closes, test for additional travel by pushing the clutch shaft. If the shaft can be moved far enough forward, with the solenoid plunger full in, to allow a

.010 inch feeler gage to be inserted between the switch lever and the shaft, the adjustment is correct and all requirements of operation will be met.

10. If it is not possible to secure a full 9/16 inch clutch travel and maintain .010 inch clutch to lever clearance, it will be necessary to adjust for the .010 inch minimum clearance and allow clutch travel to be slightly less than 9/16 inch. Should the clutch to lever clearance be over 0.10 inch, do not increase clutch travel over 9/16 inch, as the extra clearance is not harmful.

Measuring Starter Brush Spring Tension

1. Remove cover band for access to starter brushes and spring.

2. Connect one end of spring scale to brush holder. Raise spring brush holder approximately 1/8 inch above the top of brush box; the spring tension reading should be between 24 and 28 ounces. Springs which do not have said tension should be replaced.

Replacing Starter Brushes

1. Remove brush leads, being careful not to tear or damage brush lead sleeving.

2. Raise spring brush holder, and remove brush.

3. Install new brush, making sure that brush lead sleeving is not burned or frayed, and properly covers brush leads.

4. In most cases, brushes will not seat properly when first installed. If facilities are not available for running in the brushes, insert a strip of No. 00 sandpaper between brushes and commutator (sanded side facing brushes), and pull strip in direction of rotation. Keep sandpaper in same contour as commutator. Repeat operation until all new brushes are fully seated.

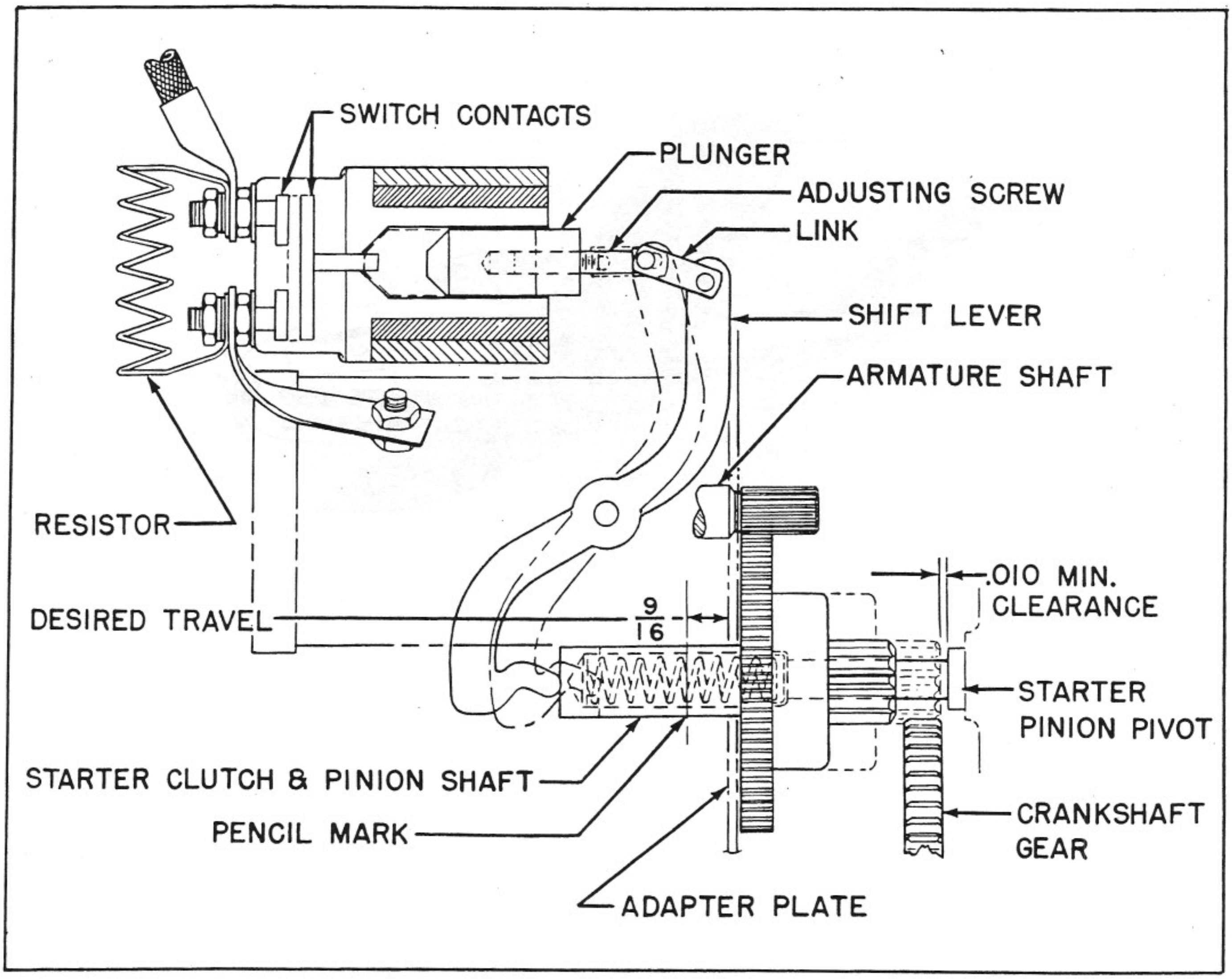


Figure 41 - STARTER ENGAGING MECHANISM

CAUTION

Never use coarse sandpaper or emery cloth.

5. Thoroughly clean starter of all sand and metal particles; replace cover band.

Cleaning Cummutator

1. If commutator is found to be dirty, it may be cleaned with a strip of No. 00 sandpaper.

CAUTION

Never use emery cloth to clean commutator.

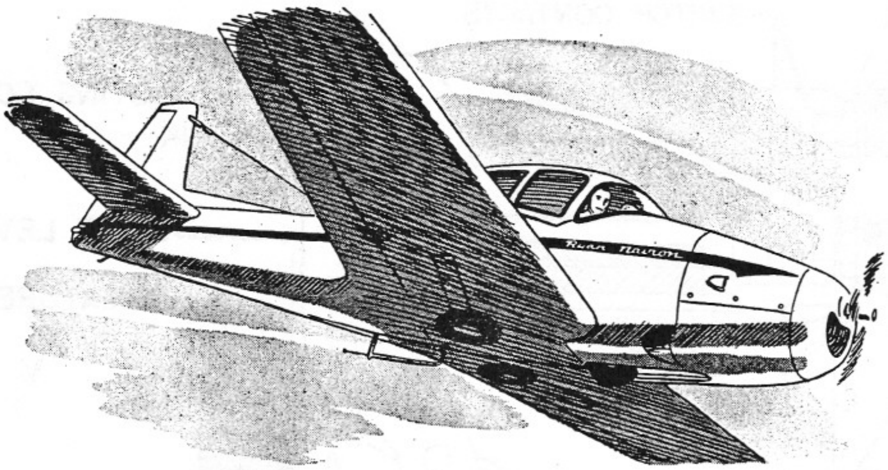
2. Blow dust from starter motor after cleaning commutator.

3. If commutator is rough, or out of round, or has high mica insulators (causes which contribute to excessive brush wear), starter should be removed from airplane, and disassembled. Turn commutator down in a lathe, removing only sufficient material to true up commutator and remove rough or high mica. Undercut the mica 1/32 inch.

Adjusting Starter Engaging Mechanism—See figure 41 for detailed procedure.

NOTE

The adjustment is necessary to ensure that starter and engine drive gears are meshed before starter is energized. It is imperative that the adjustment be checked each time a solenoid or a starter is replaced.



PROPELLER

GENERAL

The Navion is equipped with either a Hartzell hydro-selective propeller, or a Koppers Aeromatic automatic variable-pitch propeller.

HARTZELL PROPELLER

The Hartzell hyrdro-selective propeller *(figure 42)* utilizes engine oil pressure to reduce blade pitch, and counterweights to increase blade pitch. A servo valve (manually controlled from the cabin through a flexible control) regulates the oil flow to provide any desired pitch setting within the blade pitch setting limits. When the control is pushed in, the servo valve introduces oil under pressure into the diaphragm chamber which moves the jack plate forward. Links connecting the jack plate and blades move the blades to decrease their pitch angle. When the control is pulled out, the servo valve closes off the pressure oil inlet port, and opens the outlet port. Centrifugal force acting upon the counterweights moves the blades into the increase pitch angle position. The links connecting the blades and jack plate move the jack plate aft, forcing the oil through the servo valve back to the engine. The blade angle settings, measured at station 30, are 14 degrees for low pitch and 22.5 degrees for high pitch.

Removing Propeller

1. Make certain that the ignition is *off* and that the magneto ground wires are connected.

2. Remove the clevis pin from the propeller retainer nut.

3. Unscrew the propeller retainer nut.

4. Spread the counterweights by hand, until it is possible to rotate the jack plate clockwise and disengage the blade actuating links from the blade shanks.

5. Remove the propeller from the propeller shaft.

CAUTION

Do not hammer propeller or pry to break it loose.

6. The rear cone may be removed at this time or subsequently as desired.

7. Remove the bolt holding the servo neutralizing linkage to the jack plate stud.

8. Remove the jack plate.

9. Disconnect the servo valve control cable from the servo control link, and disengage the servo valve oil lines.

10. Remove the screws holding the outer diaphragm retainer ring in place, then remove the retainer ring.

11. Fold the diaphragm back and remove the four Allen head screws which mount the jack cylinder to the engine.

12. Taking care to not damage the mounting gasket, remove the jack cylinder assembly from the engine.

13. If propeller is not to be installed immediately, wrap the propeller shaft with an oil soaked rag and install a thread protector on the end of the shaft.

Installing and Adjusting Propellers

1. Clean shaft threads and splines thoroughly, removing all nicks, burrs, and galls. Make a careful check to determine that shaft threads are not burred or pulled. Stone out burrs and use crocus cloth to remove scratches.

2. Wipe the shaft clean and dry with a lint free cloth.

3. Remove piston from cylinder by removing valve link screw and sliding piston forward off piston guide rods.

4. Remove diaphragm by removing outer and inner diaphragm retainer rings.

5. The cylinder is mounted on the engine nose with the guide pins in the horizontal plane, and the servo valve on the upper left side of the cylinder, looking aft. In order to eliminate all possibilities of oil leaks it is recommended that a paper gasket be used between the cylinder and the face of the engine, together with gasket compound.

6. The cylinder is mounted with four (4) Allen head cap screws (5/16-18). Use 1/16 thick aluminum or copper washers under the heads of the screws. Be sure the screws do not bottom in the engine tapped hole before pulling up tight on the cylinder; otherwise oil will leak out. Safety screws with wire through drilled holes in screw head.

7. Install rubber diaphragm with inner and outer diaphragm rings.

CAUTION

Tighten ALL screws uniformly until the rubber squeezes out past the edges of the rings 1/16 inch. Breakage of the rings may result if only a few screws are tightened at the time.

8. Connect hydraulic lines to the servo valve.

9. Grease front face of rubber diaphragm with approved Hartzell lubricant and install piston. Connect

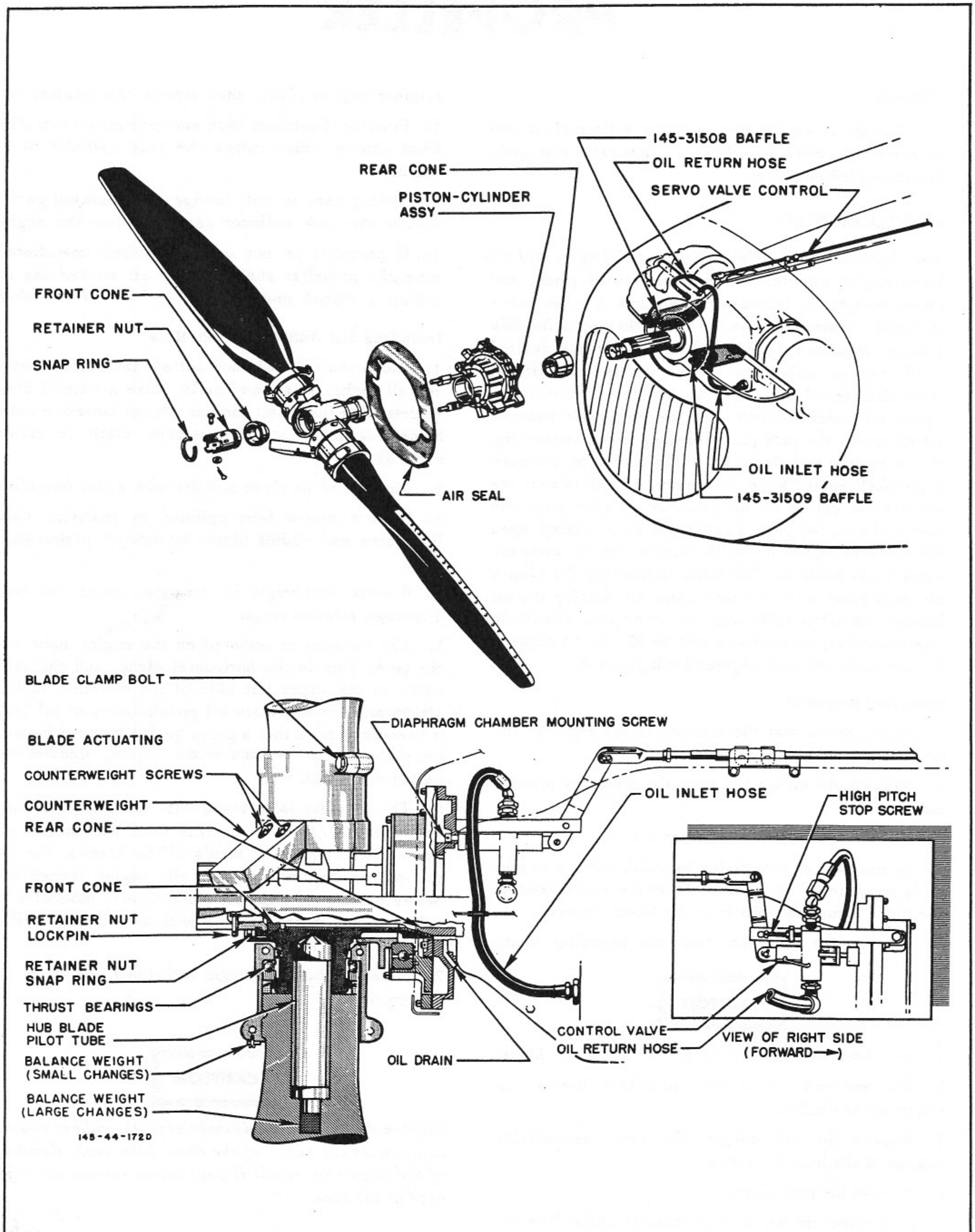
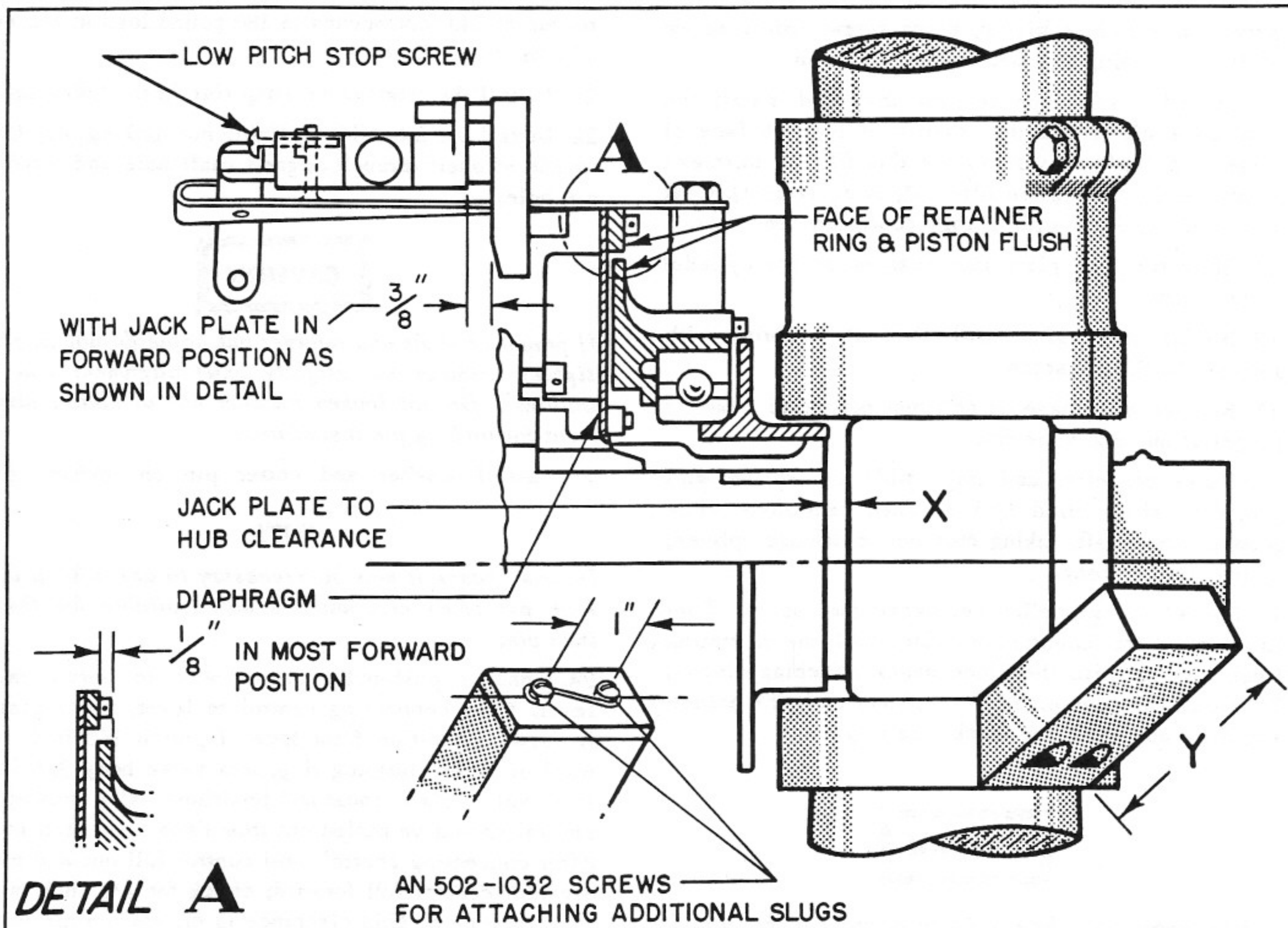


Figure 42 - HARTZELL PROPELLER INSTALLATION AND CONTROL ADJUSTMENT



WITH FACE OF PISTON AND RETAINER RING FLUSH
Dimension X = ¼" on -7, -7A or -7B Propellers

WITH PISTON IN FULL FORWARD POSITION (SEE DETAIL "A")

NOTE: With hydraulic element piston in full forward position dimension "X" should be 1/16" minimum on -1 or -5 Hartzell Propellers.

THE PROPELLER COUNTERWEIGHT LENGTH FOR THE VARIOUS ENGINE AND PROPELLER COMBINATION IS AS FOLLOWS:

ENGINE T.O. h.p.	PROPELLER BLADE TYPE	DIMENSION "Y"
185	Model 8428 (plastic) blades	4-1/2 in.*
185	Model 8433 (aluminum) blades	4-1/8 in.
205	Model 8428 (plastic) blades	4-5/16 in.
205	Model 8428 (aluminum) blades	4-1/8 in.

*On Navion airplanes equipped with model 8428 (plastic) blades and having Continental E-185-3 engines serial Nos. 4289D through 5110D inclusive, or engines which have been equipped with Tri-metal front main bearing inserts and bronze thrust washers at overhaul, the counterweight length must be adjusted in accordance with Ryan Field Service Bulletin No. 5 unless the rework outlined in Continental Motors Corp. Service Bulletin No. M48-30 has been accomplished.

Figure 43 - HUB CLEARANCE CHECK, HARTZELL PROPELLER

servo valve link to piston, using screw. Safety screw with wire running to other screws on piston.

10. Install a 1/8" spacer over shaft and install the rear cone clean and dry; then coat the hub face of cone, and shaft threads with a thin film of antizieze compound (Specification AN-C-53, or equivalent). Coat the shaft splines with a thin coating of engine oil.

11. Slide the jack plate into position on the cylinder guide studs.

12. Install the engine cowl air seal, securing with nine (9) NAS221-9 screws.

13. Remove all grease or anti-rust compound from the propeller hub and wipe dry.

14. Raise propeller and align wide hub spline with propeller shaft blind spline. Then cautiously slide propeller on shaft, taking care not to damage splines, cones seat, or cone.

15. Spread the propeller counterweights apart. Turn the jack plate counterclockwise until the actuating links line up with the blade shank attaching blocks. Then pull the counterweights together until the actuating links and attaching blocks are in place.

CAUTION

Extreme care must be exercised to prevent the propeller blade from rotating too far and allowing the micarta block to strike the hub at an angle or on the end, as this is liable to crack the block.

17. Coat the hub face of the front cone with antisieze compound.

18. Install the halves of the front cone on retainer nut shoulder. Start retainer nut and cone onto shaft, and screw up snug.

19. Check positioning of element piston to ascertain that clearance is available to allow a 3/16 inch deflection of the diaphragm to either side of neutral. By pushing or pulling the propeller counterweights, move the piston forward or aft, as necessary, to bring the face of the piston flush with the face of the outer diaphragm clamping ring. With the piston in this position, there should be a clearance of ¼ inch or more between the jack plate collar and the propeller hub. Should there be less than ¼ inch clearance at this point, insert spacers behind the rear cone, as necessary, to attain this clearance.

Example: With a clearance of 7/32 inch between the jack plate collar and the propeller hub, it will be necessary to place one (1) 1/32 inch spacer behind the rear cone.

20. Block one blade and tighten retainer nut with torque of 540 foot pounds (a 180 pound load at the end of a three foot bar).

21. Install the retainer nut snap ring in the hub groove.

22. Install the propeller retaining nut locking pin, from inside of shaft through aligned shaft hole and retainer nut hole.

CAUTION

If propeller shaft and retainer nut holes do not line up, tighten retainer nut slightly until alignment can be obtained. Do not loosen retainer nut to obtain alignment for locking pin installation.

23. Install washer and cotter pin on locking pin.

NOTE

In some cases it may be necessary to use a 3/16 inch lock pin when clearance is not available for the ¼ inch pin.

24. Connect push-pull control wire to servo valve lever. When connecting control to lever, place piston in forward position front face of piston 1/8 inch forward of outer clamping ring, and valve body 3/8 inch from valve plate (near mid position); also push-pull control should be pulled out from dash about 1/8 inch. After connecting control, pull control full out and push elevator control full forward; check for 1/8 inch minimum clearance. This clearance is critical on airplanes with serial No's. 1790 through 2000.

25. Run up engine and set low stop pitch control to provide proper static rpm (2300 ± 25).

26. Upon completion of the preceding installation, make an operational check of the jack plate clearance. In the full forward position of the diaphragm, (maximum rpm) with engine running, there must be a minimum of 1/8 inch clearance between the jack plate collar and propeller hub. Clearance may be observed from the side of the airplane while the engine is running.

NOTE

This clearance must be observed while the engine is running, as the propeller counterweights will cause a change in the propeller pitch as the engine is stopped. It is realized that no measurement can be taken while the engine is running; however, if the clearance is obviously less than 1/8 inch the low pitch stop must be adjusted to provide clearance. On later model propellers this clearance will be in excess of 1/8 inch.

It is important that this jack plate to hub clearance be maintained to preclude any possibility of overloading engine thrust bearing with propeller.

27. If the foregoing instructions are fully complied with, the maximum static rpm will be approximately

2300. This adjustment should give a maximum sea level take-off of 2600 with approximately a 500 rpm control range when the propeller control is moved from full increase to full decrease rpm.

DO NOT attempt to increase this control range, if it will cause over-deflection of the diaphragm of more than 3/16 inch forward.

DO NOT attempt to increase the maximum take-off rpm above 2600.

28. If the propeller change to high pitch is sluggish, check the length of the propeller counterweights. Proper length is 4-5/16 inches. On some early airplanes it was necessary to add plates to the ends of the counterweights as a means of attaining proper length. Any counterweight with drilled and tapped holes on the ends, if not 4-5/16 inches long, may be equipped with steel plates, as necessary, to attain the proper length.

Adjusting Propeller Blade Settings—If the desired maximum rpm cannot be obtained, the blade settings in the hub must be changed rather than removing spacers from back of the rear cone. The blade settings may be changed by the following procedure:

1. If the propeller and clamp are not already indexed, scribe a reference line from the propeller blade to the blade clamp.
2. Loosen the outboard clamp bolts.
3. Rotate the blade in the clamp as necessary to increase the maximum rpm. A movement of the blade of 1/32 inch in the clamp will effect approximately a 1° change in propeller pitch and will change the maximum rpm approximately 100 rpm. Decrease blade pitch to increase rpm.
4. Tighten the clamp bolts (torque to 20 ft. pounds) and repeat the procedure for the other blade.

CAUTION

It is essential that the pitch change of both blades is identical.

Replacing Propeller Blades—If a blade is damaged beyond repair, it may be replaced, provided the assembly (without control unit) is properly balanced prior to installation. Small changes in balance are made by the addition or removal of weight slugs on the blade clamps. Large changes that may be required are made by adding or removing lead weight in the blade shank. (Lead is in ¾-inch hole beyond hole for hub pilot tube).

AEROMATIC PROPELLER

The Aeromatic Propeller comes as either a fully automatic (hub model 220) or semi-automatic (hub model 220-1) installation.

The fully automatic propeller installation has no external controls; propeller pitch changes being determined by the balance of aerodynamic forces on the propeller blades, which attempt to decrease pitch (increase rpm), and counterweight forces, which attempt to increase pitch (decrease rpm).

The semi-automatic propeller installation is similar to the automatic; with the exception of the high pitch (low rpm) control. This control may be used to override the counterweight forces and maintain the propeller in a low pitch (high rpm) condition. As the control is moved aft the override setting of the control is decreased until, when the control is in the full aft position, the propeller is fully automatic and will increase pitch (reduce rpm) as dictated by conditions of increased altitude or reduced throttle.

Removing Aeromatic Propeller

NOTE

Steps 4 through 6 refer only to propellers with high pitch control.

1. Make sure that ignition switch is off, and that ground wires are connected to magnetos.
2. Remove propeller retainer nut clevis pin.
3. Unscrew propeller retainer nut and pull propeller from propeller shaft.
4. Remove air seal.
5. Remove the three dowel screws on the rim of the control housing, and pull thrust plate and control housing from propeller shaft.
6. Remove the four screws attaching the mounting flange to the engine, and pull mounting flange from engine.

Installing Aeromatic Propeller

NOTE

Steps 1 through 5 apply only to those airplanes with high pitch control.

