(10) During warming and ground-testing of engines, the readings taken at the various RPM shall not exceed the maximums and minimums as set forth in the accompanying charts on "Allowable Limits - Run-Up - Engine and Instrument Readings". Any deviation from the limits as set forth should be reported to the Crew Chief and corrected before plane is dispatched.

B. Starting - "C" and "C-3" Engines - Injection Carburetors

(1) Connect battery cart and place plane master electrical switch to "Battery Cart". If cart is not available set plane master electrical switch to "Plane Battery" position.

(2) Set propeller controls to "full forward" position.

(3) Set carburetor air controls to full "Cold" position.

(4) Open cowl flaps, then turn valves to "Off".

(5) Set cross-feed valve to "Off" position. This should always remain in the "Off" position except when testing valve or in case of fuel pump failure.

(6) Place the mixture controls in the "Idle Cut Off" position.

(7) Set throttles to one-quarters "Open".

(8) Push master ignition switch in and turn individual ignition switch to "Both On" for the engine being started.

(9) Set the fuel selector valve to the Main Tank for the engine which is to be started. The other fuel selector valve must be in the "Off" position when starting the first engine.

(10) Ascertain if area around propellers is clear of personnel and equipment, and obtain "clear to start" signal from ground signalman.

(11) Work wobble pump until pressure comes up to 3 pounds. Do not exceed 4 pounds.

(12) Move starter selector switch to engine desired. Pull down starter and booster switch simultaneously.

(13) When engine turns over, place mixture control in "Take Off and Climb" position, whether engine has fired or not. If engine does not start, keep starter operating and pump wobble pump to maintain 3 pounds fuel pressure until engine starts and the operate wobble pump to assist engine pump in building up normal fuel pressure.

NOTE: Pumping the throttle has no effect, since these carburetors do not have the conventional type accelerating pump attached to the throttle control.

(14) After engine has started, hold RPM down until oil pressure gauge shows an indication, after which increase RPM to 800-1000.

CAUTION: If the proper starting procedure is used and the engine does not start within 30 seconds, or if the engine backfires through the scoop, or if the exhaust catches fire, immediately close the throttle, release starter and booster switches, and cease wobbling. After 30-45 seconds, go through the starting procedure again. If a fire is present, continued operation of the starter and wobble pump with the throttle open increases the intensity of the fire and in just a few seconds the diffuser in the blower section will be buckled by the heat to a point where it contacts the impeller and

causes damage. If during starting, a squeaking noise is heard in the engine, there is most likely a fire in the blower in which case stop operation and close throttle as given above.

(15) To start second engine, set the fuel system selector valve on corresponding side to the "Main On" position, and proceed as outlined for the first engine.

(16) During cold weather starting, it is sometimes necessary to prime the engine. To operate:

(a) Place mixture control in "Take-Off and Climb" position.

(b) Operate wobble pump a few strokes to maintain 3 pounds fuel pressure to force fuel into priming system. Then operate throttle and switches as outlined above.

(c) If the engine does not start, keep the starter operating and maintain 3 pounds fuel pressure with the wobble pump.

CAUTION: If the proper starting procedure is used and the engine does not start within 30 seconds, or if the engine backfires through the scoop, or if the exhaust catches fire,--immediately close the throttle, release starter and booster switches, and cease wobbling. After 30-45 seconds, go through the starting procedure again. If a fire is present, continued operation of the starter and wobble pump with the throttle open increases the intensity of the fire and in just a few seconds the diffuser in the blower section will be buckled by the heat to a point where it contacts the impeller and causes damage. If during starting, a squeaking noise is heard in the engine, there is most likely a fire in the blower in which case stop operation and close throttle as given above.

C. Stopping - "C" and "C-3" Engines

(1) Propeller pitch controls - low pitch.

(2) Carburetor heat controls - full cold.

(3) Cylinder head temperatures - 350° F. or lower if possible.

(a) To cool cylinder heads reduce RPM slowly and rune engine at 600-700 RPM.

(4) At 600 RPM - shut off fuel supply - move mixture controls to "Idle Cut-Off" position.

(5) When engines start to die, cut ignition switches. Open throttles when engine has stopped.

(a) When stopping engines equipped with injection carburetors, the throttles may be advanced slowly if the engines do not die before ignition switches are cut.

D. Stored Engines

(1) Any engine which is to be prepared for storage, shipment, or held as a spare at stations shall be treated as follows:

a. The propeller shaft shall be well oiled, and a heavy piece of wrapping paper shall be folded over the end of the shaft, wrapped around the shaft and attached securely. This is to preclude the possibility of damage to

the splines or threads, and to prevent water and dirt from entering the propeller shaft. The engine and detached accessories shall be fastened down securely in the engine box, and two shipping tags shall be filled out properly and attached to the engine box.

b. Spare cylinders, pistons, and other engine parts which are to be stored in the stock rooms or shipped to the Repair Base and which are subject to corrosion and rust must have their surfaces coated with NO-OX-ID Oil (Grade D). Under no circumstances shall damp rags or damp paper be used in conjunction with stored or shipped engine parts.

c. Install Pratt and Whitney Protek Plugs in both spark plug bushing of all cylinders.

d. Place a container filled with one half pound Silica Gel in the exhaust stack. Tightly cover opening with an oiled paper or wooden block and attach a red tag to the cover stating: "Remove dehydrating container from the inside of the exhaust stack before installing engine".

e. Place a container filled with one-half pound Silica Gel in the carburetor air intake. Seal opening with cap furnished, and attach a red tag stating: "Remove dehydrating container from inside carburetor air intake duct before installing engine."

f. After Protek Dehydrating plugs have been installed in the cylinders, do not turn the crank-shaft over because, by so doing, the dehydrating plugs will be damaged, and moist air will be taken into the cylinders, thus defeating the purpose of the plugs.

g. Protek plugs are made from a transparent plastic material which allows visual inspection of the Silica Gel. This agent, when fresh, is deep blue and gradually fades, as it absorbs moisture, to a light pink when near saturation. As a matter of explanation, these plugs when exposed to the air will absorb moisture very rapidly and become unfit for use in the cylinders. Therefore, they should be installed immediately after they are unwrapped. These plugs may be obtained from the Repair Base.

2. Replacement Engines

A. General

1. Any engine that is not functioning properly and in which the cause cannot be located or corrected, shall be removed for overhaul, regardless of the amount of service time since last overhaul.
2. All stations shall watch engine time closely to the end that airplanes will be routed to the Repair Base before allotted time has expired.
3. No record shall be kept of the ground time on engines, with the exception of the engine test-stand time, which will be kept by the Overhaul and Repair Department and entered on the Engine Overhaul Report Form.
4. Before installing a prop into which foreign material has passed, it will be thoroughly flushed out with oleum spirits. If a hydromatic prop is involved, the cam and piston assembly shall be removed from the dome and thoroughly cleaned and oiled.

B. REMOVAL "C" or "C-3" ENGINES

1. Remove propeller.
2. Remove all engine cowling.
3. Drain oil. (When engines are removed for cause, a one-gallon oil sample will be taken in a clean can, and the can will then be sealed and shipped to the Engineering Department, Chicago).
4. Shut off fuel supply in cockpit and disconnect all fuel and oil lines, and engine and accessory controls at firewall.
5. Install front engine lifting link, hook chain-hoist and sling to engine; remove the four bolts securing the engine mount to fire wall and remove engine and mount together. (NOTE: Engine lifting links shall be carefully checked for cracks before they are used).
6. Lower engine and mount until it is easy to work on and remove all accessories, lines, engine mount, exhaust pipes, etc.
7. If an engine box or stand is not available for the removed engine, it may be placed on the floor, provided the lower cylinders are supported by sand bags or their equivalent, and the crankshaft is supported on a stand at such an angle that the weight of the engine will be distributed between the lower cylinders and the crankshaft. Care must be taken so that no load whatsoever will be supported by the oil sump.
8. When foreign material has gone through the oil system, the oil radiator and oil tank shall be replaced with a reconditioned unit, as it is nearly impossible to clean these units properly in the field.

   NOTE: When engines are removed on account of foreign material in the sump or screen, a sample of the material shall be immediately forwarded to the General Office, attention Superintendent of Maintenance.
9. Clean out oil temperature regulator and all oil lines with oleum spirits before reinstalling same.
10. Clean engine mount and inspect for cracks.

C. Installation - Engines

With all spare engines a kit shall be provided containing the necessary gaskets, hose, washers, clamps, bolts, etc., as needed for a regular engine change. These parts are to be used as needed for the engine change, and any left-over parts returned to the Repair Base with the removed engine.

1. While the replacement engine is in the vertical position, remove the plugs from the rear spark plug holes rotate the engine and drain all oil possible from the cylinders.
2. Install oil tank and oil radiator. These should be a slight movement of the tank after installation. The straps should not be drawn up so that it is impossible to move the tank.
3. Install new or overhauled engine in mount and install all accessories, fuel and oil lines, engine controls, electrical connections and propeller.
4. Install fireproof hoses on oil lines in accordance with information shown on the chards under "Engine Oil System" sections. The oil hoses in the oil lines running from the engine to the Pratt & Whitney regulator and from the

P & W regulator to the oil radiator will have double hose clamps; all other gas and oil lines will have single clamps installed.

5. When engine replacement is completed, the entire installation shall be inspected - including accessories, propeller, fuel and oil lines, connections, controls, bonding and safeties.
6. Fill oil tank to specified level with approved oil. After ground test, replenish oil tank to correct level.
7. When engines are shipped from Cheyenne, "NO-OX-ID" oil is placed in each cylinder and the engine turned over to lubricate the cylinder walls and to prevent rust. It is of utmost importance that this oil be completely drained from the cylinders and induction system before a newly installed engine is started; unless this is done, a link rod may be buckled and failure of the engine result. The only safe method in the field is as follows:
   (a) After engine is installed in the mount and before it is started, the rear spark plugs shall be removed and the lower intake pipes will be loosened enough to allow oil to run out of the pipes. The engine shall be turned over as rapidly as possible in direction of rotation six or seven times, after which the spark plugs will be installed. When oil has stopped running from the intake pipes, the pipes may be reinstalled and the engine started.
   (b) Remove front engine lifting link and return it to CX with defective engine.
8. The engine shall be run for 30 minutes to test the installation, engine, all accessories, and operation of the instruments.
9. Adjust idling.
10. The plane shall be test flown for at least 20 minutes. After test flight adjust propeller governor if necessary.
11. After test flight, remove side cowling and carefully inspect the installation. Inspect fuel and oil lines for leaks, and service the plane for dispatch on regular flight.
12. Make proper notations in the Trip Record Book, including engine number, total time, and reason for removal. List number of engine installed and its time since overhaul, if any. List number of each accessory removed and installed. These notations are to be signed by the mechanic in charge of the installation.
13. The mechanic in charge, insofar as installation is concerned, shall be responsible for the proper installation, inspection, and satisfactory performance of the installed engine.

3. Adjustment - All Engines

A. Valves

1. It will not be necessary to inspect the valve mechanism or clearance on any of our engines between overhaul periods - but if there are indications of difficulty, the valve mechanism and clearance should be inspected as follows:
   (a) Remove the rocker-box covers and where visible, inspect rocker arms and end play of bearings, valve adjusting screws, valve springs, washers

and locks. A visual inspection of the interior will disclose if the oil is reaching all working parts, if mechanism appears dry, the push rod should be removed and stoppage located.

(b) The engine should be thoroughly cool. This usually takes two or three hours because of the oil contained in the push rods. Remove front spark plugs. Then, starting with #1 cylinder and with the top center indicator inserted in the front spark plug hole, turn the engine crankshaft in direction of rotation until the piston is on exact top dead-center of the compression stroke.

(c) Measure the clearance. This clearance should be .010" on all of our engines. If adjustment is necessary, loosen the lock nut and back off or turn down valve adjusting screw. A 3/4"-6 point box wrench (with handles not over 5" long) should be used for loosening and tightening the adjusting screw lock nut.

(d) Proceed to measure the clearance of all the valves, following #1 cylinder in the firing order of the engine.

(e) When the clearance of all the valves has been measured, turn the engine two complete revolutions in direction of rotation. Remeasure the clearance of all valves in the firing sequence of the engine, and any valves having less than .010" clearance should be readjusted to this figure, and found over .010" but less than .015" should be disregarded.

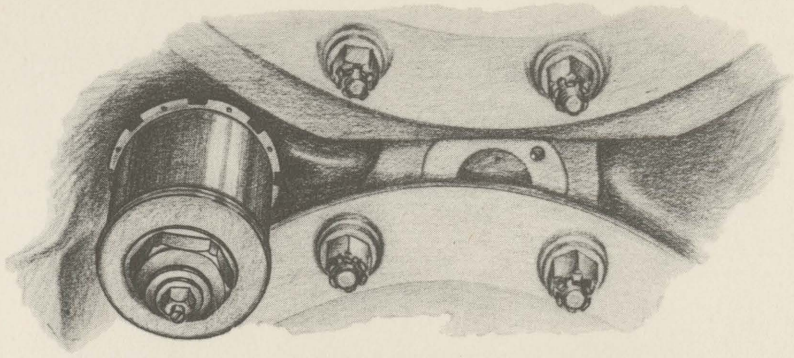
CAUTION: To avoid damage to or loosening of the valve adjusting screw, extreme care shall be used when tightening lock nuts to assure their being tightened property - The correct pressure when tightening these nuts with the Mossberg torque wrench is - 300 inch pounds.

B. Engine Idling Speed

1. Adjustments for regulating the idling RPM of the engines shall be made only at the carburetor butterfly shaft stop screw. After adjustment is completed, if the throttle lever in the cockpit contacts the control quadrant in the closed position, the control rod in the nacelle must be adjusted to give a slight "spring" of the throttle lever in the full retarded position. (See charts showing proper idleing and mixture adjustment procedure under accessories carburetor).

C. Oil Pressure - Adjustment "C" Engine

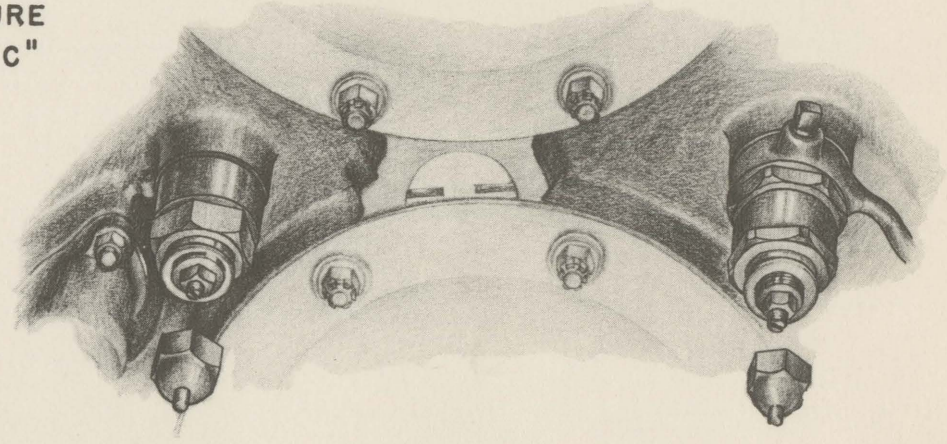
1. Whenever it is necessary to raise the main oil system pressure on a "C" engine, it will also be necessary to measure the rear case pressure after the adjustment has been made by connecting a gauge to the 1/8" pipe plug to the rear of the lower vacuum pump mounting pad. If the rear case pressure under the above conditions is below the specified minimum of 15 lbs., it must be raised by increasing the tension on the low pressure relief spring adjustment. The maximum is 40 lbs.-readings to be taken at 2300 RPM with 150° oil temperature. (See following chart for proper oil press. adjustment procedure).



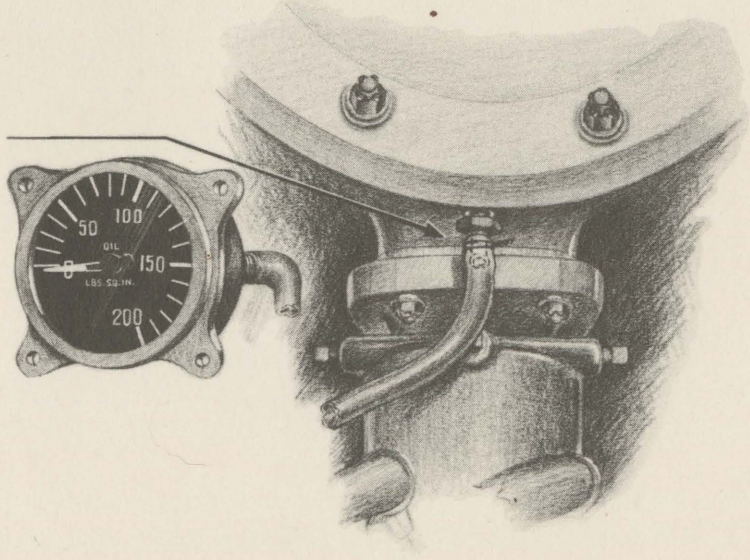
MAIN OIL PRESSURE
RELIEF VALVE - "C-3" ENGINES

MAIN OIL PRESSURE
RELIEF VALVE - "C" ENGINES

LOW OIL PRESSURE
RELIEF VALVE "C"
ENGINES



INSTALLATION OF
GUAGE TO READ
LOW OIL PRESSURE
ON "C" ENGINES.



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OIL PRESSURE RELIEF VALVES "C" & "C-3" ENGINES

CAUTION: When adjusting oil pressure relief valves, care must be used to tighten the lock nut sufficiently to prevent loosening, but not to a point where damage occurs to the threads.

D. TORQUE SETTINGS

1. The following is a list of torque settings in inch-lbs. which should be applied in tightening various nuts and cap screws of our Pratt and Whitney Aircraft Engines:

1/4" Nuts and Cap Screws	75-80 inch lbs.
5/16" " " " "	.150-175 " "
3/8" " " " "	.275-300 " "
7/16" " " " "	.400-450 " "
1/2" " " " "	.550-600 " "

Special Settings are:

Spark Plugs.	.450-480 inch lbs.
Valve Toppet Lock Nuts	.300-350 " "
Cylinder Hold Down Nuts.	.300-350 " "

2. When tightening cylinder hold down nuts, great care must be used because of the necessarily unconventional design of cylinder hold down nut wrenches. See that the cylinder hold down nut wrench, the extension, and the torque indicating handle are so assembled that the handle is directly opposite the box end of the wrench, and apply torque by rotating the assembly as a unit. Do not let the shaft of the wrench twist to one side.
3. There may be instances where it is obvious that the torque recommended for tightening a nut in a bolt or stud of given size should not be used due to the design of the part or the kind of material. Common sense and good judgment should of course be exercised in such cases.

4. Repair

A. General

1. If at any time a cylinder is found to be loose on the power case, the cylinder and piston must be replaced, in addition to installing all new oversize studs for the cylinder in question. When replacing cylinders, the hold down nuts must be properly tightened: Neglecting to tighten just one nut to the proper torque, can result in the early failure of the stud, and the eventual failure of all the studs for the cylinder involved. It is therefore, extremely important that all cylinder hold-down nuts be tightened in accordance with the torque setting given in this manual. Nuts which are less accessible than others, shall not be neglected. Further; it shall be made certain that all palnuts fit properly and are properly tightened. Opposite sides of any brackets which are installed under cylinder hold-down nuts, shall be exactly parallel, so there will be no tendency for the stud to "cock" when the nut is tightened.

2. (a) Only push rods without riveted pins through the ball end fittings shall be used for replacement on any of our engines.

(b) There are two types of push rods in service, heavy and light. The heavy type is 5/16" ID, In the event it is necessary to replace push rods, only the heavy type, Pt.#41697, shall be used on the exhaust side of all of our twin row engines.

Adjustment may be made in the length of push rods by replacement of the washers under the ball ends. Washers must be used under all ball ends and the min. thickness is .060". Length of push rods may be shortened by turning off in a lathe. Care should be used not to cut too much off without a trial. When assembling spacer washers it is important to install them with the rounded side toward the ball end. Ball ends are not interchangeable between light and heavy push rods.

3. Whenever a prop is damaged by accident or a severe blow, the propeller shaft must be tested for running true, and the nose section must be thoroughly inspected for cracks or other damage both inside and out, especially the nose case flange where it fits over the power case. This flange is under the loom and should be inspected thoroughly. In addition to this, all nose section studs which are found damaged or loose must be replaced with over-sized studs. Whenever a nose case is found loose on an engine, the cast must be removed, inspected and all studs must be replaced with the next over-size.

4. If it is necessary to replace a Flex Nose Section, order one from Cheyenne, giving engine number on which replacement will be made. It is recommended that a CX mechanic be requested to assist with the replacement unless the station has personnel who are fully qualified to do this work.

B. "C" and "C-3" Engines

1. Stations will be supplied only with the "C-1" cylinders as spares, which may be used on either the "C" or "C-3" engines. (See interchange list under procedure). On upper cylinders that do not have scavenge lines, the cylinders being installed shall use the removed valve caps without scavenge line fittings.

2. The cylinders of our Twin Row engines are not interchangeable from front to rear or vice versa; but all rear cylinders can be used in any position on the rear bank. All front cylinders, with the exception of #8 can be used in any position in the front bank. The conversion of any spare C-1 front cylinder to a #8 (front) cylinder to be used on either a C or C-3 engine is simple and shall be done as follows:

(a) Saw out the scavenger pipe between intake and exhaust ear and screw out fittings and plug with 3/8" pipe plugs.

(b) Tap inside diameter of rocker arm shafts to 3/8" x 24 thread; this is necessary to accommodate the 3/8" screws supporting the sump between the intake and exhaust ear.

(c) Cylinder is now ready to install on the engine.

NOTE: Regardless of the type of rocker shaft in the cylinder removed (the new floating or stationary type) no parts should ever be removed from the cylinder being removed from an engine.

(d) One rubber gasket shall be used on all cylinder bases.

C. "C" Engines

Breathers in engines shall never be capped in an attempt to stop oil throwing.

D. Cracked Cylinder Head Fins All Engines

The following procedure shall be followed when checking cylinders for cracked fins:

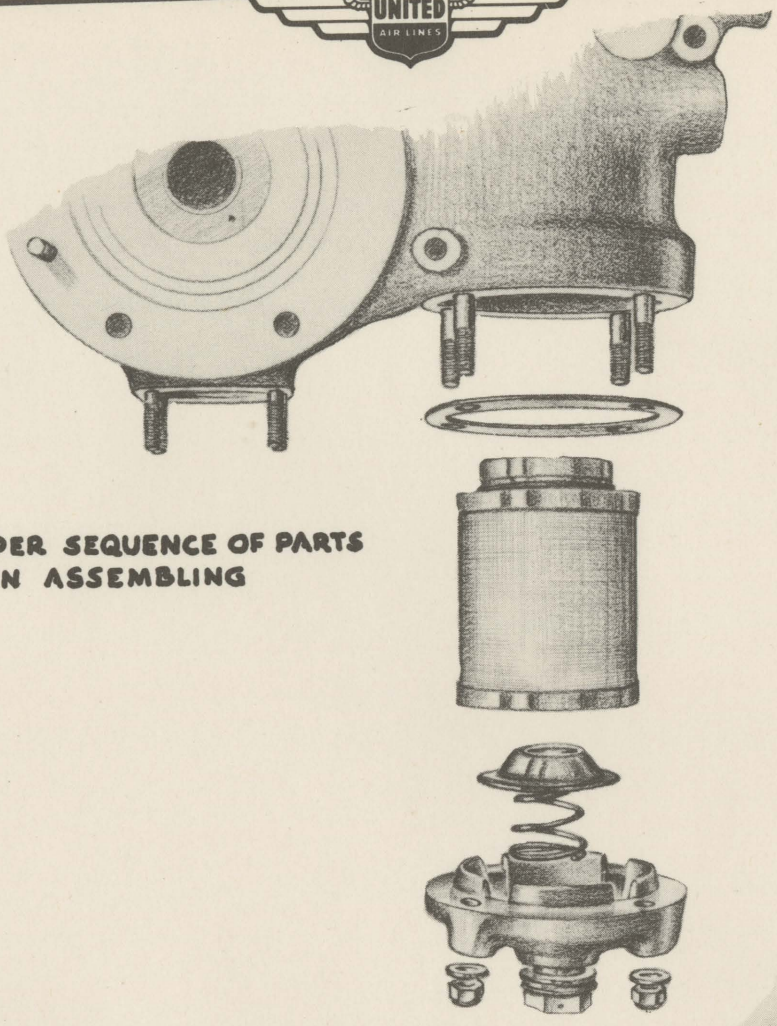
Cylinders will be allowed to remain in service with one-and one-half (1½) center head fins missing. This missing area is allowable even when the missing fins are next to each other. A cylinder with three (3) or more adjacent head fins cracked or missing for a length of one-and-one-half (1½) inches or more from the same end shall be replaced.

Broken and cracked fins shall be trimmed and rounded off during overhaul and unless new cracks develop and exceed the limits given, these cylinders shall be kept in service. Any cracked portions of fins found during service shall be removed in order to stop further growth of the crack. When fins are removed, the cylinder head shall be examined with a 4X glass to make sure that the crack does not extend into the cylinder head. While removing cracked portions of fins, care must be used to avoid breaking adjacent fins. The primary concern is the lack of heat dissipation when a series of fins become cracked in one location.

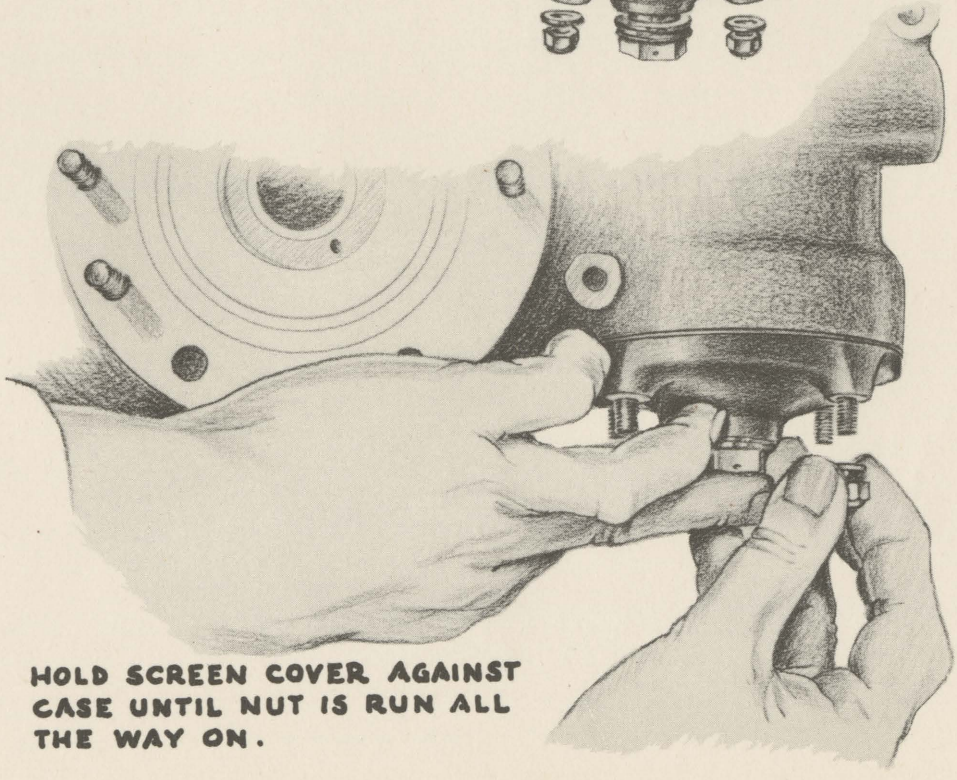
5. General Information

A. Our Twin Row exhaust collector rings use 4 links per engine as a safety measure to keep the sections from moving too far. This link is 1/2" wide by 2½" long and 3/32" thick. It has an oblong hole in one end for the express purpose of allowing movement to compensate for exhaust stack temperature changes.

B. Whenever engines are removed from planes or cylinders removed from engines wherein combustion chamber failure is involved, the spark plugs removed from the cylinders involved in the difficulty must be positively identified. This means that each spark plug should be tagged, stating from which cylinder it was removed. Also, it is very important to state whether the spark plug was removed from a front or rear position, and whether it was removed from a front or rear cylinder. This procedure should be followed whenever cracked cylinder heads, piston ring blow-by, stuck rings, failed pistons, or excessive heat is evidenced.



PROPER SEQUENCE OF PARTS WHEN ASSEMBLING



HOLD SCREEN COVER AGAINST CASE UNTIL NUT IS RUN ALL THE WAY ON.

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INSTALLATION OF ENGINE OIL SCREEN

ACCESSORIES 6

ENGINE ACCESSORIES

1. Service - Carburetors

A. Other than inspection, injection carburetors (Model PD-12) do not require routine service between overhaul periods.

1. Occasionally, it may be necessary to oil the manual mixture control latch plates (mixture position indicator) to allow free movement of the mixture control lever in the cockpit and to give a definite position "feel".

2. If a carburetor is found showing signs of loosening, mechanics shall make a close inspection of the carburetor mounting to determine if it has been working on the mounting pad. This must not be done by drawing up on the hold-down nut. If a carburetor is found only slightly loose, it may be re-tightened, but if a carburetor is found which is showing any signs of pounding, it must be removed for further inspection and/or replacement.

CAUTION: When working on carburetors, extreme care shall be used to prevent any foreign objects from dropping into the induction system.

2. Replacement

A. Injection Carburetors.

1. When a carburetor is giving trouble and a replacement of the aneroid and/or correct adjustment of the mixture control linkage does not remedy the difficulty, the entire carburetor shall be replaced. The internal adjustments of these carburetors shall not be altered in the field because for proper adjustments, a test flow bench is necessary.

2. Injection carburetors received from the Repair Base will have the gasoline chambers filled with #10 S.A.E. oil or approved hydraulic fluid. This is necessary to prevent a change in carburetor adjustment due to the diaphragms drying out. The oil shall be flushed out of the carburetor after installation on the engine in the following manner:

(a) Drain as much oil as possible from the fuel supply inlet.

(b) Remove the 1/8" brass pipe plug in the Fuel Control Unit directly above the cruise metering jet. Turn on the gas and work wobble pump, forcing air and oil out of the Fuel Control Unit. This procedure will flush the oil out of the carburetor in a satisfactory manner and will eliminate air from the gasoline chambers. WARNING: Under no circumstances should an injection carburetor be flushed out with carbon tetrachloride - as the diaphragms are readily damaged by this fluid. After installation is complete, flush out by pumping pressure up. This runs gas thru discharge nozzles. Then allow to stand several minutes before starting engine.