1. Install the control mounting flange on the nose of the engine crankcase making sure that one of the helical slots in its rim is located at the top of the engine. Secure with the four 5/16" x 18 socket head screws. No. AN960-516L washers should be placed under the heads of these screws. Safety screws with wire.
2. Install the thrust plate and housing assembly, which is fastened in place with two housing dowel screws and one control cable anchor screw. The two dowel screws require one (1) each washer No. AN960-616. Safety these screws to the housing. The cable anchor screw requires a lock washer to secure it. Before assembly, coat the sides of the inclined slots of the mounting flange with Lubriplate No. 105. Use the

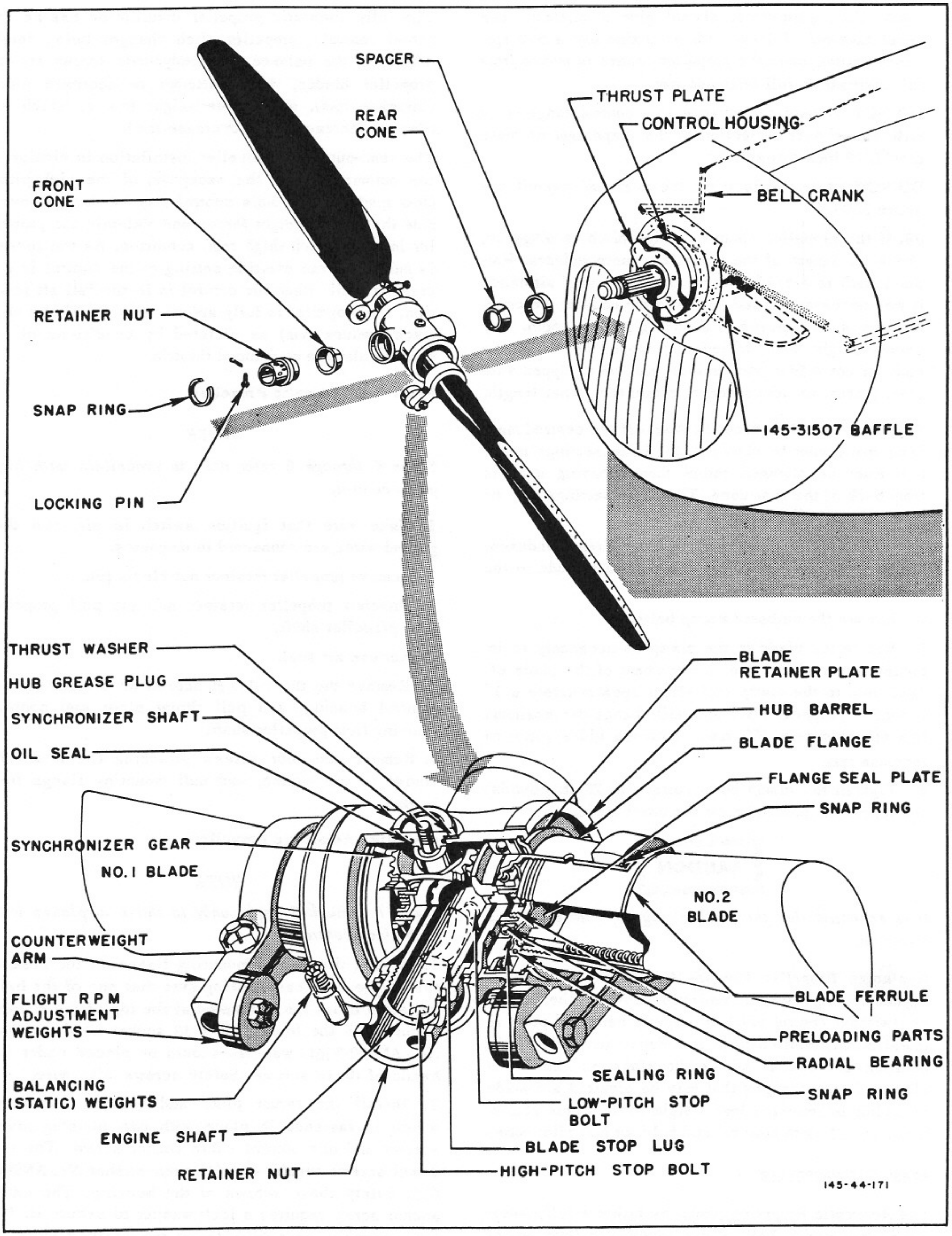


Figure 44 - AEROMATIC PROPELLER INSTALLATION

grease freely at this point as the excess grease will remain inside the housing.

3. Attach the ball joints with the control rod on the bell crank and on the anchor screw on the thrust plate housing.

4. Rotate the thrust plate housing counterclockwise, looking from cockpit, until it strikes the stops. This will be low pitch condition. Then place the instrument panel control handle at the "full forward position." Adjust the yoke on the threaded end of the control cable to proper length, connect the bell crank with clevis pin, and safety.

5. Hook the short end of the coil spring in the small hole in end of spring bracket and the other end to the thrust plate housing anchor screw.

6. Install applicable baffle plates on nose cowl, and air seal on nose cowl propeller shaft cutout.

7. Clean shaft threads and splines thoroughly, removing all nicks, burrs, and galls. Make careful check to determine that shaft threads are not burred or pulled. Stone out burrs, and use crocus cloth to remove scratches.

8. Wipe shaft clean and dry with clean lint-free cloth.

9. Install spacer and rear cone clean and dry; then coat hub face of rear cone and shaft threads with a thin film of antisieze compound (Specification No. AN-C-53), or an equivalent mixture of 70 per cent white lead, and 30 per cent engine oil by volume. Coat shaft splines with a thin coating of clean engine oil.

10. Remove all grease or anti-rust compound from the propeller hub, and wipe dry.

NOTE

Propeller assembly must be statically balanced if propeller being installed is new, or if hub or blades have been replaced.

11. Raise propeller and align wide hub spline with blind spline on propeller shaft (if used). Carefully slide propeller on shaft, taking care not to damage splines, cone seat, or cone.

12. Coat hub face of front cone with antisieze compound.

13. Install halves of front cone on retainer nut shoulder, start retainer nut and front cone onto shaft, and screw up snug; then, while blocking one blade, tighten nut, using a 180-pound load at the end of a 3-foot bar (540 foot-pounds).

14. Install retainer nut snap ring in hub groove.

15. Install propeller retainer nut locking pin, in one of the holes drilled through propeller shaft and retainer nut, by inserting pin from the inside diameter of the propeller shaft outward.

CAUTION

If propeller shaft and retainer nut holes do not line up, tighten retainer nut slightly until alignment can be obtained. Do not loosen retainer nut to obtain alignment for installation of locking pin.

16. Install washer and cotter pin on locking pin.

17. Lubricate propeller. *(Refer to PROPELLER LUBRICATION, page 6.)*

18. Set blades against high-pitch stops, and determine that a minimum clearance of ½ inch exists between blades and nose cowl. To obtain necessary clearance, remove shims of equal thickness from under each high-pitch stop bolt as required. The high-pitch stop bolts and bosses are stamped "1H" and "2H" for the No. 1 and No. 2 blades, respectively.

NOTE

Replace stop bolts in thread bosses from which they were originally removed.

19. Check and, if necessary, adjust ground (static) rpm and flight rpm settings of propeller as explained in following paragraph.

Static (Ground) Full Throttle RPM Adjustment Procedure.

a. Move control handle to full aft position.

b. Remove all counterweights from the counterweight arms.

c. Check static RPM full throttle. If static RPM is not within a range of 2525 to 2575, correction can be made by use of the low pitch stop adjusting shims located under the low pitch stop bolts. These bolts are marked 1L and 2L to correspond with Blade No. 1 and No. 2. One shim may be added to increase RPM and one shim may be removed to decrease RPM. If, for example, the engine should be turning 2150 RPM, addition of the laminated stop bolt shim No. 2660, will increase RPM approximately 100.

d. Reinstall counterweights on the counterweight arms in their original position. A slight decrease in static RPM will be noted. This is a normal sequence; *therefore, no other static adjustments should be made.*

Adjusting Aeromatic Propeller Rpm Flight Setting—Engine speed at full throttle level flight should be 2300 rpm at sea level. Tests to check or correct the engine speed should be conducted as close as practical to the ground.

If, for instance, rpm should be 2350 addition of one counterweight, 2965-2 to each counterweight arm will reduce rpm by approximately 50. Counterweight 2965-1 will reduce speed by approximately 25 rpm.

Weight, Part No. 2965-1	25 rpm
Weight, Part No. 2965-2	50 rpm
Weight, Part No. 2965-3	100 rpm

If a new propeller or a propeller with a new hub has been installed, recheck the flight rpm settings after approximately 5 hours flight time.

NOTE

When the airplane is to be operated from an airport of considerably different altitude, readjustment of flight rpm may be advisable. This is to provide maximum power at an altitude airport or to prevent engine over-speed at sea level airport. No adjustment of the ground (static) rpm is necessary in either case. Flight rpm should be adjusted as in preceding steps 1 and 2.

High-pitch Control Adjustment

1. Adjust thrust bracket screws so that there is .094 inch clearance between thrust plate and screws when blades are held in full low pitch position and control is in full forward position.

2. Make flight and determine RPM in climb at 95 MPH I.A.S. with control in full forward position. If this RPM is not 2600, the .094 inch clearance suggested must be changed. If the RPM is too low or too high, the clearance has to be diminished or increased respectively. A change of .020 inches is equal to 50 RPM. This clearance allows the propeller to operate in the Aeromatic manner during take-off.

3. After the above adjustment is completed, cruise RPM may be selected at the pilot's discretion. Push control cable to increase RPM.

Lubrication—A grease fitting is provided on the housing for lubrication of the control bearing. It should be lubricated every 50 hours with a low temperature grease conforming to AN-G-25 or Lubriplate #105 or Shell Aero Grease #11.

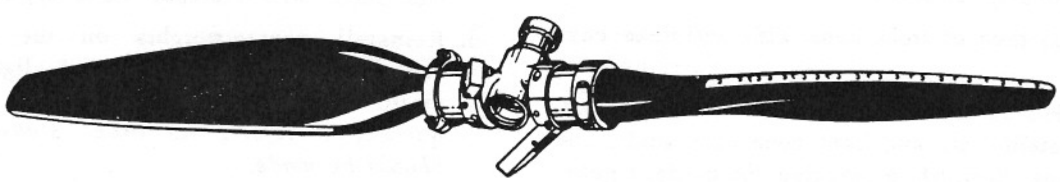
CRUISING

With the static and full throttle rpm's correctly set, the engine manufacturers recommended cruising power will be delivered by the propeller. Generally, best performance and economy may be obtained, by throttle selection, between a low cruise of 2000 and a high of 2100 rpm, obtained by throttle control.

Replacement of Aeromatic Propeller Blades—If both blades of an Aeromatic propeller are damaged to an extent where replacement is required, the damaged blades must be replaced by a pair of factory-matched blades. If only one blade is damaged, the undamaged blade must be returned to the propeller factory to be balanced and matched to a new blade. Replacement blades sent from the factory are drilled to match the original blade setting to facilitate installation. After new blades are installed in the hub, the propeller assembly must be statically balanced before installation.

NOTE

If the propeller strikes, or is stuck by, any object, the propeller must be carefully examined for possible damage. A propeller involved in any accident must not be used until it is first disassembled and all parts carefully inspected for damage. If, for any reason, the propeller is removed from the shaft prior to the required overhaul inspection, carefully inspect the propeller hub, cone seats, cones, and other attaching parts for wear, gall, etc., and replace or repair any damaged or worn parts.



ENGINE CONTROLS

GENERAL

The engine is controlled from the cabin by flexible push-pull controls *(figure 45)*, connected to the carburetor throttle lever, manual mixture and idle cut-off lever, and the carburetor air control lever on the bottom of the air mixing chamber. Navions equipped with Hartzell propellers have an additional flexible control for regulating the propeller hydraulic servo valve. The Aeromatic propeller, being automatic in operation, does not require a manual control. The various control knobs are centrally located on the cabin control panel. The throttle control incorporates an adjustable knurled friction nut, while the mixture control has a serrated shaft for locking the control in the desired position.

INSTALLING ENGINE CONTROLS

The flexible controls should be installed from the cabin, and routed through the firewall to the engine section. The controls may then be attached to their respective controlling units.

CAUTION

When installing the flexible controls, extreme care should be used to prevent them from bending in tight loops, as this will cause binding.

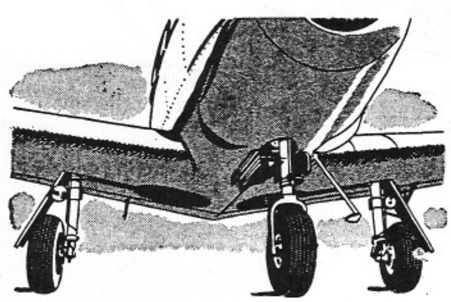
If the outer casing of any flexible control (except throttle) is too long to permit the inner wire to be attached to the unit, or interferes with full travel, pull the wire into the casing and cut off enough casing to fit the installation. Make sure that the web straps and clip securing the casings throughout the airplane are tight, and that they hold the casings firmly. If necessary, wrap friction tape on the casing under the straps and clips.

ADJUSTING ENGINE CONTROLS (Except Propeller)

1. Set all control knobs approximately 1/16 inch from the control panel for spring-back.

2. Set the throttle lever against full open stop; mixture control lever in *full rich* position, and carburetor air control lever in cold air position; then attach flexible controls to their respective positioned levers.

3. Operate controls in cabin to determine that controls operate smoothly without binding throughout entire range of travel, and that a minimum of 1/16 inch spring-back is obtained. Make sure wire ends extending forward from levers do not strike or rub any object which might be damaged, or cause control travel to be limited. Cut or bend wires to clear.



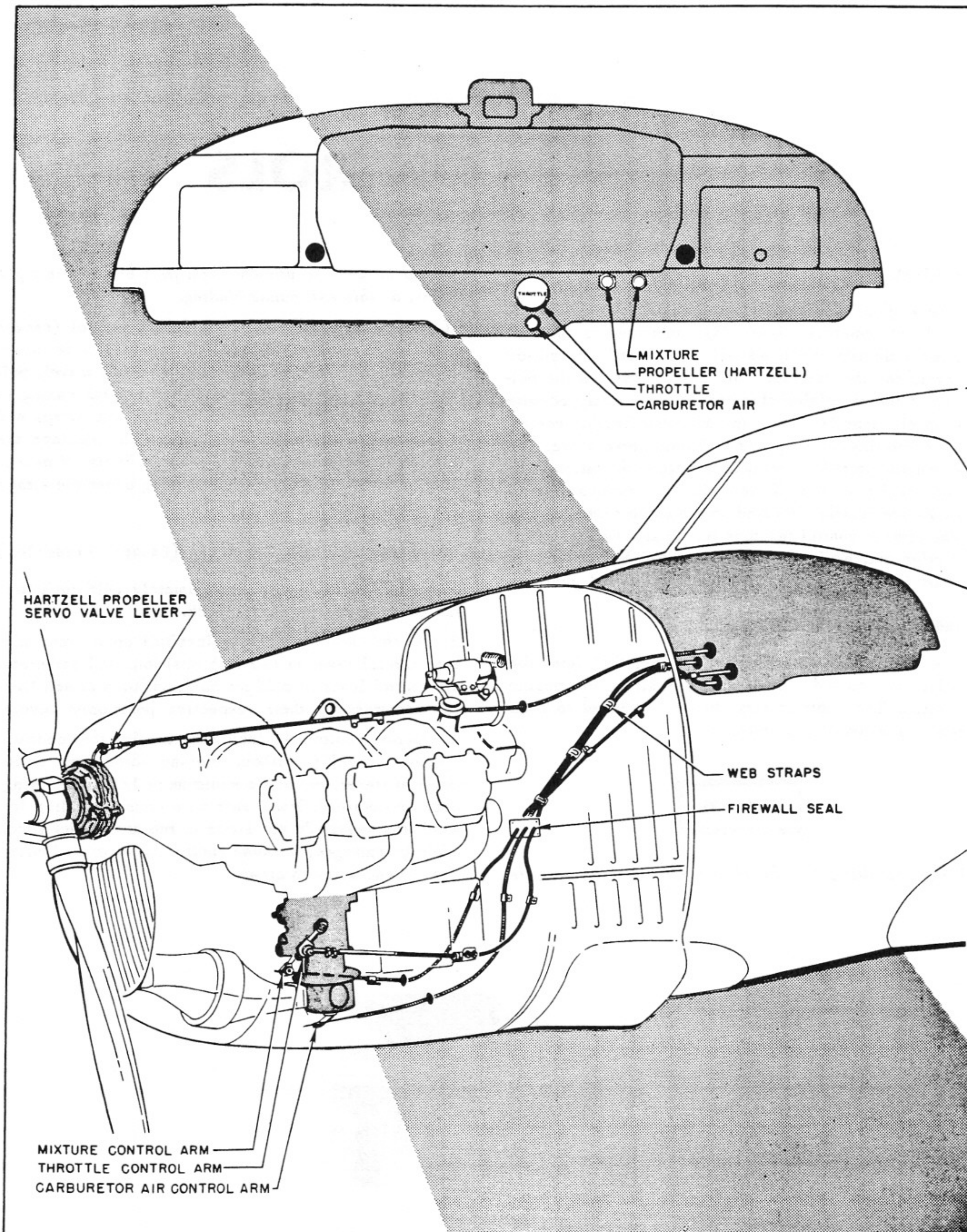


Figure 45 - ENGINE CONTROLS

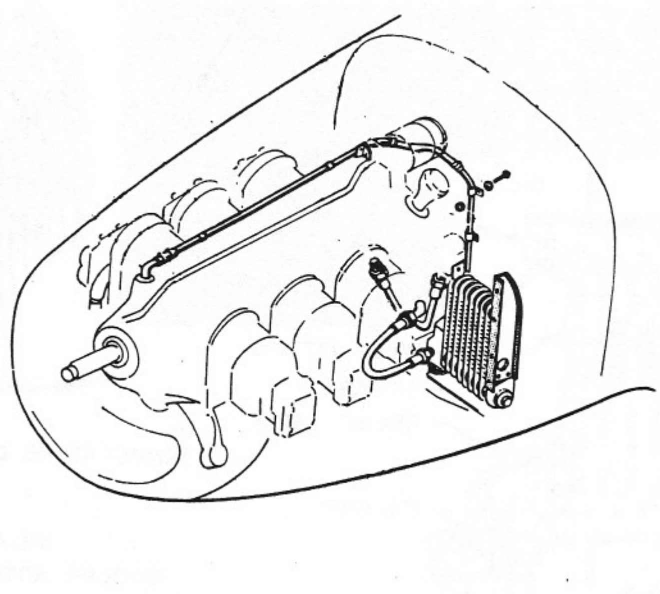
OIL SYSTEM

GENERAL

Engine lubrication is accomplished by a wet-sump pressure system of approximately 10.5 quarts capacity. The system consists of an oil cooler, oil cooler relief valve, engine oil pump and filter, and pressure regulating valve. *(See figure 46.)* Oil, drawn from a sump attached to the crankcase, is delivered by the pump to the oil cooler and then to the engine parts and pressure regulating valve. The pressure regulating valve relieves pressure in excess of approximately 50 psi and cannot be adjusted. It is preset at the factory. After lubricating the engine parts, the oil drains back to the sump and begins another cycle. Incorporated in the front of the engine are fittings for connecting an oil supply line and a return line when a Hartzell propeller is installed. The oil filler cap is located at the top left side of the engine. The oil quantity dip stick, located on the rear, left side of the engine, is calibrated in quarts. A breather tube, attached to the nose section of the engine, and exiting at the right engine cooling air exit louver, vents the engine crankcase. An oil temperature bulb is located in the cooler relief valve housing.

OIL COOLER

The oil cooler is mounted in the left side of the engine compartment, on the engine mount bulkhead. The cooler consists of cooling fins, by-pass port, and a cooler relief valve mounted in the outlet side on the bottom of the cooler. The nonadjustable cooler relief valve is set to open when a pressure drop across the cooler (created by congealed oil) exceeds 25 psi. Air is directed through the cooler by engine baffles. Oil from the engine enters the cooler at the top, and normally flows through the cooling plates to the outlet port, back to the engine. When the oil is congealed, and a difference in pressure in excess of 25 psi exists across the relief valve, the valve opens and allows the oil to by-pass the cooler back to the engine. When the oil temperature rises, thus reducing the pressure, the relief valve closes and oil is directed to its normal path through the cooling plates.



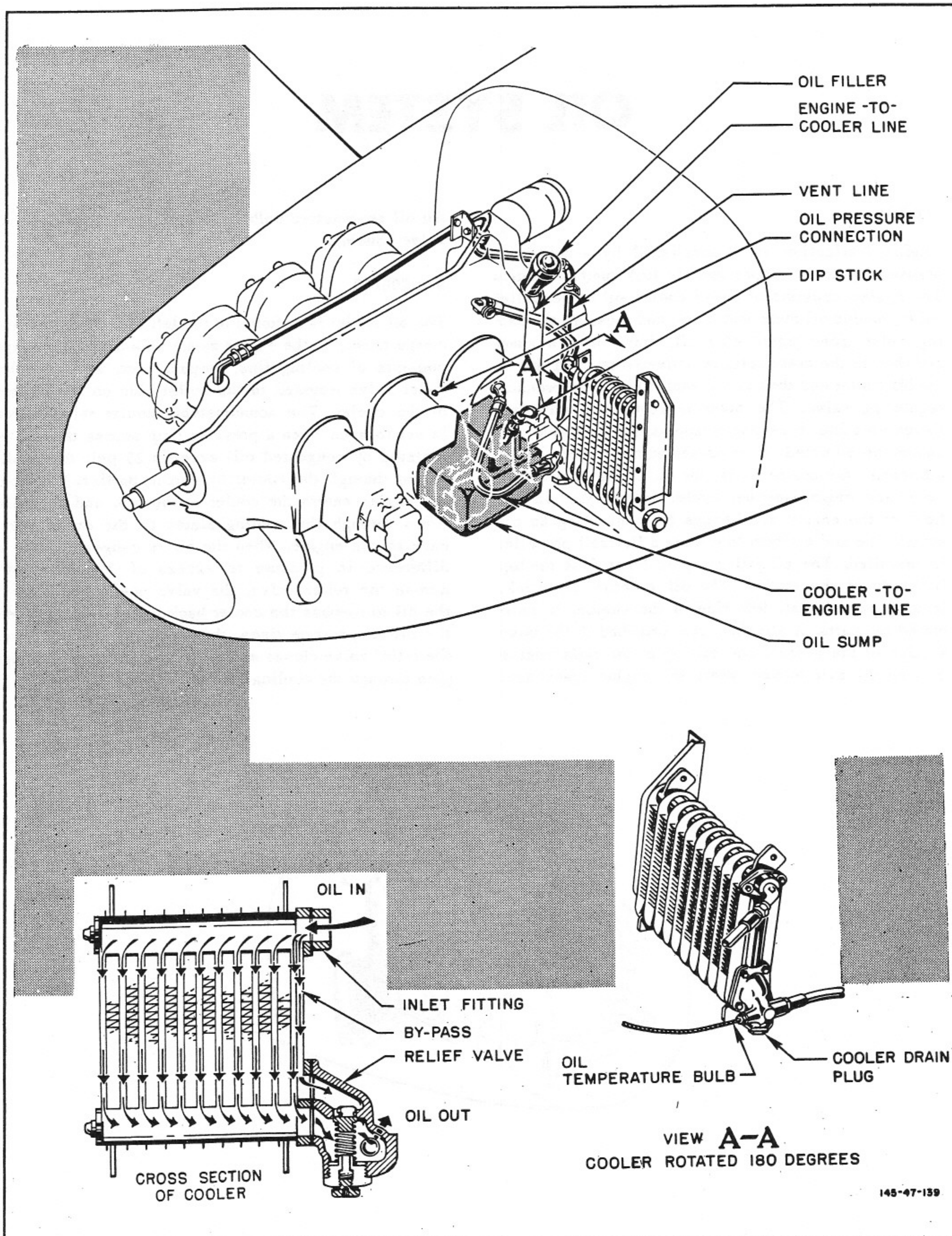


Figure 46 - OIL SYSTEM

FUEL AND PRIMING SYSTEMS

GENERAL

The fuel system *(see figure 47)* consists of two wing tanks, accumulator tank, electric-driven pump, engine-driven pump, strainer, check valve, relief valve, relief valve strainer, shut-off valve, hand primer pump, and pressure indicating systems. Fuel from the interconnected wing tanks accumulator sump is supplied to the fuel pumps through the shut-off valve. This valve may be used to supply fuel, or to turn all fuel flow *off*. The accumulator sump tank serves to assure an adequate supply of fuel during maneuvers. From the shut-off valve fuel flows through the strainer to the electric pump onto the engine-driven pump and from there to the carburetor. A check valve in the electric pump by-pass line prevents fuel from flowing back into the supply line when this pump is operating. Excess fuel pumped by either pump passes through a screen and a relief valve in the fuel return line, to be re-circulated in the system. The hand primer pump, located on the upper left corner of the control panel, obtains its fuel supply from the fuel line leading out of the electric pump, and pumps it directly into the intake manifold. The carburetor vapor return line ties into the wing tank vent system, returning approximately three gallons of fuel per hour to the right hand wing tank. The fuel pressure gage connects to the carburetor. Fuel quantity is indicated by a transmitter in the left tank (accessible thru the left wheel well) and an indicator on the instrument panel. The fuel quantity gage indicates only 36 out of a possible 39½ gallons of fuel in the wing tanks.

FUEL TANKS

The fuel tanks are of welded aluminum alloy construction. They are beaded for strength, and have no internal baffling. The right tank incorporates the filler neck. The fuel quantity gage transmitter is installed in the left tank. Each tank is bonded to the wing through a bracket welded to the top of the tank. The tanks are wedged into the wing structure, and held in place by a padded cross-bar, which bolts to the wing structure. To gain access to the tanks it is necessary to lift the fuselage from the wing and separate the wing panels.

FUEL ACCUMULATOR SUMP TANK

The ½ gallon accumulator sump tank is located between and below the wing fuel tanks. This tank is installed to insure a constant source of fuel supply during maneuvers, and to act as a sump for the wing fuel tanks. A finger-type strainer and a sump drain-cock are located on the bottom forward end of the tank. Access is provided to the strainer and drain-cock through an opening on the lower wing center line. To remove the tank from the airplane, the wing must be disassembled.

SHUT-OFF VALVE

The shut-off fuel control valve is a simple turning valve, and should not require maintenance between major overhaul periods.

FUEL STRAINER

A removable bowl strainer is incorporated in this fuel system. The strainer is mounted at the right rear of the nose wheel well. The bowl should be drained periodically by means of the drain-cock at the bottom of the bowl. Access to the strainer for cleaning is gained by removal of the bowl.

FUEL QUANTITY TRANSMITTER

The fuel quantity transmitter, located in the left main tank, is accessible through the left main wheel well. For further information regarding adjustment and calibration of the fuel quantity indicators and transmitters, refer to page 98.

ENGINE-DRIVEN FUEL PUMP

The engine-driven fuel pump *(see figure 47)*, is mounted at the left rear of the engine. This is a rotary non-pulsating type pump.

ELECTRIC-DRIVEN FUEL PUMP

The electric-driven fuel pump is an auxiliary to the engine-driven pump. This pump is used as an auxiliary pump during take-offs or landings, or in event of failure or malfunctioning of the engine-driven pump. The pump is located in the lower forward right hand section of the fuselage, and accessible by removing the fuselage baffle of the engine air cooling exhaust.

FUEL SYSTEM CHECK VALVE

The fuel system check valve is located in the electric-driven pump by-pass line, immediately forward of the electric-driven pump. When only the engine-driven pump through this check valve. When the electric-driven pump is operating, fuel is prevented from back-through the by-pass line, in a closed circuit, by this valve.

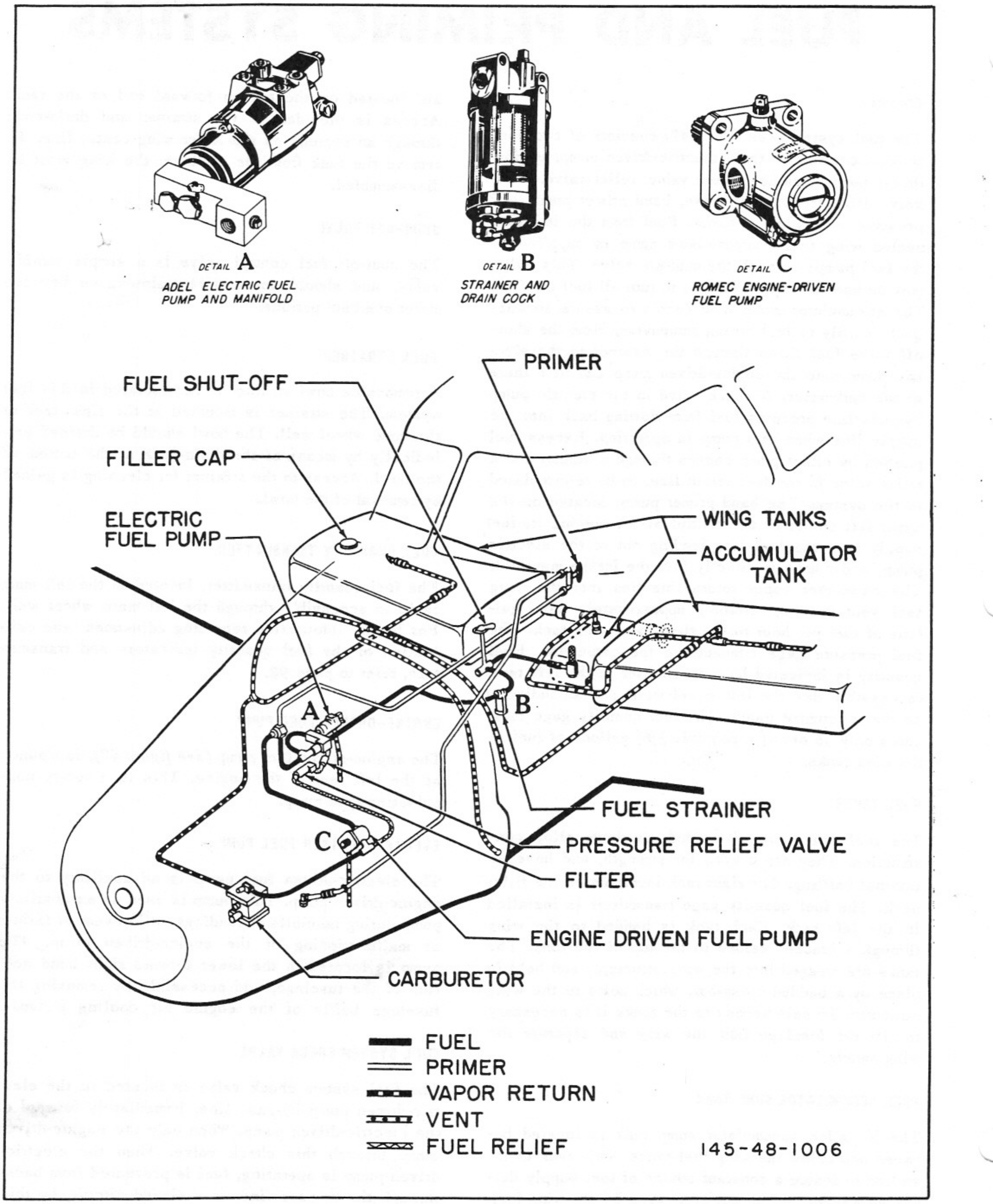


Figure 47 - FUEL AND PRIMING SYSTEMS

PRESSURE RELIEF VALVE

The fuel system pressure relief valve, is located immediately forward of, and below, the electric-driven fuel pump. This valve acts to vent excess fuel from the carburetor-fuel supply line back to the electric-driven pump for recirculation. To adjust the valve it is necessary to turn the adjusting nut inward to increase pressure or outward to decrease pressure. The relief valve is set to maintain a pressure of 12½ lbs when the engine is not operating and the electric-driven fuel pump is *on.*

RELIEF VALVE SCREEN

The relief valve strainer is of the screen type. This screen is mounted in the fuel relief line immediately forward of the relief valve. The screen should be removed and cleaned at 50-hour intervals.

CHECKING FUEL PUMP OUTPUT PRESSURES

The fuel pump relief valve is set to relieve at 12½ lbs. Check the electric-driven pump by operating the pump when the airplane engine is not running. Read the fuel pump output pressures on the fuel pressure gage. Should the pumps fail to maintain the proper pressure, check the relief valve settings before replacing the pumps. The fuel system has an operating tolerance of 10-15 lbs.

DRAINING FUEL SYSTEM

The fuel system may be drained through the petcock in the wing fuel tank accumulator sump.

CAUTION

Before draining fuel system, check that no one is smoking in immediate vicinity, there are no loose electrical connections nearby, adequate fire extinguishing equipment is immediately available, and that adequate containers are available for fuel being drained.

CLEANING FUEL SYSTEM

Should dirt or other foreign material be introduced into the fuel system, remove all strainers and screens and flush the system with clean gasoline.

CAUTION

Do not introduce water, carbon tetrachloride, or other foreign liquids into the fuel system.

PRESSURE-TESTING FUEL SYSTEM

1. Connect standard manometer to vent outlet.
2. Plug tank filler neck.
3. Apply an air pressure of 1½ psi (equal to 3.06 inches of mercury or 41.6 inches of water) to the manometer, and pinch off with a suitable clamp.
4. Should a drop in the manometer be noticed, check all connections for leaks with soapsuds, beginning with source of pressure.

ENGINE PRIMER SYSTEM

The engine primer system control is located on the left side of the control panel. The system consists of a Koehler hand primer pump and lines; the lines connect the primer pump with the fuel system at the fuel shut-off valve, and with the intake manifold primer fitting near the No. 4 cylinder intake pipe. The primer pump is the displacement plunger type, and is a self-contained unit. Shut-off is effected by pushing in and turning handle until it locks.

Operation of Engine Primer—To unlock the primer, turn and pull handle until plunger is pulled all the way out (this action draws gasoline from the fuel system at the inlet side of the fuel shut-off valve). Pushing the plunger in forces fuel into the intake manifold.

ELECTRICAL SYSTEM

GENERAL

The electrical system *(figure 50)* is a 12-volt, single-wire, direct-current type, powered by an engine-driven generator. A 12-volt storage battery (negative grounded) supplies power for operation of all electrical units, when the generator is not connected to the load. The metallic structure of the airplane serves as a ground return. A generator control regulator automatically maintains constant voltage regulation in addition to connecting and disconnecting the generator from the load. In addition to starting the engine, electrical energy is used for the cigarette lighter, flares, lights, instrument operation, electric fuel pump, cabin heating, radio, and landing gear indicator light system and warning horn. All wiring is routed in open bundles, with each wire identified by a number that corresponds with those shown in the wiring diagrams *(figures 55 through 57)*. Practically all the electrical circuits are protected by push-to-reset circuit breakers. The circuit breaker panel is hinged to the lower edge of the control panel below the ignition switch. The landing gear warning horn circuit breaker does not have a button for resetting. The only other circuit not protected by a circuit breaker is the circuit to the bank-and-turn indicator, which is protected by a one-ampere fuse, also located on the hinged panel.

GENERATOR

A two-brush, 15-volt, 25-ampere, engine-driven, Delco-Remy generator is installed at the center rear of the engine. The generator supplies the primary source of power for operation of the electrical system, when engine is operating under normal conditions, and also keeps the battery charged. Generator output is automatically regulated between 14 and 14.2 volts, and is supplied to the system through the generator control regulator mounted on the left forward side of the firewall. In order for the regulator to operate, the generator switch on the left side of the control panel must be on. A 4-microfarad filter condenser, connected between the generator terminal (on generator control regulator) and ground, is used for the suppression of generator noise from the radio equipment.

Removing and Installing Generator—Removal and installation of the generator are not difficult. However, when installing the generator, exercise care to keep the mounting nuts and palnuts from falling into the generator. If a nut is dropped in the generator, it will be necessary to remove the generator to retrieve the nut. Use a *dry* gasket between generator and engine pad.

Measuring Generator Brush Spring Tension

1. Remove generator from airplane.
2. Remove the brush inspection band on generator.
3. Hook a spring scale underneath the brush spring arm, and lift arm off the brush to a height of approximately 1/8 inch. Brush spring tension should read between 24 and 28 ounces on the scale.
4. If brush spring tension is weak, replace springs.

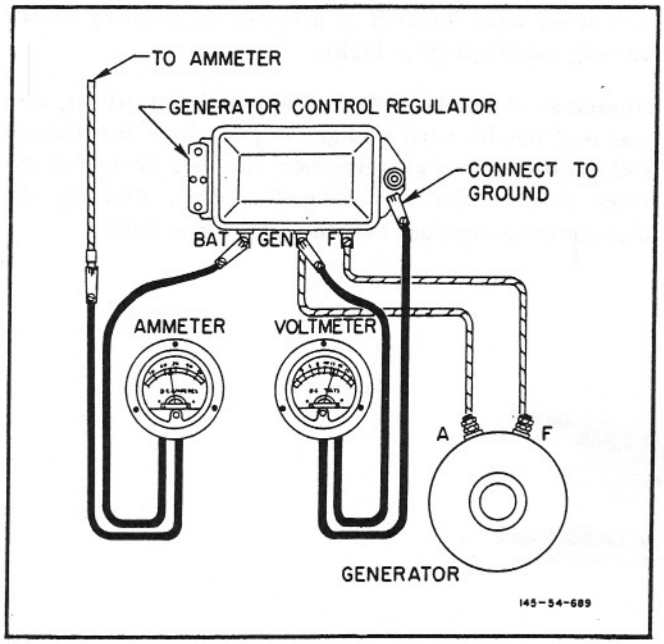


Figure 48 - TEST SETUP FOR ADJUSTING CUTOUT RELAY

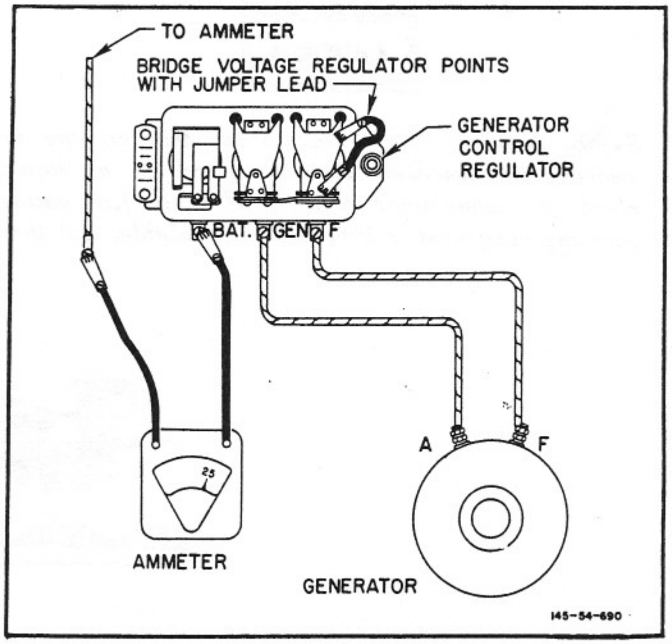


Figure 49 - TEST SETUP FOR ADJUSTING CURRENT REGULATOR RELAY

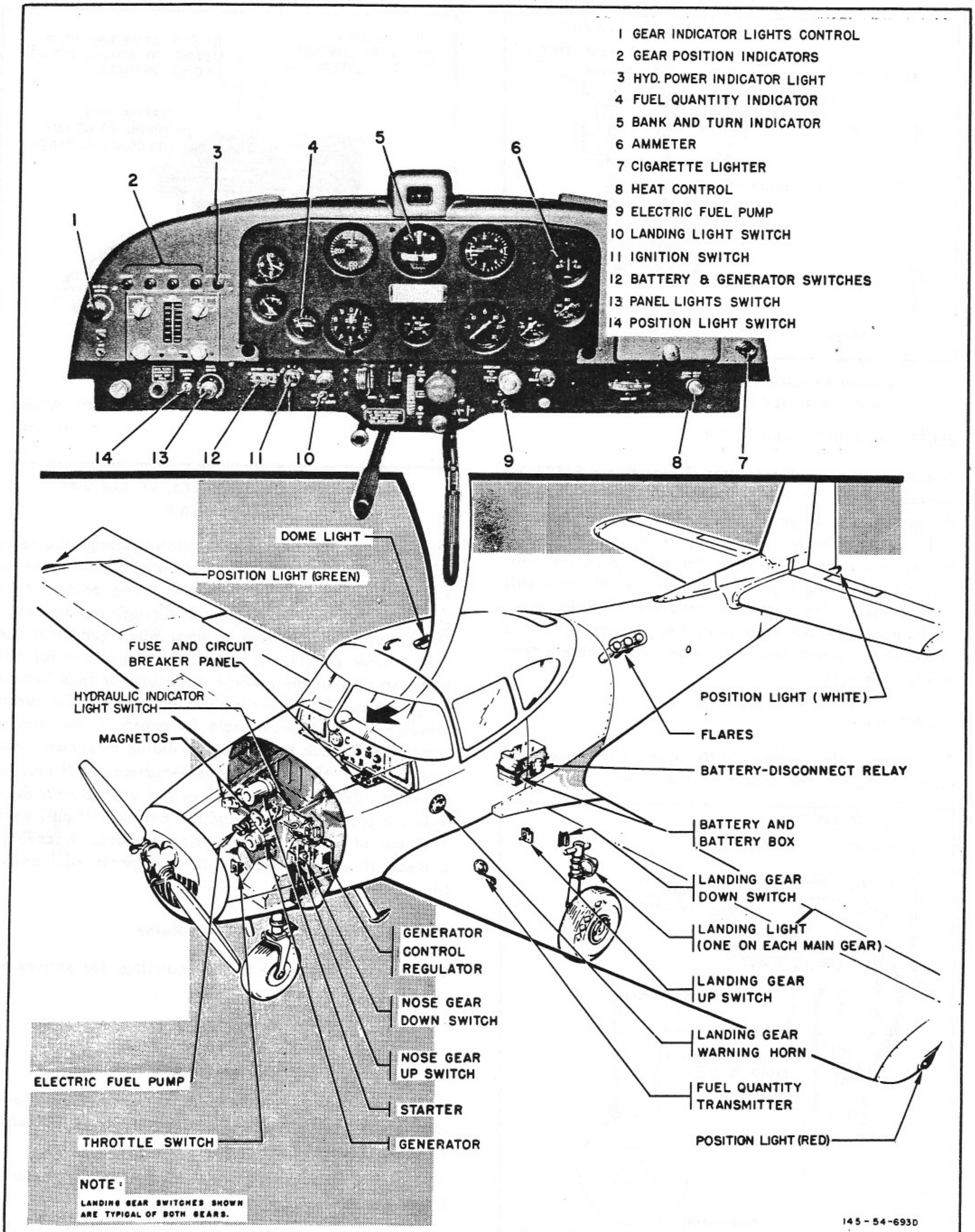


Figure 50 - LOCATION OF ELECTRICAL UNITS

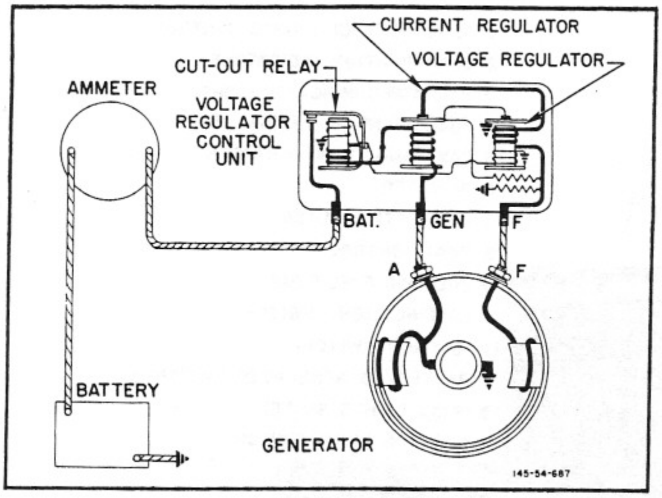


Figure 51 - SCHEMATIC DIAGRAM OF VOLTAGE REGULATOR CONTROL

GENERATOR CONTROL REGULATOR

A generator control regulator (Delco-Remy 1118263), mounted on the left forward side of the firewall, keeps the generator voltage from exceeding a safe maximum, which control keeps the battery from becoming overheated and gassy. The regulator also keeps the voltage from reaching a point where electrical units will be damaged. The regulator consists of three relay switches within the same unit; i.e., a cutout relay, a single-core current regulator relay, and a single-core voltage regulator.

CUTOUT RELAY

The cutout relay automatically opens and closes the circuit between the generator and battery. As gener-

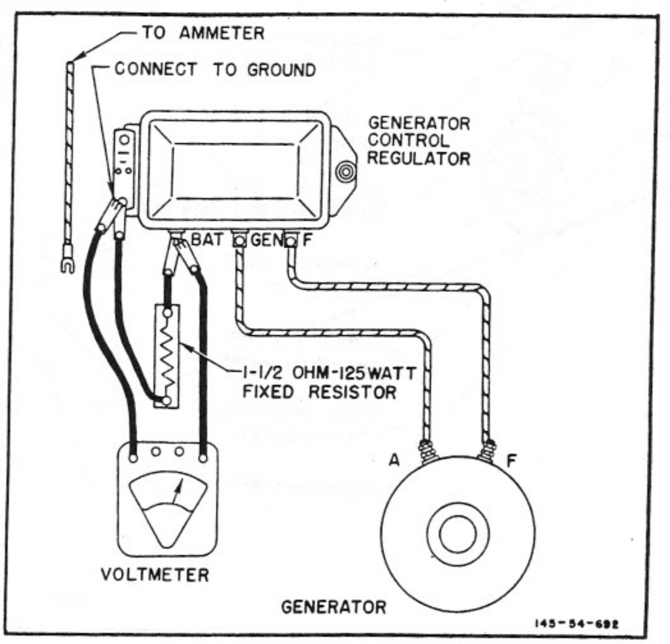


Figure 52 - TEST SET UP FOR ADJUSTING VOLTAGE REGULATOR RELAY

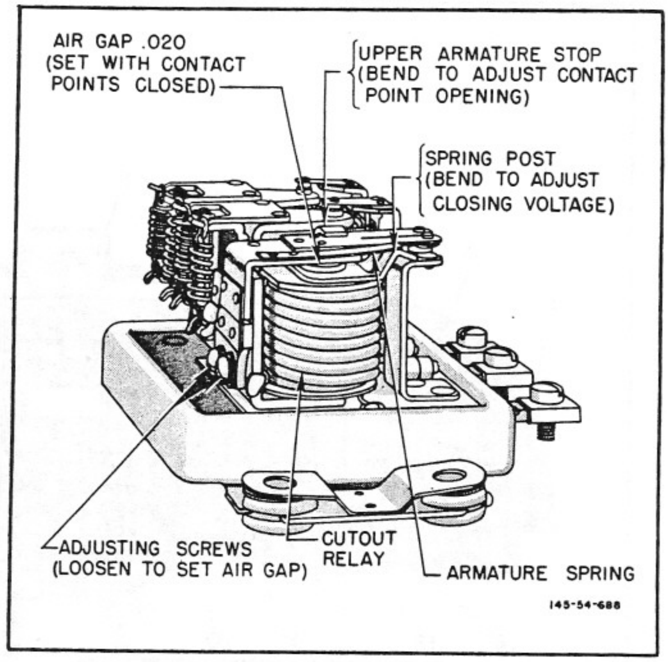


Figure 53 - CUTOUT RELAY AIR GAP ADJUSTMENT

ator voltage increases, current flows through the relay windings until the magnetic field overcomes the armature spring tension, thus closing the points. *(See figure 51.)* Then current flows through the points to the battery and distribution bus. When generator rpm falls below generating speed, or stops, current will begin to flow in the reverse direction, or from battery to generator. With a reverse-current flow in the current winding, the magnetic field is reversed and consequently will buck the voltage winding magnetic field, which is not affected by reverse-current condition. As a result, the magnetic field is not strong enough to hold the points together, and the points will pull apart because of the armature spring tension. A reverse current of approximately 1 to 4 amperes will cause the points to open.

Checking and Adjusting Cutout Relay

1. Remove the engine hinged cowling, for access to regulator unit.

CAUTION

While adjusting regulator unit, do not attempt to run engine with hinged engine cowling open, as the slipstream is likely to damage the cowling.

2. Connect ammeter and voltmeter leads as shown in figure 48.

3. Place both generator and battery switches in the *on* position, and start the engine.

4. Gradually increase engine speed, noting relay

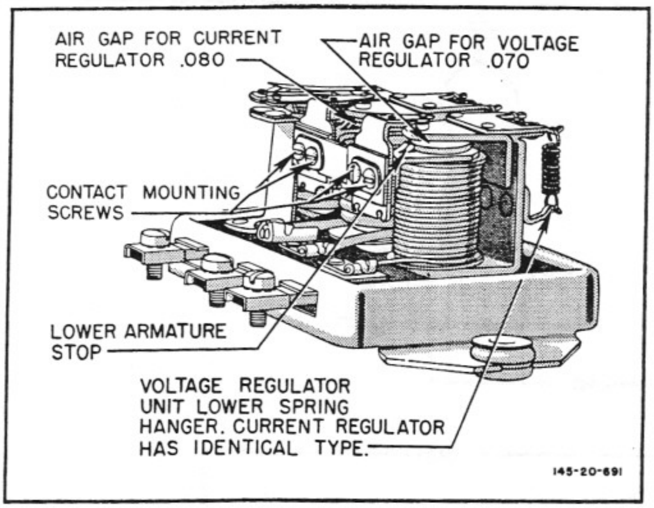


Figure 54 - CURRENT & VOLTAGE REGULATOR RELAY AIR GAP ADJUSTMENTS

closing voltage (between 12.4 and 13.4 volts); then decrease engine speed, noting that reverse current required to open the point should be between zero and 4 amperes.

5. After check is made, and the regulator is found not to be operating properly, cut the engine, turn off battery and generator switches, and remove voltage regulator cover.

6. Check the air gaps by placing finger on relay armature directly above the core, moving armature down until points just close, and measuring for a .020-inch air gap between center core and armature. If air gap is incorrectly set, loosen the adjusting screws and move armature assembly up or down in the slots for correct air gap setting. With points open, there should be a point air gap of .020 inch. This adjustment is made by bending the upper armature stop.

7. Start the engine with cover installed on regulator, and run another check as instructed in procedure 4. If closing voltage is too high, bend the spring post down; bend it up to increase closing voltage.

NOTE

As a rule, when air gaps are correct, the closing and opening voltage will fall within the correct tolerances.

8. After cutout relay is adjusted, install the regulator cover, and disconnect test equipment.

CURRENT REGULATOR RELAY

Because the generator is shunt-wound, a current regulator (center relay) is used as a means of limiting the current output of the generator. The current regulator *(schematically shown in figure 51)* is wired into the generator system.

Checking and Adjusting Current Regulator Relay—*See figure 54.*

1. Connect an ammeter to regulator unit as shown in figure 49.

2. Turn on battery and generator switch; then start engine and run it at 1600 rpm until generator output remains constant.

3. Turn on lights, radio, and other electrical accessories so as to prevent high voltage.

4. Operate engine rpm at 1600 rpm for approximately 5 minutes *so regulator will reach proper operating temperature.* The reason for warm-up is that the steel armature spring hinges are over-compensated, and operate at a higher current setting when cold.

5. *After the current regulator has reached operating temperature,* check for a 25-ampere reading on the ammeter. If the current reading is low or high, the relay will require adjustment.

NOTE

It is important that the regulator cover be in place while relay is being checked.

6. To obtain correct current setting, bend *one* of the spiral spring hangers down. (The resulting increased spring tension will increase the current setting.) Bend the spring hangar in the opposite direction to decrease the current setting.

NOTE

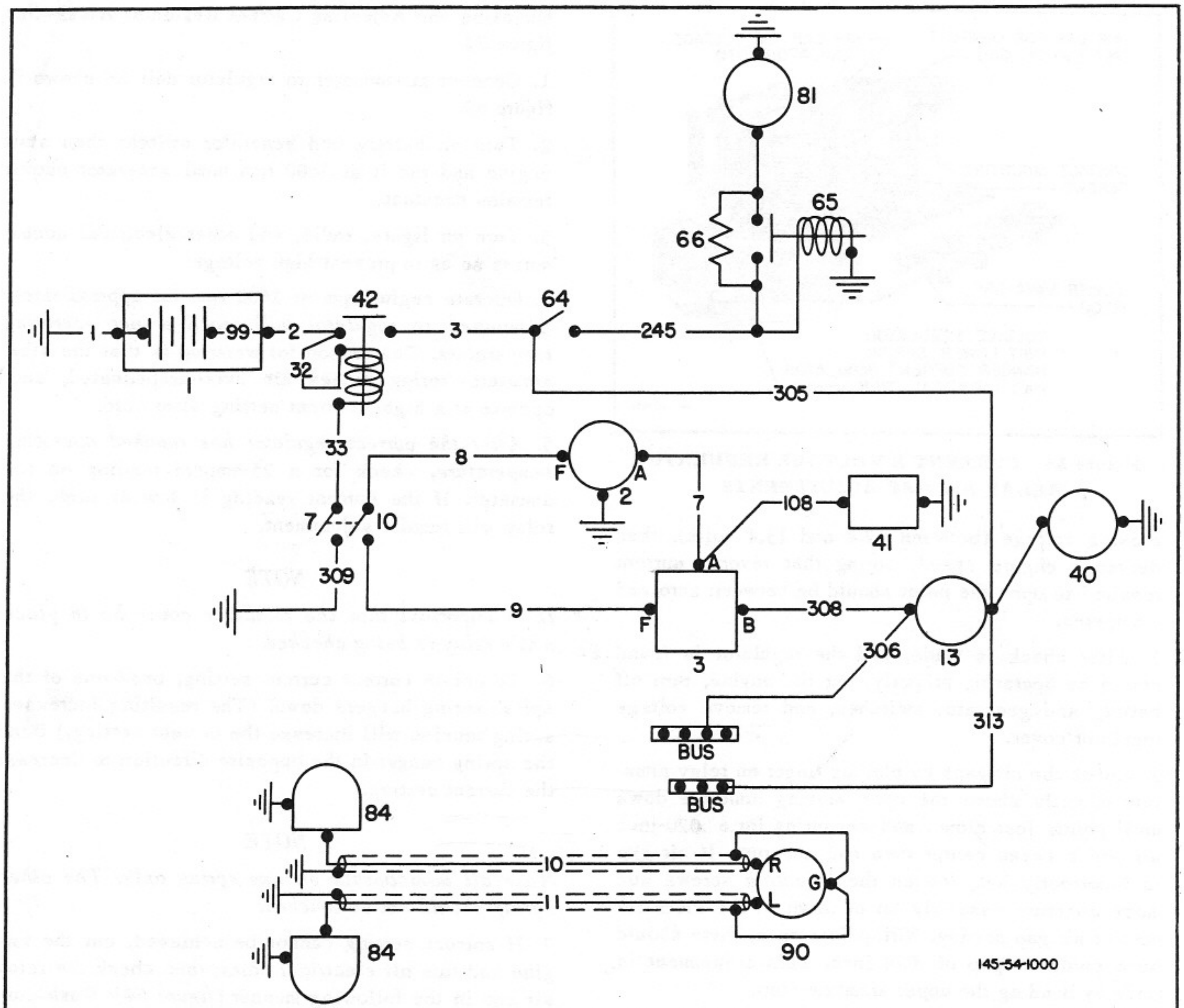
Make all adjustments on one spring only. The other spring should not be touched.