B. Aneroid

1. Care should be exercised when replacing aneroid units to prevent damage to the sylphon. When inserting the replacement unit, do so with care and be sure that the rubber packing on the lower part of the main bushing and the main flat fiber gasket located between the aneroid and the carburetor are in place. (See sketch following for proper installation procedure)

C. Float - Vapor Escapement

1. When replacing vapor escapement float, care should be taken that the needle valve is not dropped into the fuel inlet line. When installing the new float, be sure that the needle valve is placed on its hinge in the correct position - otherwise it will fall out when the float drops to the bottom of its travel.

D. Screen-Fuel

1. Care shall be used in installing the fuel screen in injection carburetors. If the fuel screen of the injection carburetor is installed wrong end to, it will result in a very lean mixture in the engine, with possible damage. Therefore, when removing these screens, always remember to reinstall them with the spring cup and spring towards the outside of the carburetor so that when it is in place, the spring will hold the screen into the recess in the carburetor. (See sketch following for proper installation procedure)
2. When using Titeseal cement to seal the carburetor screen cover, use a very thin application, as an excess amount will be forced into the screen chamber and collect on the screen. This cement is not only difficult to remove, but also reduces the effective straining area of the screen.

3. Adjustment

A. Injection Carburetors

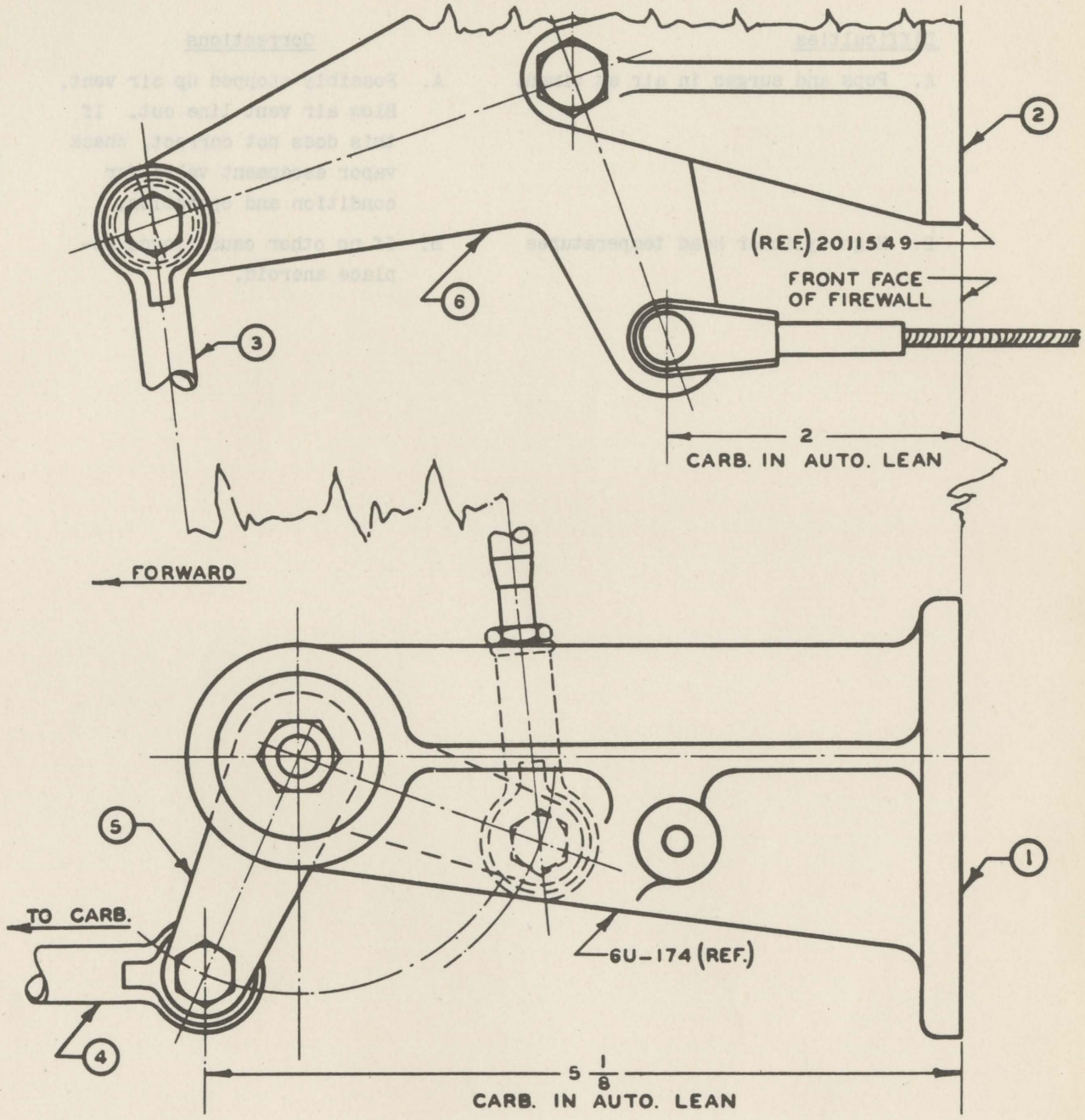
1. To adjust the idling mixture and speed of engines equipped with injection carburetors, proceed as follows:

(a) With the engine warm, adjust the idling speed to the desired figure by use of a screw-driver in the eccentric throttle stop.

(b) Loosen the lock screw for the idle mixture adjustment and turn the knurled knob clockwise for a leaner mixture and counter-clockwise for a richer mixture. When desired idle mixture is obtained, tighten and safety lock screw.

(c) Slowly advance throttle to 1000 RPM and retard to idling stop. Re-adjust idling speed if necessary.

(NOTE: No other adjustments other than those given above will be made on injection carburetors). (See sketch following for proper adjustment procedure)

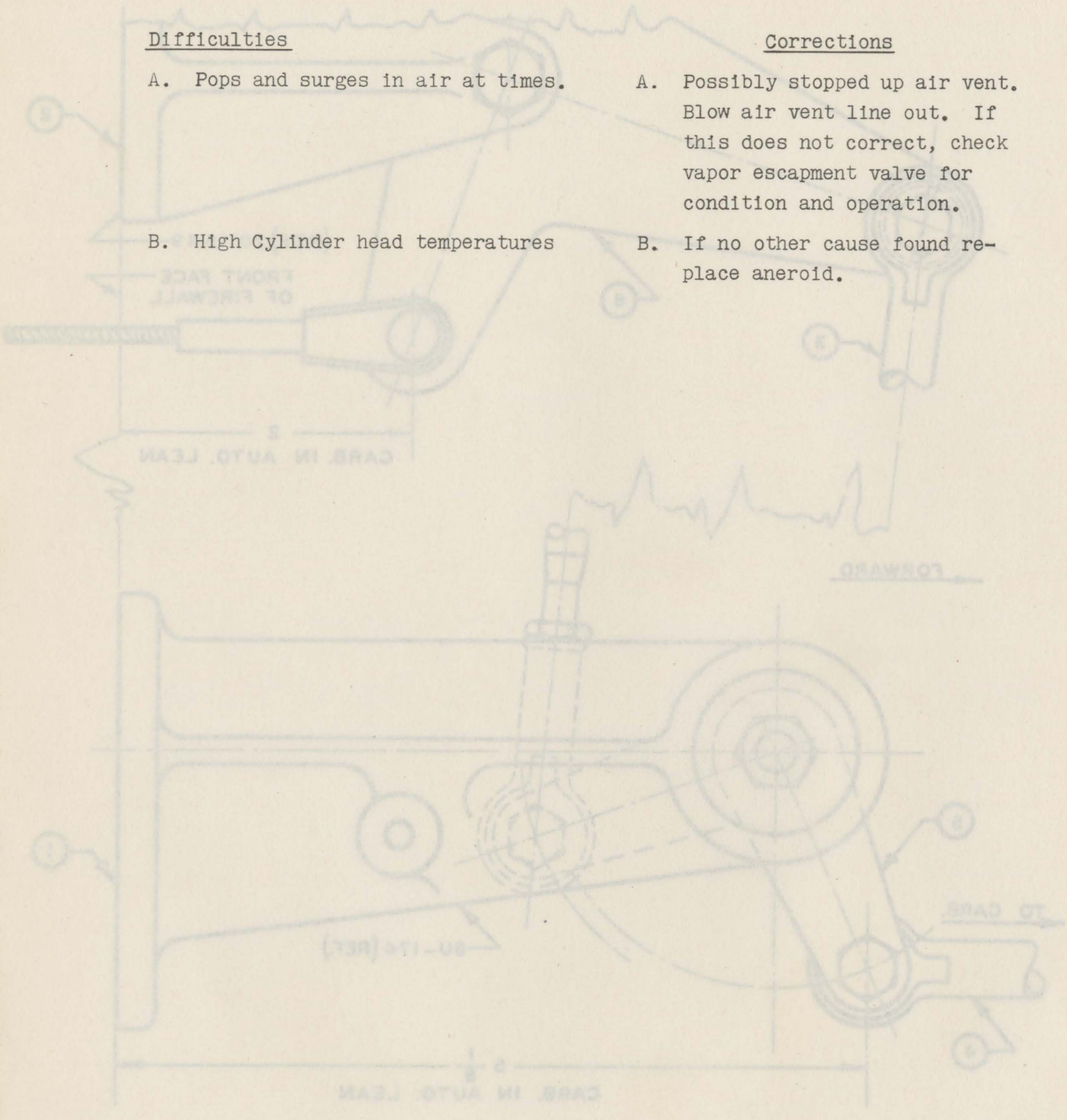


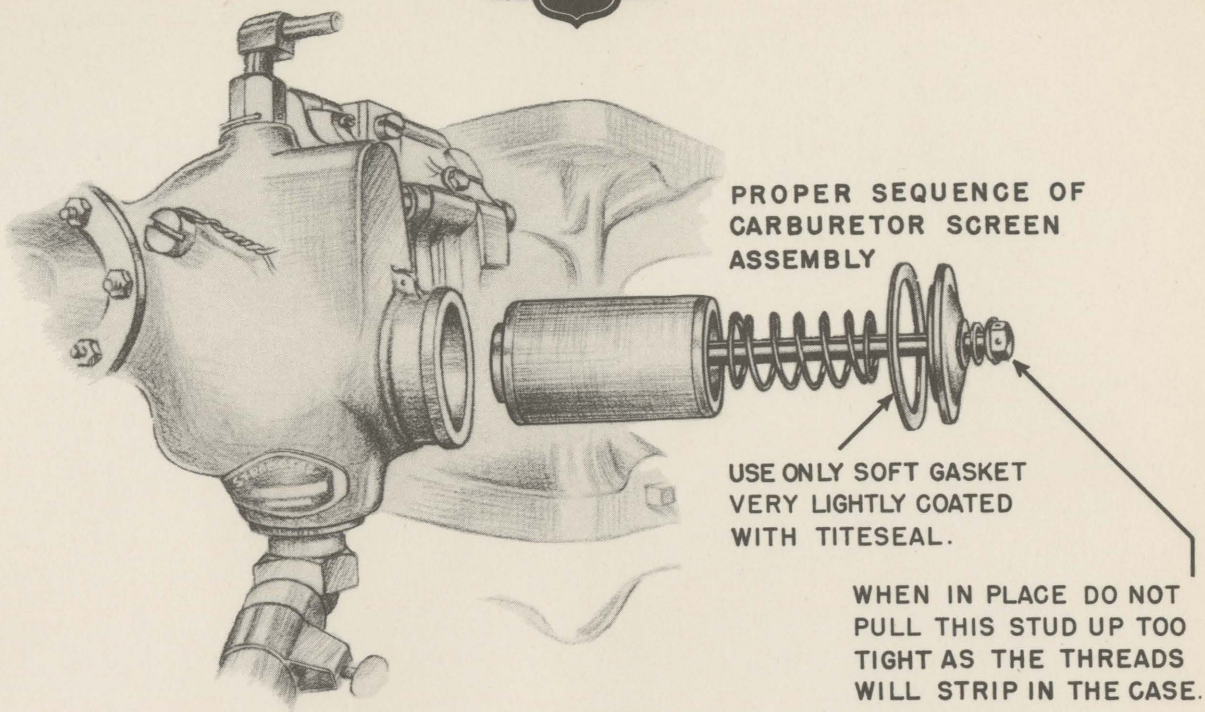
1. Rig both left and right as shown:
   A. Set carburetor mixture control lever at carburetor in automatic lean position.
   B. Set mixture control lever in cockpit to the automatic-lean (cruise) notch.
   C. Connect rod (4) to bellcrank (5) and give correct distance between bellcrank (5) and firewall as shown.
   D. Adjust mixture control cables in wheel well to give proper distance between bellcrank (6) and firewall as shown in diagram above.
   E. Connect rod between bellcranks (5) and (6).
2. After the above adjustments have been made, the mixture lever at the carburetor may have a permissable 3/16" (6^{0} of Arc) tolerance on either side of the Auto-Rich notch but not for the Auto-Lean (cruise) notch, which must be in perfect adjustment.
3. Lengthen rod carburetor-firewall four turns if propellers are not installed and two turns if propellers are installed to allow for the weight of the propeller and the thrust of the propeller while in flight.

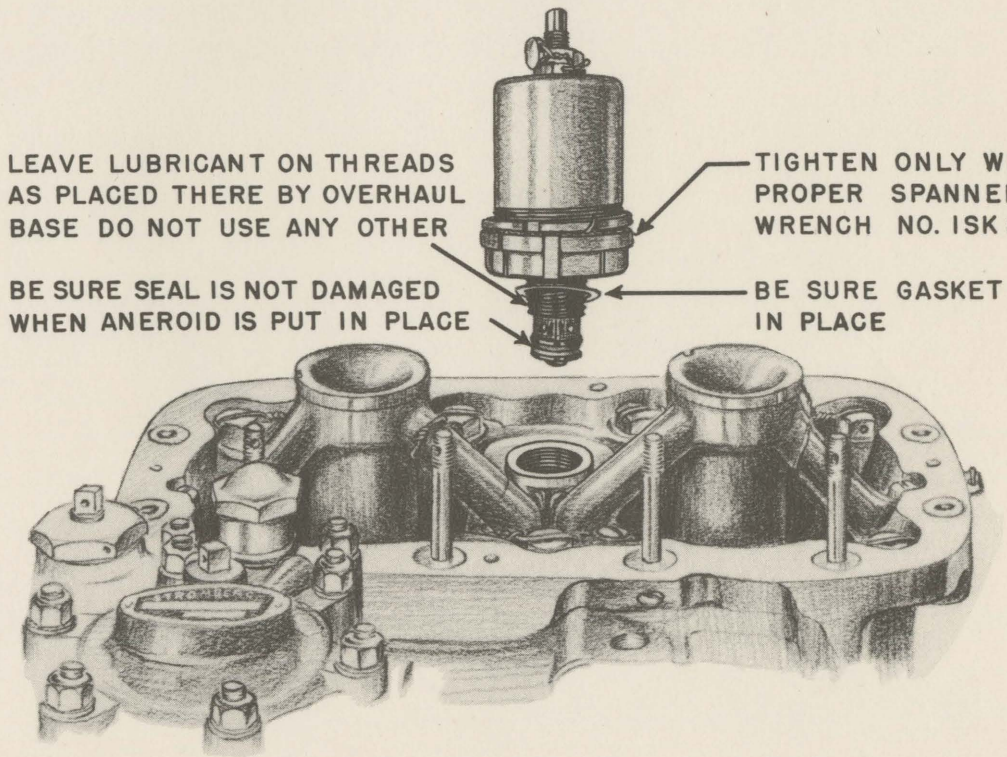
(Rev. 12-27-39)

ADJUSTMENT, INJECTION CARBURETOR MIXTURE CONTROL RODS

Difficulties	Corrections
A. Pops and surges in air at times.	A. Possibly stopped up air vent. Blow air vent line out. If this does not correct, check vapor escapment valve for condition and operation.
B. High Cylinder head temperatures	B. If no other cause found replace aneroid.







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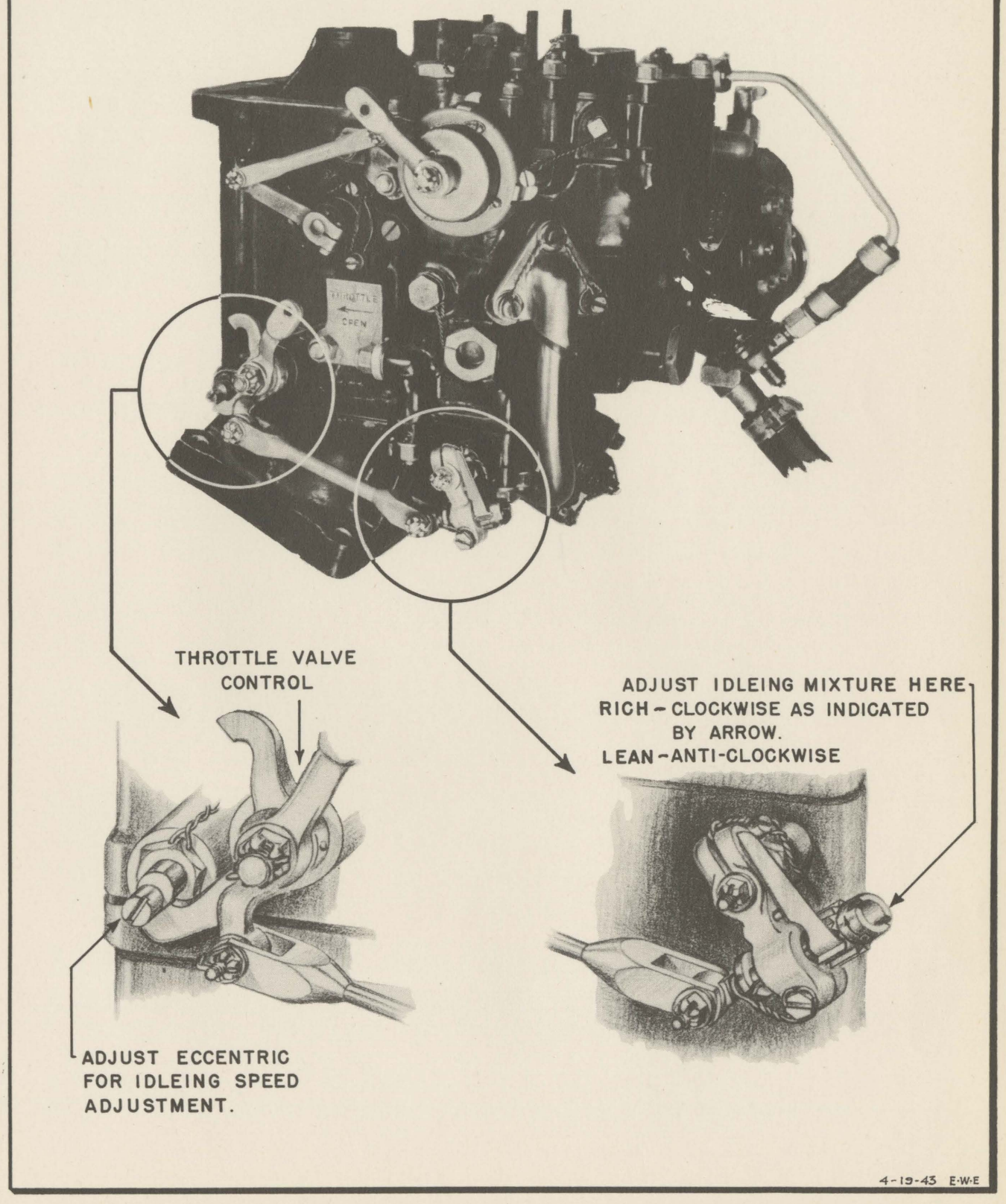
CARBURETOR SCREEN AND ANEROID INSTALLATION



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INJECTION CARBURETOR IDLE ADJUSTMENT

PROPELLER GOVERNOR

1. Service

A. Other than inspection at the specified intervals, governors do not require service. If trouble develops, the entire unit shall be replaced.

B. See interchange list under procedure for interchangeability of this unit.

2. Replacement

A. General

1. Governors shipped as spares will not include the control pulley or low pitch stop, and it will be necessary to use those from the disabled unit or see Interchange list.

2. Interchange of control pulley will be done as follows:

(a) Rotate governor pulley to full high-pitch position and pencil a line on the pulley parallel to the base of the governor.

(b) Remove pulley and install in the same relation on the new governor.

(c) Rotate replacement governor drive by hand to insure free turning.

B. Extreme care shall be used to see that governor cables are not adjusted too tight and that the governor pulley nut is properly tightened and safetied.

C. It is very important that when the governor cables are connected, it is possible to rotate the pulley and cockpit control lever to full high and low pitch.

D. On Douglas Plane governor, completely back off the pulley stop ajusting screw until after the test flight. This will allow slipping of the control cables in the cockpit during flight for adjustment of the take-off RPM.

1. After test flight, do not disturb the "take-off" setting of the governor pulley, but screw in the adjustment until it just contacts the stop and then tighten lock nut.

E. Governor settings shall be as follows:

1. "C" and "C-3" engines.
Normal Take-off --- 2450 RPM - Control lever to rear white mark.
Maximum allowable take-off and emergency RPM --- Set governor stops to 2725 RPM.

F. When Governors or controls are replaced, it is absolutely essential that they be set to operate within the limits specified above. In all cases these settings must be made by test flying the plane involved.

G. Governor Screens.

The screens used on our Douglas propeller governors are of two sizes: The large screen is used on the 4B6 Governors which have a flared screen recess.

The small screen is used for all 4K13 Governors and for those 4B6 Governors having the straight walled screen recess. In order to determine the difference between the two screens, they are identified as follows:

The smaller screen will have a drop of solder on the inside of the screen and will be stamped with the letter "S".

The large screen will have a drop of solder on the inside of the screen and will be stamped with the letter "L".

H. Whenever 4B6 governors are installed, the screen plug located on the governor base in the left front corner will be safetied by the mechanic installing same.

GENERATORS

1. Service

(See Maintenance Manual Radio Electric for information on electrical operation).

A. If a generator fails to show a charge and the trouble is definitely traced to this unit, a dirty commutator may be the cause. Remove the cover from around the brushes and clean the commutator with #000 sandpaper. (Never use emery cloth).

B. If necessary to remove oil from the commutator, use a cloth dampened in carbon-tetrachloride. Never direct a Pyrene spray into the generator to clean out dirt or oil, as this washes the lubricant from the brushes and causes excessive brush and commutator wear.

C. When handling generator brushes extreme care shall be used to prevent damage to the braided lead.

D. If corrective measures as set forth in A and B above do not correct the trouble and nothing else is found wrong, change the generator.

2. Replacement

A. Before installing a spare generator, remove the brush cover and inspect the brushes for free movement in the boxes. Inspect the commutator for corrosion and see that the generator can be turned over by hand.

B. A spare generator, before being installed, shall be tested for running free as a motor in the following manner:

1. Connect a jumper wire between the A+ terminal and the F+ terminals on the generator.

2. Connect the A+ terminal to the positive and the A- to the negative terminals of a 12-volt battery.

3. The generator should run freely as a motor. If it makes a loud grinding noise, a short in the armature is indicated; in such case the generator shall not be used.

4. The procedure set forth in 1 and 2 above serves two purposes: First, it tests the generator for operation and, second, it flashes the field to insure residual magnetism in the field poles.

3. Repairs

A. When oil is found leaking out of generators, it is necessary to replace the oil seal in the engine. Replacement of the generator does not correct this condition.

SCINTILLA MAGNETOS

1. Service

A. The only servicing required by these magnetos is an external inspection of the shielding and mounting, and the lubrication of the breaker cam by use of the special oiling device.

B. The SF14L-4 Magneto as used on the "C" engine has an 8-pole rotating magnet and an 8-lobe breaker cam. Eight sparks are produced for each revolution of the magnet and consequently the magnet is geared 7/8 crankshaft speed. The breaker plate is held in the breaker housing by use of three spring loaded screws which, when removed, will allow removal of the plate and contact points. These magnetos are timed 20° in advance of the top dead-center firing stroke of the #1 piston.

C. The SF14L-3 magneto, as used on "C-3" engines, has an 8-pole rotating magnet and a 14-lobe compensated breaker cam which gives equal firing to all cylinders, and which is turned at 1/2 engine crankshaft speed. Eight sparks are delivered for each revolution of the magnet, so it is geared 7/8 crankshaft speed. The breaker housing of this magneto retains the cam reduction gear on the back side and in no case is this housing to be removed in the field because of the difficulty in re-timing the cam gear. If necessary to inspect the contact points, loosen the two hold down screws and remove the contact assembly only. These magnetos are timed 25° in advance of the top dead-center firing stroke of the #1 piston.

D. When a magneto is not functioning properly, and correcting the timing does not remedy the difficulty, the entire magneto shall be replaced.

2. Replacement - Magnetos and Parts - Timing "Scintilla"

A. Before installing a magneto, remove air blast tube cover from the unserviceable unit and attach to the spare. Plug holes in unserviceable unit with screws removed from the spare magneto. Caution: Under no circumstances should any other screws be used in attaching blast covers, as internal damage to the magneto will result. These screws are Part #10-4018. Mechanics when installing magnetos must be very careful that a screw of improper length is not used, as otherwise the screw will extend into the mag housing and contact the rotors.

Always install the mag blast cover before attaching the magneto to the engine, and rotate drive spline by hand to be sure it turns without binding.

B. Timing of scintilla magnetos equipped with pivotless type breakers and flange mountings will be accomplished as follows:

1. Make sure the mounting flanges on the engine and on the magneto are clean.
2. Remove the distributor blocks and breaker cover of the magneto which is not being replaced.

3. Turn the crankshaft in direction of rotation until the timing mark on the distributor rotor, or gear, (as the case may be) is opposite the mark on the front end plate, and until a straight-edge placed on the step cut of the breaker cam lines up with the timing marks on the rim of the breaker housing. At this point the breaker contacts should be just starting to open and should be in a position to fire #1 cylinder.

4. Rotate the drive shaft of the replacement magneto until its timing marks are in line and the breaker points are starting to open - as explained in Paragraph 3 above.

5. Hold replacement magneto in the timed position by pressing the fingers against the distributor rotor or gear and mount it on the engine with the mounting studs approximately in the center of the magneto mounting slots. If the splines of the magneto coupling will not mesh with the splines of the engine drive in this position, remove the coupling from the end of the magneto drive shaft and turn it to a position where it will readily mesh with the internal drive on the engine. After determining this position, remove the magneto and secure coupling with washer, nut and cotter pin.

6. Install the magneto in the timed position on the engine and screw down the mounting flange hold down nuts, but do not tighten.

7. Rotate the entire magneto until the contacts just begin to open at the time the straight-edge placed across the step cut of the cam coincides with the timing marks located on the rim of the breaker housing. The point at which the breaker contacts open is determined by inserting a .001" feeler gauge between the contact points of the magneto and noting the point at which the feeler may be removed by a slight pull of the fingers.

8. When the above relationship has been obtained, tighten and safety the mounting flange hold-down nuts. Test magnetos for being properly synchronized as follows:

   (a) Turn the engine in a clockwise direction until the breaker contacts have closed. Insert a .001" feeler gauge between the contact points of each magneto. Turn engine in a counter-clockwise direction very slowly by jarring the propeller by hand until a slight pull on the feeler strips releases them. Both feeler strips should release at exactly the same point with equal tension on the strips.

   (b) If there is more than 1/8" distance between the timing marks and the straight-edge when the contact points begin to open, return the magneto to Cheyenne for point clearance adjustment. Point clearance should never be reset at a service station.

9. Turn engine until the magneto distributor finger is in the up position, then install distributor block, main cover, breaker cover and install ground wire.

C. Units for use at Magneto Synchronizer

When synchronizing magnetos with the "Magneto Synchronizer Light and Buzzer" the following procedure shall be used.

1. Mount the synchronizer in a convenient position on the engine mount by means of the two 50A battery clips. These clips function both as mechanical supports and as electrical grounds. The synchronizer must be grounded to work.
2. Remove the magneto primary leads, and install the two test leads from the synchronizer in their place.
3. Turn toggle switch on. If lamps light, the magneto points of each magneto are open. Use the procedure for timing magnetos under previous section #2, substituting the lighting of each lamp for the feeler gauge method of indicating the instant at which the points open. The magneto points open at the instant the lamps light or glow, each indicator lamp is for the corresponding magneto. (See sketch following for proper setup for using this magneto timing instrument).
4. No other type of magneto timing light shall be used.

BOSCH MAGNETOS

1. General Description

A. The American Bosch SF 14 LU magneto is a 14-cylinder, fixed ignition, 8-pole, 3-bolt, flange-mounted polar inductor type magneto of anti-clockwise rotation, which is driven direct through a splined coupling. The magneto drive shaft which turns at 7/8 engine speed, rotates the 14-lobe compensating interrupter cam at one-half engine speed through a 1-3/4: 1 gear ratio between the magneto and interrupter camshafts.

B. The coil, magnet and interrupter are stationary. The 14-lobe compensating, automatically lubricated cam is mounted on the shaft of the distributor gear assembly and the distributor block electrodes are so spaced as to be suitable for high altitude performance.

C. The inductor rotor is mounted on the drive shaft and consists of four laminated sectors which, as they rotate, alternately provide eight distinct paths through the coil core from the poles of the stationary magnet. There are, therefore, eight reversals of flux per revolution of the inductor rotor, producing eight ignition sparks when the primary circuit is interrupted accordingly.

2. Replacements and Timing - "Bosch"

A. When replacing a Bosch magneto in the field, it shall be timed and synchronized to the magneto which is not being replaced and in the following manner:

B. Remove the breaker housing cover of the good magneto and turn the propeller in the direction of rotation until #1 piston is on its compression stroke. Continue to move the propeller until the #1 cam lobe is in a position to open the breaker points. The indicating pointer on the end of the cam shaft should be in line with the red indicating mark on the breaker housing. The replacement magneto should then be set to the same position and installed on the engine as follows: With the magneto held in this position by a pressure of the fingers on the distributor gear, mount it on the engine with the mounting studs about in the center of the magneto mounting flange slots. If the splines of the magneto coupling will not mesh with the splines of the engine drive in this position, rotate the magneto drive until the points are again in position to fire #1 cylinder. Repeat until the engine and magneto splines engage when the points are in the proper position. It may be necessary to rotate the engine one cycle to accomplish proper relation of the splines.