7. If correct setting cannot be achieved, cut the engine and turn off electrical units; then check the relay air gap in the following manner *(figure 54):* Push current regulator down all the way by hand, and allow it to come back up until points are just touching; then, with a wire-type feeler gage, measure over the center of the core, for an .080-inch air gap. If setting is incorrect, loosen the two contact mounting screws, and move upper contact support up or down as required.

NOTE

After proper air gap setting is achieved, be sure points are lined up before tightening the two contact mounting screws.

8. Start engine, turn on units listed in procedures 2 and 3, and allow regulator unit a short time to reach operating temperature. The regulator cover should be in place when check is being made, as there will be a difference in regulator operation without cover installed. Check ammeter for a 24 to 26-ampere reading. If setting is incorrect, adjust relay as instructed in procedure 6.



WIRE CHART

WIRE NO	GAGE	LENGTH
1	2	17
2	2	10
3	2	112
7	10	29
8	18	43 1/4
9	18	48
10	18 Shielded	49
11	18 Shielded	40
32	18	4
33	18	99
99	2	7
108	18	6 1/2
245	2	17
305	10	60
308	10	58
309	18	15 1/4
337	10	30
338	10	33

ITEM CHART

ITEM NO.	DESCRIPTION	PART NO.
1	Battery	6-TAS-9B
2	Generator-15 Volt 25 Amp	1108263
3	Regulator-Generator Control	1118263
7	Switch-Battery Disconnect	8396-K7
10	Switch-Generator Disconnect.	8396-K7
13	Ammeter	440116
40	Cigarette Lighter	L-14001
41	Filter-Radio Noise	CA-275-X
42	Relay-Battery Disconnect	71-111242
64	Switch	405-C
65	Solenoid	1116133
66	Resistor	
81	Starter Motor	530460
84	Magneto	S6LN-21
90	Switch-Ignition	GM-10-51104-1

Figure 55 - BATTERY, GENERATOR, STARTER AND IGNITION WIRING

9. After adjustment is completed, cut engine, remove test equipment, reinstall hinged cowling, and turn all switches off.

VOLTAGE REGULATOR RELAY

The voltage regulator relay serves to prevent the voltages exceeding 14.0 to 14.2 volts, regardless of the generator output.

Checking and Adjusting Voltage Regulator Relay—Before adjusting voltage regulator, make sure the contact points on both the current and voltage regulator relays are clean. Then proceed with the adjustment as follows:

1. Connect voltmeter and fixed resistance to voltage regulator relay, as shown in figure 52.

2. Start engine and run it at 1600 rpm. Allow sufficient time (5 to 10 minutes) for regulator to reach operating temperature. *Do not remove the regulator cover when checking for meter readings.*

3. Check voltmeter for a voltage indication between 14.0 and 14.2 volts.

4. If the voltage indication is incorrect, remove regulator cover, and bend *one* of the lower spring hangers up to decrease voltage setting; to increase voltage setting, bend spring hanger in opposite direction. *Do not tamper with the other lower spring hanger.*

CAUTION

Bend hanger with care, as it is likely to break off if adjusted carelessly. Do not bend hanger much at any one time, as the adjustment is critical. If a small change in spring tension does not change the voltage reading, clean the contact points of both the current and voltage relays before bending spring hanger excessively.

5. Check the voltmeter with the engine turning up 1600 rpm. The regulator cover should be installed while this check is being made. If a correct setting of the relay cannot be obtained, check the air gap between the relay core and the armature in the following manner: Remove regulator cover. Push armature down all the way, and then allow it to come back up until points are just touching. Measure the air gap over the center of relay case with a wire feeler gage for a .070-inch gap. To adjust for this air gap, loosen the two contact mounting screws, and move the upper contact support up or down as required.

NOTE

Be sure points are lined up before tightening the two contact mounting screws.

6. Install regulator cover and start engine. At 1600 rpm, check voltmeter for a reading.

7. After adjustment is accomplished, cut engine, and remove test equipment.

Cleaning Voltage Regulator Control Points—Most reported regulator trouble can be traced to dirty contact points. In normal operation, the gaps and point opening of the regulator will not change very often; therefore, a simple cleaning of the points will, in most cases, clear up regulator trouble. Proceed as follows:

NOTE

Points can be adjusted with regulator installed in the airplane; however, a better job can be accomplished if regulator is removed from the airplane.

1. If points are just dirty and slightly burned, draw a thin, fine-cut point file over the contact points, being careful not to take too much off the small contact, as the material is very thin. Be sure the file has not been used to file other metals, and is not greasy.

2. If points are burned so they are badly pitted, use a spoon or rifler file. This is the only type file that will touch the center point of cavity formed on point. In extreme cases it will be necessary to loosen the two contact mounting screws, and swing the upper contact bracket to one side. It will be necessary to regap points, as the loosening of the two contact mounting screws will change the gap adjustments.

BATTERY

A 12-volt, 34-ampere-hour, Exide battery (6-TAS-9B) is mounted just aft of the seat, in the baggage compartment. The battery is mounted in a metal battery box which is removed with the battery. When the battery switch, in the cockpit, is turned on, the battery is connected to the airplane's electrical system, through a battery-disconnect relay, located on the underside of the battery support. Battery power is then utilized by the system when the generator is idle.

Removing Battery—Remove battery by first disconnecting vent line, then disconnecting the positive and negative leads, and loosening the snap fasteners which secure the battery case in the airplane.

MAGNETOS

Two Bendix-Scintilla magnetos (Type S6LN-21), mounted on the top rear section of the engine, supply power for engine ignition. All wiring from magnetos to the spark plugs is enclosed within a braided shield for suppression of ignition noises from radio equipment. Timing, as well as other pertinent information concerning the magnetos, is covered in IGNITION AND STARTER SYSTEM, page 60.

STARTER

The engine is cranked electrically by a starter motor attached to the top rear section of the engine. The solenoid type starter switch is actuated by a button switch mounted on the firewall above the pilot's right rudder. Engagement and disengagement of the starter pinion with the flywheel is accomplished by the starter solenoid switch. The starter is wired through the battery disconnect relay, and cannot be operated until the battery switch is tuned on. For other pertinent information on starter, refer to IGNITION AND STARTER SYSTEM, page 60.

FUEL QUANTITY TRANSMITTER AND INDICATOR

Fuel quantity indication is accomplished electrically through use of a transmitter, installed in the aft side of the fuel tank (accessible from the left wheel well) and an indicator mounted in the instrument panel. The units operate on 6-volt current obtained from the 12-volt system through a resistor. These are thermal indicating units, which are easily and accurately read as the slow speed of reaction of the units tends to dampen out minor oscillations of the transmitter float. Because of wing dihedral, the system indicates only from 0 to 36 gallons of fuel, although the capacity of the fuel tanks is 39½ gallons. The difference between 36 and 39½ gallons of fuel is consumed before the indicator needle moves off the 36 gallon mark; however, the indicator is accurate for fuel quantities of less than 36 gallons. Information pertinent to calibration is covered in INSTRUMENTS, page 98.

LANDING GEAR POSITION INDICATOR SYSTEM

The landing gear position indicator system consists of

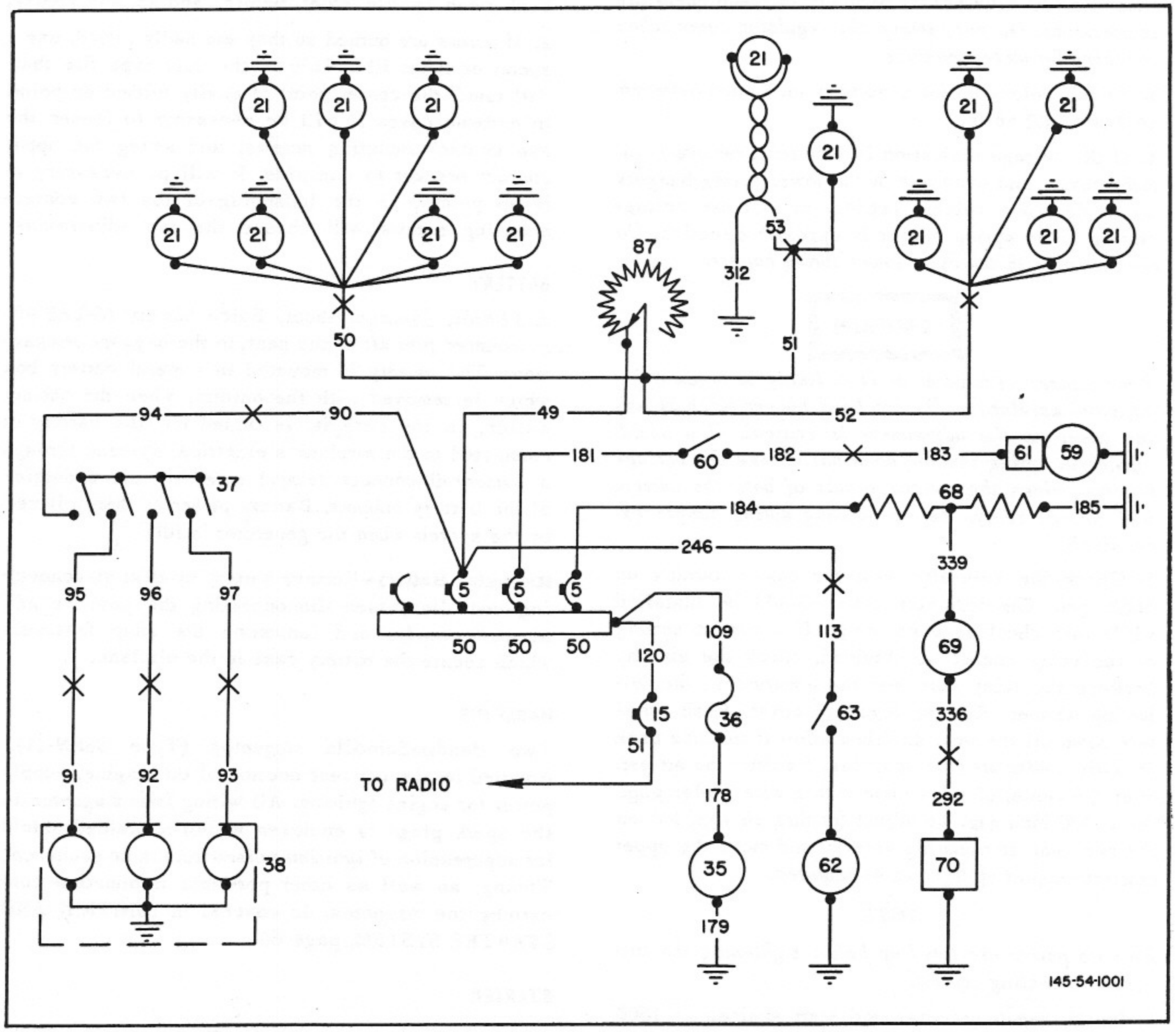


Figure 56 - CABIN HEATER, CIGARETTE LIGHTER, & ELECTRICAL FUEL PUMP

the following units: one red and three green landing gear position lights, mounted on the control panel; seven toggle-type switches (an up-lock and down-lock switch for each gear, and a switch actuated by the throttle rod); and a warning horn in the left wheel well. A green indicator light is connected to each gear down-lock switch, which is actuated by each landing gear bungee torque arm. The red light is connected to both the main and nose gear up-lock and down-lock switches. The main gear up-lock switches are actuated by each strut, and the nose gear up-lock switch is actuated by the bungee torque arm. The warning horn sounds when the gear is in an unsafe position for landing, and the throttle is retarded. A throttle switch, mounted on the carburetor, is actuated by the throttle control rod when throttle is retarded, thereby completing an electrical circuit through the throttle switch and up-lock switch to ground. The system is designed to indicate positions of the gear as follows:

Gear up and locked................	All lights off. Horn will sound when throttle is retarded.
Gear down and locked.............	All green lights on, and red light off.
Main and nose gears in........... any position other than up and locked, or down and locked.	Red light will burn. Horn will sound when the throttle is retarded.

The green lights may be dimmed by a rheostat switch, on the electrical switch panel. The horn and light circuits are protected by 20 and 5-ampere circuit breakers, respectively.

Adjusting Landing Gear Switches—Two men are required to adjust the switches; one to watch the operation of the indicator lights, and the other to make the switch adjustments. Proceed as follows:

1. Place airplane on jacks.
2. Position landing gear control in *down* position, and check to make sure gear is down and locked.
3. Turn battery switch *on.*
4. Remove engine air exit louver fairing on lower right side of fuselage, just aft of firewall.
5. Adjust nose gear down position indicator switch so that green light comes on when landing gear retracting link stop is 1/16 (± 1/32) inch from the full down and locked position.
6. Adjust main gear down position indicator switches so that green light comes on when landing gear retracting link stop is 1/8 (± 1/32) inch from the full down and locked position.

NOTE

Do not use red light or horn operation as an indicator for either of the two preceding adjustments.

WIRE CHART

WIRE NO.	GAGE	LENGTH
49	18	20 1/4
50	18	50 1/2
51	18	20
52	18	24 3/4
53	18	6
90	18	58
91	18	150
92	18	155
93	18	145
94	Furnished	
95		
96		
97		
109	18	4 3/4
113	18	104 1/2
120	14	3 1/2
178	18	37
179	18	19 1/2
181	18	27 1/2
182	18	53 1/2
183	18	
184	18	14
185	18	14 1/2
246	18	133 1/4
292	18	83 1/2

WIRE CHART

WIRE NO.	GAGE	LENGTH
312	18	20
336	18	64
339	18	9

ITEM CHART

ITEM NO.	DESCRIPTION	PART NO.
21	Lamp, Instrument Panel	53
35	Bank & Turn Indicator	NS27200
36	Fuse, 2 Amp, Bank & Turn	ACM-1
37	Switch Assem, Flare	
38	Flares	
50	Circuit Breaker, 5 Amp	CM-5
51	Circuit Breaker, 15 Amp	CM-15
59	Pump, Fuel	
60	Switch, Fuel Pump	8396-K7
61	Plugs Disconnect	AN3106-10S-25
62	Lamp, Cabin	1141
63	Switch, Cabin Lamp	
68	Voltage Divider	7219
69	Fuel Level Indicator	40520
70	Fuel Level Transmitter	145-51071-2
87	Rheostat, Panel Light	

KEY TO FIGURE 56

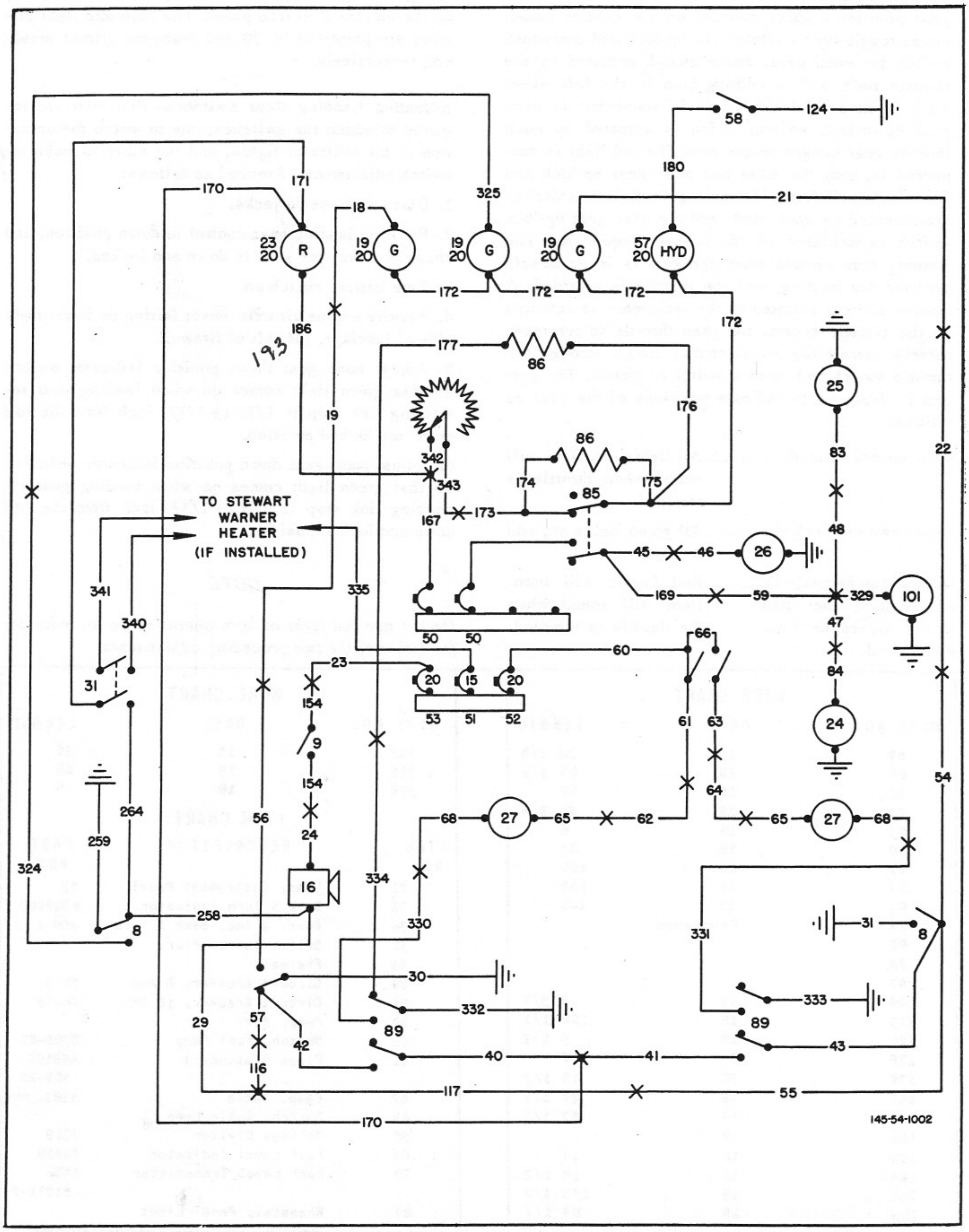


Figure 57 - LANDING LIGHT, LANDING GEAR INDICATING SYSTEM, HYDRAULIC INDICATOR LIGHT WIRING, AND POSITION LIGHT WIRING

7. Retract main gear, and adjust nose gear up position switch so the switch lever moves 1/16 (+1/32/–0) inch after the red light goes out and the gear is moved to the up and locked position.

8. Adjust main gear up position switches so switch levers have 1/32 (± 1/64) inch overtravel when gear is held in up position by hydraulic pressure.

9. Relieve hydraulic pressure and pull each gear down individually against the up-lock hooks to see that red light *does not* come on.

10. After all switches have been adjusted, retract and extend gear several times to see that light indications are correct. With gear in the up position, retard throttle; the horn should sound.

11. Turn battery switch *off,* lock gear in the down and locked position, and remove jacks.

WIRE CHART

WIRE NO.	GAGE	LENGTH
18	18	56
19	18	100
21	18	63
22	18	102 1/2
23	18	45 3/4
24	18	34 1/2
29	18	88
30	14	26
31	14	26
40	18	94
41	18	95
42	18	26 1/2
43	18	26 1/2
45	18	244
46	18	37
47	18	220
48	18	219
54	18	15 1/2
55	18	15
56	18	15 1/2
57	18	15
59	18	70 1/2
60	14	19 1/2
61	14	55 1/2
62	14	130 1/2
63	14	55 1/4
64	14	131 1/2
65	14	25 1/2
66	14	2
68	14	29 1/2
83	18	14
84	18	14
116	18	26 1/2
117	18	29
124	18	4 1/2
154	18	6
167	18	34 3/4
169	18	59
170	18	68 1/2
171	18	52 1/2
172	18	20 1/2
173	18	12 1/4
174	18	3
175	18	3
176	18	3
177	18	66
180	18	44 1/2
186	18	4 1/2

WIRE CHART

WIRE NO.	GAGE	LENGTH
258	18	71
259	18	5
264	18	29 1/4
324	18	45 1/2
325	18	49 1/2
329	18	84
330	18	43 1/2
331	18	44
332	18	3
333	18	3
334	18	94
335	16	33 1/2
340	18	49
341	18	47
342	18	2
343	18	2

ITEM CHART

ITEM NO.	DESCRIPTION	PART NO.
8	Switch, Landing Gear Position Indicator	8215
9	Switch, Throttle Warning	8215
12	Switch, Landing Lights	7402-K4
16	Horn, Landing Gear Warning	145-54042
19	Lamp Assembly Indicator, Green	810-BS
20	Lamp, Indicator	1816
23	Lamp Assembly Indicator, Red	810-BS
24	Position Light-RH, Green	A1285-G-12
25	Position Light-LH, Red	A1285-R-12
26	Position Light-Tail, Clear	A-2064
27	Landing Light	4509
31	Switch, Nose Gear Up Indicator	8715
50	Circuit Breaker-5 Amp	CM-5
51	Circuit Breaker-15 Amp	CM-15
52	Circuit Breaker-20 Amp	CM-20
53	Circuit Breaker-20 Amp	CA-20
57	Lamp, Amber	810-BS
58	Switch, Hydraulic Power On	8396-K7
85	Switch, Position Light	AN 3027-3
86	Resistor, 10 watt 10 ohm	
88	Rheostat, Indicator Light	PW25-D4-8
89	Switch, Gear Up Indicator	8715
101	Flap Midway Position Light	145-54076

KEY TO FIGURE 57

Adjusting Landing Gear Warning Horn Microswitch

1. Start engine and set throttle for between 1250 and 1350 rpm for the Hartzell propeller in low pitch, and between 1400 and 1500 rpm for the Aeromatic propeller.

2. Measure distance from the panel to forward side of the throttle knob, and then cut the engine. This is important, for several times during adjustment of the microswitch it will be necessary to return throttle to the correct setting.

3. Remove the left half of the cooling air intake grill and the access door, immediately below carburetor, for access to warning horn switch.

4. Connect a jumper wire from the horn terminal, on which wires 29 and 258 are attached, to ground.

5. With throttle set in correct position, loosen both warning horn switch mounting screws, and move switch against actuating arm until horn sounds. Tighten mounting screws.

6. Push throttle back and forth several times for positive check that switch is adjusted properly.

7. Remove jumper wire from horn.

Adjusting Warning Horn—The warning horn can be adjusted while installed in the airplane. Proceed as follows:

1. Connect a 0 to 25-ampere ammeter and a momentary closed switch in series from airplane structure to the horn terminal to which wire 29 is connected.

2. Turn on battery switch, and then close the throttle.

3. Adjust horn for the loudest sound (in the cockpit) at the lowest reading on the ammeter (approximately 3.5 amperes). Lock adjustment screw.

4. After adjustment is completed, turn battery switch off, and disconnect the portable ammeter and the switch from the horn circuit.

EXTERNAL LIGHTS

The external lights *(figure 50)* consist of three position lights and two landing lights. The position lights are installed as follows: red light on left wing tip, green light on right wing tip, and a clear light on the lower trailing edge of the rudder. These three lights are controlled by one switch on the electrical panel. A 100-watt, sealed-beam landing light is attached to a bracket which is secured to the outboard side of each main landing gear. Each light is wired through the down-lock switch on the gear, so that when the wheels are down and locked, the landing lights will burn, provided the double-pole, single-throw landing light switch on the electrical panel is on. With the landing lights wired this way, the lights will be out, regardless of position of the control switches when gear is up.

Adjusting Landing Lights—To adjust the landing lights, proceed as follows:

1. Position airplane on level ground facing a vertical wall 30 feet from the propeller.

2. Level the airplane longitudinally by raising or lowering the tail as necessary.

3. Make a vertical mark on the wall corresponding to airplane centerline; then, 52 inches on each side of this mark, make another vertical mark. On each of these two horizontal marks 12 and 18 inches from ground.

4. Cover one light, and loosen the U bolts of the other light bracket. Rotate light around strut until beam is on vertical mark on same side of centerline as light being adjusted. Tighten U bolts; then loosen the two screws that hold the lamp housing to the bracket. Move the lamp up or down until *top edge* of beam (not center) strikes wall between the horizontal marks. Tighten housing screws.

5. Repeat step 4 to adjust other light.

CAUTION

After lights are adjusted, the airplane should be placed on jacks, and each gear pushed up to the locked position by hand to ensure that there is no interference between the lamp bracket and the wing structure.

HYDRAULIC PRESSURE INDICATOR LIGHT

An amber light, mounted on the face of the control panel, is provided to indicate that hydraulic power control knob is pulled out. A toggle switch, mounted on the front of the firewall, is actuated by a striker plate on the power control linkage and is located to close the light circuit when the power control is full out. A rheostat incorporated in the circuit for dimming the light is cut in or out by a double-pole, single-throw switch also used for dimming landing gear indicator lights.

INSTRUMENT LIGHTS

There are thirteen instrument panel lights: twelve on the instrument panel behind the reflector, and one in the compass shroud. The brilliancy of all instrument lights is controlled by a rheostat on the control panel. To prevent electromagnetic fields, which cause erroneous compass readings, the campass light is not grounded at the compass. Instead, the ground wire is twisted around the hot wire and grounded at a distance from the compass. The instrument panel lights are easily replaced by removing the reflector, or the compass shroud.

TURN-AND-BANK INDICATOR

A Schwein electric turn-and-bank indicator (27200) is installed on the instrument panel. This instrument operates directly from the airplane's electrical system (12 to 14 volts), and will operate whenever the battery or generator switch is turned on. More information on this instrument will be found in INSTRUMENTS, page 96.

FLARES

On some airplanes a flare assembly, consisting of three parachute-type flares, is mounted above and just aft of the battery on left side of the airplane. There are four switches on the control panel used to fire the flares; one switch is a master switch, and the remaining three switches are for firing each flare individually. The airplane master switch must be on before flares can be fired.