C. It is important that when the magneto is mounted on the engine, the mounting studs be as near the center of the adjusting slots as possible. When the magneto has been mounted, tighten up the holding nuts just enough to hold the magneto firmly against the mounting pad, but loose enough so that it may be moved in the adjusting slots for accurate timing to the engine.

D. With the engine in the proper position as described above, a strip of .001" feeler gauge stock is inserted between the breaker points and the magneto is moved in its adjusting slot until a slight pull on the feeler strip will just release it. In this position, the magneto is tightened down and the synchronization of the two magnetos is checked as follows: Turn the engine in a clockwise direction until the breaker points have closed. Insert .001" feeler strips between the breaker points of each magneto. The engine is then turned in counter-clockwise direction in small increments by jarring the propeller blade with the hand until a slight pull on the feeler strips releases them. Both feeler strips should release at the same time and at the same tension when timing pointers are registering with the specified marks. Finally, install distributor blocks shielding and breaker covers. There is no need to replace the distributor blocks unless damaged as they are interchangeable between magnetos.

E. When timing with light, the same procedure shall be used except the light will be used in place of feeler gauges as explained under, "Timing Scintilla" magnetos.

FUEL PUMPS

1. Service

A. The only service required for fuel pumps is inspection at the required intervals.

B. The Pesco Fuel Pump - as used on our Douglas Planes - is of the rotary, four-vane, positive displacement type, incorporating a pressure relief valve, and a by-pass arrangement whereby fuel can be routed around the pump in the event of pump failure or inoperation.

2. Adjustment - Fuel Pressure

A. Pesco Fuel Pump

1. Before the pressure relief valve screw is adjusted on a Pesco Fuel pump, the air vent line, and the #80 vent hole (which is located in the pump vent fitting) shall be inspected to be sure they are not plugged. High fuel pressures will result from a plugged air vent line or hole. Blow out fuel pressure line; low fuel pressure will result from excessive gas in the pressure line.

2. To adjust pressure:

a. Type 600-CWB or CEB: loosen the lock nut and turn the adjusting nut clockwise to increase pressure or counter-clockwise to decrease pressure.

CAUTION: Tighten lock nut - just enough to keep adjusting screw from turning, as excessive tightening is unnecessary, and failure of this nut will cause loss of fuel pressure. (See sketch following for precautions).

b. Low idling fuel pressure usually is caused by foreign matter under the by-pass valve seal.

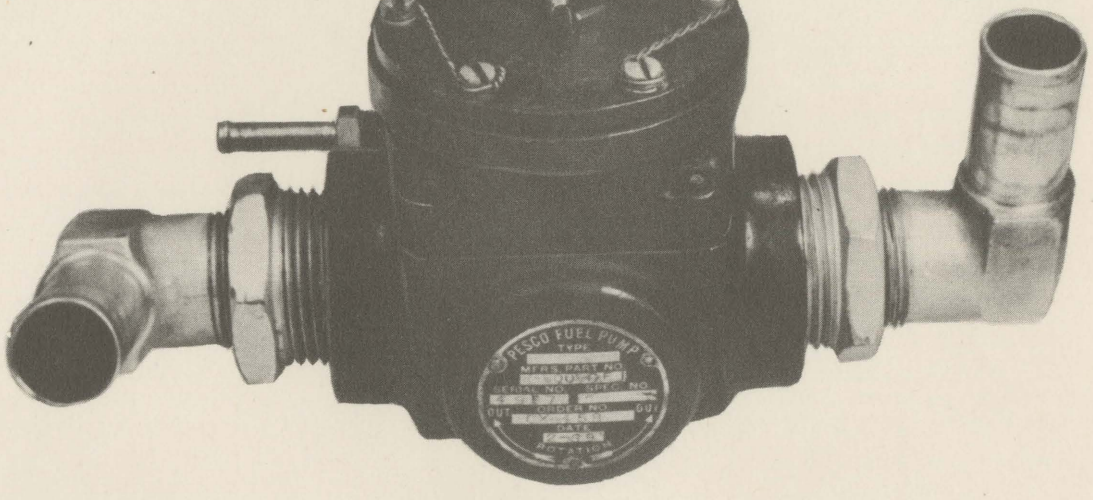
To correct - Disconnect line to the carburetor and force a quantity of fuel through the pump to dislodge dirt. Do not take the pump apart; replace it if necessary.

3. Repairs

A. When oil is found running out of the fuel pump drain line it will be necessary to replace the seal in the engine fuel pump drive. Replacement of the fuel pump will not correct this condition.

ADJUST FUEL PRESSURE HERE
TURN CLOCKWISE TO RAISE
PRESSURE,-ANTICLOCKWISE
TO LOWER.

USE EXTREME CARE WHEN
TIGHTENING LOCKNUT.
TIGHTEN ONLY SLIGHTLY
MORE THAN FINGER TIGHT
EXCESSIVE TIGHTENING
WILL DAMAGE NUT.



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FUEL PUMP

HYDRAULIC PUMPS - PESCO

1. Service

A. Other than inspection, including base mounting and connections, Hydraulic Pumps do not require service unless difficulty is reported.

B. If, at any time, the loss of hydraulic fluid is reported, and the cause cannot be found (such as leaking lines, connections, hoses, or valves), the hydraulic pumps shall be removed and inspected for evidence of oil leaking past the universal block. Any pump found in the condition shall be replaced.

C. Any hydraulic pump which is incapable of building up pressure to the operating point of the 800 pound relief valve at 1500 engine RPM, shall be replaced.

2. Replacement

A. The Pesco 214U type hydraulic pump with spline drive to be used with "C" or "C-3" engines will be held at Service Stations for replacements.

B. When hydraulic pumps are replaced the lines shall be bled. This shall be done by leaving the exhaust line fitting slightly loose at the fire wall, then running the engine until the oil leaks by. Tighten and safety nut after this operation.

3. Repairs

A. Head bolts on hydraulic pumps shall not be tightened to stop leaks. Leaking pumps shall be replaced.

VACUUM PUMPS

1. Service

A. Any vacuum pump found during inspection to have the paint on the case blistered shall be replaced. This indicates overheating and is probably caused by lack of lubrication or improper relief valve operation on account of too high suction or pressure too high.

B. When a plane is reported to have high instrument vacuum, the relief valve screens shall be inspected, and if found to have an accumulation of dirt, they shall be cleaned and the engines test-run to determine if this has been the cause of the trouble before an adjustment is made to the relief valves.

2. Replacement

A. Before a vacuum pump is installed, turn the rotor to make sure that it is free to move.

B. When replacing vaccum pumps, gasket #9633-010 shall be used between the mounting pad and adapter. Gasket #16532-010 shall be used between the adapter and the vacuum pump body.

C. When replacing vacuum pumps, only the special heat resisting hose shall be used for connecting the discharge fitting.

3. Adjustment - Vacuum

A. Douglas Planes

1. Place the vacuum pump selector valve in the cockpit in the right-hand (#2) position, and with the left engine running at 1500 RPM or more, adjust vacuum relief valve in the left engine section until vacuum gauge on bank and climb unit indicates 4" suction.

2. Place vacuum pump selector valve on instrument panel in the left-hand (#1) position. Run the right engine at 1500 RPM or more and adjust relief valve in right engine section in the same manner to 4" suction on the Bank-and-Climb vacuum gauge.

3. Leave the vacuum selector valve in the #1 position, and adjust the Eclipse vacuum relief on the left side of the instrument panel to give a suction of 3-1/2" on the auxiliary horizon vacuum gauge.

IGNITION SYSTEM

1. Service.

A. General

1. Spark plugs are assigned to stations for completing the necessary replacements in accordance with estimated needs. In order that these assignments be adequate, it is requested that when spark plugs are removed from engines, they be promptly forwarded to the Repair Base for reconditioning, and replacements requested for them.

2. Spark plugs removed from engines, whether because of time, or faulty operation, shall have a Repairable Parts Tag attached thereto which is completely filled out. In addition a note shall be made at the bottom of the tag showing time since last #3 check.

3. Spark plugs, when not in use, shall be packed in the proper wooden trays which are provided for this purpose.

B. The following summary shows spark plugs now being used by UAL and the proper service procedure for them. (NOTE: Some are test plugs. When servicing test plugs or when trouble is encountered with them, see the log book and forms #474 for special instructions, which shall be followed).

Type of Plug	7KL-S	7S-2	LS3AB	C-34-S	BG-LS514
Engine Used On	Twin Row	Twin Row	Twin Row	Twin Row	Twin Row
Insulators Used	Formica or Ceramic	Formica or Ceramic	Formica or Ceramic	Formica or Ceramic	Formica or Ceramic
*Sealer Used	#4	#4	#4	#4	#4
Gaskets Used	None	#1U-753 Copper Gaskets	#1U-753 Copper Gaskets	#1U-753 Copper Gaskets	#1U-753 Copper Gaskets
Plug Wrench Size	3/4" Hex Socket	7/8" Hex Socket	7/8" Hex Socket	7/8" Hex Socket	7/8" Hex Socket
Gooseneck Wrench	5/8" Hex Crowfoot	3/4" Hex Crowfoot	3/4" Hex Crowfoot	3/4" Hex Crowfoot	3/4" Hex Crowfoot
Approved or Test	Approved	Approved	Approved	Approved	Test
**Type Spark Plug Standard	Standard	AN	AN	AN	AN

Note: Sealer will not be used when ceramic spark plugs are used with ceramic insulators.
* #4 means, "Corning Dow #4 compound".
** Standard and AN Spark Plugs are not interchangeable due to the difference in gooseneck nut sizes.

C. Ignition System - Testing.

The following work is to be carried out at each #3 Check. Some of these instructions may seem unnecessary; however, each step outlined is very necessary and must be carried out in detail to insure the best possible operation of our ignition systems.

1. At each #3 check the spark plug shielding leads shall be checked with a standard station ohmeter for continuity. This check shall be carried out as shown on the sketch following this section. If the meter at any given connection shows less than a dead short, the connection must be disassembled and all surfaces cleaned by either sandpaper or scraping to increase the conductivity. After reassembly, the test meter shall be again used to determine if the trouble has been remedied. This procedure shall also be used to correct any reports of ignition noise.
2. At each #3 Check the ignition system shall be tested with a "UAL Ignition Harness Insulation Tester" (Lambert megometer type). This test is to be thorough and complete and done in accordance with instructions furnished with these testers. The test shall cover all exposed wire at the elbows, the insulators and the spark plugs. Any indication of moisture as outlined in the instructions shall be corrected before the ignition system can be considered serviceable.

D. Spark Plug and Insulator Sealing

1. Corning Dow #4 compound shall be used to seal all mica plugs and/or formica insulators. This means that when C-34s ceramic spark plugs are used with ceramic insulators this sealing compound shall not be used. Any other combination of spark plugs and insulators shall use this sealer.
2. Examples -- "C-34s ceramic plugs with formica insulators" shall use this sealer.
3. Any "mica plugs with ceramic insulators" shall use this sealer.
4. "C-34s ceramic plugs in all cylinders with all ceramic insulators" shall not use this sealer.
5. Each spark plug terminal shall be completely filled with Corning Dow #4 sealer. This sealer shall be applied from the tube or with a paddle as moisture or dirt from the fingers could easily cause a short.

E. Spark Plug Gooseneck Gaskets.

1. The soft copper gaskets #1U-753 shall be used with all AN spark plugs whether sealer is used or not. A close inspection shall be made to see that this gasket is in good condition and in place on all leads. Any gaskets that are not in first class condition shall be replaced.
2. All insulators shall be closely inspected to see that they are in good condition. Any insulators that appear defective shall be replaced. Special attention shall be given to keeping the wire ends and insulators clean and free from dirt or moisture. It must be realized, that as little as moisture from the fingers left while handling insulators, can cause a short. Carbon tetrachloride may be used to clean wires or insulators, but caution must be used when doing this. Wires will be damaged if too much carbon-tetrachloride is used.

3. The gooseneck nuts must be pulled up tight as anything less than a tight seal will permit moisture to enter at these points and this will eventually cause trouble.

2. Replacement of Spark Plugs

A. The following procedure shall be used whenever replacing spark plugs; whether #3 check or non-routine change.

1. Be sure the threads on the cylinder spark plug bushing are clean. Use a tap to clean the threads where necessary to allow the spark plugs to screw in freely.

CAUTION. Be sure the piston is in the clear before turning the tap in the cylinder to avoid hitting the top of the piston.

2. Lubricate spark plug threads with regular #32 GREDAG grease.

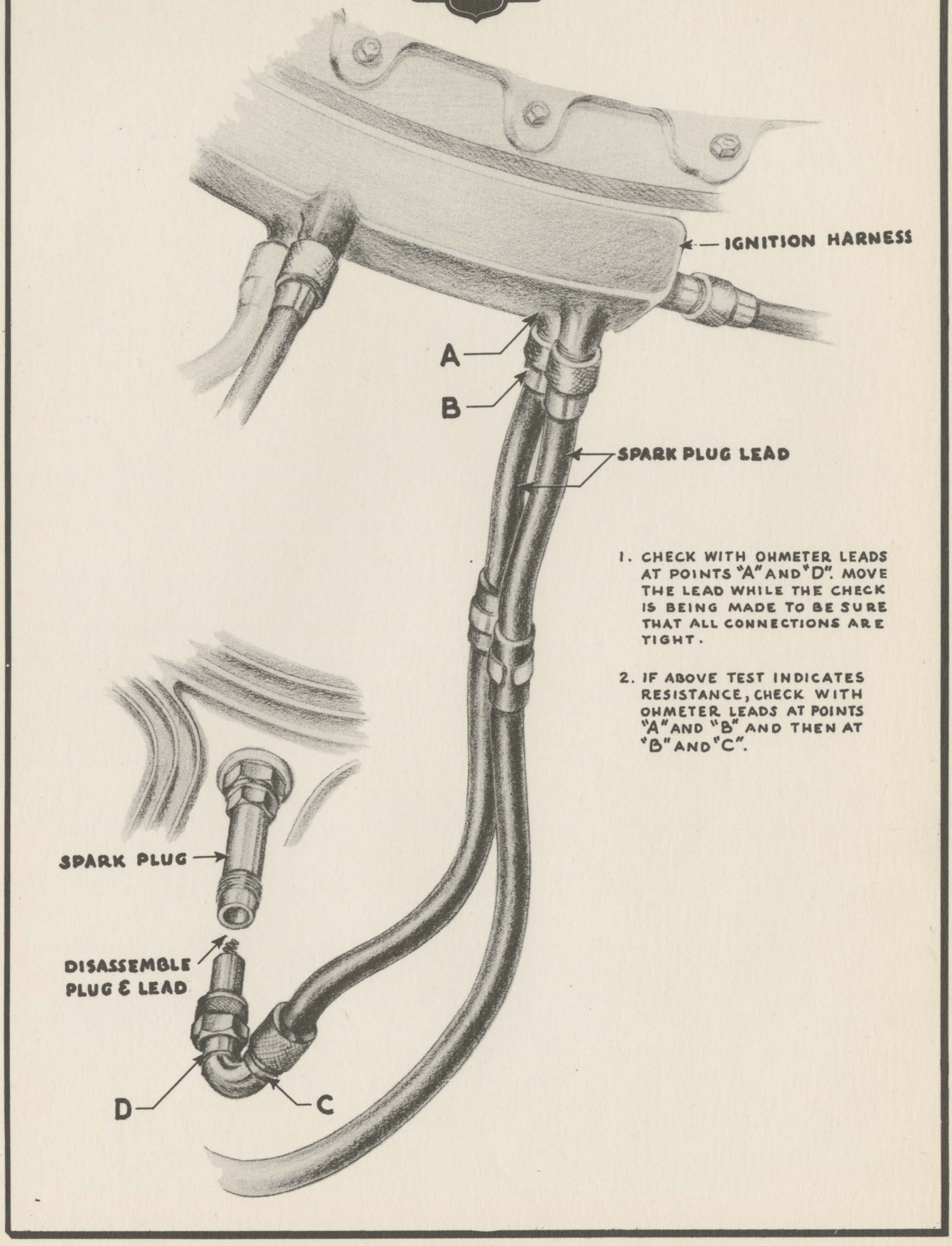
NOTE. Use only enough of this lubricant to lubricate the threads. Do not allow any grease to come in contact with the spark plug electrodes. Before installation, wipe the turned end of the spark plug threads clean, as excessive grease at this point will cause malfunctioning of the plug when it is heated, due to the grease melting and running into the electrodes.

3. Tighten the spark plugs with the torque wrench furnished to a torque setting of 450 inch pounds.

3. Repairs to Ignition Leads

A. Repairs to ignition leads are permissible when spare harnesses are not available or if there is insufficient time for complete replacement of the harness. These repairs shall be made with a standard goose-neck end, and shall be done in accordance with the following:

The end of the Harness cable shall be prepared in a manner identical to the gooseneck ends as supplied. Following this, the wires shall be bent to form a loop and then the two shall be hooked together and twisted tight by use of pliers. The loops should be drawn tight so that there will be no end clearance or looseness at the joint. The wires shall not be soldered. Victor rubber tape, #8 obtainable from Repair base, shall be wrapped around the splice starting at the exposed wires. It should be wrapped very tightly to prevent electrical loss, completely filling the portion over the wires first; then wrap the next two steps one at a time. Build the tape up to a diameter equal to the original cable. Press the rubber together tightly with the fingers. Bare approximately 1/2 inch of the covered shielding and slide the shielding up and over the shielding of the harness cable. Wrap with safety wire and solder. Completely wrap the exposed portion of shielding with rubber tape and splice will be complete.



ISS 95827

CONTINUITY TEST SPARK PLUG LEAD SHIELD

A note shall be written in the Trip Record Book showing which wire was spliced and it will be the responsibility of a station holding a spare to replace the harness at the first opportunity. This splice when done in accordance with the foregoing instructions will not be classed as a temporary repair. However, stations shall not allow these spliced cables to remain in service indefinitely, but shall make every effort to replace at first opportunity. It should be definitely understood that a wire shall not be spliced unless it is proved to be defective as otherwise needless expense and damage to harnesses will result. When a defective gooseneck and wire have been removed they should be sent to the Repair Base, properly tagged, so that study may be given to this type of failure with the thought of improving this portion of the harness.

ENGINE OIL SYSTEM 7

UNITED AIR LINES, INC.

FROM: Regulations Dept. CGGO PLACE: Chicago, Illinois

TO: All Holders of Maintenance Manual DATE: February 23, 1944

SUBJECT: Change and Addition Memo # 59

Changes and additions are indicated by small arrows in the margin. It will be noted that the effective date of this revision is November 15, 1943.

REMOVE	INSERT
Overhaul - page 25	Overhaul - page 25

PRT

P. R. Thoreen

RETIREMENT OF PARTS

THE FOLLOWING LISTED PARTS WILL BE RETIRED AT OR PRIOR TO THE MAXIMUM TIME LIMIT AS SHOWN:

	MAX. SERVICE HRS.
ENGINES - P AND W MODELS -- S1CG, S1C3G	No Fixed Time
PART	
BOLTS, MASTER ROD -THRU-	2175
→ BEARINGS, BLOWER IMPELLER -	1450
PINS, PISTON-	3000
→ RINGS, PISTON-CHROME-PLATED COMPRESSION	1450
RINGS, PISTON-(PLAIN) COMPRESSION	725
RINGS, PISTON-DUAL OIL AND SCRAPER-	1450
SCREW, RETAINING - CENTER MAIN BEARING CRANK CASE LINER	1450
VALVES, INTAKE-	4500
VALVES, EXHAUST-	4000
PROPELLERS -H.S. MODEL 23E50	--
PART	
HUB -	12000
BLADES -	10000

ENGINE OIL SYSTEM

1. General

A. All DC-3S are equipped with 29-gallon capacity oil tanks for each engine. Some are equipped with "standard 11" oil radiators and separate temperature regulators, others are equipped with "Harrison" oil radiators which have the temperature regulators integral with the radiator. Planes equipped with "Harrison" oil radiators also are equipped with Hopper oil tanks.

2. Service

A. No service work required other than that called for under Periodic Inspection.

1. The following procedure should be used to measure the oil level in tanks: Unscrew the measuring stick and hold it over to the opposite side of the tube during withdrawal. Wipe the measuring stick off, and with the numbered side toward the person checking the oil level, hold the stick toward the opposite side of the tube; then insert it until the bottom of the threads contact the top of the boss on the tank. At this point the proper indication is given. While continuing to hold the stick against the opposite side of the tube, remove it and read the amount of oil as indicated. This shall be 16 gallons for DC-3 planes. Install oil tank cap and close and secure the cover with the D2 fasteners provided.

(NOTE: The gauge stick must be straight, as a bent tube will smear oil around the tube and give and incorrect reading.)

B. Oil Drains

1. Separate containers must be used to catch the drainings from each engine at time of oil drain. Each container must be clean and equipped with a #10 mesh, .035 wire screen. This is an extra precaution to preclude the possibility of overlooking foreign substances in the drainings, which, if found would avoid possible engine failure at a later date.

3. Temperature Regulator Valves

A.1. The adjustment of this valve is made at the Repair Base and should not be tampered with in the Field. It is set to operate at 150°F; and operating limits should be within + or -10 degrees.

2. The inlet oil to the engine passes through the housing containing the sylphon, and if the oil temperature is below 150°F, the valve in the unit routes the oil back to the bottom of the oil tank, and it returns directly to the engine. When the oil temperature is above 150°F, the sylphon expands, and the valve diverts the engine return oil flow to the oil radiator, from where it goes to the tank.

(NOTE: The by-pass valve for the lla radiator is set to open at 25 lbs. per sq. in.)

B. Harrison Oil Radiator and Hopper Oil Tank

1. When this system fails to operate properly the units shall be replaced rather than attempting adjustments in the field.

4. Repairs

A. All operating units of the oil system shall be replaced when they are found to be operating incorrectly.

5. Replacements

A. When replacing oil tanks they shall be inspected internally for condition and cleanliness before they are installed.

B. Do not pull oil tank hanger straps up too tight as this will put too much strain on the tank.

C. Care shall be used when replacing oil radiators to be sure they line up properly in the hangars to prevent strain which would cause them to leak.

D. Replacement - Heat Resisting Oil Hose

1. In accordance with a CAA ruling to the effect that heat resisting oil hose must be installed on oil inlet fittings and lines in the engine nacelles of transport planes, the following chart will indicate the lines, size of hoses and number required per engine for UAL planes.

2. The various hoses used may be visually identified as given below:

a. The Weatherhead hose (fireproofed heat-resistant) is a dull red with a white stripe running the length of the hose and each piece is marked "CAA" in black letters.

b. The Goodrich hose (fireproofed and heat-resistant) is all black, has no stripes, and has the following lettering in silver letters: "Goodrich AO-19CAA".

c. The Goodrich hose (standard non-heat-resistant) is black with a dull red stripe and a white stripe running the length of the hose. There is no lettering on this type of hose.

DC-3-A Planes - "C" or "C-3" Type Engines

Line	Size	No. Req'd. Per Engine
Tank to Regulator.	1-1/2" I.D. x 3-1/2"	2
Regulator to Engine.	1-1/2" I.D. x 3-1/2"	2
Regulator to Drain Cock.	1" I.D. x 3"	1
Inlet at Propeller Feathering Pump . . .	3/4" I.D. x 2-3/4"	1

Hydromatic Propeller - Douglas

Line	Size	No. Req'd. Per Engine
Pump End	3/4" I.D. x 2-3/4"	2
Part Nos. for "C" and "C-3" Installation.	15U-105.5 (Left) 15U-105.6 (Right)	

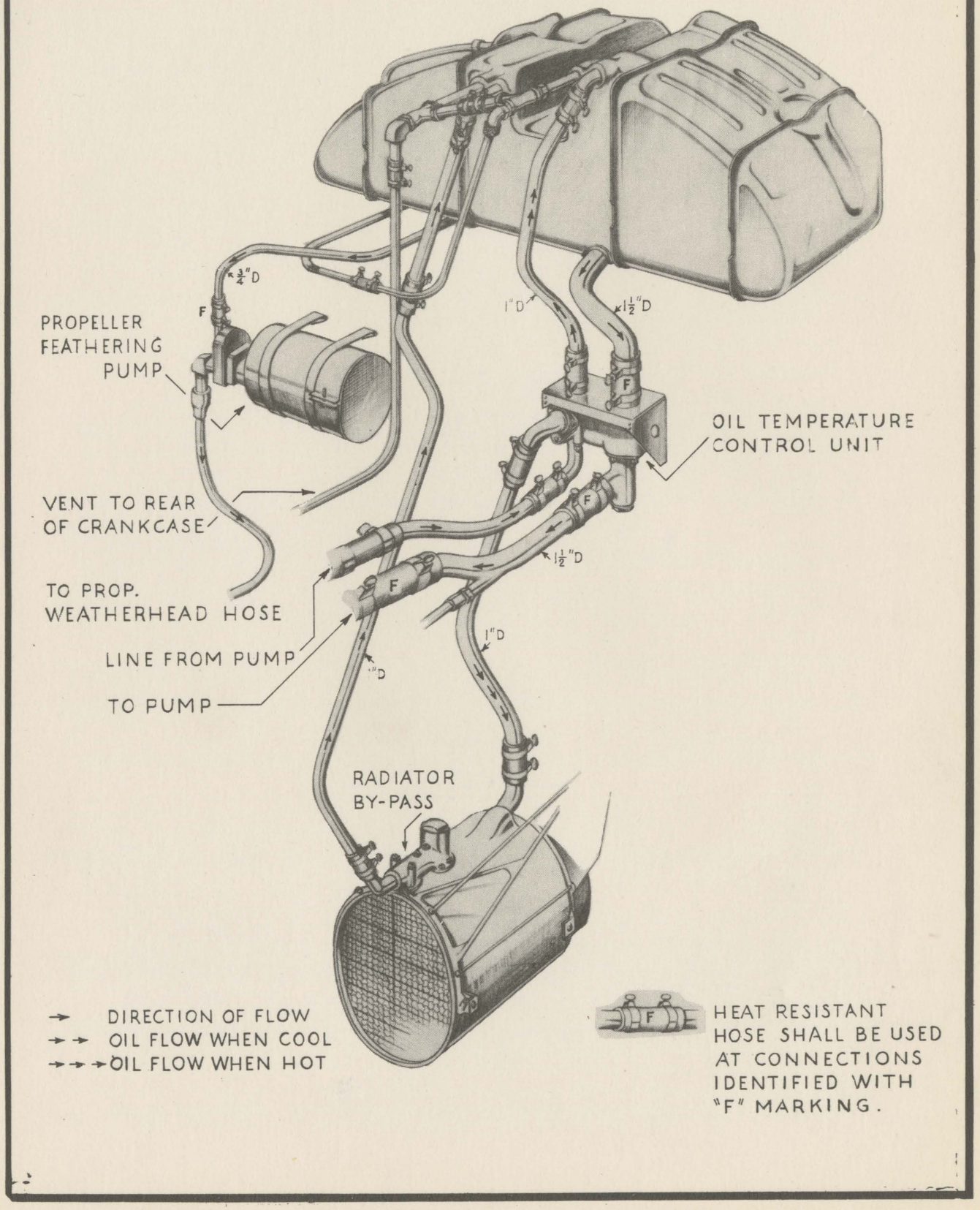
6. Difficulties

	Cause and Correction
	In Flight.
A. Excessive oil temperature low oil pressure and cold oil radiator.	A. Probably caused by congealed oil radiator. Close radiator shutters until radiator thaws out; then open them only enough to keep oil cool. On ground same as above or oil pressure regulator stuck. Can be found by getting oil hot on ground (above 150°); if oil radiator does not warm up regulator is stuck. Replace regulator.
B. Leaking oil hoses.	B. Oil hose hard. Replace with new hose.

7. References

A. Harrison "Aviation Oil Cooler and Control Valve Service Manual".

B. Interchange list.



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OIL SYSTEM "STANDARD DC3-A"

INSTRUMENTS

INCLUDING AUTOMATIC PILOT

GENERAL

(See "Maintenance Manual-Radio and Electrical" for information on instrument electrical circuits).

1. Service mechanics shall only concern themselves with correctness of instrument installation and with the instruments only to the extent of removal and replacement when the source of trouble has been traced to them. The complete installation of such units should be given particular attention. Instruments are not to be opened or adjusted in the field. When instruments are reported inoperative or not functioning properly, all information possible relative to and co-existent with the difficulties should be obtained from the pilots and the Trip Record Book.
2. Bear in mind that cracked or loose cover glasses in flight instruments will cause faulty operation and they are one of the first things to inspect when difficulty is encountered.
3. Due to their delicate construction, instruments should be given special care during handling and shipping, and instruments equipped with caging devices should be engaged whenever the instrument is handled during shipment or installation. Included in the following pages is a résumé of the most frequent instrument failures and their remedies.

AIRSPEED INDICATORS

1. Difficulties and Correction

   A. Airspeed Inoperative

      (1) Test pitot tube for water, for ice, and instrument pointer for zero return by disconnecting lines from instrument. If pointer was off zero (1/16") and return to zero, line stoppage exists. Blow out pitot and static lines.

      CAUTION: Before blowing out a static line, disconnect all other instruments which are connected to this line. See diagram on Pitot Static Hook-up.