CAUTION

Be sure all flare switches are off and locked before connecting flares. Remove flares before working on any part of the firing circuit.

CIGARETTE LIGHTER

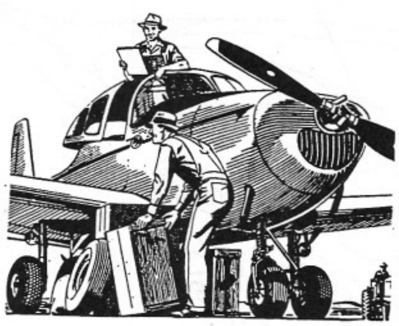
An automatic cigarette lighter is installed on the right side of the control panel. A special fuse is installed in series with the lead on the back of the lighter case. To replace this fuse, unscrew the lead wire from the fuse, and then unscrew the fuse from the lighter.

CAUTION

Before a new fuse is installed, determine and correct the cause of the failure.

ELECTRIC FUEL PUMP

The electrical fuel pump is mounted directly behind right hand engine compartment cooling air exit. Access is through removable baffle. Pump motor operates on 12 volt system. Wired through 5 amp. circuit breaker in breaker panel, through manually operated switch on control panel, and onto pump. Ground circuit is grounded to frame by pump.



RADIO EQUIPMENT

GENERAL

The Navion is equipped with RCA, Model One Sixteen, aircraft transmitter-receiver equipment. The equipment includes a six-channel vhf transmitter for operation in the range between 121.5 and 122.9 megacycles and a receiver which provides range band reception (200-400 kilocycles), standard broadcast band reception (540-1600 kilocycles), and reception of marker beacon signals (75 megacycles). The specifications for the set are as follows:

RECEIVER

Frequency Range

Range Band	200-400 kc
Broadcast Band	540-1600 kc
Marker Beacon	75 mc
I-F Frequency	455 k

RECEIVER

Output Impedance

Phones	300-600 ohms
Speaker	3.5 ohms
Current Drain, Receiving	4.5 amperes at 13 volts
Tube Complement	6BE6 converter 6BA6 IF 6AT6 Det MBAF 6AU6 1st AF 6V6GT/G 2nd AF and modulator

TRANSMITTER

Frequency Range	121.5-122.9 mc
Emergency	121.5 mc
Channel 1	122.1 mc

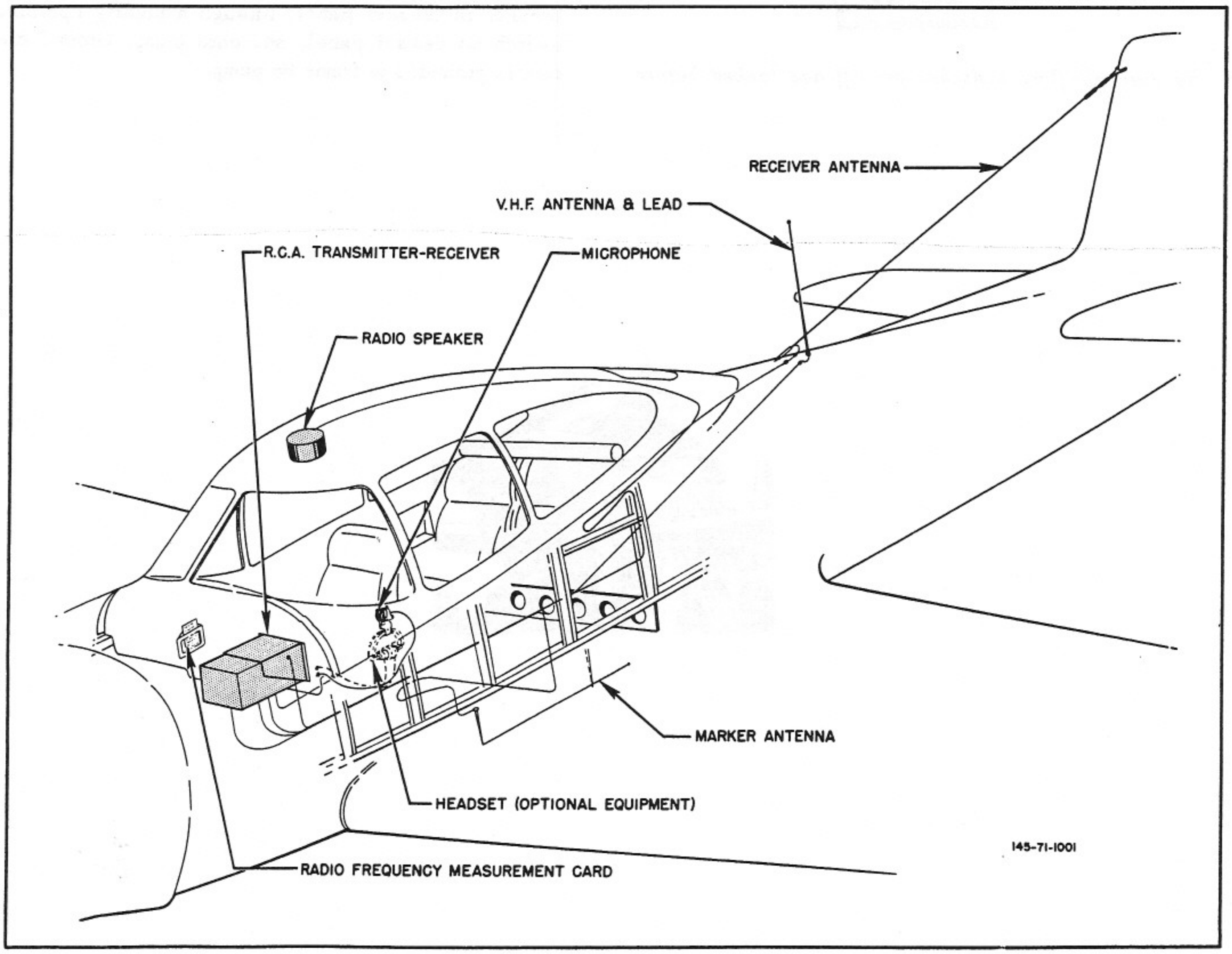


Figure 58 - LOCATION OF R.C.A. RADIO EQUIPMENT

TRANSMITTER (cont.)

Channel 2	122.3 mc
Channel 3	122.5 mc
Channel 4	122.7 mc
Channel 5	122.9 mc
Type of Transmission	Voice
Carrier Output	1 watt
Current Drain, Transmitting	6.5 amperes at 13 volts
Tube Complement	6AQ5 Oscillator Doubler 6AQ5 Doubler 6J6 Doubler-Power Amp 6X5GT Rectifier

Transmitter-Receiver Operation

Transmitter–

Set the receiver TUNING dial to the desired ground station transmitter frequency.

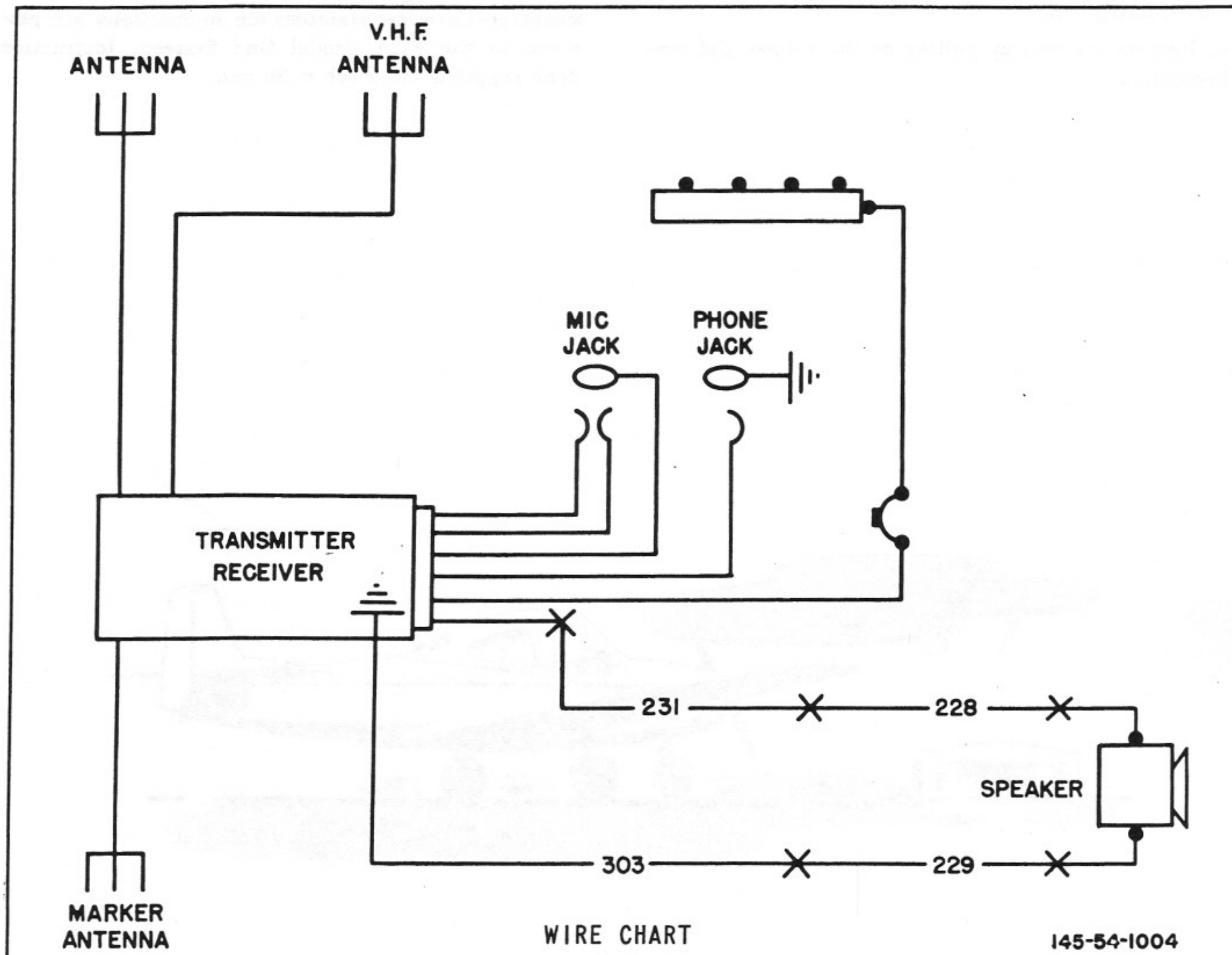
Rotate the channel switch to the desired channel number.

Depress the microphone pushbotton switch and proceed with the speech transmission.

Receiver–

Rotate the VOLUME control clockwise to turn power on; allow one minute for all tubes to reach operating temperature. Then rotate the volume control until background noise is heard in the speaker or headphones.

Rotate the receiver selector switch to the desired band.



WIRE CHART

WIRE NO.	GAGE	LENGTH
228	18	10
229	18	10
231	18	108
303	18	103

Figure 59 - R.C.A. RADIO EQUIPMENT WIRING DIAGRAM

Rotate the TUNING knob to the desired signal frequency and adjust the VOLUME control as required. Marker signals are received on RANGE ANT. and both LOOP positions of the selector switch, but not on the RANGE VOICE or BC ANT. switch positions. There is no volume adjustment on marker reception.

Removing Transmitter-Receiver—The transmitter receiver unit may be removed from the airplane by the following procedure:

1. Place battery switch in *off* position.
2. Pull the power and antenna plugs from the bottom of the unit.
3. Remove the four thumb screws binding the unit to the mounting box.
4. Remove the unit by pulling on the volume and tuning knobs.

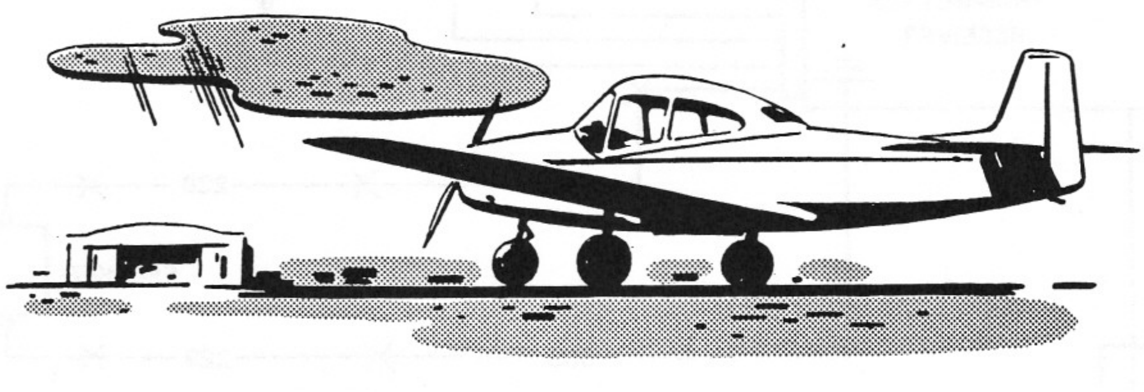
CAUTION

Do not bump or jostle the unit against the airplane structure, as tubes are likely to be damaged.

Installing Transmitter-Receiver

1. Make certain battery switch is *off.*
2. Position transmitter-receiver unit in case; then slide set forward as far as it will go.
3. Install four thumb screws in base of unit to secure the unit to the mounting box.
4. Insert the power and antenna plugs in the base of the unit. These plugs should slide in easily, and not require excessive pressure.

Maintenance, Checking, and Adjusting Transmitter-Receiver—Complete maintenance instructions are provided in the RCA, Model One Sixteen, Instruction Book supplied with each radio set.



INSTRUMENTS

GENERAL

The standard Navion instrument panel includes: a tachometer, ammeter, clock, sensitive altimeter; and turn-and-bank indicator, airspeed, rate-of-climb, fuel pressure, fuel quantity, oil pressure, and oil temperature indicators. The instrument panel is so designed that, by changing the reflector panel, removing the adapter plates, and re-arranging the instruments, it is possible to install a gyro horizon, vacuum gage, and directional gyro in the panel.

A magnetic compass and an outside air temperature gage are mounted independently of the instrument panel. The magnetic compass is mounted at the top center of the control panel, and the outside air temperature gage is mounted above the left windshield.

INSTRUMENT PANEL

The instrument panel is rubber shock mounted at five points. To remove the instrument panel, first disconnect the instruments from all wiring and tubing; then remove the shock mount pins and lift the panel from the airplane. Cap all instrument tubes to prevent the entrance of dirt or other foreign matter, while the instruments are disconnected. When installing an instrument, treat any fitting threads with thread lubricant. After installation is made, check the line connections for leaks.

AIRSPEED SYSTEM

The airspeed system *(figure 61)* consists of a pitot tube, two static plates, airspeed indicator, altimeter, and vertical speed indicator.

NOTE

The static and pitot openings should be clear of dirt and debris for proper functioning of the instruments affected.

Testing Airspeed Static Pressure Line

NOTE

This test procedure applies to Navions having the sensitive altimeter installed.

1. Put masking tape over static plates.

2. Remove sump and attach monometer. (Access to the static sump is through the cabin aft of the rear seat on the right side.)

3. Set altimeter pointer at zero.

4. Slowly apply suction until altimeter indicates 1000 feet (1.05 inches of mercury or 12.24 inches of wat then *pinch off* the tube and secure it with a suita clamp.

5. The altimeter should not indicate less than 8 feet after a one-minute period. Tap the altimeter keep the pointer swinging freely.

6. If altimeter indicates less than 850 feet, loca leak with soapsuds and repair it.

7. Remove masking tape from static plates. Remo manometer, and reinstall sump.

CAUTION

Do not apply pressure to static line.

Testing Airspeed Pressure Line

1. Cover drain hole at bend of pitot tube with maskin tape, and connect a source of pressure and a manome ter to pitot pressure opening.

2. Apply pressure slowly until airspeed indicator in dicates 150 mph (.82 inch mercury or 11.18 inches o water pressure); then *pinch off* source of pressur with a suitable clamp.

3. The airspeed indicator should not indicate less than 140 mph after a one-minute period. Tap the indicator to keep the pointer swinging freely.

4. If airspeed indicator reads less than 140 mph, locate leak with soapsuds and repair it.

5. After test is completed, remove manometer from pitot tube.

PITOT TUBE

The pitot tube is a single unit installed on the underside of the right wing with its axis parallel to the thrust line of the airplane. It furnishes an accurate value of impact pressure, caused by the motion of the airplane through the surrounding air. The forward part of the tube is open to receive the full force of the impact pressure.

AIRSPEED INDICATOR

The airspeed indicator is a sensitive differential pressure gage that measures the difference between pitot tube impact air pressure and static air pressure.

SENSITIVE ALTIMETER

The altimeter indicates the altitude at which an airplane is flying by measuring atmospheric pressure.

VERTICAL SPEED INDICATOR

The vertical speed indicator shows the rate of ascent or descent of the airplane; it is used in maintaining a definite rate of ascent or descent during instrument flying.

TURN-AND-BANK INDICATOR

The turn-and-bank indicator is composed of an electrically driven, gyro rate-type turn indicator (which operates on 12-volt direct current) and a bank indicator is a liquid-filled curved tube in which a free-rolling inclinometer ball changes position according to the direction of the force of gravity and centrifugal force.

DIRECT-READING COMPASS

The direct-reading, vertically mounted compass is mounted on the top center of the control panel. This compass consists of a metal bowl filled with compass fluid, and a semifloat-type card graduated in increments of 5 degrees. For the purpose of correcting deviations of the card which result from magnetic disturbances, a compensating system utilizing a built-in permanent magnet compensator is attached to the compass. This type of compass should be compensated every 100 hours, or at least once in each 3-month period, and at times when a change of equipment likely to affect the instrument, is made.

COMPASS BASE (ROSE) METHOD OF COMPASS SWINGING

The compass swing base (compass rose) should consist of a level, circular area having a smooth surface of sufficient strength to support the weight of the aircraft, without cracking or forming depressions under the wheels. No magnetic materials should be used in construction of the compass rose. The direction of the horizontal component of the earth's magnetic field, measured at any point between 2 and 6 feet above the surface of the base extending over the whole area of the base, should not differ by more than one degree from the direction measured at any other point in the space. The direction and uniformity of the earth's field should be determined prior to the use of the area for compass swinging; annually thereafter; and also after any magnetic material such as buildings, railroad tracks, direct-current power lines, etc., are installed within 200 yards of the base or rose. Any change in direction of the magnetic meridian, and the date of this observation should be clearly and permanently marked on the surface of the rose.

CAUTION

The Navion should be at least 100 yards from automobiles, steel buildings, or other aircraft. All magnetic materials (such as pocket knives, tools, mechanical pencils, and steel scales) should be removed from personnel engaged in swinging the compass. All airplane equipment having any magnetic effect on the compass should be secured in the position occupied in normal flight, and the engine must be running throughout swinging procedure.

Swinging the Compass

1. Place the airplane on a swinging base, and level to within 5 degrees.

2. The compass should be checked for sufficient compass fluid. If the external surface of the compass is damp with liquid, or if a bubble forms within the compass, liquid is required and the compass should be filled.

3. Align the white dots on the compensating screws with the dots on the compass, using a non-magnetic screwdriver.

4. See that all movable magnetic objects are in the usual flight positions.

5. Start engine and run at approximately 800 to 900 rpm during adjustments and recording of readings.

6. Place the airplane on a magnetic heading of 90 degrees.

7. Adjust the E-W compensator screw until compass reads 90 degrees.

8. Place the airplane on a magnetic heading of 180 degrees, and adjust the N-S compensator screw until compass reads 180 degrees.

9. Place the airplane on a magnetic heading of 270 degrees. Note the deviation, and reduce to one-half by adjusting the E-W compensator screw.

10. Place the airplane on a magnetic heading of 0 degree. Note the deviation and reduce to one-half by adjusting the N-S compensator screw.

11. Place the airplane on magnetic headings of every 15 degrees, and record the corresponding compass readings on the correction card.

TACHOMETER

The tachometer is used for indicating engine speed and is driven by a flexible shaft connected to the engine.

OIL TEMPERATURE INDICATOR

The oil temperature indicator is an instrument of the capillary type, and is connected to a bulb located in the oil cooler relief valve housing.

OIL PRESSURE INDICATOR

The oil pressure indicator, which indicates from 0 to

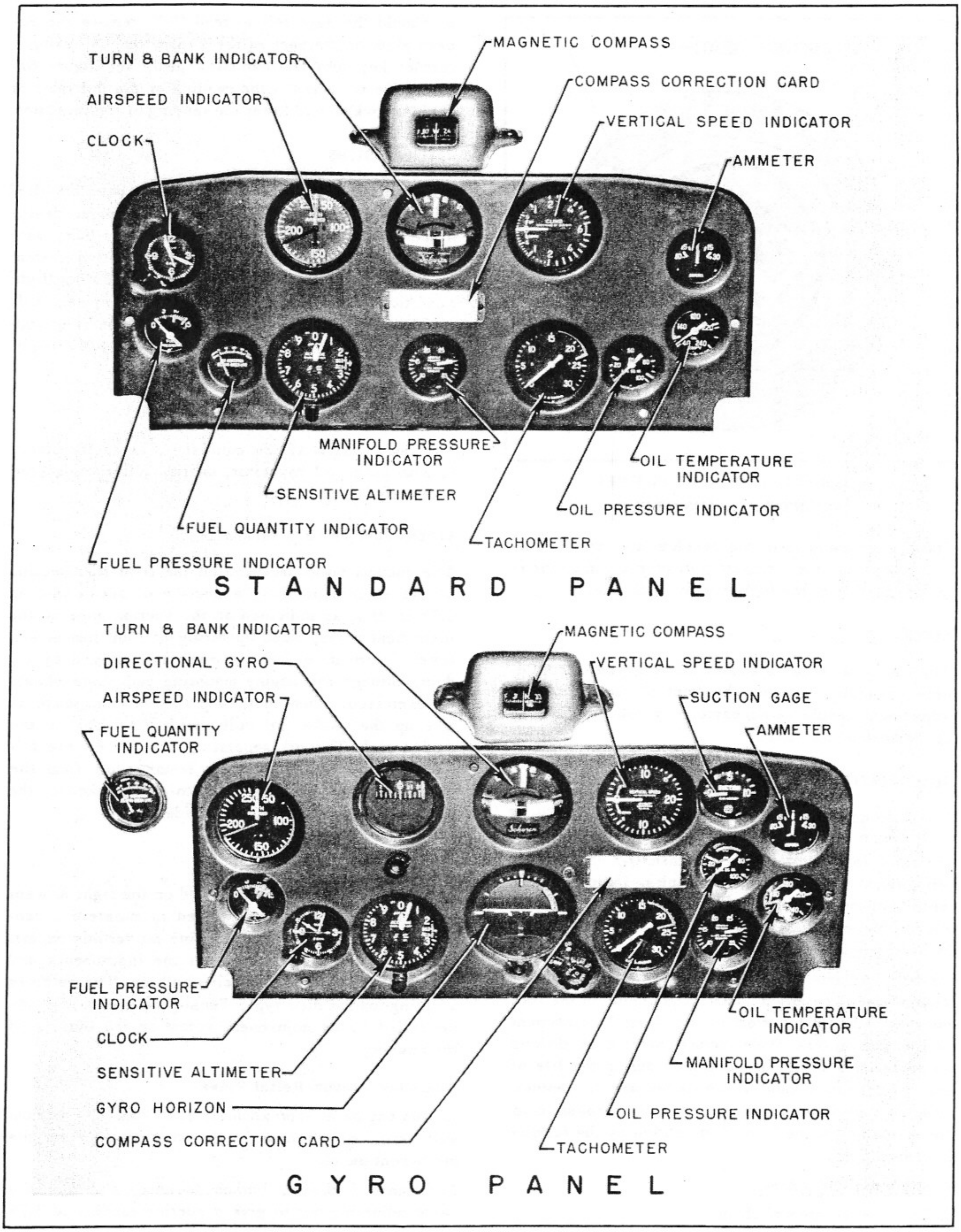


Figure 60 - INSTRUMENT PANELS

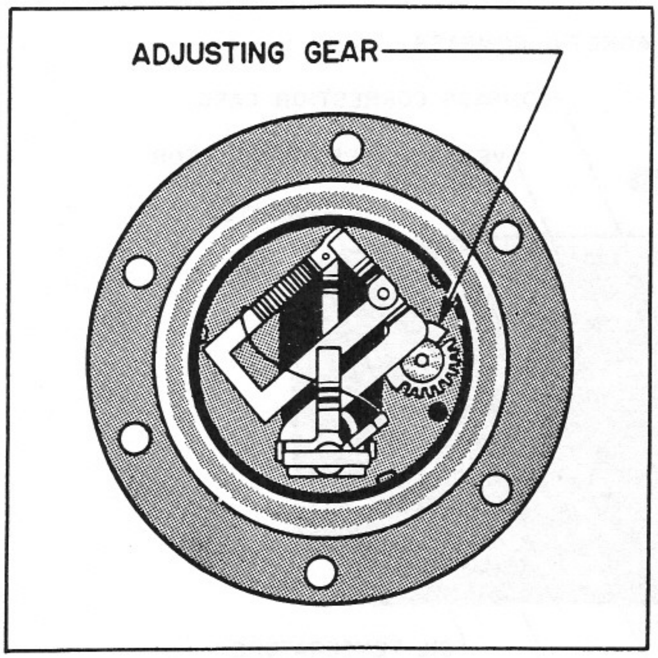


Figure 61 - ADJUSTMENT FUEL QUANTITY TRANSMITTER

100 psi pressure, is of the bourdon-tube type. A line attached to the fuel pressure port on the carburetor is routed directly to the fuel pressure indicator.

CLOCK

The clock, an 8-day standard aircraft type, incorporates a winding knob on the front of the case. The adjustment needle is accessible by removing a plug at the back of the case.

FUEL QUANTITY INDICATOR

The fuel quantity indicator, indicates the amount of fuel, from 0 to 39 gallons, in the wing fuel tanks. The indicator is controlled by a transmitter in the left wing tank. These are thermal units, indicating the amount of fuel by the proportionate amount of electrical flow necessary to break an electrical contact, by heating a bi-metal arm.

"Zero" Adjustment Fuel Quantity Indicator and Transmitter—The only adjustment possible on the fuel quantity indicating system is the "zero" adjustment of the transmitters. Under normal service conditions no adjustment should be necessary during the life of the instrument. Should it be necessary to replace either a transmitter or an indicator, it is possible to check and adjust the "zero" indication by the following procedure:

a. Drain the fuel tanks.

b. Turn the battery switch *on*.

c. Allow a one-minute stabilization period, then note whether or not the indicator gage reads "0".

d. Should the gage fail to read "0", remove the access plate on the back of the transmitter, and using a ratchet key turn the adjusting gear *(see figure 61)* clockwise to increase the reading of the indicator or counterclockwise to lower the reading of the indicator.

VACUUM SYSTEMS

Either of two vacuum systems may have been installed on these airplanes, by kits. The systems, as designated by the vacuum source, are known as pump vacuum system or venturi vacuum system. Either system is designed to deliver 4 in. Hg. suction during flight conditions. However, the pump vacuum system will supply suction at any time that the engine is operating; while the venturi vacuum system will supply suction only during flight.

PUMP VACUUM SYSTEM

The pump vacuum system consists of an engine-driven vacuum pump, oil separator, suction relief valve, and necessary tubing.

VACUUM PUMP AND OIL SEPARATOR

The vacuum pump, mounted on the right rear section of the engine, provides a suction of not less than 3.75 in. Hg., as indicated on the suction gage on the instrument panel, when operating at 1000 rpm at sea level. Lubrication for this pump is provided by oil ducts through the engine mounting pad. Care should be exercised, when installing the vacuum pump, to line up the gasket oil holes with the holes on the engine pad. The oil separator, mounted on the left forward side of the firewall, removes oil from the pump discharge and returns it to the crankcase; the air is then exhausted to the outside air.

VACUUM RELIEF VALVE

The vacuum relief valve, mounted on the right forward side of the firewall, is designed to maintain a constant vacuum in the instrument line for various engine speeds, and thus protects both the instruments and pump from sudden or excessive suction. The valve is a spring-loaded disc type. Tension of the spring may be varied by an adjustment screw on the outside of the housing.

Adjusting Vacuum Relief Valve

1. Run engine at approximately 1000 rpm. The vacuum will then be indicated at the suction gage on the instrument panel.

2. Remove lockwire, loosen locknut, and turn the valve adjusting nut to give a suction reading of 3.75 in. Hg.

3. Increase the engine speed to the maximum rpm at-

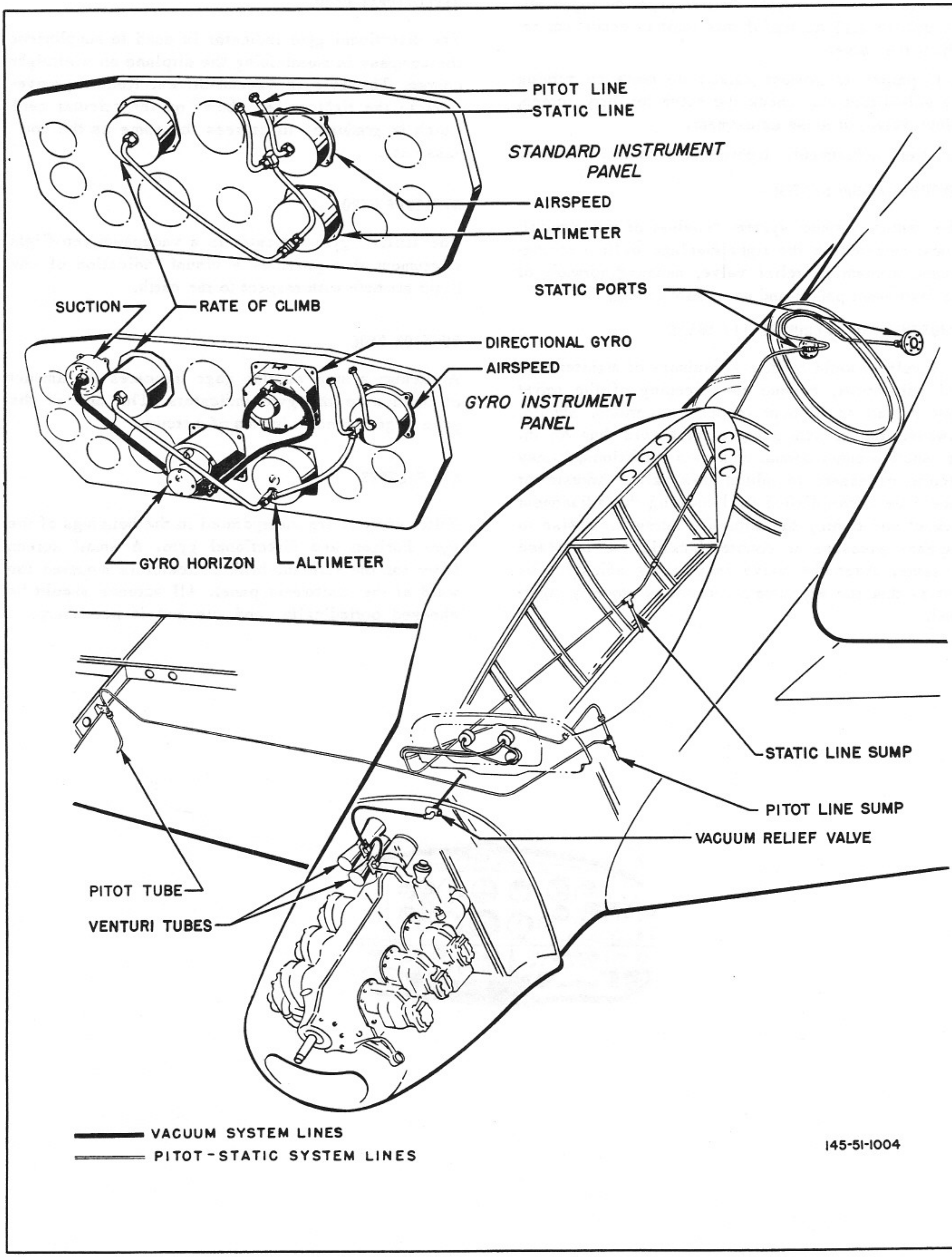


Figure 62 - INSTRUMENT SYSTEM

tainable on the ground; the suction gage reading should not exceed 4.25 in. Hg. If this limit is exceeded, re-adjust the valve.

4. If proper adjustment cannot be made by turning the adjustment nut, check the valve for dirty screen, sticky valve, or loose adjustment.

5. After adjustment, tighten and safety locknut.

VENTURI VACUUM SYSTEM

The venturi vacuum system consists of two venturi tubes, mounted on the right fuselage wall; a spring-loaded adjustable relief valve, mounted forward of the instrument panel; and necessary tubing.

ADJUSTMENT OF VACUUM RELIEF VALVE

This valve should require a minimum of maintenance and adjustment, beyond the cleaning of the relief vent screen at 50 hour inspection periods. Should, however, the vacuum gage register more than 4½ in. Hg. suction under normal operation conditions, it may become necessary to adjust this valve. Adjustment should be accomplished by loosening the adjustment locknut and turning the adjusting screw clockwise to increase pressure or counterclockwise to decrease pressure. After the valve is properly adjusted, be certain that the adjustment locknut is properly tightened.

DIRECTIONAL GYRO

The directional gyro indicator is used to supplement the compass in maintaining the airplane on a straight course. The gyro is vacuum-driven. Relative movement to the right or left shows on the cricular card which is graduated in degrees the same as the compass card.

ATTITUDE GYRO

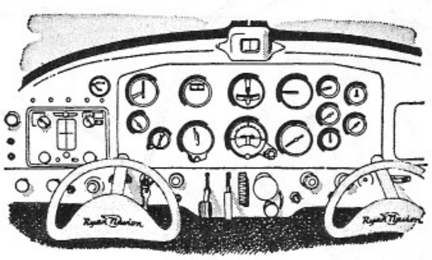
The attitude gyro indicator is a vacuum-driven flight instrument that provides a visual indication of any flight attitude with respect to the earth.

SUCTION GAGE

A vacuum system suction gage indicates the amount of suction to the gyro indicators. The dial of the gage is graduated in inches of mercury.

AIR FILTERS

Filter screens are incorporated in the housings of the gyro horizon and directional gyro. A small screen filter for the turn-and-bank indicator is mounted forward of the instrument panel. All screens should be checked periodically, and cleaned if necessary.



HEATING AND VENTILATING SYSTEM

CABIN HEATING AND VENTILATING

Navions are equipped with a ventilating system, for cabin centilating or windshield defogging; and an exhaust heat exchanger type heater which uses the ventilating system ducts for heated air distribution. Both heated air and ventilating air enter the system under ram pressure *(See figure 63).* Ventilating air is obtained by a scoop on the right cowl. Heating air is obtained by an open duct facing into the stream of the engine cooling air. A mixing valve on the right forward side of the firewall allows heating or ventilating air to enter the distributing system in any desired proportion. The mixing valve has a push-pull control located below the glove compartment on the control panel. When the mixing valve control is pulled out, the amount of cold (ventilating) air entering the system is decreased, and the amount of heated air entering the system is increased, until, when the control is full out, heated air only is entering the system. When the control is full in, ventilating air only enters the distributing ducts; and all heated air is dumped overboard by the mixing valve. A control valve, immediately aft of the mixing valve, on the firewall, controls distribution of ventilating and heating air within the airplane.

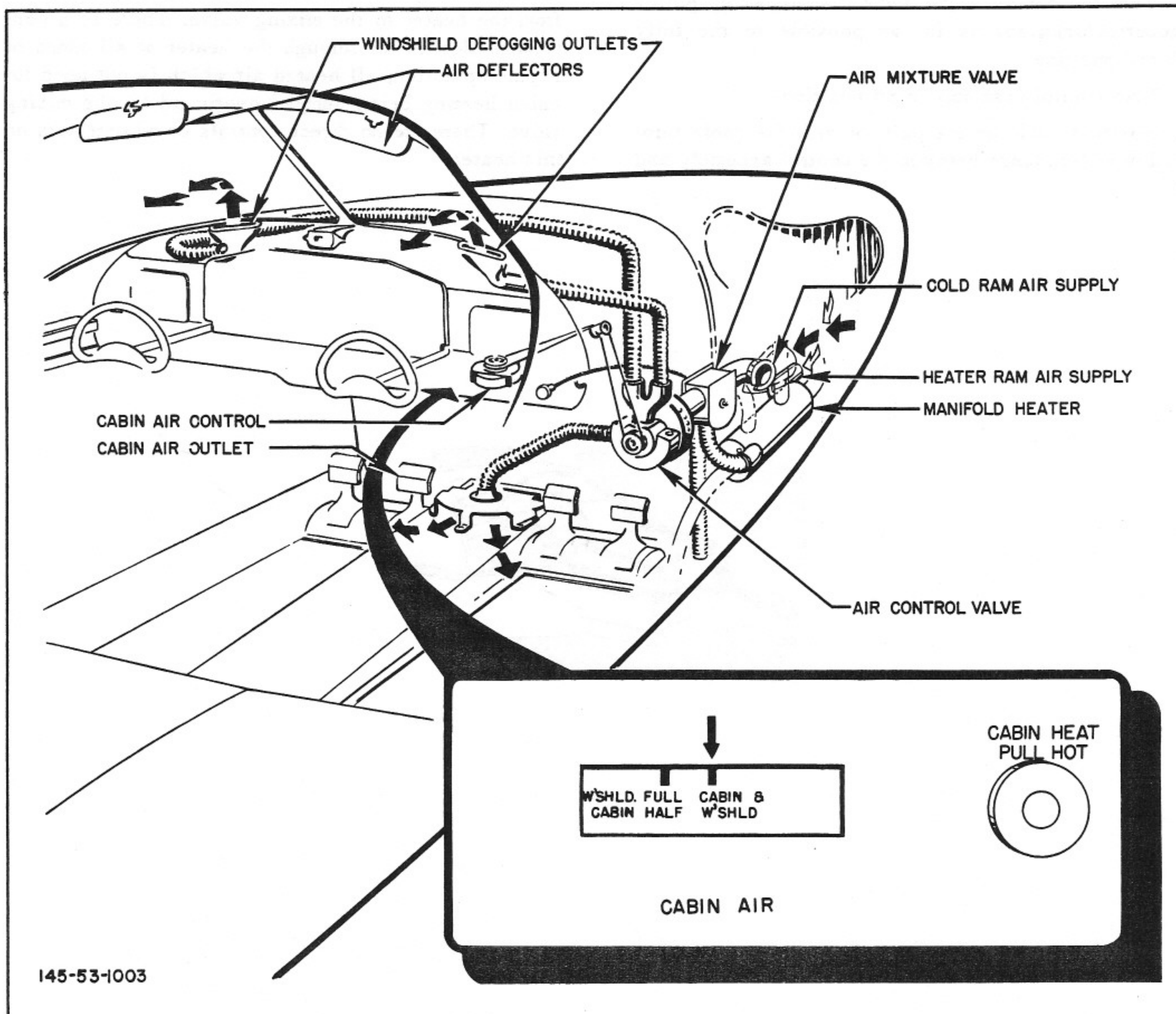


Figure 63 - HEATING AND VENTILATING SYSTEM

CONTROL VALVE AND OUTLET ASSEMBLY

A combined control and outlet valve (located on the right side of the firewall) regulates the quantity of heated or ventilating air being admitted, and directs it to the windshield for defogging and to the cabin. The control valve is operated by a cabin control (mounted on the right side of the instrument panel) and a cable assembly which is connected to a pulley of the control and outlet valve assembly. Movement of the control (left or right) will bring about a change in air distribution.

Adjusting Control Valve and Outlet Assembly Control Mechanism

1. Loosen cable lockscrews on both the control assembly, and the control valve and outlet assembly pulleys.

2. Turn the control valve and outlet assembly pulley (counterclockwise) as far as possible to the fully closed position.

3. Turn control assembly to off position.

4. Position cable on the pulleys with the cable turnbuckle mid-distance between the control assembly and cable support bracket (located on the firewall above control valve and outlet assembly).

5. Tighten the cable so there is no slack remaining in the cable. Safety the turnbuckle.

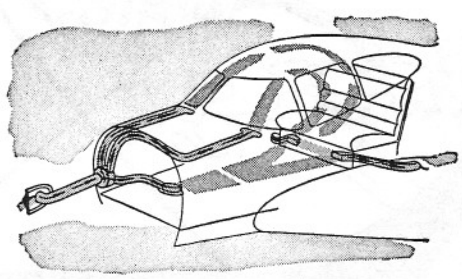
CAUTION

Excessive tightening will damage the bracket, the control assembly, or the control valve and outlet assembly.

6. Tighten cable lockscrews in both pulleys.

MANIFOLD HEATER

The manifold heater used on the Navions is of the heat exchanger type. The heater is composed of a shroud around the exhaust muffler, and necessary tubing to carry ram air into the heater and heated air from the heater to the mixing valve. There is a continuous flow of air through the heater at all times of engine operation; all heated air which is not used for cabin heating being dumped overboard by the mixing valve. There are no direct controls or adjustments on this heater.



MISCELLANEOUS EQUIPMENT

GENERAL

The airplane is equipped with two front seats, a rear seat, armrests, seat belts, and ash trays. There is also a glove compartment in the right side of the control panel. Provisions have been made for carrying three flares on the left side of the fuselage behind the baggage compartment *(See figure 64.)*

CABIN SEATS

The seats for the pilot and front passenger are individual, adjustable fore and aft, and are constructed of alclad frames, with removable spring cushions made of airfoam rubber enclosed in fabric upholstery. The rear seat, extending the full width of the fuselage, is made of a bottom and a back tubular frame with removable cushions. These cushions, also, are made of airfoam rubber enclosed in fabric upholstery. The back of the seat pulls forward to allow easier access to the baggage compartment. Installed on the lower forward section of the rear seat are two adjustable cabin air vents.

Installing and Removing Cabin Seats—See figure 65.

FLARE EQUIPMENT

The flare equipment (installed on some airplanes) consists of three parachute flare assemblies, a holding bracket attached to fuselage structure, and a switch box, with one master switch and three operating switches, located on the left side by the pilot's seat. The flares, each having an individual control switch, are released by electrical operation. The three switches are controlled by the master switch. After flares are released, it is necessary to remove the flare cans, before installing new flare assemblies. The flare assemblies are fastened on the inboard end by the same bolt to which the electric wire attaches.

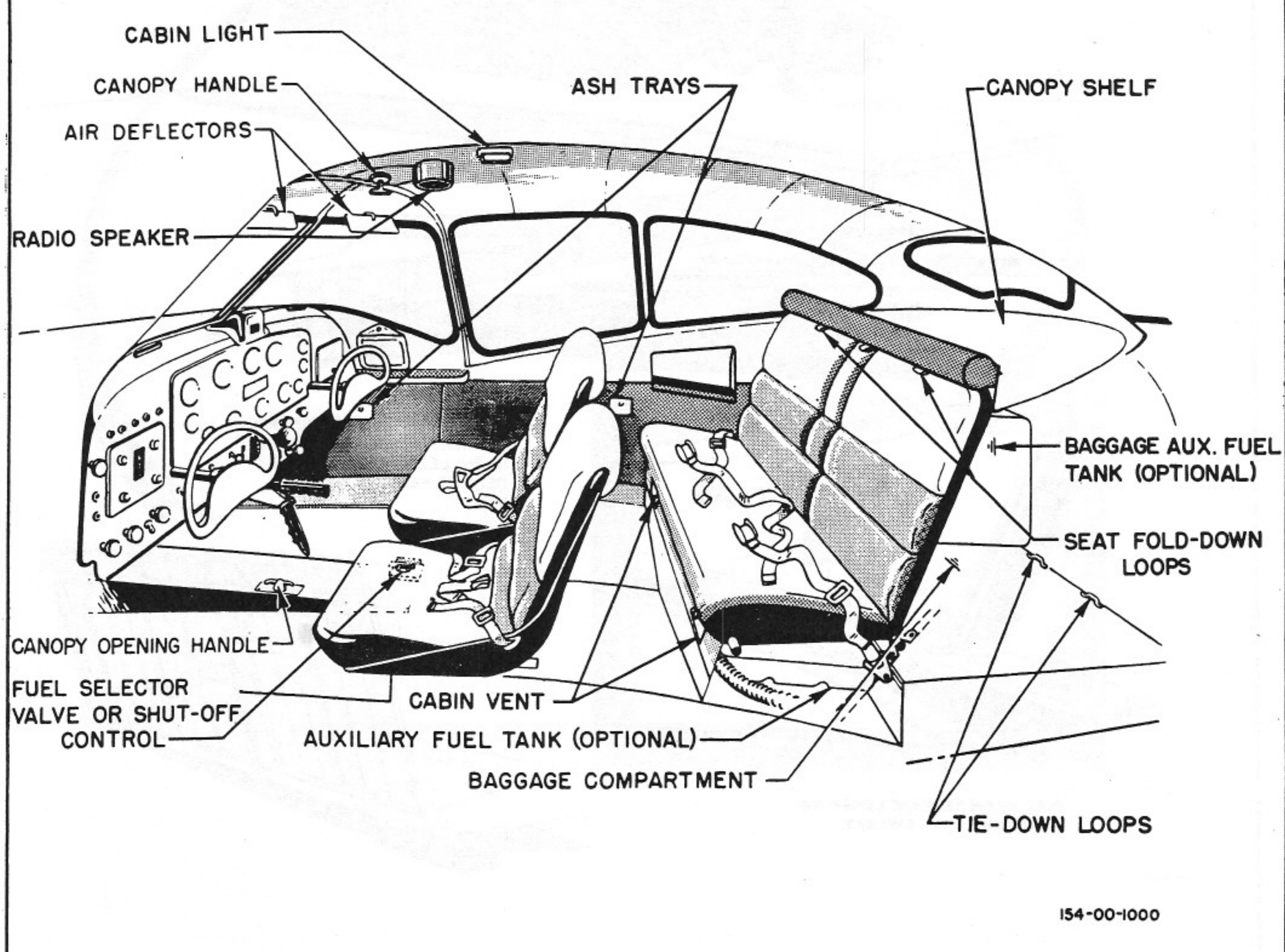


Figure 64 - FURNISHINGS AND MISCELLANEOUS EQUIPMENT

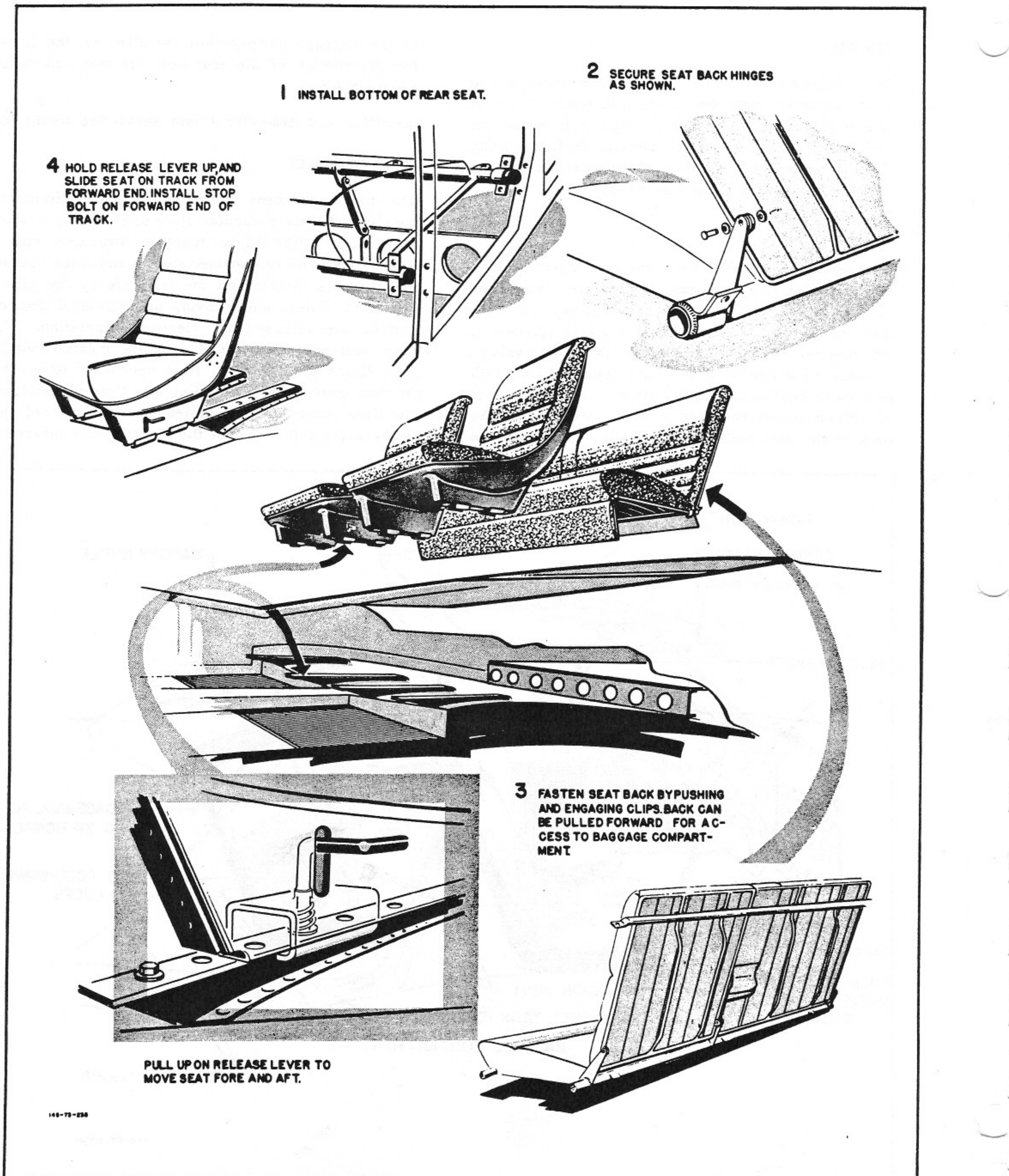


Figure 65 - INSTALLING AND REMOVING CABIN SEATS

AIRPLANE STRUCTURE

GENERAL

The Navion structure is fabricated from 2SO, 3SO, 24ST, and 52SO alclad aluminum, except in certain assemblies where a few steel parts are used. The number of extruded parts has been kept to a minimum, and rivets, screws, and other fasteners are standard, approved parts. Rivets are A17ST flat head, 100-degree countersunk, and modified brazier head. In certain highly stressed areas, Hi-shear rivets, which may be replaced with approved bolts and nuts, are employed. Lap joints are used for the joining of skin sections over the entire airplane. Structural repairs should be made in accordance with procedures given in Civil Aeronautics Manual 18. However, numerous parts of the airplane are heat-treated after they have been arc-welded. Welded repairs to these parts must not be made unless proper heat treating facilities are available. Alignment of the airplane may be checked by reference to measurements and procedure given in figure 72.

FUSELAGE

The fuselage is a semimonocoque, stressed-skin, metal structure consisting of two sections–main section (which includes the cabin enclosure), and engine mount section. *(See figures 66 and 67.)*

Main Section–The fore part of the main section is semimonocoque, consisting of four longerons, firewall, and formers covered by alclad sheet. Spanning the cabin, and just aft of the rear seat, is a tubular tie rod which is riveted to the upper longerons and restrains longeron kick loads. Two longitudinal beams, supported at the firewall and fuselage frame aft of the wing leading edge, accommodate the nose gear. The pilot's floor covers these two beams and consists of a single aluminum sheet riveted to the fuselage side panels and firewall. The baggage compartment floor is supported fore nad aft by fuselage frames, and at the sides by the lower longerons. The control panel is formed from a single piece of alclad sheet, and is cut out for installation of the rubber-mounted instrument panel.

From the aft end of the cabin to the tail, the fuselage is semimonocoque, and comprised of vertical bulkhead rings covered by three sheets of alclad. Each sheet of alclad is flanged inboard at one longitudinal joint to

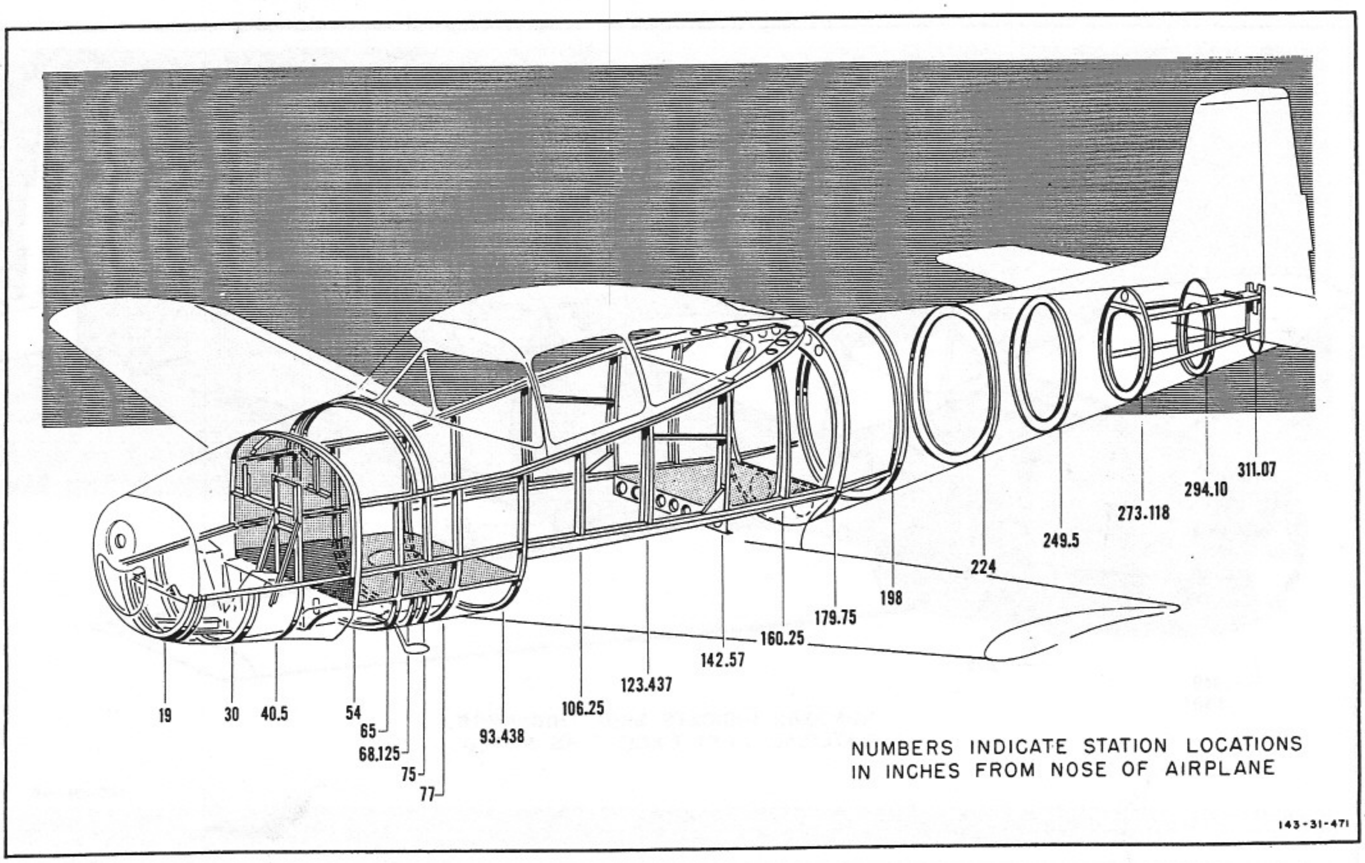


Figure 66 - FUSELAGE STRUCTURE

provide additional strength and rigidity. The forward section of a dorsal fin is riveted to the upper rear fuselage skin at an angle 2 degrees to the left of the fuselage centerline. A spring-leaf tail skid is mounted on the aft bottom end of the fuselage to protect the tail in the event of a tail-low landing.