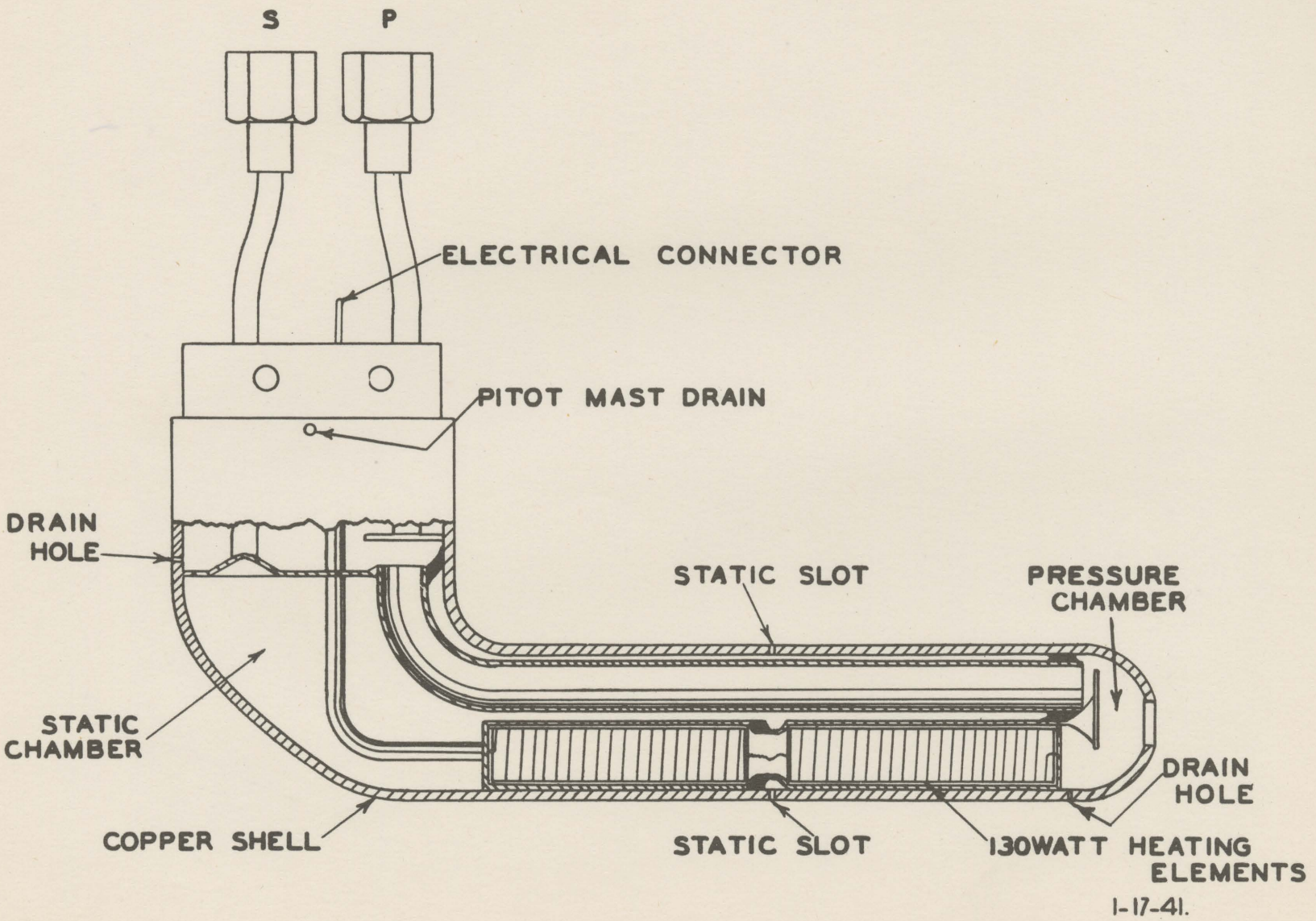
      (2) If the pointer is on zero when the plane arrives, or if the pointer, after having been off, returns to zero when the lines are disconnected, it may be assumed that the instrument is in good condition. If the pointer does not return to zero, the instrument should be changed.

      (3) Test pitot heater for operation.

   B. Airspeed Slow

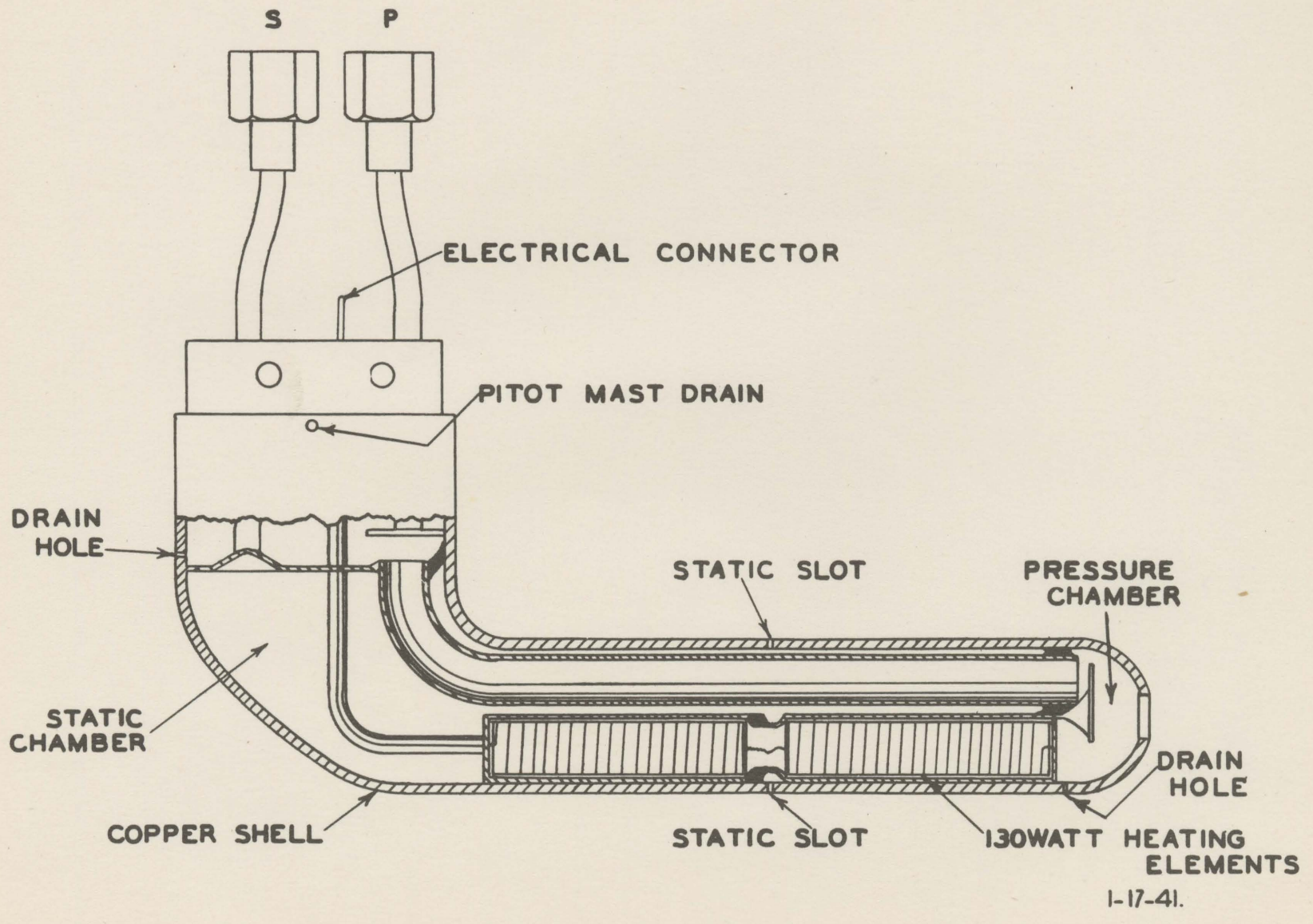
      (1) Causes:

         (a) Leaks in either lines or instrument.
         (b) Misalignment of pitot tube.
         (c) Instrument off calibration.



KOLLSMAN PITOT TUBE

JSS 95827



KOLLSMAN PITOT TUBE

JSS 95827

(2) Remedy:

(a) Test lines for leaks. (See paragraph on final test).
(b) Inspect pitot tube alignment.
(c) If lines and pitot tube are not at fault, change instrument.

C. Airspeed Unreliable or Sluggish

(1) Disconnect lines and blow out with dry air.

CAUTION: Before blowing out a static line disconnect all other instruments which are connected to this line. See diagram of Pitot Static hook-up.

(2) Test pitot heater to see that it works properly.

(3) If no installation trouble is found, change instrument.

D. Final Test

(1) Whenever an airspeed instrument is replaced or a line has been disconnected, the following final test must be made:

(a) Test static line for leaks by covering the slits in pitot tube with tape so that they are air tight. Suck on the line from the instrument end. If the tongue sticks, the line is okay.

(b) Cover pitot tube drain holes with tape. Test pitot line for leaks by blowing into the tube enough to give an indication of about 150 MPH and have an observer in the cockpit notice if the instrument holds its indication when the tongue is placed over the end of the tube.

(c) When testing is completed, remove tape from static slots and pitot drain holes.

(d) Test the pitot heater. (See "Maintenance Manual - Radio & Electrical," Section B-2 for additional information).

E. Douglas Planes

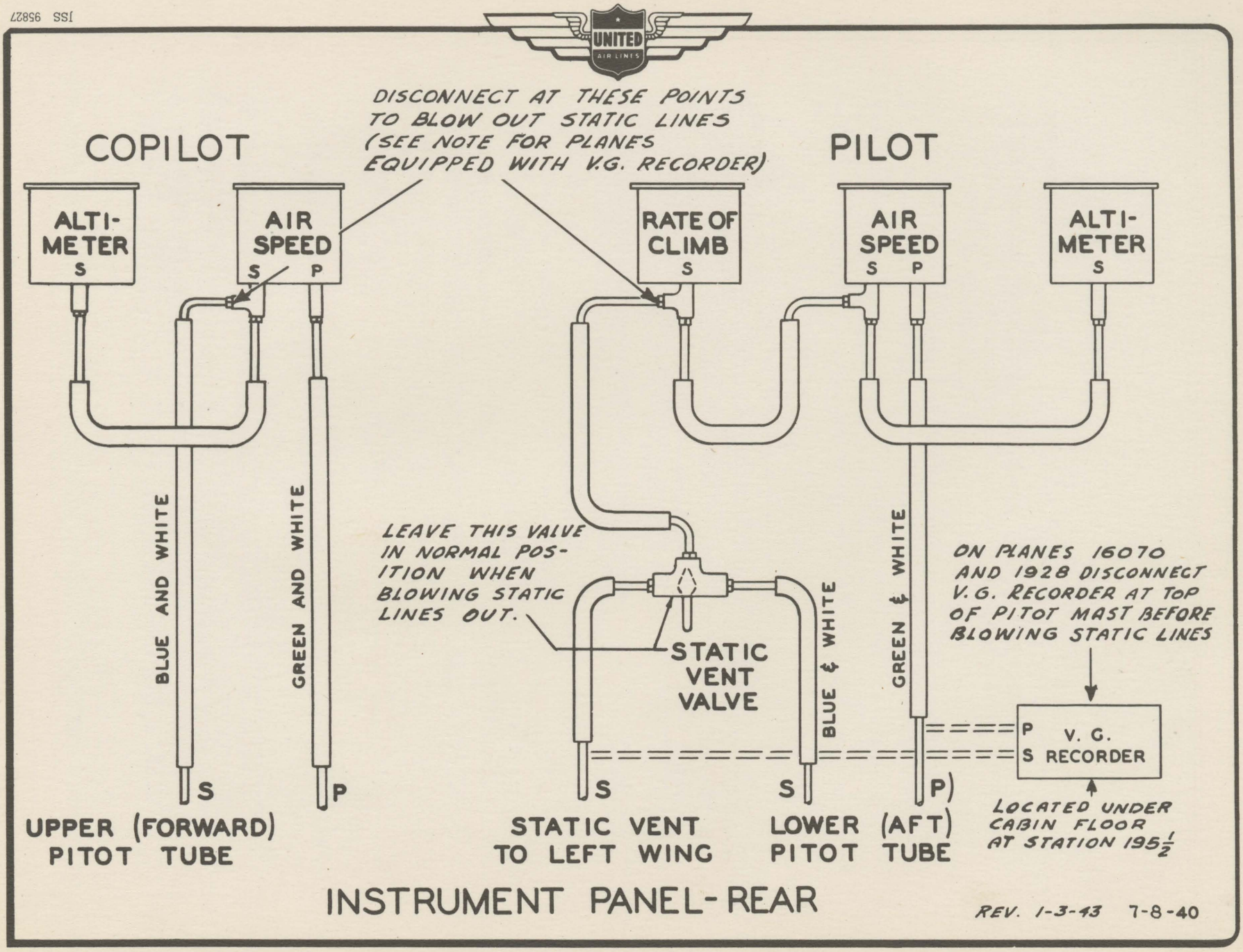
The auxiliary static line is connected to a selector valve on the pilot's instrument panel and runs to a point between the left main and auxiliary fuel tanks. If this line is suspected as being restricted it should be blown out with air.

ALTIMETERS

1. Difficulties and Correction

A. Barometer Off Setting

(1) If the reading of the altimeter does not correspond with the standard station altimeter reading within plus or minus 40 feet, the instrument should be replaced. (NOTE: UAL shop tolerances for altimeters at altitudes are:



PITOT STATIC HOOK-UP DC3-A AND DST-A

0 to	6,000	feet	+ or -	20 feet
	8,000	"	" -	30 "
	10,000	"	" -	50 "
	12,000	"	" -	75 "
	15,000	"	" -	120 "
	20,000	"	" -	200 "

(2) When an altimeter is reported as above, the static line should be disconnected and then the reading taken. If the reading is then within limits it indicates water of foreign material in the static line.

(3) Another influence on the reading is atmospheric conditions. Gusts of wind can cause momentary pressure changes in a hangar equivalent to 40 feet or more. In the latter case, an average of several readings should be taken.

B. Difference in Readings Between Two Altimeters - Douglas Planes

Landing Gear Extended and the Pilot's Instruments connected to auxiliary static line.

(1) This is not noticeable on the ground but when the plane is in flight with the wheels down, this error may sometimes be noticed. The cause is due to the location of the auxiliary static line between the left engine and auxiliary fuel tanks, and the turbulent condition of the air about the wheel well with the landing gear down. When this condition is reported, the service man shall attempt to learn the flight condition when the altimeter difference was observed. If he learns that the wheels were up during the observation he should blow out the lines of both altimeters so as to eliminate the further possibility of any water or foreign material in either static line.

CAUTION: Before blowing out static lines, disconnect the static lines to other instruments. See diagram of Pitot Static Hook-Up.

C. Types of Altimeters

(1) A Pioneer type altimeter with a speedometer type scale will be installed on the lefthand side of the instrument panel, and a Kollsman altimeter will be installed on the right side for the First Officer. Therefore, in the event of replacement, be sure to install the right type of altimeter.

AMMETERS

1. General

When any difficulty is reported, it is usually that the ammeter is burned out. The pointer is usually bent and off setting when this has occurred and it is necessary to replace the ammeter with a serviceable one. (See "Maintenance Manual - Radio and Electrical" B-16 for additional information).

COMPASS

1. Difficulties and Correction

(a) Swinging and Oscillating:

Caused by rough air or leakage of dampening fluid. Replace the instrument if fluid is leaking and a large air bubble is noticed while the compass is held level.

(b) Sluggish Card:

Caused by friction in pivot bearing. If reported by two or more different pilots, the instrument should be replaced.

(c) Sticking Card:

Caused by a stuck pivot assembly. Replace compass.

(d) Compass Light out:

Inspect for blown fuse, loose or broken connection and for burned out lamp. To change lamp, remove drawer from behind correction card and replace lamp with a spare from the lamp compartment at the gyropilot bank and climb unit.

(e) Deviation is excessive when checked with known magnetic bearings or during flights, when operating any electrical equipment that affects the compass heading.

1. Probably caused by variable magnetic fields if the indication is erratic. Check electrical wiring, switches, shielding of electrical instruments, radio influences, etc., for effects.

2. Probably caused by permanent magnetic fields, if the indication is not erratic. Compensate the compass.

(f) Correction Card Lost.

Usually due to carelessness. Compensate compass and replace with new card.

(g) Whenever it is necessary to replace a compass, it must be compensated in the following manner:

1. Douglas

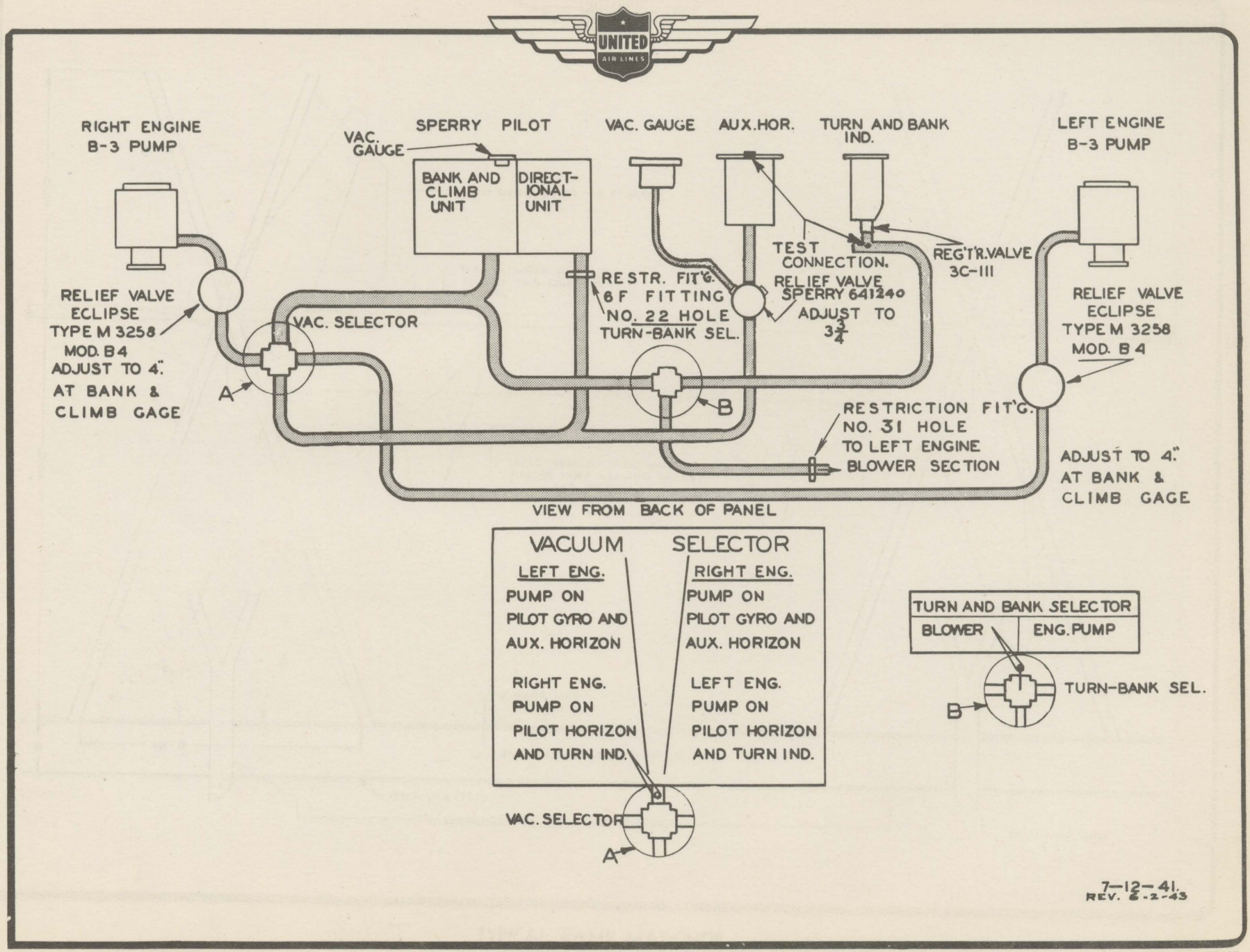
a. Align the airplane on a compass rose with the nose of the plane pointed to magnetic North, run engines, and then turn on radio and cockpit lights. Using a non-magnetic screwdriver, turn the N-S compensating screw until the compass reads N. Turn the plane to the East heading of the rose and adjust E-W compensating screw to bring the compass card to E. Head the plane South on the Rose and by turning the N-S screw, divide the error between the compass card reading and S. Head plane West and divide the error between compass card reading and W. Turn the plane to each of the 30° rose headings and record headings in the proper place on the correction card.

CLOCKS

Replace if reported or if found to be inoperative.

DEICER PRESSURE GAUGE

1. Difficulties and Correction



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VACUUM SYSTEM DC3-A AND DST-A—REVISED

A. Reads low - or fails to indicate:

(1) Cause

Usually heavy oil in the line to the gauge especially during cold weather.

(2) Correction

a. Disconnect line at gauge and blow out with air under pressure.

b. Flush the line out with oleum.

DIRECTIONAL GYRO

1. Difficulties and Correction

A. Drifting

This is the chief complaint on this instrument. An attempt should be made to get the amount of drift during 15 minutes of observation by the pilot. The maximum allowable drift is 6^{0} in 15 minutes on one heading. If this is exceeded, the instrument should be replaced, provided the vacuum gauge indicates the proper value of 3½ to 4" HG. Improper vacuum will augment the amount of drift. Test vacuum and clean Eclipse regulator valve and screen if necessary.

B. Spinning

1. This indicates a very low vacuum which may be the result of a kinked hose, leaking line, or a vacuum pump being out of operation. The instrument is to be suspected if none of these faults are found, and it should be replaced.

2. Steep banks of the airplane also produce spinning, but are not reached in normal transport operation.

3. A simple test of the instrument is to spin the card slowly with the caging device after the rotor has stopped turning. If the card stops spinning suddenly, the instrument is at fault.

C. Excessive Rotor Noise

This indicates increased clearances of rotor pivots or balls within the instrument. Unless this noise is exceptionally disagreeable, the instrument should not be replaced for this cause alone.

"FRIEZ" FLIGHT ANALYZER

(See "Maintenance Manual - Radio and Electrical" B-7 for additional information)

1. General

A. This instrument is mounted on the back of the rear cargo compartment wall and is used for making a permanent record of altitude in terms of barometric pressure during flight. It also has two additional features which are used while installed on Mainliners. These are: Recording length of time the automatic pilot is used and recording the number of times the radio transmitter is used. These operations are recorded continuously against time over the maximum of an 8-hour period.

B. It is a requirement that barographs be carried on all of our commerical trips.

2. Service

A. A new chart must be installed each time the flight crew is changed.

B. To remove the card from the instrument, open the hinged door and release the pen lift. Slide table down, remove card and inspect for indications of unsatisfactory performance of the unit. If a pen has run out of ink or the clock has stopped, indicate such on the chart. Inspect the back side of the card to see that it is completely filled out.

C. Deliver card to Dispatcher on duty.

D. The pens will be cleaned each time they are serviced with ink and as otherwise indicated. Use only the special blade cleaner as provided in the analyzer service kit and draw it straight through the pen points without bending or twisting because otherwise the points may be spread apart and the pen damaged. Replace ink as necessary, filling the circular portion of the pen half full of only the special J. P. Friez ink.

NOTE: Never bend the pen arms downward to obtain increased pressure on the pen.

E. Wind clock, but never turn the key until it is impossible to wind further. Stop before this point is reached.

F. Completely fill out the reverse side of a card giving all information necessary on the trip in question. Install the card on the table and secure by means of the piercing pin. Slide the table to bottom of its travel -- carefully lower pens on the card and close lid. Within 30 minutes before departure, raise pens, slide table to full "UP" position and carefully lower pens to prevent ink from splattering card. Move table down about 1/8" and back up to test pins for making a good record. Close lid, listen to the clock to be sure it is running.

G. Install in holder in rear wall of rear baggage compartment, fasten holding clamp and close and fasten cover door with fasteners provided.

3. Adjustment

A. No adjustment other than the one providing for pen pressure will be made.

B. When pen pressure is insufficient to hold a pen on the card or is so great that free movement of the pen is not permitted, adjust as follows:

(1) Make sure the pen is straight.

(2) By means of the small screw located back of the pivot, adjust to increase or decrease pen pressure as required. Pen should ride card with sufficient pressure to make a good ink record and at the same time operate freely.

4. Replacement

A. When the instrument is due for overhaul, as determined by the Pre-date written under the cover, a tag shall be attached to the handle with the request "Route to Repair Base" written thereon.

B. When the instrument is malfunctioning and adjustments do not remedy the trouble, ship the unit to the Repair Base.

C. These instruments must never be shipped without a card in place to protect the pen points.

FUEL PRESSURE GAUGE

1. Difficulties and Corrections

A. Oscillation

This can usually be corrected by disconnecting the gauge line at both ends and blowing it out with air. (CAUTION: Disconnect gauge line at cross feed valve to avoid possible damage to carburetor or fuel system.) If the gauge is taken off of the instrument panel, shake out any gasoline that may be inside of it.

B. Sticking

Steadily increase the fuel pressure on the gauge by means of operating the wobble pump. If the pointer makes a sudden jump exceeding an indication of one-half pound pressure while pointer is going up or returning to its original position, gauge should be replaced.

C. Fuel Leak in Gauge - Replace

D. Fuel Warning Light Stays on

Grounded or faulty gauge will cause this trouble. Make certain that there has been no fuel pressure failure and if there has been none, correct the wiring and/or replace the defective gauge.

E. Warning Light Flickers During Take-off or Idling

This may be caused by fuel in the pressure line or due to a faulty gas pressure regulator. Blow out pressure line with air and if trouble persists, replace fuel pressure regulator. If trouble still persists, replace fuel pump.

F. Fuel Warning Light Fails to Come On

(1) Inspect for a burned out fuse and replace if found.

(2) Inspect bulb to see if it has been burned out.

(3) Inspect for loose connections or other wiring trouble.

G. Fuel Gauge - Liquidometer

(See "Maintenance Manual - Radio and Electrical" for all information on circuit and adjustment).

HORIZON

1. Difficulties and Corrections

A. Sluggish

(1) The Horizon has the characteristic of being sluggish at certain times and the cause must be understood before a proper analysis can be made of a

report of this type. The indicating bar will pick up the bank in a long slow turn and will return to level position in about the same time that it took to indicate the banked position.

(2) This apparent sluggish condition is most pronounced in cold weather and just after take-off if the rotor has not attained normal operating speed. Low vacuum and the accompanying slow rotor speed also cause this trouble.

B. Right or Left Wing Low

(1) The mounting installation should be inspected to assure proper alignment of instrument with panel, and panel with the airplane. There are a few degrees of movement permitted by the mounting screws which can be used to correct small errors. Occasionally, an instrument may need just a slight turning in the panel to correct for a low wing report.

C. Horizon Out

(1) The suction hose may be off or kinked.

(2) The instrument itself may be out of operating condition and fail to level up.

(3) Inspect installation thoroughly and change instrument if no vacuum trouble is found.

D. Climb or Dive Indicated in Level Flight.

The attitude of an airplane is affected by loading conditions and altitude. Inquiry regarding these conditions should be made as the horizon may be reported when it is indicating a true condition of flight.

MANIFOLD PRESSURE GAUGE

1. General

A. Douglas

(1) On Douglas planes one gauge is provided for each engine. The line from the instrument is connected to the output side of the blower section. A selector valve is interconnected between the two gauges so that in the event one gauge fails, the Manifold Pressure of either engine may be determined by moving the selector handle to the desired engine as shown on the Placard. There are two points at which the selector valve will vent the instrument lines to cockpit atmosphere.

(2) Sluggish Indication of Gauge

(a) Probably caused by foreign matter or fuel in the lines, excessive friction in gauge, or engine not responding to changes in throttle settings with speed equal to opposite engine.

1. On Douglas planes, operate the engine at idling speed and place selector to proper vent position for one or two minutes. If this does not correct the trouble the line should be disconnected and flushed out and then blown dry.

CAUTION: Blow line out from instrument and towards engine to eliminate possibility of damage to gauge.

(b) If gauge is OK, lines are clear, and no leaks are present, there is cause for a complete investigation of the engine condition.

2. Difficulties and Corrections:

A. Low or High Pressure:

(1) Probably caused by leaks and/or instrument off calibration. A leak in the line will cause a higher reading than the true value when the engine is operating at a Manifold pressure below outside atmosphere. A leak in the line will cause a lower reading than the true value when the engine is operating at a manifold pressure above outside atmosphere.

(2) It is to be remembered that, if the instrument is accurate and the lines are clear, the pointer will indicate the correct atmospheric pressure in inches of HG. (Not reduced to sea level standard) when the engine is not running.

OIL PRESSURE GAUGE

1. Difficulties and Corrections:

A. Sluggish and Inaccurate:

(1) This is probably due to the long lines becoming filled with heavy oil and is experienced most frequently during the winter months. To overcome this, blow the lines out thoroughly with dry compressed air and then fill them completely with ice machine oil. If the lines are not refilled with this oil, they will gradually fill up with heavy engine oil or sludge again, and the same difficulty or sluggish and inaccurate pressure indications will recur.

B. Gauge Sticks at Certain Indications:

Replace the instrument.

C. Oil Leak Inside Gauge:

Replace the instrument.

D. Oil Warning light fails to come on.

(1) Inspect for burned out fuse and replace if found.
(2) Inspect bulb to see if it has burned out.
(3) Inspect for loose connections or other wiring trouble.

HEATING SYSTEM GAUGE

1. Limits

A. Light is off at 5 lbs. up to 20 lbs.

Light is on up to 5 lbs. and over 20 lbs.

B. If warning light does not operate, check fuse and globe for being burned out, replace if necessary. (CAUTION: Be sure to use the proper type globe in this warning light).

RATE OF CLIMB INDICATORS

1. Difficulties and Corrections:

   A. Climb indicator out:

   Blow out static line and replace instrument. (CAUTION: Before blowing out a static line, disconnect all other instruments which are connected to this line. See diagram on Pitot-Static hook-up.)

   B. Climb indicator off calibration or sluggish:

   Blow out static line with air. If next report indicates same trouble, replace instrument.

   C. Climb indicator hand off zero:

   Disconnect instrument and blow out static line with air. If trouble is not remedied and hand is off zero by 1/8" or more, replace instrument.

FLOWMETERS - ANTI-ICER

1. General

   A. These two units, installed on the cockpit wall back of the captain, are flowmeters for indicating the amount of anti-icer fluid being supplied to the propeller slinger rings. They each consist of a glass tube with a tapered bore in which rides the flow indicating rotor. These rotors, made of stainless steel, will not, of course, float in the anti-icer fluid when it is stationary, and any indication by them is dependent on the flow of fluid around them. The height to which they rise in the glass tubes increases as the rate of flow by them increases.

2. Difficulties and Corrections

   A. Outside of breakage of the glass tubes, about the only irregularity likely to be reported is that of sticking rotors. In this case the whole propeller anti-icer system should be blown out and thoroughly cleaned to remove any foreign particles that may be restricting flow. Visual inspection will show whether the glass tubes and rotors need cleaning. It will be necessary to remove the flowmeter to do this and install plain tubing. Remove hoses at line ends. Leave hose connections on the flowmeter when they are removed.

TACHOMETERS - ELECTRIC

1. Difficulties and Corrections

   A. Oscillation or erratic operation:

   (1) Look for loose or dirty wiring connections, particularly at the terminals of the magneto.

   (2) If no wiring trouble is found, replace magneto.

   (3) Oscillation should not exceed 25 RPM.

B. Tachometer Reads High or Low:

(1) Only in very rare cases do our present tachometers give a high reading. If the tachometers show a difference of indication with the engines synchronized, it is likely the fault of the one showing the least indication. Mechanical or electrical trouble with the Tachometer Indicator is very unlikely and all other possibilities should be investigated before replacing it. Check the electrical connections at magneto first. If no apparent trouble is found, replace magneto. If this does not correct the trouble, refer to the Maintenance Manual - Radio and Electrical for wiring diagrams and additional information.

C. Tachometer Indicator Hand Sticking:

(1) Replace the indicator.

D. Tachometer Magneto Drive Broken

(1) Occasionally a tach-mag drive key breaks off in the engine drive and is impossible to remove. In these cases, it is O.K. to push the broken key down into the engine drive and install a replacement tach-mag. Prior to installing the new mag, however, be sure to measure the distance with a small rod to see that there is sufficient end clearance to allow for the length of the mag drive key; otherwise it shall be necessary to replace the drive.

TACHOMETER TESTER - Frahm Vibrating Reed

(See Maintenance Manual - Radio and Electrical Section B-17 for information).

THERMOCOUPLE

(See Maintenance Manual - Radio and Electrical B-17 for information).

THERMOMETERS - Resistance

(See Maintenance Manual - Radio and Electrical B-5 for information).

AIR THERMOMETERS - Vapor Pressure

1. Difficulties and Corrections

A. Air Thermometer Out:

(1) Inspect capillary line for breakage. When capillary is broken, the pointer generally goes completely off the scale on the low side. When this is the case replace the instrument.

CAUTION: Do not allow sharp bends or kinks to form in the capillary when installing.

B. Air Thermometer Off Calibration:

(1) This report is frequently in error. The conditions existing when the temperature is observed should be closely noted. If an airplane is in the sun for

a time, the temperature recorded by the thermometer is likely to vary by a marked amount from that of the free air; the reason being that the bulb is in the direct rays of the sun and is absorbing heat from them.

(2) Another report on air thermometers is in the case of a pilot reporting a thermometer being off a few degrees at freezing. Ice has been known to form on airplanes while the air temperature was as high as 38°F.

(3) Until the plane has been inside the hangar for a time long enough for the temperature conditions to become quite uniform, the thermometer should not be condemned unless it is observed to be off calibration by a noticeable amount from the temperature then existing.

TURN AND BANK INDICATORS

1. Difficulties and Corrections:

A. Sluggish or Improper Timing:

This may be caused by:

(1) Insufficient vacuum due to leaks or restrictions in lines. If vacuum at the Gyropilot is O.K. the trouble will be between these and the Turn and Bank Indicator. (See Vacuum System Chart in this Manual).

(2) Improper calibration of the instrument. To correct, replace the instrument.

(3) Improper calibration of the vacuum regulating valve. To correct, replace the instrument. (The regulating valve 3C-111 is considered a part of the instrument and should not be changed separately.)

B. Instrument Hand Sticking.

Replace instrument.

C. Ball not in center of bank indicator.

If instrument cannot be rotated enough in mounting by loosening screws and readjusting, replace instrument.

NOTE: Be sure plane is level.

VACUUM OR SUCTION GAUGE

1. Difficulties and Corrections

A. Report - High Vacuum:

This report usually represents the true state of affairs. The regulator valve should be cleaned and adjusted. The gauge may be off calibration but this is a remote possibility.

B. Report - Low Vacuum:

(1) One vacuum pump may be out. Test each pump individually by running each engine separately. If the gauge fails to respond to one of the engines, the pump on that engine is inoperative or pump line is off or restricted.

(2) The pump suction line should be tested and if necessary the pump should be replaced.

(3) The regulator valve may need adjustment.

(4) The gauge may be off calibration but all other possibilities should be eliminated before replacing this instrument.

AUTOMATIC PILOT

1. SERVICE

A. While making Operational Test required under Periodic Inspection, the Automatic Pilot will be ground tested in the following manner:

B. Operational Test:

(1) Make certain that exterior control surface locks are not installed on the plane before any attempt is made to engage or test the Automatic Pilot system.

(2) Make a visual inspection of the gyropilot control units.

(3) Check the operations of the lamp and rheostats in gyropilot control units.

(4) Operate all flight controls by hand. Note that the movement is free and that the follow-up indices follow the movement of the controls.

(5) Turn on the auto-pilot oil valve located on the hydraulic control panel. See that all speed valves are closed and inspect to see that at least 80# oil pressure is showing on the Sperry Pilot Oil Pressure Gauge. If sufficient pressure is not indicated, increase the speed or adjust the pressure if necessary. Open the speed valves on the lower portion of the instrument panel to 2 but not more than 4 position. Operate the surface controls to full travel in one direction and hold for approximately 10 seconds. Then operate the controls to the opposite full travel and hold the same length of time. This procedure forces air, which may be in the system, back to the hydraulic fluid supply tank.

(6) Return all surface controls to their neutral position and line up the automatic pilot instrument indices by means of turning the knobs located on the directional gyro, and bank and climb units.

(7) Engage the automatic pilot control located on the control pedestal. The automatic pilot should now hold the controls in the neutral position. By using force on the various controls, test to see that the automatic pilot can be over-powered manually. Note if the follow-up indices follow the movement of the various controls. Also, that when over-powering the various servos, that the controls are not spongy as is indicated when the system is not entirely free of air. Do not mistake the spring of the control cable system with the resilient action of air in the servos. Servo position movement is indicated by movement of the follow-up indices. Turn all control knobs to their extreme position and note that the control surfaces and the indices respond properly.

(8) Disengage the automatic pilot control and manually upset all controls. Do not move the control knobs on the instrument panel. Re-engage the control

of the pedestal and note that the follow-up indices and control surfaces all return to coincide with the positions for which the control surfaces are adjusted.

(9) During the test procedure of the automatic pilot note that the vacuum gauge indicates 3" to 5" HG, the correct value as given on the ground run-up chart.

(10) Test operation of both oil pressure pumps and vacuum pumps to insure that they are operating within their respective pressure and vacuum ranges.

C. Replacement

(1) The gyropilot units have the rubber airseals grommets coated lightly with castor oil when they go thru overhaul. Prior to installation of these units, inspect the grommets to be sure there is still a light coating of castor oil present. If no oil is visible, apply a very small amount of castor oil on the grommets.

D. Trouble Shooting

(1) The main causes for poor operation of the automatic pilot are either lack of oil, improper oil pressure, air in the servo cylinder, (which causes "hunting" of the controls) or low vacuum.

(2) A few causes and remedies of the trouble most prevalent in our automatic pilot system are below. Before any adjustment or testing of the controls is made, make sure that the vacuum and oil pressures are at the correct values and that all air is expelled from the servo cylinders.

Symptoms	Causes and Remedies
a. A control surface when being tested with the automatic pilot moves in one direction from neutral but not in the other; or upon engaging pilot with controls and follow-up indices in neutral; a control moves to full travel in one direction.	a. This probably is caused by a dirty air relay filter or a balanced oil valve being stuck or out of adjustment. Remove the instrument of the control affected. Place the control in question in neutral and engage the automatic pilot. By use of the fingers push in and pull out on the small shaft which extends through the air relay valve and operates the balanced oil valve. DO NOT USE PLIERS Note if control surfaces respond in both directions. If they respond properly, the trouble is in the instrument proper and it should be replaced. If it is possible to move the air relay shaft past its resting point in both directions by the fingers, it indicates that the

	oil valve is out of adjustment and that dirt is not causing the valve to be stuck.
b. Directional Gyro drifting excessively or spinning.	b. This is caused by incorrect vacuum or trouble in the instrument proper. If the vacuum is correct, the directional unit should be replaced.
c. Control surfaces "hunt" during flight.	c. Trouble is most likely caused by air in the servo cylinders. Remove air from system by following procedure given under ground test.
d. Lagging or slow movement of all controls in both directions.	d. This is probably caused by low vacuum, low oil pressure, obstruction in oil lines, or servo relief valves operating below the desired pressure. Eliminate the first three items as possible causes, and if symptoms still persist, the servo cylinder unit should be replaced by a spare assembly.
e. One or more controls lagging in one direction only.	e. This probably caused by follow-up pulley of the control affected not wound sufficiently, dirt in balanced oil valve, oil valve not properly balanced, or unbalanced air cut-off in control unit. Test follow-up cables for proper tension. With the follow-up cable unwound as much as possible, and the control in question to its full travel, there should be approximately one-quarter to a one-half turn left in the follow-up pulley spring mechanism. Test for dirt in balanced oil valve as given above. Test for balanced oil valve being mal-adjusted as given above. While the control unit is removed and with the surface controls located in the neutral position, test to see that the controls travel speed is equal in both directions, when the same pressure is applied to either side of the

air relay. If speed is approximately equal on either side of neutral, a defective control unit is indicated, in which case replace with a serviceable unit.

f. Controls Binding.

f. This probably caused by autopilot servo packing gland nuts too tight. The packing nuts must be tight enough to prevent leaking of fluid, but not so tight as to cause binding of the controls.

g. Sluggish operation at extremely low temperatures.

g. This probably caused by chilled oil in the servo unit; To correct, disengage the gyropilot to open the by-pass valves in the servos and then offset the indices of the control unit 5° or 10°; this opens the balanced oil valves and allows warm oil from the pump to circulate through the servo lines.

FUEL SYSTEM 9

FUEL SYSTEMS

1. SERVICE

A. General.

1. No routine work other than that given under "fuel system" in Periodic Inspection will be done unless trouble is found or difficulty is reported.

B. Douglas.

1. A study of the diagram on the dual fuel system of the Douglas planes will facilitate a better understanding of the installation and enable personnel to locate trouble more quickly. Diagram follows.

2. Dump Valves.

(a) The right main and left auxiliary tanks, as can be seen on the diagram of the dual fuel system, are equipped with dump valves. The valves between the two tanks so equipped are connected by means of a push-pull rod. Both valves are operated simultaneously from the cockpit control by means of a cable installation which is connected to the operating lever of the forward valve.

(b) The dump valves, when reported defective, should be tested outside the hangar and away from buildings and other equipment in the following manner for proper operation: Place a suitable container on the ground under the extension of the dump chute and ground the extension to the container, the container to the ground and plane to ground by suitable ground wires. One man should be stationed in the cockpit and one under the dump chute extension. Raise the control handle marked "open" until an apparent stop is reached. The mechanic stationed below the plane should hold up on the extension to prevent it from violently snapping in the extended position. This procedure allows the dump chute outlet to be fully extended before fuel is released from the tank. The dump valves in the tanks can then be tested momentarily by pulling the control lever out against its next stop; then by pulling out on the control handle marked "closed", the valves will return to their "off" position and within a short time fuel should stop running from the outlet. The dump chute extension then should be pushed upward into the recess provided causing it to snap into place. NOTE: Unless absolutely necessary, fuel should not be discharged from the plane dump chute mechanism while on the ground, because then it is necessary to remove the center section plate under the forward valve and resafety the operating lever in the "off" position.

CAUTION: Extreme care should be exercised to see that no electric motors, vacuum cleaners, or machines which may cause electric sparks, are operated near the plane while fuel is being dumped or until gasoline fumes have ceased to emit from the extension. Personnel should never work directly under the extensible dump chute unless

certain that no one is in the plane working near the release cables or mechanism. The extension springs are necessarily very strong (in order to extend the chute in the air) and if released inadvertently, heavy loads will be imposed on the plane structure, and if a person is struck by this extension, serious injury may result.

(c) In the event of leaks in dump valves the plane should be routed to the Repair Base (with the subject tank empty and the cockpit placarded to this effect) for repairs. This must be done as it is necessary to pull the fuel tanks to replace dump valves. Do not tighten pressure nuts on dump valves as they are set to the maximum at the Repair Base

3. Filling Tanks

CAUTION: Any person servicing or checking any fuel tank, whether an airplane, truck, or ground installation, shall not have any loose objects such as tools, pencils, matches, cigarette lighters, etc., in his pockets that might fall into the tanks during these operations.

4. Aromatic Fuels

(1). Planes which are marked "Suitable for the use of Aromatic Fuel" adjacent to the fuel tank filler caps, may be serviced with aromatic fuel wherever this is found to be necessary.

(2) If at any time it is necessary to install a part, which has not been modified for use with aromatic fuel, on a plane which is marked "Suitable for the use of Aromatic Fuel", the Maintenance Department, Chicago, shall be notified by wire immediately so that they may follow up to see that the unmodified part is replaced with a modified part as soon as possible.

5. C-3 Fuel Strainers

(1) Care shall be used to see that C-3 fuel strainers are not installed upside down. This screen shall be installed with the pointed end of the cone at the top and the open end of the screen at the bottom.

(2) The C-3 fuel screen bolts shall never be tightened excessively. They shall be inspected for condition during regular inspection and replaced whenever this inspection indicates they are not in first class condition. Replace fuel strainer gaskets at each #2 and #3 check. They shall be coated with a thin film of medium grade Tite Seal applied to both sides of the gasket. (Caution: Do not use an excessive amount of Tite Seal).

6. Weatherhead Drain Cocks.

Care shall be used not to overtighten these drain cocks. Excessive tightening only distorts them. If normal tightening will not stop any leaks they shall be replaced.

7. Inspecting System for Leaks.

Wobble fuel pressure up to 16 lbs. and maintain this pressure while a complete inspection at the fuel lines which are under pressure is made. The mixture control shall be in idle cut off during this operation. Hose clamps shall be tested by twisting them slightly by hand, to be sure they are properly adjusted.

2. REPLACEMENT

A. General - Douglas

1. At the present we have two different types of fuel systems in our Douglas planes, (UAL Dual and Douglas Company Dual); consequently, the K-3 valves and the D-2A wobble pumps are not directly interchangeable, due to the fact that the positions of the fittings for each individual location vary. When it is necessary to replace a K-3 valve or a D-2A wobble pump, to eliminate confusion in securing the proper part, a telegram should be sent to the Repair Base stating the plane number, the type of fuel system, the type and location of the unit being replaced, left or right. The C-3 fuel strainers may be interchanged from one position to another by changing the position of the fittings. In an emergency, the relief valve and sylphon assembly from the D-2A wobble pump, if defective, may be replaced by the same assembly from any other D-2A wobble pump. Care should be exercised during this operation so that during tightening or loosening the cap of the assembly, the wrench does not slip off and snap the drain fitting from the cap. The same spring is used in both the high and low pressure systems, and after the replacement has been made the valve should be adjusted to relieve fuel at 25# per sq. inch for planes equipped with the injection carburetors. (NOTE: See interchange list for additional information).

2. Removal and Installation of Tanks

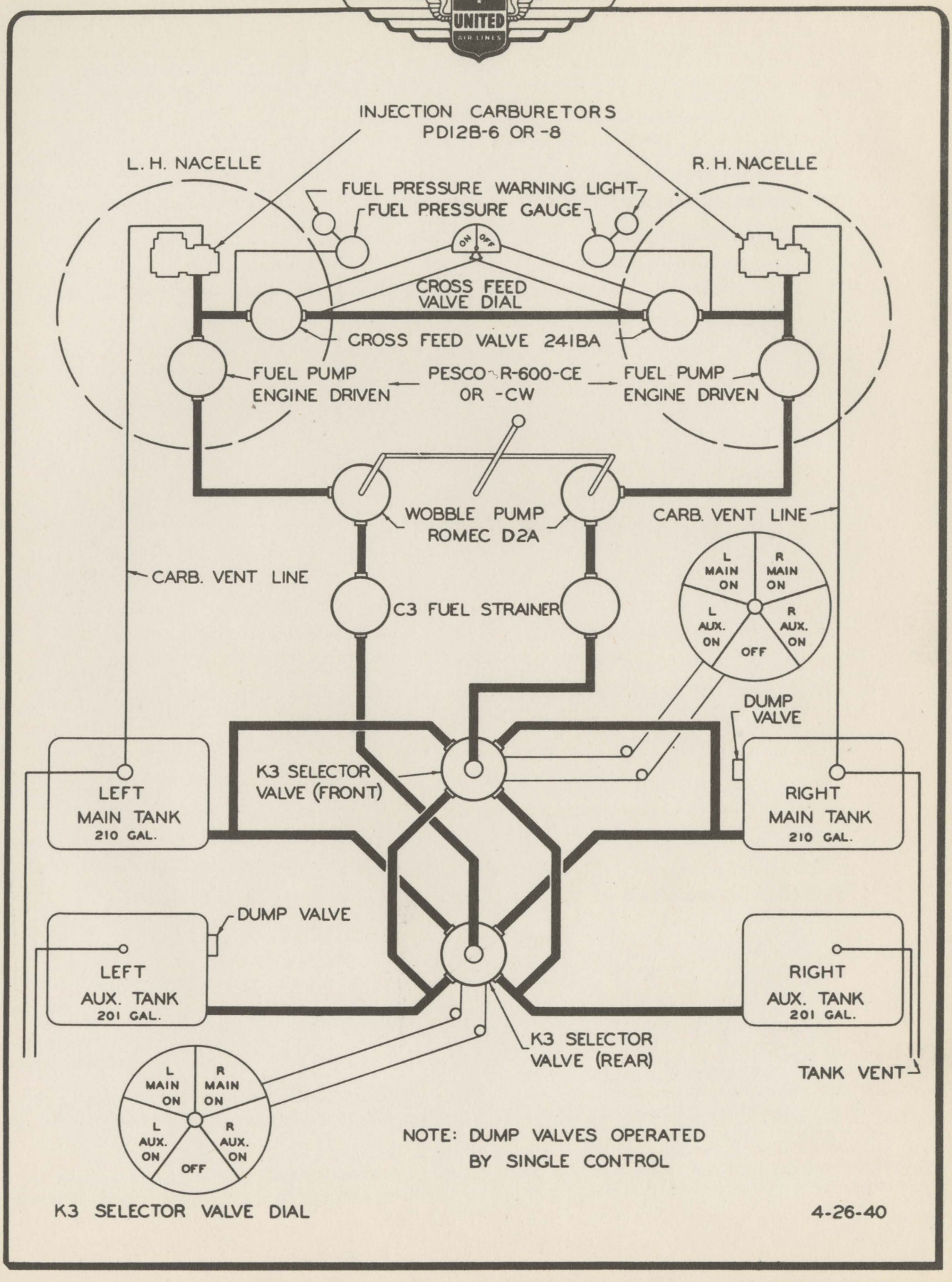
Before removing the bottom plate under a gasoline tank, it will be necessary to take a 4 x 4 and cut it to proper length to fit between the propeller hub and the regular station jack. The jack should then be extended until the oleos just start to extend which will indicate that the suspended weight of the engine and propeller has been taken.

(a) This is necessary to prevent the center section from twisting slightly, due to the heavy loads imposed by the weight of the engine and propeller. The jack should remain until after the tank plates have been replaced and the screws all started in their respective nut plates. The supporting timber should never be placed under the propeller cylinder or at any point other than the propeller hub.

3. REPAIR

A. Fuel tanks will not be repaired in the field, and when replacement is necessary a spare will be obtained from the Repair Base.

B. There are several operations which are necessary besides welding for the proper repair of fuel tanks such as the acid, and potassium dichromate baths and exterior finishing. Only the Repair Base is properly equipped for this type of work and consequently fuel tank repairs will be concentrated at this point.



DUAL FUEL SYSTEM—DC3-A AND DST-A

FUSELAGE 10

FUSELAGE

1. Service

A. General

1. Other than the work outlined under periodic inspection, no work will be necessary unless difficulty is found or reported.

B. Douglas

1. The fuselage skin and supporting members consist of 24 ST Alclad sheet and 24 ST bulb angles. The fuselage is of a semi-monocoque construction and considerable load is carried by the skin. Consequently, any holes in the skin or the nacelle materially reduce the strength of the adjacent structure and must be repaired before the plane is allowed to proceed. Repairs will be made in accordance with Section "Repairs" of this chapter.

2. Repairs

A. Douglas

1. Holes, cracks or dents which cover less than a single section of skin bound by four adjacent bulb angles may be repaired in the field, provided the bulb angles are not damaged, and the replacement of heat treated rivets is not required. Before repairing damage which involves more than one single section of skin bound by four adjacent bulb angles, a bent or damaged bulb angle or bulkhead, or the repair of any portion of metal necessitating the replacement of heat treated rivets, the Engineering Department in Chicago will be contacted and given the location and a complete description of the damage, so that material and specifications may be supplied for a satisfactory repair.

2. Holes or cracks will be repaired by use of Alclad 24 ST of the same thickness as the metal surrounding the damaged area. The jagged edges of a hole will be trimmed out and smoothed up with a fine file in order to prevent cracks caused by "oil-canning" of the skin surface. Before a crack is repaired a small hole will be drilled at each end to prevent the crack from progressing further.

3. Rivets used on the Douglas planes are of two types: (1) A17ST rivets, which may be identified by the small depression in the center of the head, are used in general throughout the fuselage except at points which are highly stressed. These rivets do not require heat treatment; (2) 17ST rivets requiring heat treatment are used at highly stressed points and may be identified by a small raised tit located on the center of the head. Size, material, type, and spacing of rivets will be governed by and conform to those located in the nearest adjacent bulb angle. In no case will rivets be closer to the edge of a sheet than twice the diameter of the rivet shank measured from the center of the rivet hole to the edge of the sheet.

4. Damaged areas which cover more than one-half of a single section of skin will be repaired by cutting out the skin to within one inch of the four adjacent bulb angles and replacing the entire single section, using the rivet holes in the bulb angles for securing the patch. Damaged areas involving less than one half of a single section will be repaired by installing a suitable rectangular patch extending, if possible, one inch in all directions beyond the damage.

5. Skin patches will have the corners rounded and the edges smoothed down with a fine file and the four edges of the patch will be bent very slightly (not over .015") towards the side facing the fuselage so that a tight fit around the patch will be obtained.

6. After the patch is riveted in place, a small amount of Lionoil will be worked in between the patch and the main fuselage skin from the inside for the purpose of making a water tight repair.

7. Small holes of 3/16" or less may be repaired by drilling and driving a single rivet in the hole.

8. Screws used to secure line covers on fuselage must not be too long as they will go through and puncture the lines.

3. Retouching paint on fuselage.

A. Touching Up.

1. Dampen a rag in alcohol and carefully clean the unpainted surface and also a small portion around the bare spot. Do not use an excessive amount of alcohol or prolong the cleaning process on the surrounding paint or the paint will become blistered.

2. Mix four parts paint to one part clear synthetic enamel, apply by means of a soft paint brush and allow to dry. Black enamel when used will be applied without mixing with the clear enamel.

B. Spraying.

1. Cleaner to be used shall be a mixture of one ounce of phosphoric acid in one gallon of alcohol. (The acid may be obtained from a local pharmacy).

2. Mask off the area to be cleaned for painting - this should, where possible, extend in each direction to the nearest rivet line. The cleaning solution shall be applied by dipping a small hand brush into the solution and then thoroughly scrubbing the area to be painted, extra care being taken to remove all the dirt and grease around the rivet heads, screw heads and seams. Follow up with a clean rag dampened with alcohol and then with a clean dry rag. The surrounding paint should be cleaned with the solution without scrubbing and dried as quickly as possible in order to avoid blistering.

3. The paint to be applied shall be Glidden synthetic enamel and shall be mixed one part clear synthetic to four parts paint. The above combination shall then be reduced four parts enamel to one part #22144 reducer for spraying. Glidden synthetic black shall be used without the addition of the clear synthetic.

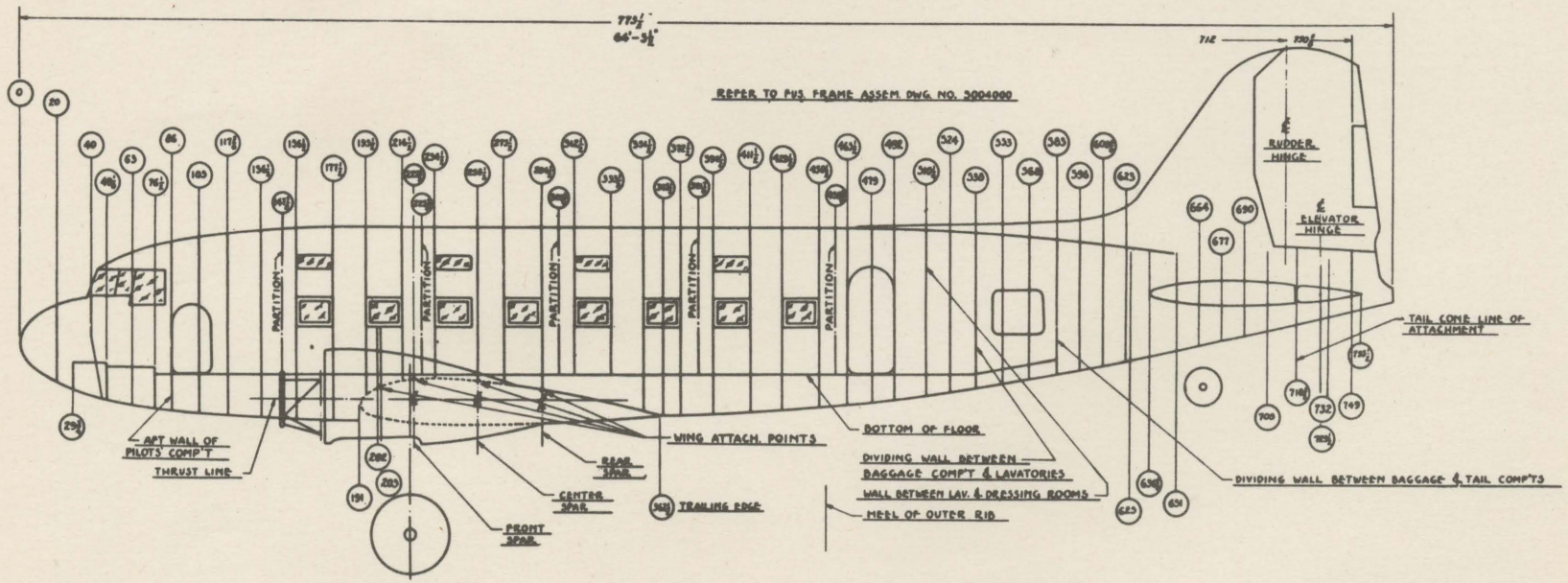
4. Spray a normal coat over the unpainted surface and after 15 minutes take the same enamel and reduce it one part enamel to one part #22144 reducer. Apply a thin mist coat over the entire masked-in area. This will cause the fresh paint to blend in with the old painted surface.

5. The numbers of the Glidden synthetic enamels are:

1.	Blue	39609
2.	Red	39643
3.	White	39644
4.	Clear	45206
5.	Black	39951
6.	Reducer	22144

6. Pure Solox (which does <u>not</u> contain glycerine) may be used wherever the above instruction calls for alcohol.

7. The percentage of acid used makes a very weak solution with much less strength than acetic acid and will not cause harm to the skin.



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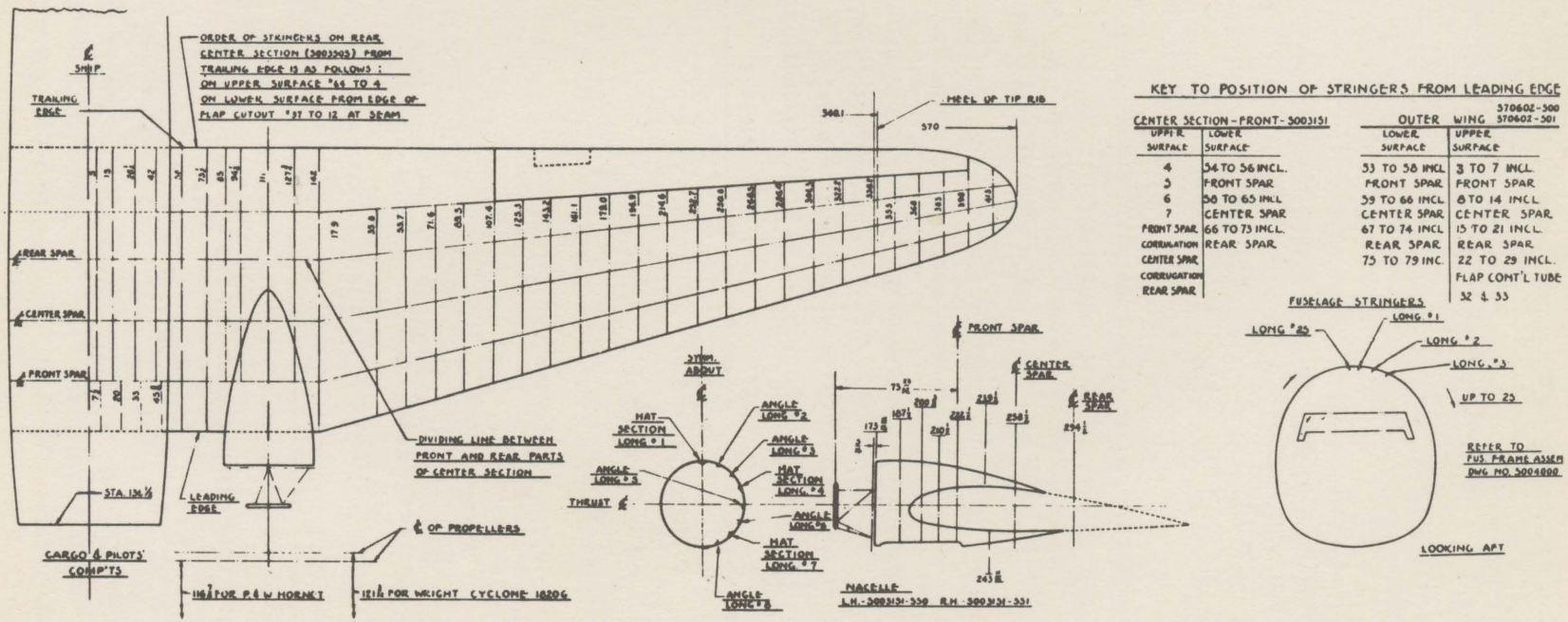
DC-3 FUSELAGE STATIONS



KEY TO POSITION OF STRINGERS FROM LEADING EDGE

CENTER SECTION - FRONT - 3003151

UPPER SURFACE	LOWER SURFACE
4	54 TO 56 INCL.
5	FRONT SPAR
6	58 TO 65 INCL
7	CENTER SPAR
FRONT SPAR	66 TO 73 INCL.
CORRUGATION	REAR SPAR
CENTER SPAR	
CORRUGATION	
REAR SPAR	

OUTER WING 3706G2-500 3706G2-501

LOWER SURFACE	UPPER SURFACE
33 TO 38 INCL	3 TO 7 INCL.
FRONT SPAR	FRONT SPAR
39 TO 66 INCL	8 TO 14 INCL
CENTER SPAR	CENTER SPAR
67 TO 74 INCL	15 TO 21 INCL.
REAR SPAR	REAR SPAR
75 TO 79 INC.	22 TO 29 INCL.
	FLAP CONT'L TUBE
	32 & 33

FUSELAGE STRINGERS

DC-3 CENTER SECTION AND WING STATIONS

CABIN

A. Buffet

1. The locks and latches on the buffets and various cabin doors need constant attention to maintain them in satisfactory working order. The buffet doors of the DC3-A planes should be inspected at each regular check and their locks repaired or replaced as necessary.