Cabin Enclosure—The windshield consists of two pieces of formed plastic sheet installed in an alclad frame. The sliding canopy is constructed of formed aluminum sheet with plastic window panels. Two channel-shaped longerons extend the full length of the canopy. Attached to the longerons and spot welded to the top are a bowed extruded angle and a hat section which maintain the contour. Two tracks attached to the rear of the canopy engage rollers on the fuselage. The front of the canopy has rollers on each side that engage tracks on the fuselage. A transverse web at the aft end of the canopy covers the baggage compartment, and is strengthened by beading.

Engine Mount Section—The engine mount, semimonocoque in construction, is removable from the fuselage and consists of two longerons, frames, a bulkhead, a steel cross-tube, and alclad sheet covering. The engine is rubber-mounted on four fittings, two on the crosstube and two on the bulkhead. The mount is secured to the main fuselage section at the firewall and forward end of the nose wheel beams. The engine nose cowl, bolted to the engine mount, is supported at the top by a channel member extending from the firewall forward. The channel also provides attachment points for the hinged cowling, which is secured by dzus-type fasteners at the engine mount longerons.

WING

The full-cantilever wing, of advanced design, has two bent-up alclad sheets at the trailing edge, which serve as a rear spar and part of the lower skin. The wing consists of two panels (each having a fuel tank compartment, and a wheel well for the main landing gear) bolted together at the fuselage centerline. Wing flaps and ailerons are hinged to the trailing edge of each panel. *(See figures 68 and 69.)*

Wing Panels—The airfoil sections used are NACA4415R at the root, and 6410R at the tip. The angle of incidence at the root is 2 degrees; incidence at the tip is minus one degree. Dihedral is 7 degrees, 30 minutes, and the leading edge sweepback is 2 degrees, 55 minutes, and 46 seconds.

There are two short beams near the wing root. One of these, with another shorter beam, supports the main landing gear and retraction mechanism. Each beam consists of a web with top and bottom edges flanged

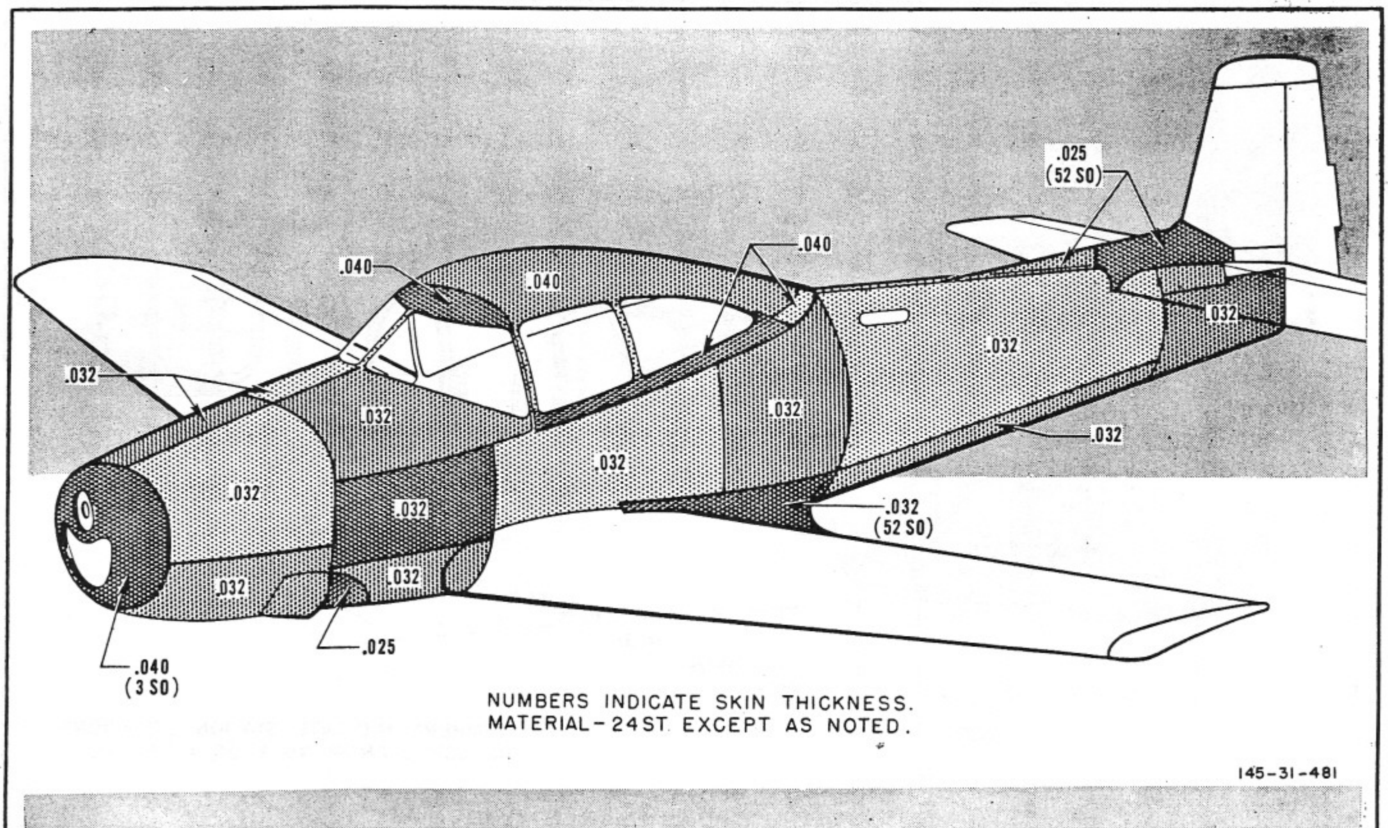


Figure 67 - FUSELAGE SKIN ARRANGEMENT

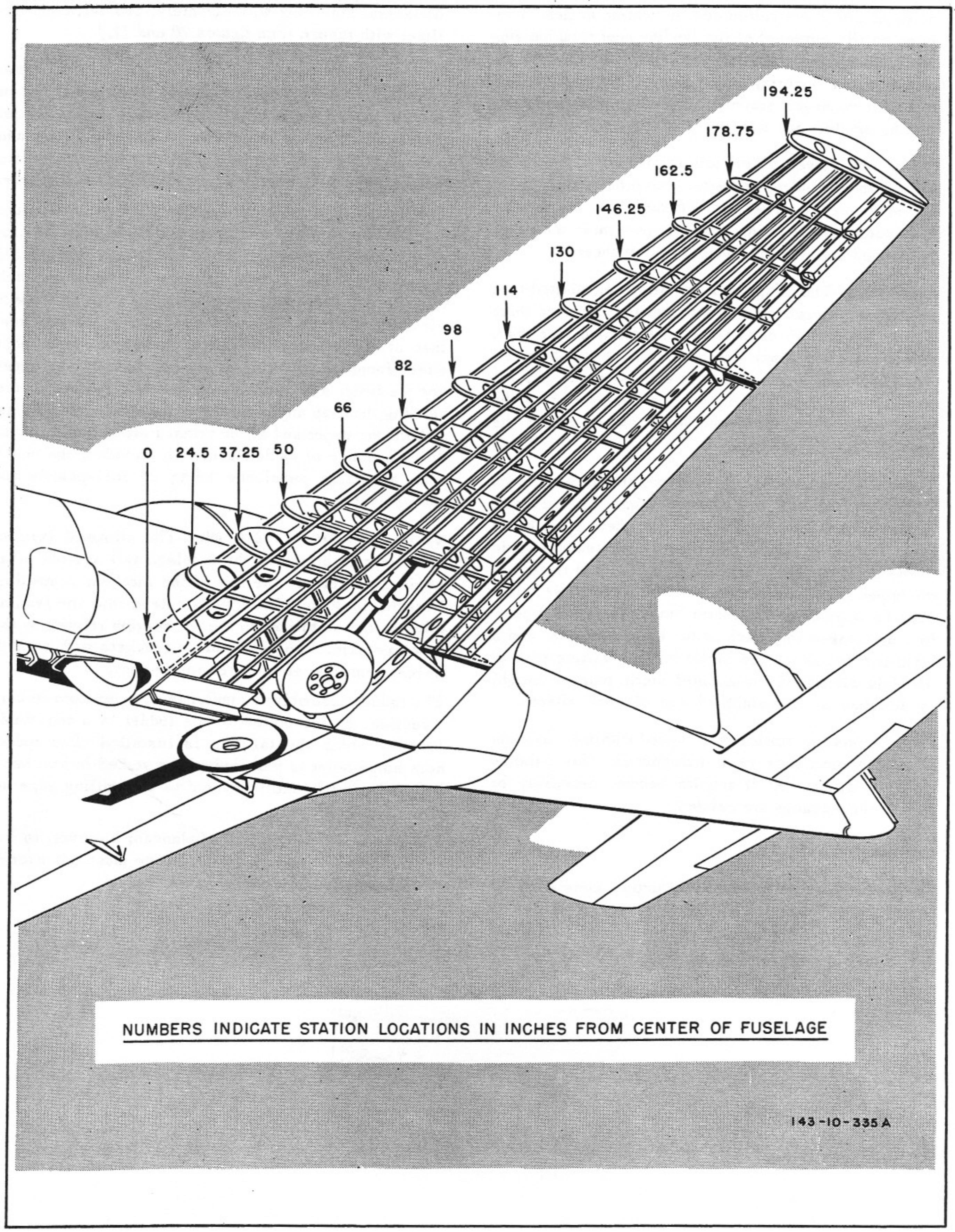


Figure 68 - WING PANEL STRUCTURE

as caps which are reinforced by bent-up angles. A reinforced rib, outboard of the landing gear trunnion supports, distributes landing loads and provides for attachment of mooring and jacking fittings. Highly stressed members around the landing gear and wing bolting angles are secured with Hi-shear rivets.

Upper and lower skins are reinforced spanwise by formed and extruded stringers. *(See figure 68.)* A closeout strip on the lower surface runs from the landing gear cutout to the wing tip. The removable wing tips are formed and welded aluminum alloy sheet.

Wing Flaps—The wing flaps are all-metal, slotted-type structures, hinged to the wing trailing edge at three points. Each flap consists of a front and rear spar, with a full rib at each end and six nose ribs between. The lower cap of the rear spar extends as skin to the trailing edge, where it is joggled and riveted to the upper skin. Both upper and lower skins, except the leading edge, are beaded.

Ailerons—The all-metal, Frise-type ailerons are hinged to the wing trailing edge at three points. The structure is identical to the flaps except that there is only one spar. The lower cap of this spar also extends as skin to the trailing edge, where it is joggled and riveted to the upper skin. The center nose rib is of double thickness for support of the center hinge. Sealed ball bearings are staked into each of the hinge brackets, and a fixed trim tab is riveted to the inboard trailing edge of the right aileron. A streamlined static balance weight is attached at the outboard end of each aileron.

The ailerons are statically balanced within a maximum allowable unbalance of 4 inch-pounds. This balance must be maintained if repairs become necessary or even if the surfaces are painted.

EMPENNAGE

The empennage is all-metal structure consisting of horizontal stabilizer with elevators, and vertical stabilizer with rubber. *(See figures 70 and 71.)*

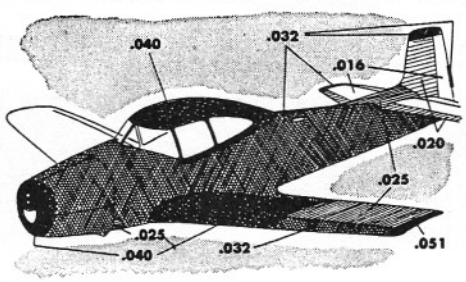
Horizontal Stabilizer and Elevators—The horizontal stabilizer is of the full-cantilever type, and it set on the airplane at a negative 3-degree angle of incidence. Removable tips are made from deep-drawn 52SO, and are attached with screws. Elevator hinge brackets with staked ball bearings are installed on the spar.

The elevators are interchangeable. Each is built around a frame consisting of two spars and three ribs. Adjustable metal trim tabs are installed between the inboard and center ribs. Torque tube cups riveted to each elevator are connected to an actuating horn at the airplane centerline. The skin arrangement differs from that of the ailerons and flaps in that a single bent sheet forms the trailing edge, and neither the upper nor the lower skin surfaces are beaded. Instead of the beading, bent-up angle stiffeners are riveted chordwise to both the upper and lower skins. Partial dynamic and static balance of each elevator is provided, the maximum allowable unbalance being 25 inch-pounds for each elevator.

Vertical Stabilizer and Rudder—The all-metal vertical stabilizer is bolted to the fuselage tail section at an angle 2 degrees to the left of the airplane centerline. Detachable dorsal fin sections extend from the leading edge of the stabilizer to the fin section riveted to the fuselage skin. Two rudder hinge brackets with staked-in ball bearings, are secured to the spar.

The rudder assembly is similar to the elevators in construction. At the bottom of the rudder is a removable boot in which the taillight is installed. The rudder horn hinge point is provided with a staked-in ball bearing. A fixed trim tab is riveted to the trailing edge aft of the center hinge.

The rudder is not statically balanced; however, in the event of repair, the static unbalance must not exceed 47 inch-pounds.



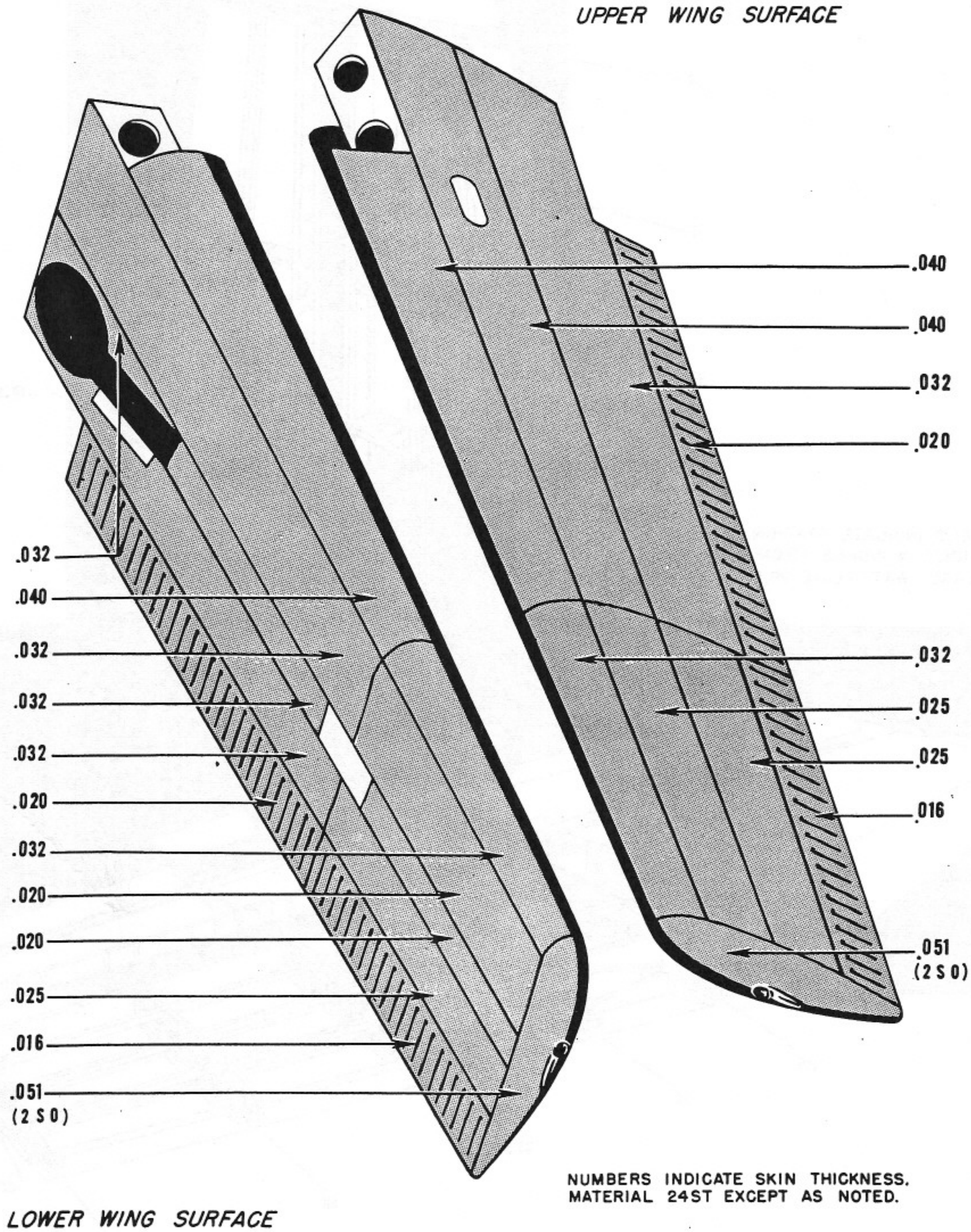


Figure 69 - WING SKIN ARRANGEMENT

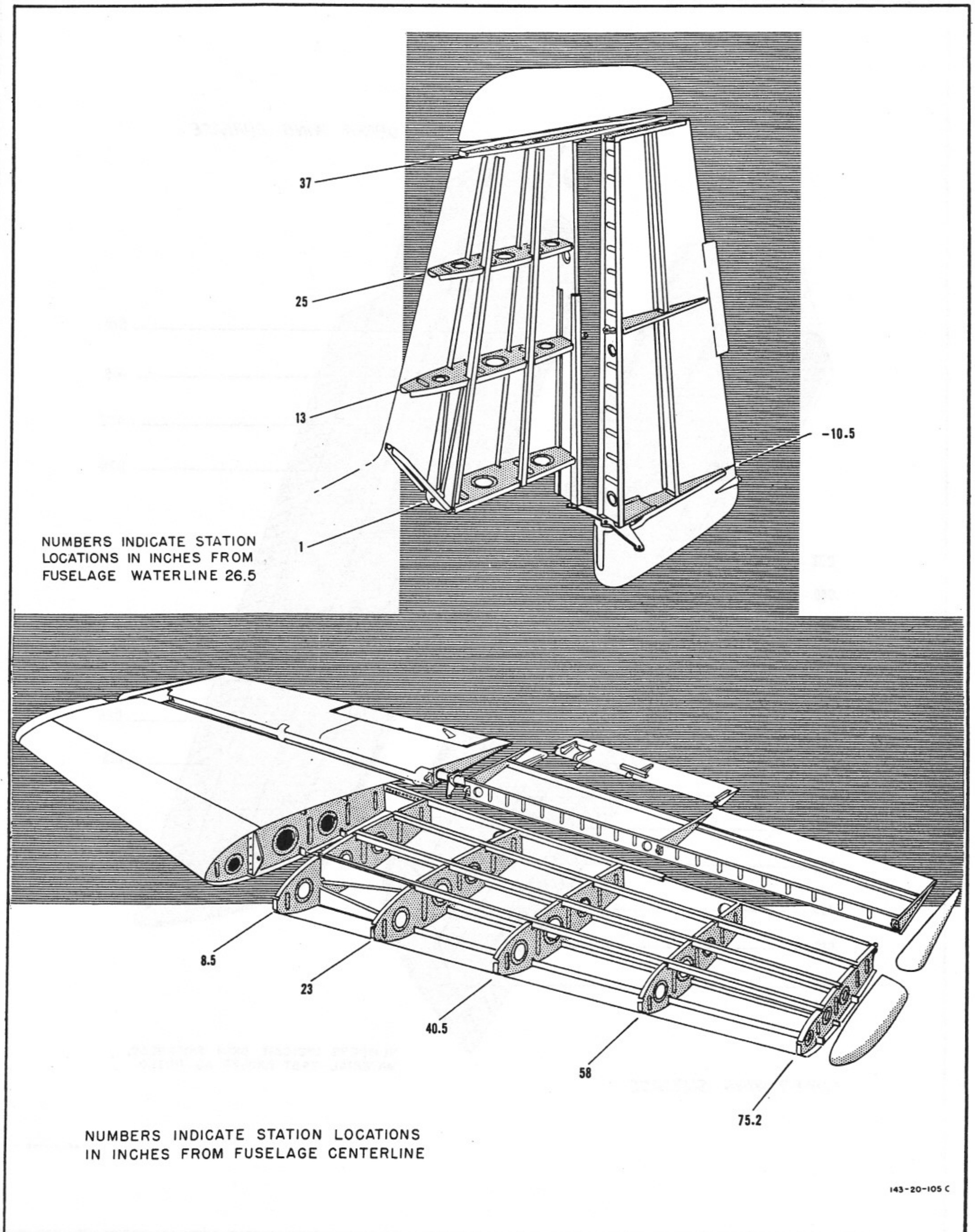


Figure 70 - EMPENNAGE STRUCTURE

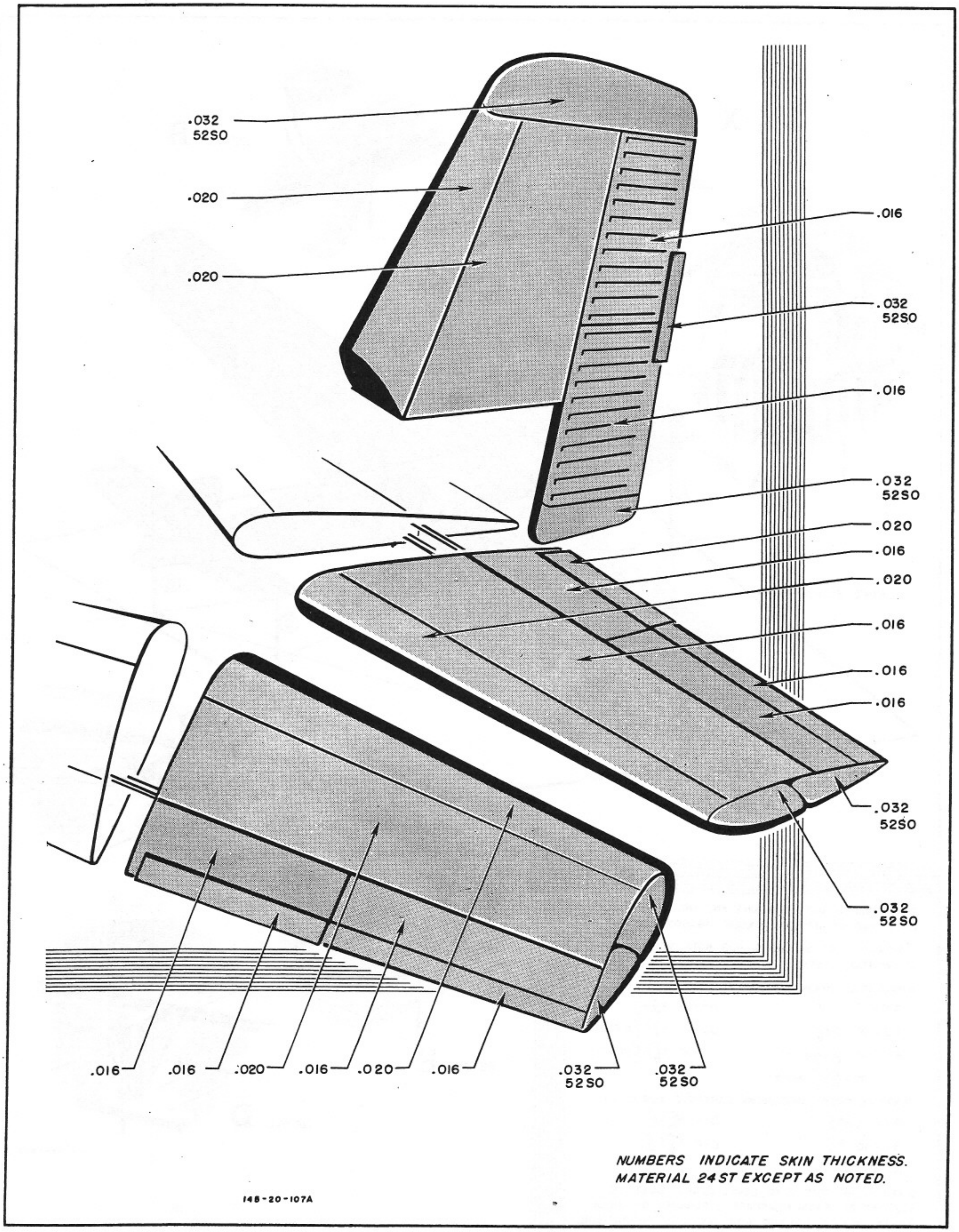
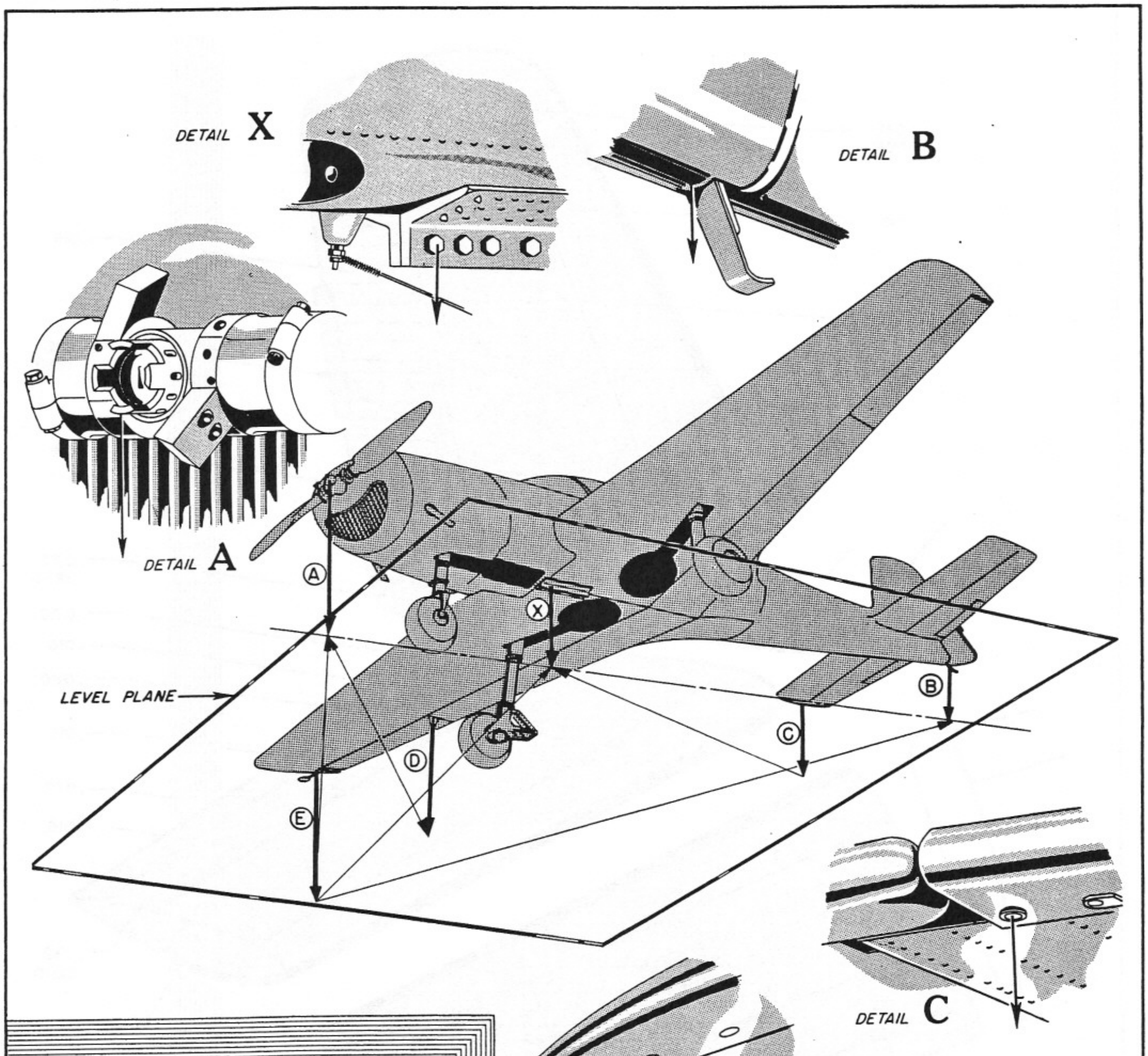


Figure 71 - EMPENNAGE SKIN ARRANGEMENT



CHECK POINTS AND DIMENSIONS ARE THE SAME FOR LEFT SIDE OF AIRPLANE EXCEPT AS NOTED.

AIRPLANE MUST BE LEVEL FOR BOTH VERTICAL AND HORIZONTAL CHECKS.

HORIZONTAL CHECK DIMENSIONS:

AD = 15' $3'' \pm \frac{1}{2}''$

AE = 19' $0'' \pm \frac{1}{2}''$

EX = 16' $3\frac{1}{8}'' \pm \frac{1}{2}''$ (LEFT)

16' $4\frac{1}{8}'' \pm \frac{1}{2}''$ (RIGHT)

BE = 22' $4\frac{3}{16}'' \pm \frac{1}{2}''$

CX = 17' $5\frac{3}{4}'' \pm \frac{1}{2}''$ (LEFT)

17' $6\frac{1}{8}'' \pm \frac{1}{2}''$ (RIGHT)

VERTICAL CHECK DIMENSIONS (DISTANCE ABOVE X):

A = 2' $2\frac{1}{2}'' \pm \frac{1}{4}''$

B = 1' 10" $\pm \frac{1}{4}''$

C = 3' 1" $\pm \frac{1}{4}''$

D = 1' $3\frac{13}{16}'' \pm \frac{1}{4}''$

E = 2' $5\frac{1}{2}'' \pm \frac{1}{4}''$

DISTANCE OF POINT X TO LEVEL PLANE MUST BE SUBTRACTED FROM MEASURED DISTANCES OF CHECK POINTS TO LEVEL PLANE FOR VERTICAL COMPARISON.

Figure 72 - CHECKING AIRPLANE ALIGNMENT

TROUBLE SHOOTING

ENGINE

Failure of Engine to Start

1. Insufficient fuel in tank, or fuel shut-off valve closed.

2. Overpriming or flooding, as indicated by weak or intermittent explosions, and puffs of black smoke issuing from the exhaust pipe. This condition is remedied by turning ignition switch off, setting throttle full open, mixture control out, and turning engine over several revolutions with starter.

3. Engine underprimed.

4. Loose ignition wiring connections, breaks in insulation, or shorting at terminals.

5. Spark plugs dirty, or improperly gapped.

6. Improper timing of magnetos, or short circuit between magneto ground terminal and ignition switch.

Low Oil Pressure

1. Insufficient oil, or dirty or diluted oil in sump.

2. Oil pressure relief valve dirty, or plunger sticking in guide.

3. Dirt in oil screen. Remove oil sump; inspect and clean oil screen at end of suction tube.

4. Worn bearings.

High Oil Temperature

1. Insufficient oil in sump.

2. Dirty or diluted oil.

3. Loose or broken baffles, or broken cylinder fins.

4. Prolonged ground operation at high rpm.

5. Excessively lean fuel mixture.

Low Power

1. Propeller out of track or balance. If propeller has been exposed to damp weather for any length of time, the blades may have warped and increased pitch, or if controllable pitch propeller is used, the pitch may be too great.

2. Malfunctioning ignition system, incorrect magneto timing.

3. Air leakage in intake manifold.

4. Restricted motion of throttle valve, or improper operation of carburetor heat valve.

5. Tachometer inaccurate.

Rough Running

1. Propeller out of balance or track, or retaining nut loose.

2. Spark plugs dirty or improperly gapped.

3. Improper ignition.

4. Sticking valves.

5. Engine mounting bolts loose.

6. Malfunctioning carburetor.

Engine Fails to Accelerate Properly

1. Engine cold or overheated.

2. Mixture too lean.

3. Carburetor heat control on, or not functioning properly.

4. Worn intake valve guides and piston rings.

5. Carburetor idling jet not adjusted properly, or plugged.

Engine Fails to Idle Properly

1. Incorrect idle speed adjustments.

2. Air leaks in the intake system.

3. Improper spark plug gap.

4. Dirt in carburetor idle needle valve.

CARBURETOR

Engine Idles Too Rich

1. Improper idling adjustment.

2. Carburetor poppet valve leaking.

3. Carburetor accelerating pump diaphragm leaking.

Engine Idles Too Lean

1. Insufficient fuel pressure. Check fuel strainer and pump pressure.

2. Improper idling adjustment.

3. Air leakage in manifolds or intake pipes.

Engine Runs Too Lean at Cruising Power

1. Air leakage at suction side of carburetor air diaphragm.

2. Insufficient fuel pressure. Check fuel strainer and pump pressure. Tighten the six screws through mating flanges and diaphragm of pumps.

3. Carburetor main metering jet clogged. Check by removing jet plug in regulator cover.

4. No. 70 restriction missing from vapor vent connection in carburetor. Disconnect vapor return line, and check.

5. Check all 1/8-inch and taper-seat plugs in carburetor for tightness.

Engine Runs Too Rich at Cruising Power

1. Manual mixture control improperly adjusted.

Engine Runs Too Lean or Too Rich at Take-off or Rated Power, but Operates Satisfactory at Cruising Power

1. Improper fuel pressure. Check pump output pressure.

Engine Does Not Shut Off in Idle Cut-off Position

1. Leaking carburetor poppet valve.

2. Mixture control improperly adjusted or restricted.

IGNITION

Excessive Drop in Rpm, or Stoppage of Engine During Single Magneto Check

1. Magneto points dirty or improperly spaced.

2. Weak breaker arm spring.

3. Breaker cam follower worn.

4. Incorrect timing. Time magnetos if required.

5. Cracked or burned distributor rotor or block.

6. Failure of coil or condenser.

7. Defective ignition wiring or switch.

8. Disconnected ground wire at magneto.

Weak Spark

1. Faulty spark plug terminal connections.

2. Incorrect spark plug gap.

3. Spark plugs fouled by lead or oil.

4. Soot on nose of spark plug insulator, causing short. (This deposit may be the result of a too rich mixture, or incorrect spark plugs that are operating at too low temperature. If necessary, install hotter plugs.)

Engine Roughness at High Altitudes, but Smooth Operation at Lower Altitudes

1. Wrong spark plug gap or magneto gap setting.

No Spark During Cold Weather Start

1. Ice on spark plug electrodes.

STARTER

Starter Fails to Operate, or Low Starter Motor Rpm and Cranking Speed

1. Low battery.

2. Loose or dirty wire connections.

3. Dirty or worn brushes. Clean with unleaded gasoline, or replace if necessary.

4. Commutator dirty. Smooth and polish commutator with No. 0000 sandpaper. If pitted, turn down or replace.

Leakage of Engine Oil From Starter Clutch Assembly

1. Replace engine starter springs, or clutch housing felt seal.

2. Worn engine baffle plate friction oil seal. Replace if necessary.

Starter Operates at Proper Speed, but Fails to Crank Engine.

1. Faulty clutch. Replace if necessary.

Excessive Arcing of Motor Brushes

1. Dirty or worn brushes. Wipe brushes and brush boxes with unleaded gasoline. Replace if necessary.

2. Brush springs weak. Replace if necessary.

Starter Operates at Very High Speed Without Cranking Engine

1. Broken shaft in the engaging mechanism.

2. Broken or damaged clutch assembly.

3. Broken engaging spring.

4. Broken or stripped gear.

HARTZELL PROPELLER

Failure of Pitch to Change

1. Low oil pressure (below 30 psi).

2. Congealed oil in piston-cylinder assembly. Engine stopped with propeller control in full increase rpm during cold weather.

3. Worn blade bearings.

4. Blade clamps too tight, causing blades to bind on hub pilot tube.

Maximum Rpm Too High

1. Low pitch stop bolt incorrectly adjusted.

2. Blade angles incorrect.

Oil Leakage

1. Worn or damaged "0" rings.

2. Loose or fractured diaphragm.

Blade Bearings Worn Excessively

1. Insufficient lubrication.

Blades Turning in Clamps

1. Loose clamp bolts.

LANDING GEAR

Failure of Landing Gear to Lock in Down Position

1. Dirt in actuating arm linkage.
2. Operating arm out of adjustment.

Failure of Landing Gear to Lock Down on Emergency Operation

1. Emergency bungee spring loose or broken.
2. Dirt in actuating arm linkage.
3. Improper linkage adjustment.

Failure of Gear to Lock in Up Position

1. Locks out of adjustment.
2. Operating strut linkage too short.
3. Lockspring broken.

Failure of Nose Gear to Steer Properly

1. Rudder pedal linkage out of adjustment.
2. Steering mechanism loose.

HYDRAULICS

Failure of System to Build Up Pressure

1. Insufficient fluid in reservoir.
2. Hydraulic pump inoperative.
3. System relief valve out of adjustment.
4. Excessive external or internal leakage.
5. Emergency shut-off valve closed.

Slow Operation of All Systems

1. Improper gpm output of pump.
2. Control valve linkage out of adjustment.
3. Internal leakage in operating cylinder.
4. Clogged filter in reservoir.

Failure of Landing Gear to Operate

1. Incorrect gear up-lock adjustment.
2. Defective actuating cylinders.
3. Landing gear valve shaft out of adjustment.
4. Excessive internal leakage in system.

Failure of Wing Flaps to Operate

1. Defective actuating cylinder.
2. Flap valve shaft out of adjustment.
3. Excessive internal leakage in system.

ELECTRICAL

Low Charging Rate With a Fully Charged Battery

1. This condition indicates normal voltage regulator operation, but current regulator may be defective or require adjustment. In some cases, the points may need cleaning.

High Charging Rate With a Fully Charged Battery

NOTE

It is important to remember that the charging rate at any given voltage depends as much on battery temperature as on battery specific gravity. The charging rate to a fully charged hot battery will be greater than that obtained with a cool battery which has a fairly low specific gravity. After considering these facts, if the charging rate is still deemed excessive, proceed as follows:

1. Disconnect the "F" terminal lead from the regulator unit. The output should normally drop to zero. If it does not, the generator field circuit is grounded, either internally or in the wiring harness.
2. If the output drops off to zero with the "F" lead disconnected, the regulator should be adjusted.
3. Inspect field circuit within regulator unit for shorts. Pay particular attention to bushings and insulators under contact point supports of the two regulator relays, and make sure they are correctly assembled.

Low or No Charging Rate with a Low Battery

1. Loose circuit connections, frayed or damaged wires. High resistance resulting from these conditions will prevent normal charge from reaching battery.
2. Dirty or oxidized regulator contact points, or a low voltage setting.
3. Faulty generator.

Low Generator Output

1. Bad connections throughout field circuit.
2. Weak brush tension springs.
3. Brushes sticking in holders.
4. Oil on generator commutator.

High Generator Output

1. Loose or corroded connections in charging circuit. A condition such as this will result in a burned field or armature windings.
2. Ground in field circuit in generator, regulator, or wiring.

No Output

1. Sticking Brushes.
2. Burned-out armature.
3. Open field circuit.
4. Broken brush lead or poor connection.

RADIO

Power Amplifier Cathode Current is High and Will Not Tune to Minimum Dip With the Antenna Disconnected From Transmitter

1. Defective oscillator tube.
2. Defective crystal.
3. Defective power amplifier tube.
4. If none of these replacements clear up the trouble, it can be assumed that there is a defective component in either the oscillator or power amplifier stages. If this is the case, remove the set for bench checkout.

Power Amplifier Cathode Current is Low With Antenna Connected

1. Antenna out of resonance. Tune the slug on antenna coil for maximum output.
2. Low battery voltage. There must be 12 volts do to radio equipment.
3. Defective oscillator or power amplifier tube.
4. Power unit may be defective, resulting in low voltage output.
5. Antenna couple tap too low.
6. Defective component in either oscillator, or power amplifier stages.

With Antenna Disconnected, Power Amplifier Current Dips Too Low

1. Defective power amplifier tube.
2. Low battery voltage.
3. Low plate voltage due to power unit defect.
4. Defective component in power amplifier stage.

Power Amplifier Current is Too High With Antenna Connected

1. Antenna coupling too high. Change tap to next lower point.
2. Defect in antenna circuit.

No Modulation

1. Defective microphone.
2. Defective modulator tube.
3. Defective component or circuit in audio stage.
4. Defect in microphone circuit.

Low Modulation As Indicated by a Low Voltage Reading on Output Meter Connected Across the Headset

1. Defective microphone.
2. Defective modulator tube.
3. Low plate voltage.
4. Not speaking loudly enough into microphone.
5. Defect in headset circuit, or defective component in audio circuit.

NOTE

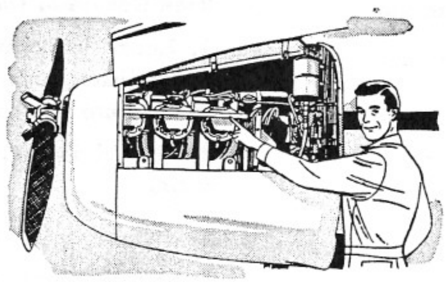
Refer to manual covering operation and maintenance on this radio equipment for internal wiring diagrams of transmitter, receiver, and power unit. The wiring diagrams furnished in this manual cover only wiring from the power source to the equipment.

High Battery Drain

1. Defective power unit.
2. Defect in receiver-transmitter filament or plate circuit.

Fuse Blow

1. Short circuit in filament wiring.
2. Defective vibrator. Check tubes and vibrator points for short-circuited points. If vibrator is replaced, *always replace buffer condenser.*
3. Fuse too small. Use a 20-ampere fuse.



INSPECTION GUIDE

PREFLIGHT INSPECTION

This inspection is essentially a check of the complete airplane, prior to flight, to ensure that all controls are functioning properly; that all cowling and fuel caps, etc., are secure: and that the airplane is properly serviced and safe for flight.

After checking the area around and under the airplane for obstructions or loose objects, proceed as follows:

Power Plant

1. Check ignition switch off.
2. Examine propeller for nicks, cracks, and oil or grease leakage. Check cleanliness of blades and security of mounting. Check retainer nut lockpin to see that it is loose.
3. Pull propeller through three revolutions.
4. Examine carburetor air filter for cleanliness and freedom from obstructions.
5. Check oil level and security of filler cap.
6. Check hydraulic reservoir filler cap for security.
7. Examine engine section for cleanliness. Check to make sure that engine section contains no rags or tools.
8. Fasten cowling and make sure that right and left gill access doors and oil drain door are secure.

Landing Gear

1. Observe struts and tires for normal inflation. (Shake airplane if necessary.)
2. Examine wheels, struts, and torque links for cleanliness.

Wings and Wheel Wells

1. Check wheel wells for freedom from obstructions.
2. Drain small amount of fuel from accumulator tank to remove sediment or water. (Before first flight of day only.)
3. Remove fuel filler cap, check fuel quantity, and replace cap securely.
4. Remove pitot tube cover.
5. Check wing access doors and fairings for security. Inspect wing surfaces for cleanliness. Check wingfor damage.

Fuselage and Empennage

1. Check fuselage access doors and removable section of dorsal fin for security.
2. Check all surfaces for damage. Inspect surfaces for cleanliness.
3. Shake stabilizers to detect looseness.

Cabin

1. Check cabin interior for proper stowage of equipment and freedom from loose objects.
2. See that windshield and window panels are clean.
3. Check operation of radio, lights, and surface controls.
4. Start engine and check for proper operation according to Pilot's Check List.

DAILY INSPECTION

In addition to the preflight inspection, this daily inpection should be accomplished either before or after the day's flying to see if any obvious defects have developed as a result of previous flight, or during storage. Loose bolts and nuts, missing cotter pins, dirt accumulation, and fuel or oil leaks are typical defects that should be corrected before the airplane is flown.

Service the airplane with fuel and oil; then make the following checks:

Power Plant

1. Check engine installation for security of mounting, wiring, hose connections, controls, accessories, and baffles.
2. Check fuel, oil, and hydraulic lines and fittings for leaks.
3. Check engine proper for oil leakage.
4. Add hydraulic oil if necessary.

Landing Gear

1. Check tires for cuts and bruises.
2. Check tires and struts for proper inflation.
3. Wipe strut pistons clean if dirt has accumulated.
4. Make sure that brake lines are secure. See that no leaks are evident.
5. Check wheel retainer nut cotter pins for security.
6. Check side braces and torque links for looseness or missing bolts or nuts.

Wings and Wheel Wells

1. Check wheel wells for security of hydraulic lines, mechanical linkage, and wiring.

2. Check for fuel or hydraulic leaks.

3. Check flap and aileron hinge bolts for looseness, or missing cotter pins.

4. Check wing tips for loose or missing screws.

5. See that pitot tube opening is clear.

Fuselage and Empennage

1. Check rudder, elevator, and trim tab hinge points for loose bolts or missing cotter pins.

2. Check trim tab cable attachments for security.

3. Check rudder cable attachments for security and safety.

4. Check stabilizer and control surface tips for loose or missing screws.

5. Check static plate openings to see that they are clear.

6. Check radio antenna for security of attachment and general condition.

Cabin

1. Check windshield and window panels for obvious looseness or damage.

2. Check operation of canopy lock and opening mechanism.

3. Check hydraulic hand-pump operation by slightly lowering, then raising, flaps.

4. Check specific gravity of battery, and add water if necessary (at least once a week or every 10 hours).

PERIODIC INSPECTIONS

Part 43, section 43.22, of the Civil Air Regulations states that for relicensing purposes, privately owned aircraft must be inspected annually by a representative of the C.A.A. For airplanes used for hire, Part 43, section 43.22, states the aircraft must be inspected at the completion of each 100 hours flying time. Normally each periodic inspection should result in the airplane's being restored to as nearly a like-new condition as possible. Thereafter, trouble that may develop between periodics should be taken care of during daily inspections; however, because time does not always permit the most thorough daily inspections, Ryan Aeronautical Company recommends that the greater portion of the following periodic inspection be accomplished at each 50 hours flying, or at 6-month intervals, whichever comes first. This recommendation, though not mandatory, is made with an aim toward assuring the owner of continuous and safe operation by obviating untimely repairs or replacement of parts.

When either of these inspections is made, all checks listed for the daily should be included. However, those items listed in the daily requiring only a visual inspection, should be given an actual physical check to positively determine the security and fitness of the airplane and equipment.

NOTE

Omit items in italics when 50-hour or 6-month inspection is being made.

GENERAL

1. Drain oil system while engine is hot, and refill with proper grade oil.

2. Remove, clean, and replace oil screen in engine accessory housing.

3. Remove carburetor air intake filter and clean with white gasoline. Dry filter; then use light-grade cylinder oil to cover surfaces. Reinstall filter.

4. Remove carburetor drain plug and drain inlet chamber. Replace strainer and plug, and safety.

5. Remove and clean fuel system strainers. One strainer is located at the aft end of the nose wheel well; the other strainer is in the line between the fuel pump and the pressure relief valve.

6. Check electrical fuel pump.

7. Check pressure output of each fuel pump.

8. Remove generator brush bands, and check brushes for wear, sticking or loose connections, and excessive arcing between brushes and commutator. Replace bands.

9. Remove cover from generator control unit, and carefully check points for excessive arcing. Inspect points for cleanliness, and security. Reinstall cover.

10. Remove access doors, and lubricate entire airplane according to lubrication chart.

11. Remove, clean, and regap spark plugs, or replace if necessary.

12. Remove magneto breaker cover, and thoroughly clean and dry the breaker mechanism. Check condition of breaker points and set gap.

13. Remove rocker box covers and inspect general condition of all parts. Interior of covers should show complete coverage with oil.

14. Remove hydraulic fluid reservoir filter, and check for clogging. Replace with new filter if necessary.

Power Plant

1. Closely examine propeller installation for excessive grease or oil leaks around flanges, synchronizer shaft, and grease filler plug.

NOTE

Slight leakage around flanges is permissible, as it may occur as a result of internal grease pressure caused by temperature changes.

2. If inspection of propeller reveals excessive grease or oil leakage, replace necessary seals. If Hartzell control mechanism shows excessive wear, replace parts affected.

3. Check to make sure that all safety wires, cotter pins, nuts, and screws of propeller installation are firmly in position.

4. Check to make sure propeller blades are not loose in hub and that they move freely between high and low pitch.

5. Check alignment of piston cylinder on Hartzell propeller.

6. Check Hartzell propeller control valve linkage and diaphragm clamping rings for security. (The movement of this linkage must be positive.)

7. Check propeller track; check scribed lines on Hartzell clamps and blades to see that they match.

8. Inspect entire engine installation for missing or loose bolts and nuts, and safety of all plugs.

9. Inspect cylinder cooling fins for damage.

10. Check intake and exhaust manifolds and heat shrouds for security.

11. Check all engine mount bolts for security.

12. Check ignition wiring for security. Inspect wiring for evidence of burning, and check spark plugs for signs of gas or oil leakage.

13. Check nuts and bolts attaching carburetor to engine, and air duct adapter to carburetor, for tightness.

14. Check oil sump and cooler for security of mounting. Inspect for leakage.

15. Operate all engine controls to see that travel is correct and unobstructed.

16. Check generator control unit for proper settings.

17. Inspect cowling for damage and condition of hinges and fasteners.

Landing Gear

1. Jack airplane and check retraction of gear. See that up-locks are properly adjusted and that landing gear warning system switches are correctly adjusted.

2. Check all landing gear mechanical linkage for general condition, cleanliness, and security. Check position switches for security.

NOTE

If nose gear shock strut collar nut lockscrew is removed and not shifted, a new hole must be drilled into threads to provide a positive lock for screw.

3. Check nose wheel steering linkage for security.

4. Check landing gear up-lock cables for security and adjustment.

5. Inspect rudder and elevator cable attachments in nose wheel well for security.

6. Check actuating cylinders for leakage and security of attachment.

7. Check landing lights for security of attachment.

8. Check brake clearance to see that adjuster valve is properly set.

Wings and Wheel Wells

1. Check aileron bellcranks for security of cable and rod attachment bolts.

2. Inspect flap mechanism for security of all mounting and pivot bolts. Check actuating cylinder and connecting lines for leakage.

3. Check travel of ailerons and flaps for correct limits.

4. Check attachment of rudder-aileron coordinating cables for security.

5. Check control surface cable tensions.

6. Check wing-to-fuselage attaching bolts for security.

7. Check position light cover glasses for cleanliness and security.

8. Check wing structure for loose attaching angle bolts, loose rivets, and buckled skin, ribs, and spars.

9. Drain fuel tanks, and clean accumulator tank screen; then check fuel quantity indicator calibration by adding fuel to the tanks in increments of 5 gallons. (Pay particular attention to the readings on the low side.)

Fuselage and Empennage

1. Inspect structure within fuselage for cracked or damaged frames, corrosion, etc.

2. Check all structure and skin for loose rivets.

3. Check control cable pulleys and pulley brackets for misalignment or damage.

4. Check control cables for fraying and proper clearance through structure.

5. Check surface control cable tensions and travel of surfaces.

6. Check attachment of elevator cables to torque tube arm for security.

7. Check trim tab actuating mechanism for security and condition.

8. Check position light on rudder for cleanliness and security.

9. Check lower longeron bolts in fuselage directly above the front spar for looseness.

Cabin

1. Check battery-disconnect solenoid connections for security.

2. Check battery leads for condition of insulation and security of attachment. See that battery case is secure.

3. *Check inside of battery box for corrosion.*

4. Check all instruments for correct pointer position. Inspect for loose or broken glass, moisture in the case, chipped luminous or operating limit markings, or other visible defects.

5. *Replace any illegible instrument markings.*

6. Check compass for loss of fluid.

7. *Check condition of all wiring and tubing in back of instrument panel.*

8. *Inspect all switches, rheostats, and warning lights for security of mounting and connections.*

9. *Check all controls for security of mounting and linkage.*

10. Check for required number of spare lamps and fuses.

11. Check radio equipment for security of mounting.

12. *Test all radio tubes for proper operation.*

13. *Make sure radio receiving equipment is in proper adjustment by tuning in stations of known frequencies.*

14. Check security of seat and safety belt attachments.

15. *Drain pitot and static pressure sumps.*

16. *Check canopy opening mechanism cable and spring for condition and security.*

17. Thoroughly clean all enclosure window panels. Check for cracks or deep scatches.

18. Check rubber extrusions around windows for deterioration.

ALPHABETICAL INDEX

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