2. A complete set of eight cargo tie-down straps should be neatly coiled and placed in the former valuables compartment of the buffet.

B. Lining

1. Occasionally it becomes necessary to patch a hole or tear in the fabric lining of the cabin. This may be done by doping a small pinked patch over the damaged spot using acetate dope--under no circumstances should nitrate dope ever be used for this purpose.

2. The lining installed in the companionway and cockpit is "Koroseal fabric" felt insulation 1/4" thick. This lining is flameproofed, and dopes and paints must not be used on it.

C. Window Curtains

A close check should be kept on all cabin window curtains. Tears shall be sewn and missing buttons replaced. If station is temporarily out of stock, thread and buttons may be purchased locally.

D. Chair Operating Mechanisms

Caution should be observed, when working around the mechanism, to prevent bending the spring steel strap, as any bend sufficient to cause a permanent set or wrinkle will greatly reduce the tensile strength of the strap.

E. Wash Basin

Prior to dispatch the water supply tank must always be filled.

(1) If leaks are found in the system at the time the tank is filled, the crew chief should be notified so that necessary steps can be taken to correct. The tank, supply line, and faucet shall always be checked for leaks and proper operation at each regular service check.

(2) During cold weather, hot water shall be placed in the supply tank just prior to departure of an originating trip and the heater switch shall be placed in the "ON" position. The heater switch should remain in the "ON" position as long as the plane is enroute. It will not be necessary for Service Stations to drain any of the DC-3 21 passenger tanks while the plane is enroute but they shall check the water level and replenish with hot water when necessary.

F. Interior Painting

(1) Major service stations shall touch-up cabin interiors as required to keep them in presentable condition.

(2) The following paints shall be used for cabin interior touch-up:

Fuller #TL451 - Light Blue Lacquer - for window frames - Thin with 50% Lacquer Thinner.

Fuller #TL509 - Dark Blue Lacquer - for lavatory and magazine racks - " " " "

Dupont #258-38242 Purple Duco - Top shade in lavatory - " " " "

Dupont #258-38241 Purple Duco - Second shade from top in lavatory - " " " "

Dupont #258-38240 Purple Duco - Third shade from top in lavatory - " " " "

Dupont #248-38239 Purple Duco - Fourth shade from top in lavatory - " " " "

Acme #800 White Lacquer - Buffet paint - " " " "

Fuller #TL8533 - Light Blue Acetate Dope - for ceiling of cabin - Thin with 40% acetate Thinner.

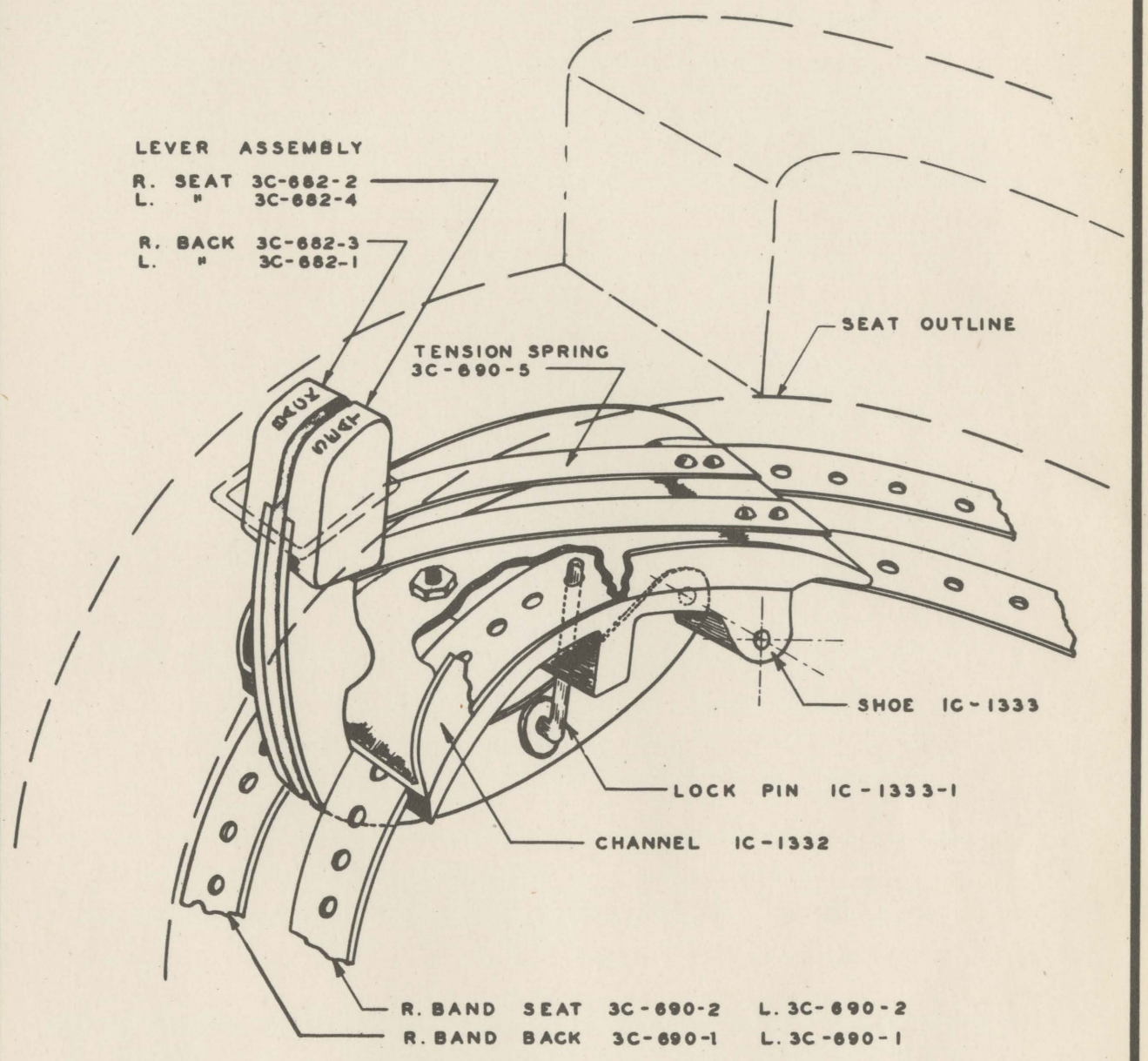
Dupont #212-DST-7 - McDonald Gray - For side walls in cabin - Thin with 40% acetate Dope

Dupont #258-38069 - McDonald Gray Lacquer - For bulkheads - Thin with 50% Lacquer Thinner

G. Cabin Window Frost Shields

1. Carefully remove the cambric tape and press the rubber strips firmly in place on the cabin windows.
2. It is not necessary to use cement of any kind when installing these shields.

NOTE: It is very important that the window glass be perfectly clean before the installation of frost shields.



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CABIN SEAT RECLINING MECHANISM

WINGS 12

WINGS

1. Replacement

A. Douglas

1. Occasionally it becomes necessary to replace a wing tip in the field. Nearly all replacement tips sent out by the Repair Base will have blank attaching and doubler strips, and it will be necessary to locate the attaching holes when the tip is being installed. The blank portion of the tip is equipped with doubler strips which equal the combined thickness of the original doubler strip and wing skin. Therefore, it is not necessary to locate the new holes directly in the center of the original attaching holes. When installing a reworked tip it may be necessary to trim the upper or lower doubler strip slightly to allow the tip to align itself with the main wing, and have a good butt joint between the tip and wing skin.

2. When a wing tip is replaced it is sometimes found that the outboard aileron hinge of the replacement tip does not align properly with the aileron. It is possible to spring an aileron tip slightly to engage the hinge bolt. If the aileron is then in proper alignment it is OK, but if it is warped, it will be necessary to install a blank fitting and drill the holes when the aileron is straight. One set of blank left and right hand hinge fittings are being assigned to SF, CG and LG for use when needed. Outlying stations requesting a wing tip shall also order a blank hinge and if it is not used, return it with the old tip.

2. Repair

A. Douglas

1. Douglas planes have stressed-skin wings, and in no case will a plane be dispatched with even a small hole or crack in either the upper or lower surface. The skin on the under side of the center section and wing between the #36 outer wing stations forward of the rear spar and rear of the front spar will never be spliced or patched. A hole or crack in this area will necessitate grounding the plane until a complete panel can be replaced.

2. An area other than that stated in (1) above may be patched provided that instructions given under "Fuselage Repair" in this manual are adhered to.

EMPENAGE 13

EMPENNAGE

1. Service

A. No service other than that outlined in periodic inspection is necessary unless trouble is reported or found.

B. Mechanics shall not lift up or push down on the elevators or on any of the control surfaces to line up the controls for installation of the control surface blocks while the automatic pilot is engaged. This will cause damage to the trailing edge of any of the surface controls, as they are not stressed to support these loads.

2. Repairs

A. Small holes in the fabric covering shall be patched by doping on a small round pinked fabric patch.

B. Large holes should be covered with square or rectangular patches, with the patch covering the entire damaged area. When repairing an L-shaped tear, the old fabric should be taken out and the edges trimmed, and a square or rectangular patch with round corners placed over the entire hole. A single patch should be used to cover a given damaged area.

C. The patch should overlap the hole by at least 2" on all sides, and whenever possible the edges of the patch should terminate under the adjacent reinforcing tape.

D. Apply nitrate dope around the edge of the damaged area and apply the fabric patch. Allow to dry and apply another coat of dope around the edges of the patch only. After the second coat has dried, the entire surface may be doped again. This procedure enables the center of the patch to shrink and draw the fabric to its correct tension. If time permits, the area should be painted, but if impossible to do so, the patch may be smoothed up with fine sandpaper and allowed to remain in service until time is available for the painting of the patch.

E. Metal Repairs

A. The same instructions for patching and repairing as outlined for fuselage will apply to the empennage, except that the rivet spacing will be identical to those located on the next in-board rivet line between the damaged area and the fuselage.

FLIGHT CONTROLS 14

FLIGHT CONTROLS

1. Service

A. Under no circumstances will any of the control cables, fair leads, or pulleys be oiled or greased, as this procedure causes dust and dirt to collect and form an abrasive material which will rapidly wear the cables, guides, and pulleys.

B. Service personnel should be constantly on the lookout for frayed or rusted cables. Cables with small rust spots may be allowed to remain in service provided they are cleaned by means of a cloth saturated in cleaning solvent. After the cleaning has been accomplished a dry cloth will be used and the cable rubbed briskly to dry off excess fluid. It must necessarily be left to the judgment of mechanical personnel whether a cable with a rusted area may be left in service or not, but if a cable is rusted to a point where strands are likely to break, and in general an unsafe condition is indicated, the cable must be replaced before the plane is allowed to proceed.

2. Replacement

A. Replacement surface control cables may be obtained from the repair base on short notice, and when ordering a given cable for replacement, the exact location, size, and length should be given to insure securing the correct replacement cable. These parts should be ordered by telegram or telemeter to eliminate confusion and the possibility of securing the wrong part.

3. Adjustments

A. It is intended that the major part of our rigging of the control surfaces will be accomplished at the repair base. However, in some cases it is necessary for stations either to inspect rigging dimensions or to change them slightly. If more than two reports are made by different pilots concerning the rigging of the control surfaces, they shall be inspected for proper rigging, and adjustments will be made if necessary, to insure good flying qualities of the airplane.

B. Before any adjustments are made at a service station, a thorough analysis of the trouble should be made by contacting the pilot of the trip in question and discussing the trouble with him. It should be borne in mind that an airplane improperly loaded will give the same symptoms as an airplane on which the controls are mal-adjusted. If information is not available as to whether or not the plane was loaded properly and the pilot cannot give specific symptoms of the trouble, the plane should be loaded properly and test-flown in order to determine the cause of the undesirable flying characteristics.

C. Mechanics familiar with the rigging procedure of our planes will be assigned the job of making any necessary adjustments.

D. Rigging Procedure

The manufacturing tolerances of the various bellcranks and units of the control system make it impossible to rig all airplanes exactly the same, and in rigging the airplane these variations should be taken into consideration and the three general rules listed below should be remembered.

1. The tension of the control system cables should be tight enough to prevent sloppy control, but should not be tight enough to distort or strain the pulley bracket mountings, especially where cables go around corners.
2. The control surface travel should conform to within the limits as listed in the following pages.
3. In order to prevent the formation of ice on the leading edge of the ailerons, they will be adjusted so that the specified droop may be obtained. Care should be taken that the cables are not sloppy, as otherwise the ailerons will not maintain the desired position when the plane is in level flight.

E. The airplane will be rigged while resting in the three-point ground position and shall conform to the measurements given below.

1. Aileron Adjustment - Douglas

Set control wheel in neutral position, center the chain, and adjust cables (from control column to main bellcrank) until the bellcrank arms are at right angles to the airplane's center line. Adjust outboard cables in wing to bring bellcrank cable arms perpendicular to rear spar. Connect the inboard aileron actuating push-pull rod to each aileron and adjust the rods to bring ailerons to "neutral" position.

NOTE: Both ailerons in "Neutral" position should droop zero to 5/8" at the trailing edge, measured from the trailing edge of the wing after ailerons and cables have been rigged. Connect the outboard aileron actuating push-pull rod. Adjust it to allow bolt to drop into place through clevis and fitting on aileron. To tighten cables, rotate turnbuckles clockwise when facing toward front of airplane or when facing inboard. Measurements are taken at the trailing edge of the wing and the inboard end of the aileron and tab.

Ailerons	Inches	Aileron Tabs	Inches	Degrees
Uptravel	-12 11/16" to 13"	Uptravel -	2 ± 1/8	$12\frac{1}{2} \pm \frac{1}{2}^{0}$
Downtravel	- 7 (Min.)	Downtravel -	2 ± 1/8	$12\frac{1}{2} \pm \frac{1}{2}^{0}$

NOTE: The uptravel should be held to 12-11/16 to 13 inches. The Aileron downtravel will vary with each airplane.

Aileron droop should be 0 to 5/8".

1A. When airplanes are reported wing heavy in flight, the aileron trim tab indicator shall be set to neutral, with the tab set as required. This shall be done by:

1. Setting the tab to allow the plane to fly "hands off".
2. Leaving the tab in this required position, and then resetting the indicator to neutral.

NOTE: A total of, but not to exceed 3^{0}, shall be allowed between the actual setting of the tab and indicator.

2. Adjustment of Elevator - Douglas

With the elevator set in neutral position and the control column in its neutral position (13° forward of the vertical) adjust both front and rear turnbuckles for equal tension in the cables. Set the stops on the control column for the proper movement of the elevators which is 30° upward and 20° downward.

NOTE: After stop adjustments on control column are made, adjust elevator horn stops to correspond. To tighten cables, turn turnbuckles clockwise when facing toward front of airplane. Measurements are taken at trailing edge of elevators on inboard end adjacent to tail cone.

	Elevator			Elevator Tabs	
	Inches	Degrees		Inches	Degrees
Uptravel	- 12 ± 1/8	30 ± ½°	Uptravel	- 1-3/8 ± 1/8	10 ± ½°
Downtravel	- 8 ± 1/8	20 ± ½°	Downtravel	- 1-7/8 ± 1/8	14 ± ½°

NOTE: Set cockpit indicator 2° nose down when rigging Elevator tabs to zero angle.

3. Adjustment of Rudder - Douglas

With rudder and pedals in their neutral positions, adjust both rear (2) and front (2) turnbuckles for equal tension in the cables. Set the stop on the rudder pedal assembly for the proper movement of the rudder, which is 27" either side of neutral. The rudder stop cables are tightened to give a throw of 26-1/4" after adjusting the stops at the pedals to 27".

NOTE: To tighten cables, turn turnbuckles clockwise when facing toward front of airplane. Measurements are taken at trailing edge of rudder on lower end adjacent to tail cone.

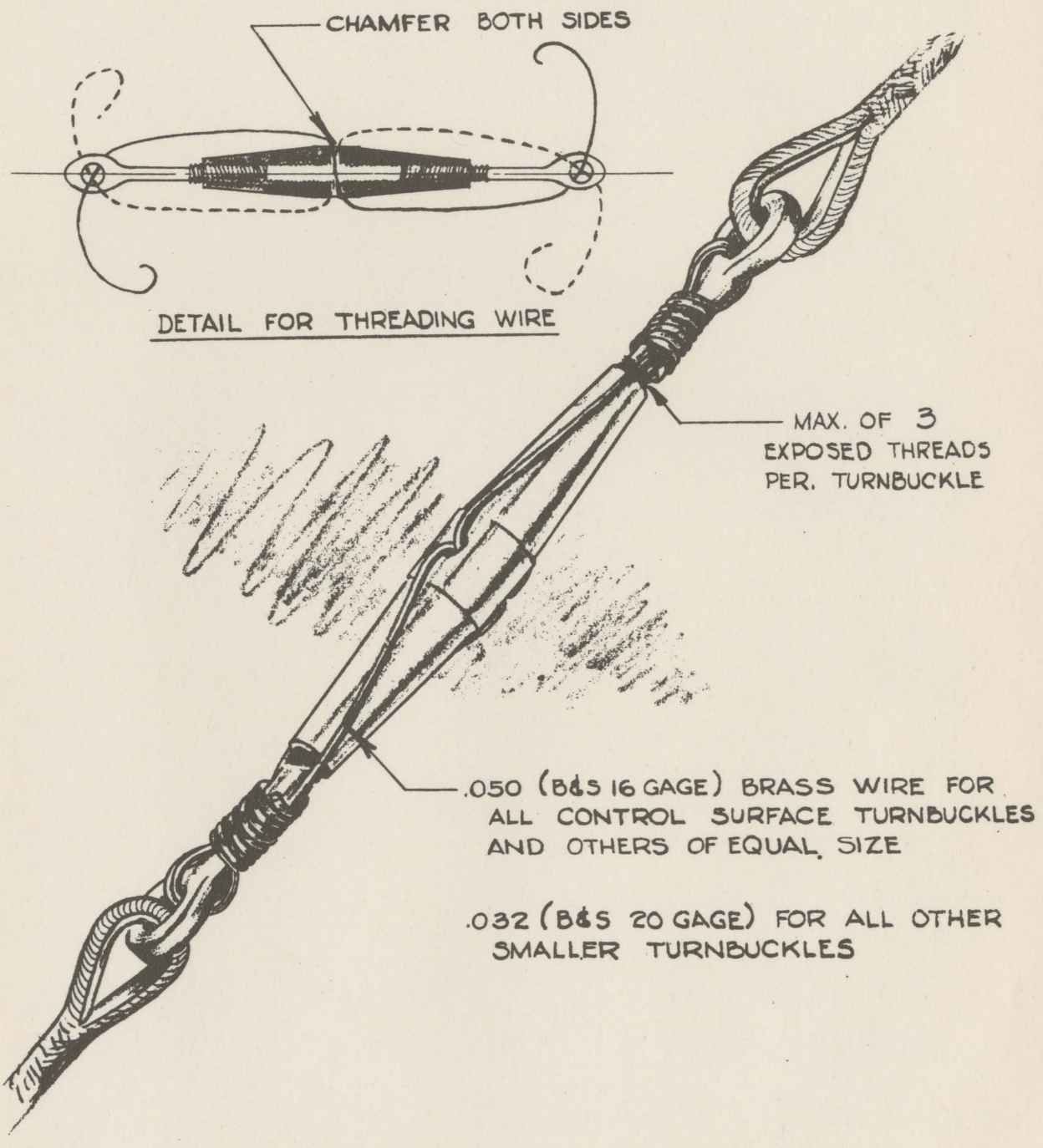
	Rudders			Rudder Tabs	
	Inches	Degrees		Inches	Degrees
Left Throw	- 27 ± 1/4	30 ± 1°	Left Throw	- 2-3/4 ± 1/8	12 ± ½°
Right Throw	- 27 ± 1/4	30 ± 1°	Right Throw	- 2-3/4 ± 1/8	12 ± ½°

F. Turnbuckle Safetying

The diagram on the following page shows the method of safetying turnbuckles, which is the UAL standard for all planes. No other method or material shall be used.

G. Clevis and Rod Adjustment

Control clevis fittings have a 1/16" drilled test hole in the barrel. When adjusting these clevis and rod assemblies, the threads of the rod must cover the test hole. When the clevis is adjusted, try to pass a small piece of safety wire through the hole. If it will go through, the rod must be screwed farther into the clevis, or a longer rod must be used.



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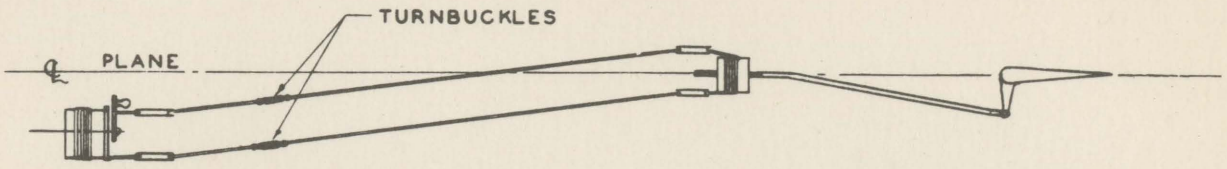
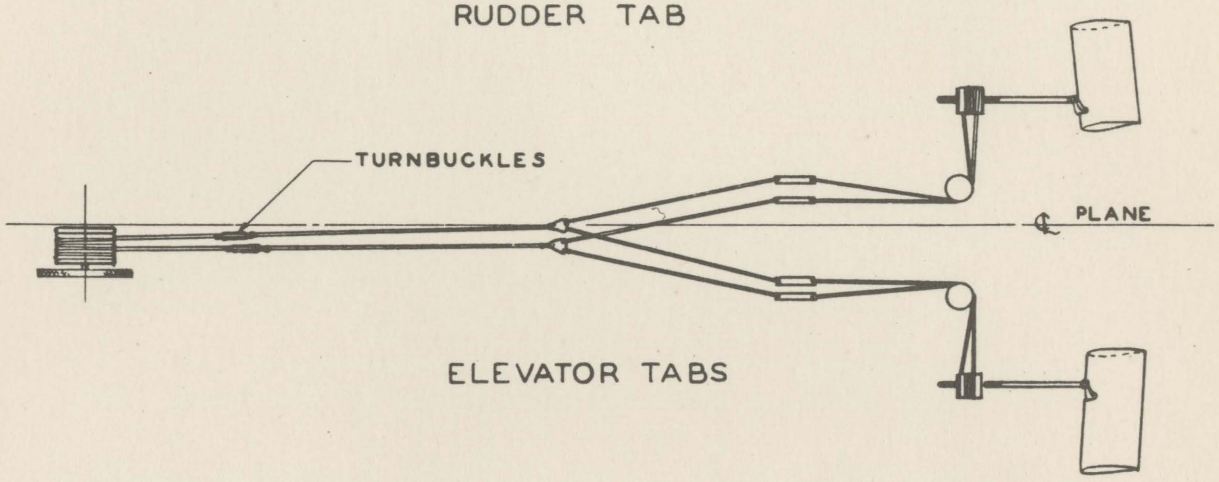
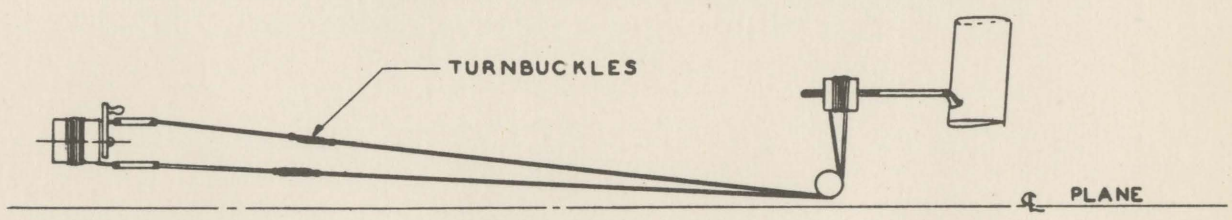
APPROVED METHOD FOR SAFETYING TURNBUCKLES



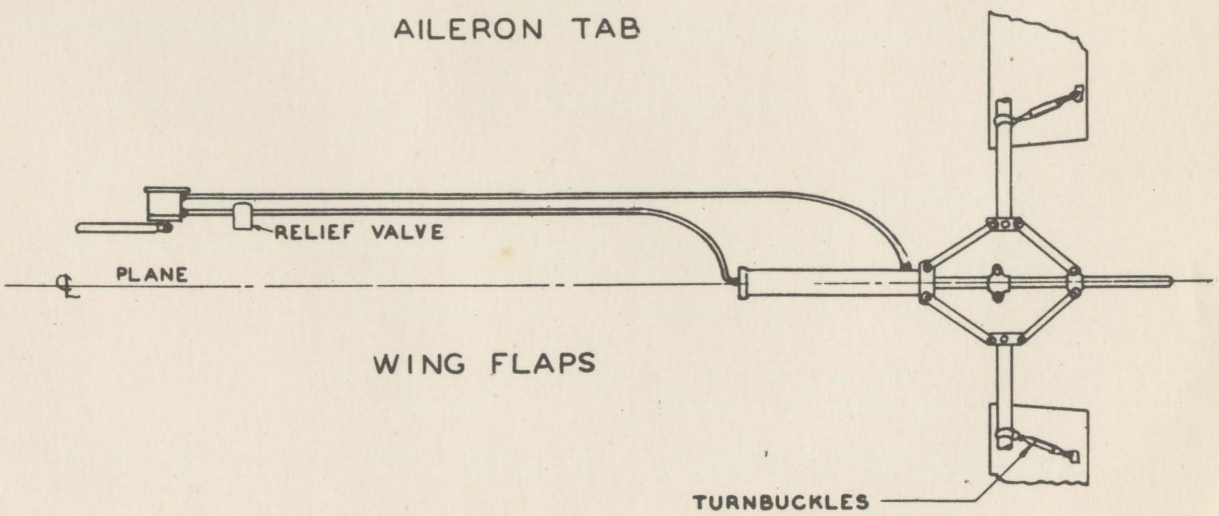
RUDDER TAB



ELEVATOR TABS



AILERON TAB



WING FLAPS

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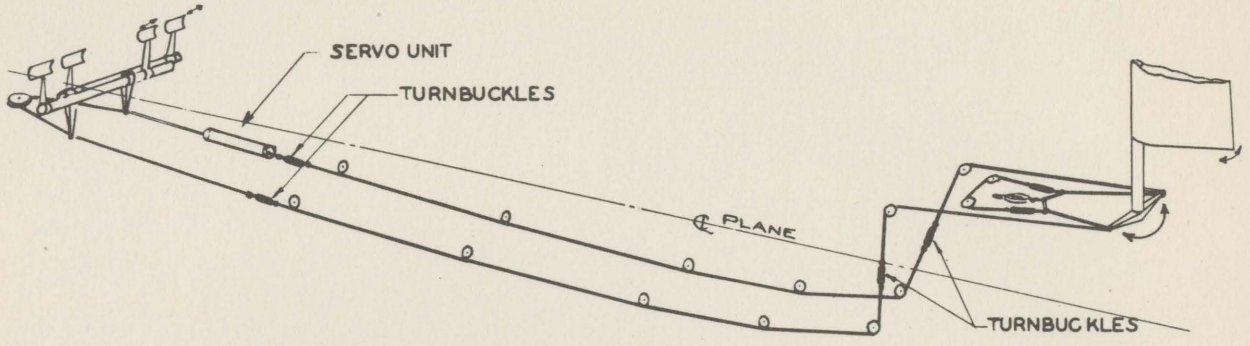
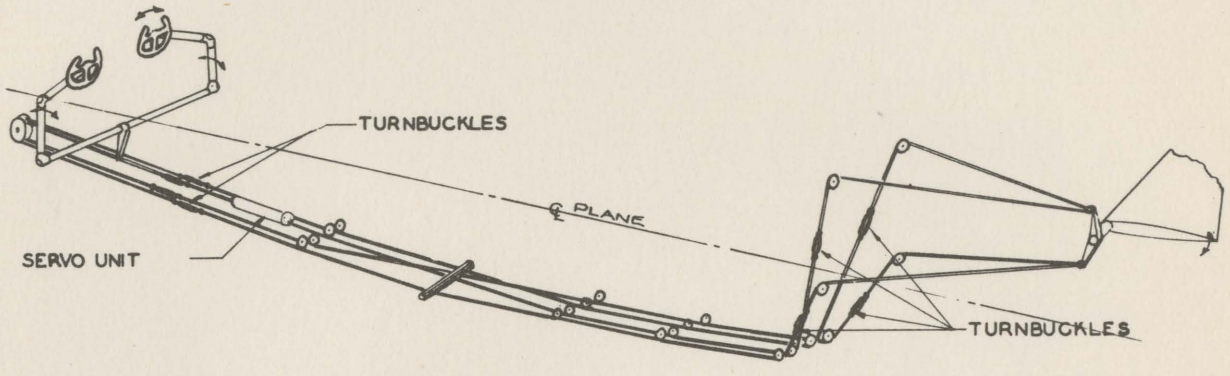
JSS 95827

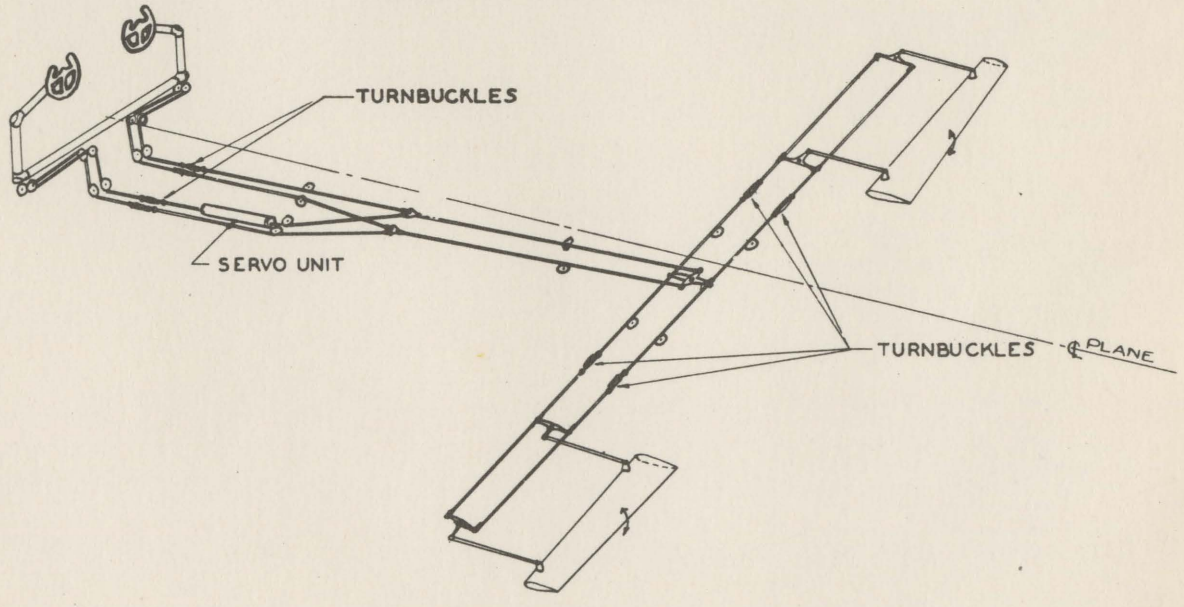
DC-3 CONTROL SURFACE TRIMMING TABS AND WING FLAPS



RUDDER CONTROLS



ELEVATOR CONTROLS



AILERON CONTROLS

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CONTROL SURFACE CABLES DC3-A AND DST-A

HYDRAULIC SYSTEM - DOUGLAS

1. SERVICE

A. No work will be necessary except as listed in periodic inspection, unless trouble is found or reported.

B. Trouble Shooting and Corrections

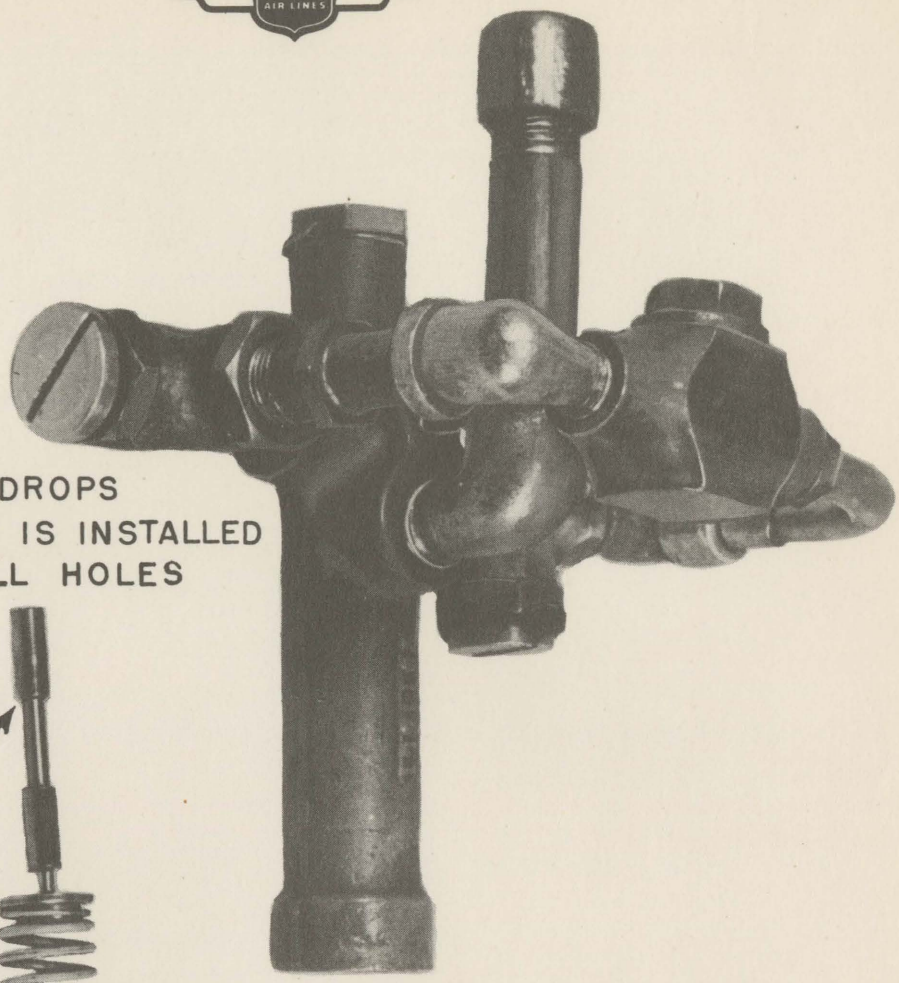
1. The main trouble with which we have to contend in the hydraulic system is limited mostly to leaks in the various units or lines. This must be watched for constantly, and if a plane arrives and an excessive amount of hydraulic fluid has leaked from the reserve tank, the cause of the leak shall be determined and corrected before the plane is allowed to proceed. Wherever hydraulic units and lines are located, a general inspection should be given for signs of leaking hydraulic fluid. If the leak cannot be found, the most probable cause is due to an engine driven hydraulic pump which, if the oil seal becomes defective, passes hydraulic fluid directly into the engine.

2. Pump up 500# hydraulic pressure in the system by means of operating the hand pump. Then operate each control individually, allow to remain in this position a few minutes and note whether the pressure remains in the system. If the hydraulic fluid pressure drops and the fluid on the sight-level gauge of the reserve tank shows that oil is not going back to the reserve tank, a leak is indicated in the system which is under test.

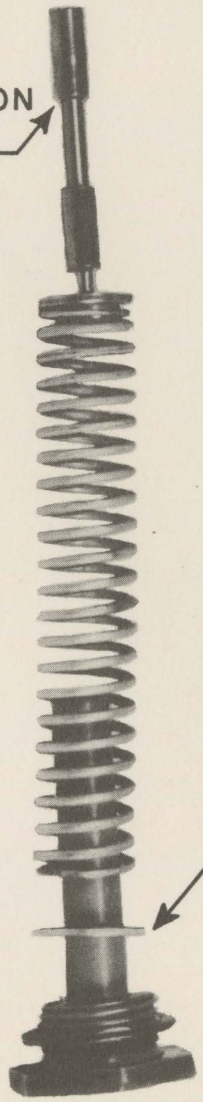
3. Occasionally, a report is made indicating that the hydraulic system hand pump actuating lever rises to the "Up" position, after having been left in the "Down" position. This indicates a leak in the forward check valve on the hydraulic hand pump, and also a leak in the check valve within the pump or leaking Piston Packings. This is not an objectionable feature, but the check valve on the forward side of the pump should be changed at the first opportunity.

4. It is possible, but very improbable, that the 600 to 800# pressure regulating valve will stick and prevent the building up of hydraulic pressure. In a case of this kind try each hydraulic pump on the auto-pilot to make sure it is operating and delivering fluid. Then operate an engine pump on the hydraulic system and if fluid pressure does not build up in the system (provided there is no loss of hydraulic oil) indications are that the regulating valve has become stuck. Tap it with a small fibre mallet and if it does not resume normal operation, it must be replaced.

5. The hydraulic hand pump shut-off valve, commonly called the Star Valve, should remain in a closed position at all times, except when testing, or when it is desired to build up pressure in the hydraulic pressure tank by hand. A small bleed hole is located in the valve core to provide a balance of pressure between the pressure manifold and the pressure supply tank. If the bleed hole were not located in this Star Valve, it would be possible to build up a dangerous pressure in the pressure manifold, because of the fact that a check valve is located between the manifold and the pressure supply tank which prevents a reverse flow of fluid from the manifold to the pressure tank. This valve may



IF THIS PISTON DROPS OUT BE SURE IT IS INSTALLED WITH THE SMALL HOLES UNDER THIS SHOULDER IN THE UP POSITION



PERMISSABLE TO INSTALL 1 EA. $\frac{7}{16}$" DIA. PLAIN WASHER UNDER SPRING

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WING FLAP RELIEF VALVE

be tested to determine if the bleed hole is open, by closing the Star Valve and exerting a considerable force on the hydraulic pressure hand pump lever, and noting the hydraulic system pressure gauge. A slight jump of the hand will indicate that fluid is passing through the bleed hole.

6. To correct a report of improper automatic pilot oil pressure, an engine should be test run and the automatic pilot engaged with all speed valves closed. The cap should be removed from the gyro pilot relief valve, and with the pump on the engine being operated connected to the autopilot system, the relief valve adjusting screw will be turned until the proper operating pressure is indicated on the auto-pilot oil pressure gauge.

7. A report that the wing flaps will not extend to their full down position, even though the plane is below 112 miles per hour, indicates that the wing flap relief valve is by-passing fluid. This condition can, in most cases, be remedied by installing a 7/16" dia. plain washer 1/16" thick under the spring in the valve if the flaps retract at 90 to 100 MPH. No more than one washer shall be used. If this does not remedy the trouble, replace the relief valve assembly. The relief valves are set during overhaul to relieve at 390 lbs. per square inch. Adjustments in the field should not be attempted on this valve unless proper equipment is available for the purpose. (See sketch for proper installation of 1/6" thick washer).

C. Pressure Accumulators

1. At the present we have two different types of pressure accumulators in our Douglas planes; the cylinder type, and the spherical type.

2. In order to service and trouble shoot these accumulators properly, it is necessary to understand their operation.

3. Cylinder Type

(a) The cylinder type pressure accumulator consists of machined chrome molybdenum with screw capped ends. A piston rod sealed with suitable packing glands is attached to a piston which moves up and down in the cylinder as the pressure changes.

(b) This unit may be tested quickly by pumping up 500# pressure on the hydraulic system and operating the wing flaps. If the pressure drops suddenly, when the brakes or other units of the hydraulic system are used, it indicates that there is insufficient air in the air chamber, and also that the air has probably escaped past the piston packing and is trapped in the lower portion of the hydraulic cylinder. If a spare cylinder is available it should be installed; otherwise complete operations (c), (d) and (e) following.

(c) Normally there is carried in the upper portion of the cylinder, a half pint of hydraulic oil to seal the piston packings and to prevent the escaping of air. If the foregoing test indicates trouble in this unit, first release air pressure, then unscrew the Shrader Air Valve housing,

and by means of the hydraulic hand pump force fluid into the lower portion of the cylinder until the piston rod is all the way up. During this operation, a suitable container should be held under the air valve fitting, because if the piston packings have been leaking, it is possible that oil will be ejected from the air filler fitting. (NOTE: Always replace the valve core with a new core of approved type, see SPA book).

(d) Replace the air valve housing and air valve in the upper portion of the cylinder. Connect the pneumatic booster pump to the air valve fitting and build up pressure in the air chamber. As the pressure is being built up, operate the wing flaps to extend the piston rod bleeder cap to a point in line with the arrows indicated on the forward cargo compartment wall below the pressure cylinder. When the bleeder cap has reached this point, place all valves in neutral. Continue to raise the air pressure in the upper portion of the cylinder until the hydraulic system pressure gauge reaches 320# per square inch. Disconnect the booster pump, test the valve, and install the cap on the valve fitting.

(e) Remove safety valve on bleeder cap, and while holding a container under the bleeder cap back off until fluid or air emits from the bleeder hole. When a solid flow of fluid comes from the bleeder hole, it indicates that all air has escaped from the lower portion of the pressure cylinder. Tighten and safety bleeder cap.

4. Spherical Type

(a) The spherical type pressure accumulator is mounted in approximately the same location as the cylinder type and consists of a heavy metal sphere divided in the center by a heavy synthetic rubber diaphragm. The upper portion is occupied by hydraulic fluid when the system is under pressure and the lower portion is occupied by air pressure. Very little difficulty is encountered with this unit, but it should be tested regularly for having the correct air pressure.

(b) To test the air pressure, pump up approximately 350 to 400# pressure in the system. Then by operating the wing flaps, drop the pressure in the accumulator. The air pressure in the accumulator will be indicated on the gauge at the moment just before the pressure gauge drops to zero. If the air pressure is below 250# it should be raised to this figure by use of the pneumatic booster pump, the pressure being tested at intervals as is outlined in the fore part of the paragraph. In case the rubber diaphragm becomes ruptured, pressure will build up and be exhausted with just a few seconds of operation and the only alternative is replacement of the entire pressure accumulator.

D. Cowl Flaps

The restriction fittings in the cowl flap lines which are located in the wheel wells on rare occasions become plugged. These fittings are installed in the cowl flap lines just before they pass from the wheel wells into the center section.

When the cowl flaps are reported as sticking, not opening or closing and no other cause can be found, disconnect the restriction fittings and flush the lines out by operating the cowl flap valves. If the holes in the fittings are plugged, clean out with a 1/64" drill (.0156", No larger), and reinstall fittings.

E. Acrotorque windshield wipers

Description & Operation (Refer to diagrams)

The complete windshield wiper assembly consists of:

1. A hydraulically-operated motor, with needle valve for speed control.
2. An Ahrens Control enclosed in a steel tube.
3. A window control housing assembly mounted just aft and to the lower side of the windshield.
4. A windshield wiper arm and blade.

When the windshield wiper is in operation, it receives hydraulic system oil at the prevailing pressure taken from a tee connection at the hydraulic system pressure gauge, thence into the needle valve through a restriction having #60 drilled hole As the oil enters the motor, it operates a piston back and forth, as can be seen from the diagram. As the piston completes the full travel of a stroke, it contacts a spring loaded valve reversing assembly, which diverts the fluid flow so that pressure is applied to the opposite face of the piston and causes it to be moved back again. After the oil has served its purpose, it is routed through the gyropilot hydraulic oil return line. In the present unit, lubrication is supplied to the Ahrens control and window control assembly by leakage in the motor where oil leaks up through a hole in the drive shaft and out to the window control assembly through the Ahrens control tube. To prevent this oil from leaking forward and onto the windshield, there is a small neoprene washer directly underneath the triangular shaped wiper mounting plane assembly located on the forward side of the windshield.

Service

#1 Check - No work will be necessary unless difficulty is reported.

#2 Check - Visually inspect the motor, Ahrens control, drive head, and lines for hydraulic leaks. This shall be done by operating the motor. (CAUTION: To do this, it will be necessary to wet the windshield with a sponge saturated in water or by other similar means. Never operate wiper blade on dry glass.) While the blade is operating, take particular notice to see that the blade is contacting the windshield throughout its length and that the distance from the blade to the lower windshield frame is approximately equal for both extremes. The wiper blade must not contact the lower frame of the windshield in either of its extreme positions. If it does, it indicates that the Ahrens control is broken or that the wiper arm is out of time with the drive motor. Take particular notice to see that no hydraulic oil is leaking out around the shaft on the forward side of the windshield. Turn valve "off" and

inspect the rubber of the blade to see that it is not damaged or cracked. If the wiper does not make a clean sweep throughout the full arc of operation, the wiper blade is either worn out or, if in good condition, the wiper arm may not be set to the proper pressure. Snug up the packing nut on the needle valve if necessary.

#3 Check - In addition to the inspections called for under #2 Check, test the pressure of the blade on the windshield as follows: by use of 0 to 64 oz. spring scale supplied to all Service Stations, engage the hook under the wiper arm at the center portion of the wiper blade. Lift up until blade just leaves windshield. At this point the spring scale should read 24 oz. If the reading varies more than + or - 2 oz., the pressure must be adjusted by means of the screw at the base of the wiper arm assembly.

Replacement - For Cause

Wiper Blade

Remove the two cotter pins securing the wiper blade assembly and install new blade and resafety. Whenever a new blade has been installed, it will be necessary to test the pressure of the blade on the glass and adjust if necessary, as shown under #3 Check.

Wiper Arm

Disconnect the center pivot of the windshield wiper blade from the arm and remove the acorn nut securing the wiper arm on the shaft. Connect the new wiper arm to the center pivot of the wiper blade and turn on the valve operating the hydraulic drive motor. Operate the unit very slowly until the serrated drive shaft has reached its full travel, which can be determined by a click noise in the hydraulic motor. Stop motor immediately and install wiper arm engaging the serrations to time the blade at the particular point where the drive shaft has stopped. When the blade is in the correct position, the outward end should be between 4 and 5 inches from the windshield frame. Tighten down acorn retaining nut and safety with the special lock by bending the locking ear up against the flat of the acorn nut and also the other ear down around the side of the wiper arm base. Loosen the tension screw at the base of the wiper arm and by holding up on the wiper blade to prevent it from touching the windshield, operate the wiper assembly very slowly by turning on the hydraulic valve to make sure that the wiper blade arc is centered with the windshield. Following this and by use of the spring scale, adjust the pressure of the blade on the glass.

Ahrens Control

If the Ahrens control is broken, operation of the wiper blade will cease while the motor can be heard to run. The Ahrens control must then be replaced as follows:

1. Loosen the Parker fittings on both ends of Ahrens control.
2. Remove the two screws which hold the drive head onto the motor.

3. Remove the Parker nuts, loosen and unscrew the Ahrens control from the drive head. Slide off the outer tube and remove the Ahrens control. Install new control in reverse order of disassembly. It is not desirable or necessary to screw the control in too tight. A good snug fit is all that is necessary.

4. It is now necessary to time the position of the motor drive with the gear in the motor drive head. This may be done as follows: On the motor drive square will be found two small punch marks on one side of the square. Line this up with the two punch marks on the head drive and engage the coupling. This may be done by operating the motor until the square drive on the motor turns to the position at which the punch marks are lined up on both squares. At this point the drive head may be slipped down to make contact with the motor. Install and safety the retaining screws and tighten the nuts on the Ahrens control tube.

5. Hold the wiper blade off the glass and operate the windshield wiper assembly very slowly to make sure that the arc of the wiper blade is centered on the glass. If it is not, it will be necessary to reset the wiper arm on the serrated drive shaft on the forward side of the windshield.

It should not become necessary for mechanics to disassemble the window control housing assembly, but in the event it is, it will be necessary to time the window control assembly in a similar manner to the drive head in order to synchronize the operation of the racks and pinions. All parts to be timed are punch-marked by two small punch marks, and they must be engaged so that they correspond as assembly progresses.

If any other portions of the windshield wiper assembly, other than those listed above, become defective, it will be necessary to tag the wiper assembly "inoperative". This shall be done by placing a tag on the windshield wiper motor stating "Inoperative" and turning the valve to the full "off" position. It shall then be necessary for the station tagging the wiper "inoperative" to arrange with the Repair Base for the supply and reinstallation of the parts to return the windshield wiper to normal operation within a day or two.

The most likely trouble with these wipers is that they occasionally leak hydraulic oil onto the forward side of the windshield. This may be corrected by installing a new #B16010 window control shaft seal. Care must be taken to see that the window control shaft bearing protrudes through the windshield frame 3/64"; otherwise, the seal cannot be expected to last long.

Occasionally oil will leak from between the motor and its drive head. Either the #A16014 seal needs replacing, or the drive head attachment screws are bottoming in the threaded holes in the motor before the head is tightened down. In the latter case, use washers under the screw head.

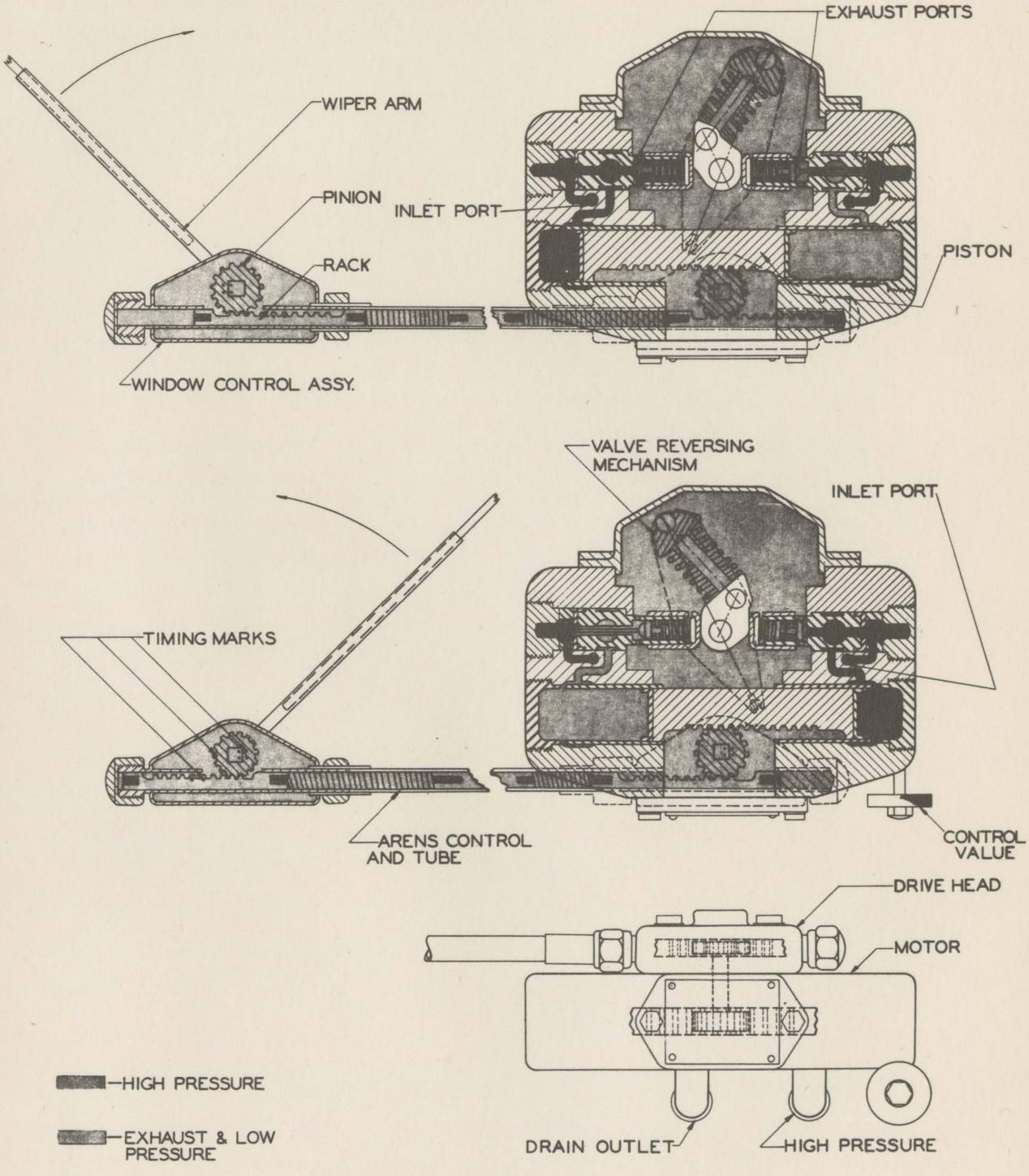
Leaks from the control valve are usually caused either by a defective packing, loose packing nut, or the high pressure oil from the hydraulic system connected to the side of the valve. The pressure oil supply line must be connected to the end of the valve opposite the knurled control knob.

NOTE: Should the Acrotorque Windshield Wiper Motor case crack and leak oil when the auto-pilot is being used, it may be corrected as follows:

(a) In the air by cutting off the hydraulic pressure to the auto-pilot by shutting off the auto-pilot valve on the hydraulic control panel.

(b) When parts are not available for repair the return line may be removed from the bottom of the wiper and the line plugged. The wiper should be tagged "inoperative" when this is done. Repair should be made to the wiper as soon as possible, the line reconnected, and the inoperative tag removed.

Leaks from sources other than those mentioned above will most likely be self-evident as to cause, and proper steps must be taken to correct.



1-5-42 E.F.C.

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ACROTORQUE 2V15 WINDSHIELD WIPER DC-3-A & DST-A

LINE IDENTIFICATION CHART

RED	FUEL	BLUE	VACUUM AIR
YELLOW	OIL	GREEN	DEICER AIR
BLACK	HYDRAULIC	WHITE BLUE	AIRSPEED STATIC
BLACK	HYD. EXTEND. *	WHITE GREEN	AIRSPEED PRESS.
PURPLE	BRAKES	ORANGE	MANIFOLD PRESS.
YELLOW BLACK	AUTO. PILOT	WHITE BROWN	HEATING SYSTEM
GREEN BLACK	PROP. DEICER	RED GREEN	OXYGEN
		BROWN	FIRE EXTINGUISHER

* PRESSURE LINE THAT EXTENDS OR OPENS UNIT.

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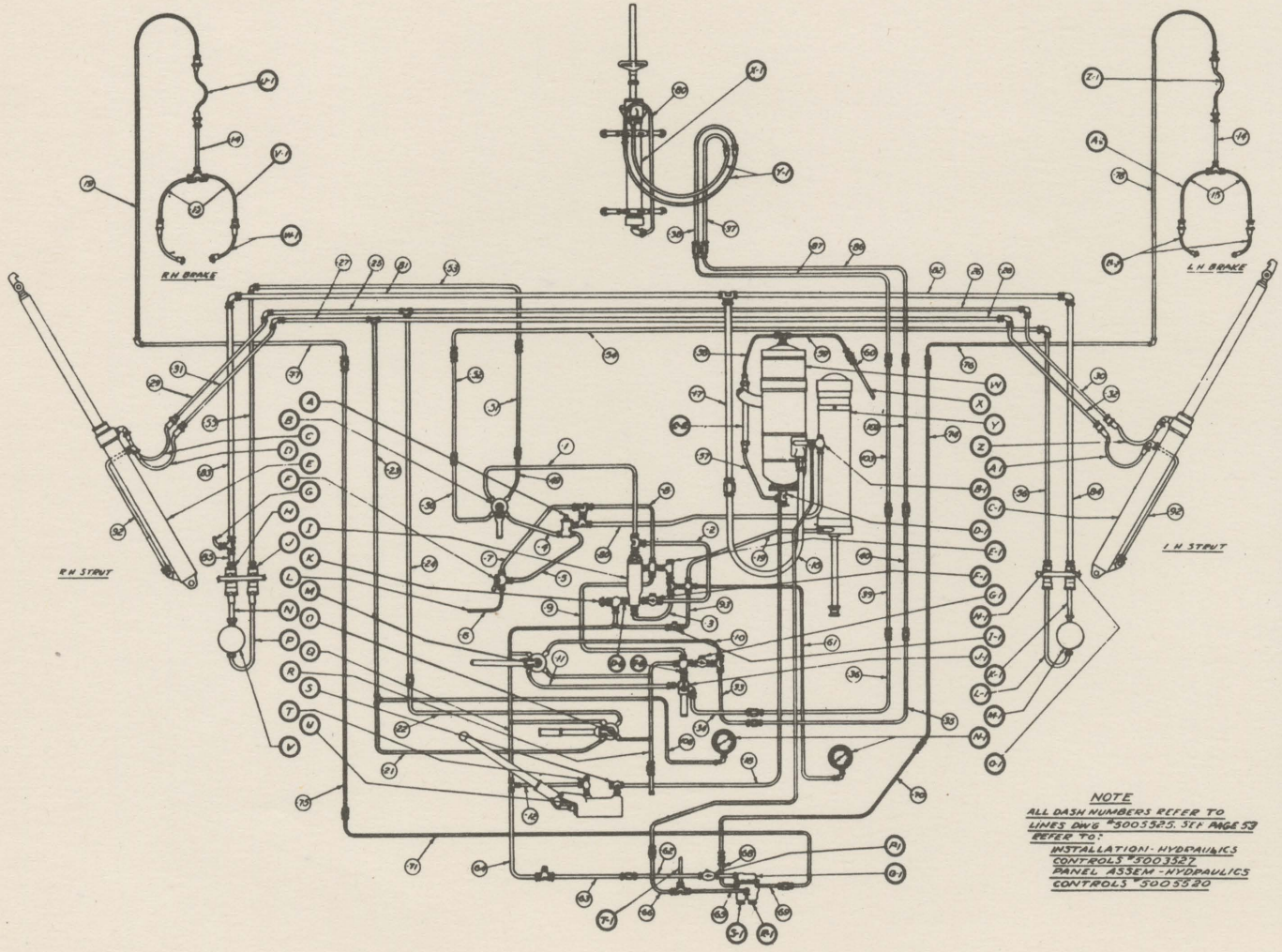
LINE IDENTIFICATION DIAGRAM DC3-A AND DST-A



A — 641921 RELIEF VALVE (SPERRY GYRO PILOT)
B — 4006985 SELECTOR VALVE ASSEMBLY (SEE PAGE 55)
C — 2011888-1 HOSE
D — 2011888-2 HOSE
E — 4006284 LANDING GEAR RETRACT STRUT (SEE PAGE 60)
F — 8DVO-D 3 WAY VALVE (SPERRY GYRO PILOT)
G — SPERRY PILOT DRAIN
H — 2007298 SUCTION DISCONNECT VALVE
I — 4003434 PRESSURE VALVE (SEE PAGE 53)
J — 2007291 PRESSURE DISCONNECT VALVE
K — 8AGVD-D SHUT-OFF VALVE
L — TO SPERRY PILOT
M — 4005050 WING FLAP 4 WAY CONTROL VALVE
N — 4007652-2 PRESSURE LINE
O — 4005050 LANDING GEAR 4 WAY CONTROL VALVE
P — 4007653-2 SUCTION LINE
Q — 3007974 PRESSURE MANIFOLD LINE
R — 3007975 RETURN MANIFOLD LINE
S — 8AGVM-D CHECK VALVE
T — 8AGVD-D CHECK VALVE
U — 4005112 HYDRAULIC HAND PUMP (SEE PAGE 59)
V — RIGHT HAND ENGINE PUMP
W — 4006771 RESERVE TANK
X — VENT LINE
Y — 3006364 PRESSURE CYL (SEE PAGE 59)
Z — 2011888-1 HOSE
A1 — 2011888-2 HOSE
B1 — 8AGVM-D CHECK VALVE
C1 — 4006284 LANDING GEAR RETRACT STRUT (SEE PAGE 60)
D1 — RESERVE TANK DRAIN
E1 — 272778-1 RELIEF VALVE ADJUST TO 1000 #/30 IN.
F1 — 8GV6-D CHECK VALVE
G1 — 8GV6S-D CHECK VALVE
H1 — 2007291 PRESSURE DISCONNECT VALVE
I1 — 8GVM-D CHECK VALVE
J1 — 101655 RELIEF VALVE ADJUST TO 300 #/30 IN.
K1 — 4007652-2 SUCTION LINE
L1 — 4007653-2 PRESSURE LINE
M1 — LEFT HAND ENGINE PUMP
N1 — 4012680 PRESSURE GAUGE
O1 — 2007298 SUCTION DISCONNECT VALVE
P1 — 8GV8 CHECK VALVE
Q1 — 3007940 BRAKE VALVE (SEE PAGE 61)
R1 — RIGHT HAND BRAKE
S1 — LEFT HAND BRAKE
T1 — FROM SPERRY PILOT
U1 — 2008478 HOSE ASSEM.
V1 — BRAKE LINES
W1 — 101353 HOSE AND 2008473 HOSE ASSEM. (WITHOUT BOOT)
X1 — 338647 WING FLAP OPERATING CYL (SEE PAGE 63)
Y1 — 2008399-1 HOSE ASSEM.
Z1 — 2008476 HOSE ASSEM.
A2 — BRAKE LINES
B2 — 101353 HOSE AND 2008475 HOSE ASSEM. (WITHOUT BOOT)
C2 — 1009136 GAUGE ASSEM
D2 — 1010096-1 SPECIAL NIPPLE
E2 — 1010096-2 SPECIAL NIPPLE

NOTE
ALL DASH NUMBERS REFER TO LINES DWG #5005525. SEE PAGE 53
REFER TO:
INSTALLATION-HYDRAULICS CONTROLS #5003327
PANEL ASSEM-HYDRAULICS CONTROLS #5003520

5-4-42

HYDRAULIC SYSTEM

LANDING GEAR - DOUGLAS

1. **Service.**

A. To Raise Plane For Working on Landing Gear

1. Before an attempt is made to jack the plane clear of the floor, the tail wheel should be aligned with the fuselage, and the tail wheel lock engaged.
2. See that all stands and equipment are clear of the plane. Install the wing jacking pads and tighten all retaining screws securely. After plane is raised slightly, the retaining screws on the jacking pads should be tested again for tightness. These screws should be inspected before each installation to make sure that they are in good condition.
3. Personnel should be careful when working in the cabin or cockpit when plane is raised clear of the floor, and persons other than those doing actual work or inspection should not be permitted inside the plane.
4. Before lowering plane to the floor, make certain that all stands and equipment are in the clear.

B. To Test Landing Gear Retracting Mechanism

1. After plane is raised clear of the floor, remove safety pins from each landing gear assembly and release the mechanical latch handle from the cockpit floor. Pull latch lever back until it catches. While in this position inspect the clearances between the lowest point on the landing gear latch located on nacelles bulkhead, and the highest point on the landing gear retracting strut latch. The distance between these two points must be at least 1/8". If this clearance is not correct the gear may not be locked down properly or on the other hand, the gear may be prevented from retracting. This clearance is adjusted to 3/16" at time of landing gear overhaul but is OK if it does not go below 1/8"
2. Lift landing gear hydraulic control valve lever out, move to the full "up" position and by means of the hydraulic hand pump, retract the gear until both units are full up against the rubber bumpers. Note that the gear raises and lowers freely and without the use of undue pressure.
3. Test landing gear indicating lights and warning horn for proper operation. (See Maintenance Manual - Radio and Electrical for information on electrical circuit) Rotate wheels and note that they are not rubbing on anything but the flight wheel brakes. When the hydraulic control valve is in the "Up" position, the spring loaded dog on the valve should be inspected to see that it extends at least 1/32" below the landing gear retract valve shoe.
4. Extend wheels by moving the landing gear lever to the full "down" position and operating the hydraulic hand pump. Note that the latches fall into place in the spring loaded position when both units are in their full "down" position. Secure mechanical latch lever to the floor.

NOTE: Never lock the latch lever to the cockpit floor when the gear is retracted. Leave it in the spring loaded position until the gear is fully down and the green light is showing on the signal panel.

C. To Service Main Oleo Struts With Fluid and Air.

When the packings on oleo struts are found leaking, the plane should be taxied or towed straight ahead to a level position to relieve the side load. If this does not correct the leak, the procedure given below should be followed to tighten the packings:

1. Raise plane on jacks, inflate shock struts to 250 psi, shock struts fully extended. (This pressure may be taken on the booster pump gauge).
2. Inspect and check all filler plugs, valves, balancer lines, and fittings with soap suds for leaks.
3. Lower jacks until plane is supported by shock struts and jacks are low enough to allow shock struts to come all the way down.
4. Release all the air from the shock struts by unscrewing the air valve fitting, approximately one-half turn. Allow all the air pressure to escape before completely removing this fitting, and make certain that both struts are fully compressed. Remove both filler plugs, one from each strut, and fill with approved fluid until the fluid in each strut is level with the filler hole. (Be sure to let set long enough during filling for the air bubbles to dissipate).
5. Reinstall and tighten both filler plugs.
6. With the landing gear shock strut packing adjusting nut wrench #TB-1281, tighten the packing nut as tight as possible by hand. Do not use an extension on the wrench handle. Safety packing nuts.
7. Raise plane on jacks until shock struts are fully extended, inflate shock struts to 350 psi.
8. Remove jacks.
9. Recheck all filler plugs, valves, balancer lines and fittings with soap suds for leaks.
10. Adjust oleos to proper height which is 4-1/2 inches of piston exposed when the plane is loaded with gasoline and oil only. (Note: Use only approved Valve cores, See S P A book)

If shock struts continue to leak after being tightened in the manner described, they should be replaced.

CAUTION: If an oleo leg is replaced, extreme care should be used in tightening the truss assembly clamps around the oleo legs. If these clamps are tightened excessively, it may cause the oleo to stick, which under some conditions may make it impossible to lower the landing gear.

D. To Service Tail Oleo Unit

1. Old Style

This unit will be serviced in a manner similar to that set forth for the main landing gear oleos, except that the oleo will be inflated to 9½" between the center of the filler plug and the upper face of the cylinder. Use only approved Valve Cores.

2. New Style
Same as (1) above, except when the plane is loaded with gas and oil only. Then, inflate strut until the dimension between the lower edge of the red stripe and the upper shelf on the main cylinder body is 1-1/2 inches.

2. Replacement of Wheels

A. To remove and Install Main Landing Wheels

Landing gear wheels are numbered as follows:

B-1 Wheels	C-100 to C-299
Tail Wheels	C-300 to C-399

1. Raise plane until both tires are barely touching the floor.
2. Operate the wing flaps until the hydraulic pressure gauge reads zero. Remove the valve core and allow air to escape from the tire until it will only support its weight and that of the wheel; then install valve cap to prevent the loss of all the air.
3. Remove bolts from axle clamps on each side of wheel and remove torque collar bolts.
4. Remove landing gear safety pin from the landing gear where wheel is being removed, and see that the opposite pin is installed in place. Have a mechanic in cockpit retract the landing gear slightly by use of the hydraulic hand pump. Make sure that the axle clamps hinge downward, clear of the axle, while the plane is being raised. Retract landing gear until fork portion of the drag strut is slightly above the level of the tire. Slide the brake torque collars off each side of the axle and roll wheel back clear of landing gear.
5. The brake assemblies may be replaced in the axle clamps and the clamp bolts dropped into place. The brakes may be cleaned and inspected easily while in this position. The brakes should never be suspended from the brake hoses.

B. To Install Wheel

1. Reverse procedure as set forth above.
2. Before securing the axle clamps, the stub axles should be forced hard against the axle spacer, and the clearance inspected between the edge of the brake drum and the torque collar frame. This clearance must be 3/16" minimum to 7/16" maximum between the brake drum and the dust cover. If it does not come between these figures, remove or add spacer washers as the case may require, between the axle collar and torque collar. These washers may be obtained from the Repair Base in thicknesses varying from .015" to .065" by requisitioning part No. 143908-230D-324T. When proper clearance has been obtained, the torque collar bolts should be snugged up to prevent the collar from sliding back and changing the clearances previously adjusted, while the wheel is being installed.

C. To Dismantle Wheels

1. Completely expel all air from the tube.
2. Remove lock wire and lock screw from axle nut.
3. Insert a bar through axle holes to prevent turning, and with the wrench provided, remove the axle nut. Remove axle from the wheel.

4. Remove lock rings, dust caps, and felts, and remove bearings. (NOTE: It is not necessary to remove the axles from the wheels during #3 checks, unless inspection indicates this is necessary.)
5. Loosen the tire beads. This should be done by the use of the special jacking device, if available, or if it is necessary to use tire irons and a heavy rawhide mallet, be very careful not to drive the iron in against the wheel.
6. Remove wheel flange. Wheel may now be removed from tire, care being taken to see that the valve stem is not crushed between bead and wheel.
7. Inspect inside of tire for rock bruises, bead wire failure, or weak spots in cords.
8. Inspect inner tube at base of valve, check for bent valve stem, check threads inside and outside of stem, install Schrader #4000 valve core, and check for thin spots in rubber; check also for mold folds and bad splices.
9. Inspect the wheel for cracks: these when found, generally appear near flanges, on spokes, and/or in key-ways. (See sketch for exceptions)
10. Check carefully the removable flange and flange key-way for looseness.
11. Any nicks or sharp edges on the wheel flanges shall be removed.
12. Inspect brake drums for cracks; also for size. Drums are ground to 14.025 ± .005" at overhaul. Wheels having the brake drums smaller in diameter than 14.000" or more than .004" out of round are to be removed from service and returned to the Repair Base. Brake Drums having cracks 1" in length or longer or, shorter cracks exposing sharp edges, are to be changed as they are likely to cut lining blocks.

D. To Reassemble Wheel and Axle

1. After complete inspection has been made of the foregoing units, a graphite lubricating pencil should be used on the tire beads and the surfaces between the removable flange and the main wheel. This should be done without fail, as otherwise, disassembly at the next major check may be very difficult due to the galling of the wheel flange surface, and the tendency of the tire beads to vulcanize to the wheel.
2. To adjust the tension of the removable flange retaining bolts, tighten them down until the springs cannot be compressed further; then back off nut on each bolt ½ turn. Safety with .040" soft iron wire.
3. Inflate tire to approximately 20# pressure.
4. Clean and inspect the main bearings, apply new grease, and reinstall axle in the wheel. Do not install the dust felts, caps, and lock rings until after the axle is reassembled in the wheel, as otherwise a portion of the felt may become lodged between the retaining nut or shaft collar and cause a maladjustment of the bearings.
5. Tighten retaining nut down tight and rotate wheel two or three turns to remove excess grease from under the bearing rollers. Back off on the axle retaining nut until the wheel rotates freely without any apparent clearance in the bearings. Install and safety the lock screw. Install felt washers, dust caps, and safety rings. Inflate tire to 45# air pressure. Cheyenne, Denver, and Salt Lake only will inflate 17 x 16 tires to 48 lbs. This is because of higher altitudes.

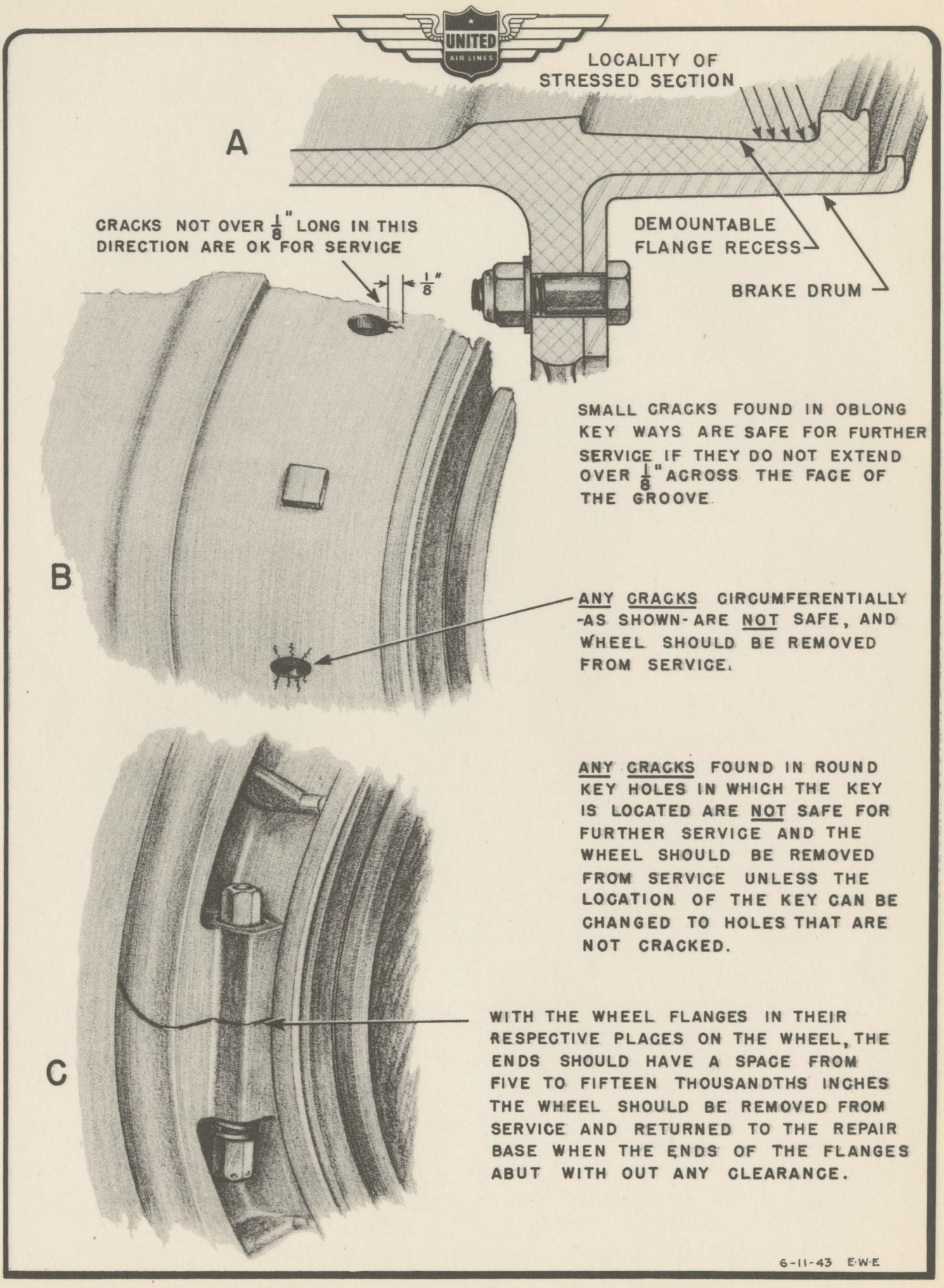
3. Douglas Tail Wheels

A. When checking the 1/4" through bolt nut tension on the Douglas tail wheels, see that they are snug. If drawn up too tight, these bolts will stretch or the castings crack where the bolt and nut seat; the same condition may develop due to pounding, if these nuts are too loose. Care should be taken during the assembly of the wheel and axle so that the felt washer retainer wall is not struck with the end of the axle, as such hammering may easily crack the wheel. Care should also be taken in replacing felt washers in the retainer grooves, and in no case should the casting be pried upon or hammered during this operation.

B. When tailwheel shimmy is reported on a plane, the tail shall be jacked clear of the floor and an inspection made to determine whether any fittings are loose. Also, a complete inspection of the tailwheel lock mechanism shall be made. This shall be done by engaging the tailwheel lock and by shaking the tailwheel back and forth. If replacement of the tailwheel and tire, tightening of fittings and repairing of lock do not accomplish the desired results, the tailwheel yoke must be replaced. If it is definitely known that a tire is causing the trouble, the tire shall be replaced.

Bendix B-1 Wheels - Inspection

Due to the fact that a certain portion of our B-1 wheels as indicated by the diagram following is under greater stress than any other part of the wheel, it is obvious that this portion should receive a very close visual inspection at every #3 Check. The portion we refer to is the area near the outer radius of the demountable side of the wheel. Mechanics completing inspections on these wheels should be very careful to inspect the area as noted for cracks or signs of failure.



ISS 95827

TYPICAL WHEEL FAILURES

BRAKING SYSTEM - DOUGLAS

1. Service

A. It is becoming more important than ever before that the brakes be kept as nearly perfect as possible. Consequently, mechanics always should be on the lookout for hydraulic oil coming from the region of the brakes, for signs of overheated brake drums, and for questionable brake hoses.

B. Reports such as "Plane swerves to left (or right) when braking", "Brakes grab", or "Brakes slow to take hold (or release)" are all definite symptoms of brake trouble and should be corrected.

C. Whenever brake assemblies are removed from the wheel, the glaze should be removed by use of strip emery cloth and the dust and dirt should be blown from around and between the blocks by means of compressed air. This will insure free operation of the brake blocks and retracting springs. Goggles should be worn during this operation.

2. Replacement

A. Replacement of only the complete brake assembly shall be made at service stations and installation of individual parts shall not be made unless a complete unit is not available.

B. When the brake blocks are worn down to within 1/32" of the retracting springs the brake assembly will be replaced; it will be replaced also if the gap between the brake block stops and the brake blocks exceeds 1/8".

C. Broken retracting springs may be replaced provided the rest of the brake assembly is in a serviceable condition.

D. Brake Hose and Expander Tube Failures

1. In case of a brake expander tube failure, or the failure of a brake hose, provided this does not render more than one side of one landing wheel inoperative on a plane, it will be permissible to disconnect the upper end of the brake hose and to install the Parker 6F cap on the end of the line. This procedure will be permissible only at stations having the brass cap ends assigned as listed, to avoid lengthy delays in replacing expander tubes, or when no brake hose is available in stock.

2. Stations listed below shall stock 2 each of the Parker 6F Brass Cap Ends for use in plugging brake lines:

Allentown	Boise
Cleveland	Pendleton
Moline	Vancouver
Omaha	Medford
North Platte	Sacramento
Denver	Fresno
Elko	Bakersfield
Reno	San Diego

3. The plugging of these hydraulic lines will be accomplished by disconnecting the hydraulic lower brake hose, (Part 81371 of the inoperative brake,) from the individual supply line and plugging the individual supply line with a

Parker 6F Brass Cap End as supplied. Since these Parker cap ends are threaded to fit these connections, all that is necessary is to screw the cap end to the individual supply line without the necessity of using any seal. The lower brake hose then will be completely removed and forwarded to the next service station with the plane.

4. Planes will not be dispatched under these conditions with more than "one side of one wheel inoperative" on the entire landing gear, and the captain of the plane must be informed fully of the circumstances and must be agreeable to this procedure. Planes will NOT be dispatched from the following stations in this manner: LaGuardia, Chicago, Cheyenne, Salt Lake, Seattle, San Francisco, Portland, or Burbank.
5. On dispatching a plane with a plug installation, it will be the responsibility of that station to so advise the next terminal station by either telephone or telegraph so that preparations can be arranged in ample time to make the necessary corrections. No mention of this irregularity will be made in the dispatch or via radio, if possible.

3. Adjustment

A. Adjustment of Douglas Brakes for Planes equipped with Hayes Brakes and DV2541 linings.

Nomenclature of brake control valve parts referred to shown on following sketch.

1. Check the oil sight gauge level on the hydraulic system supply tank.
2. Set the rudder in neutral, as it is easier to compare pedal travel in this position.
3. Make sure there is at least 550 P.S.I. pressure in the hydraulic system.
4. Attach a brake testing harness #3SK-109 with low and high pressure gauges to the inside bleeder port of the brake reported defective.
5. Open the valve on the low pressure gauge on test harness. Static pressure should be between 6 and 7 P.S.I. If more than that amount is indicated, back off adjusting screw on brake control valve. Due to the linkage and line hook-up on the brakes, the brake cylinder "adjusting screw", "clamp" and "tuning fork" on the right side are connected to the brakes on the left wheel, while the left side of the assembly is connected to brakes on the right wheel.
6. Trip the valve by hand by pulling down on the rear of the tuning fork until 20 P.S.I. is obtained before releasing. (Allow time for the brake expander tubes and brake springs to force all of the oil back to the supply tank before reading gauge). This operation should be repeated two or three times to make sure the action is free and static pressure is the same after each operation.
7. Tighten "adjusting screw" jam nut.
8. Close the low pressure gauge valve and open high pressure gauge valve on brake test harness.
9. Have the brake pedal pushed full on and note the pressure on the high pressure gauge at wheel; it should be 275 P.S.I.

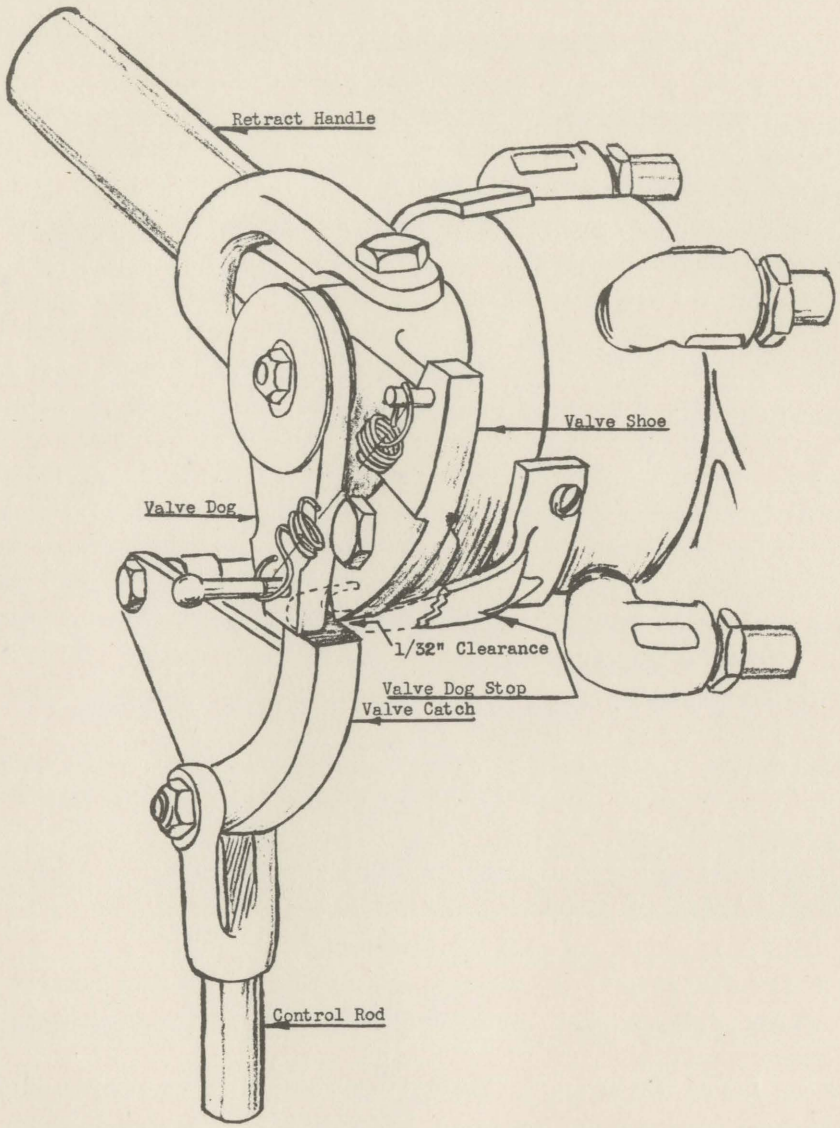
10. If too low, release pedal and move the "clamp" on the "tuning fork" forward slightly and lock in place with the "set screw". If the pressure is too high, move the "clamp" back slightly. Continue moving the "clamp" and checking until 275 P.S.I. is indicated on the gauge at the wheel with brake full on.
11. Tighten the "set screw" and the jam nut on the "clamp" securely.
12. Set the parking brake and check:
    (a) The high pressure gauge for leak off. The pressure should drop to about 200 (plus or minus 25) P.S.I. but should hold steady and not continue to leak off or build up.
    (b) Check all lines and hose connections for leaks.
13. Release the parking brake and remove the brake test harness.
14. Safety wire the "adjusting screws" by wrapping wire around the adjusting screw above the end of the tuning fork, and bring one end down through the screw driver slot in the end of the adjusting screw, then back up and twist the ends together. Safety set screws in clamps and all bleeder port screws at wheels.
15. Spin wheel and operate brake pedal to see if braking is obtained instantly upon application of pedal, and the release also is immediate when the foot is removed from the pedal.
16. Repeat procedure on other wheel if reported defective.

B. Replacing a Power Control Valve.

1. Whenever abnormal pedal travel is required after proper adjustment to obtain brake action, the valve should be replaced. Abnormal pedal travel occurs only when the power control adjustment valve is screwed too far out of the body, leaving too much clearance between the control valve operating pin and the steel ball check. The adjustment of this clearance should be made on the test bench only.
2. In replacing the control valve, the "clamps" are removed from the "tuning forks" of the defective unit, and placed on the "tuning forks" of the unit being installed. The "clamp bolt" is secured by an elastic stop nut. This nut is drawn up tight. The shoulder on the "clamp bolt" should be long enough to allow the "clamp" to slide freely along the "tuning fork" after the nut is tightened. Locate the clamp on the "tuning fork" with the center of the "clamp bolt" 1-7/16" from the center of the "tuning fork" "push rod" bolt. Tighten the set screw enough to hold the clamp in this position while the low pressure adjustment is being made.
3. Check brake pressure as outlined under adjustment. If a leak occurs at the piston when the brakes are off, it will be necessary to tighten the packing nut. Care should be taken to see that there is no turning of the piston rod as the nut is tightened, as this would cause maladjustment of the operating pin.
4. The brakes should then be operated a few times to insure that the tightening of the packing nut has not caused the piston rod to bind or stick.

C. To Bleed Brakes

1. Loosen the bleeder valve screw on each brake, and with at least 300# pressure showing on hydraulic gauge, depress the brake pedals slightly until the fluid runs out of the bleeder valves free of air bubbles. Place a small bucket under each bleeder valve before loosening screw to prevent wasting liquid and spilling it on the floor.
2. A report on weak brakes, providing the pressure is correct, is sufficient cause for removal of wheels and completely inspecting the brakes and drums for oil, worn brake shoes, and cracked or defective drums.



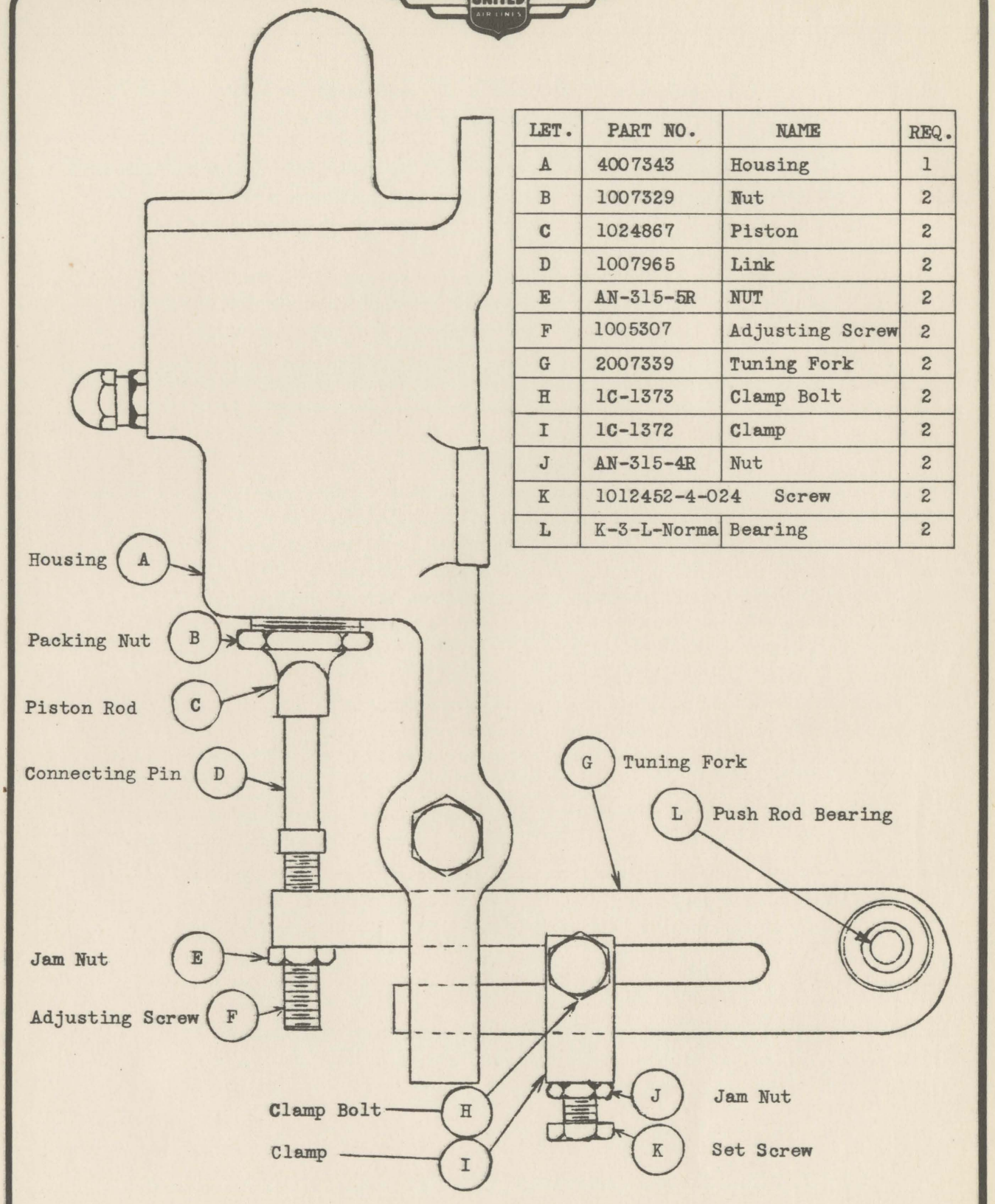
LANDING GEAR INSPECTION

Mechanics are cautioned regarding the inspection of the landing gear safety latch mechanism during #3 Checks.

Above will be found a sketch of the retract valve safety latch assembly. In the sketch the retract valve is in "NEUTRAL". The latch lever on the cockpit floor is back to the 60° position and the valve control catch is being held down by the valve dog.

At each #3 Check the retract valve and safety latch should be placed in this same position. In this position there must be 1/32" clearance between the valve control catch and the shoe. If the catch or dog wears down to a point where there is no clearance, the retract lever in some cases cannot be raised. If necessary, the repair of the dog can be made by building up with the welding torch, using a steel rod, then grinding down to obtain the 1/32" clearance. (Plane on jacks for this Test).

The assemblies should be test operated to see if all parts are functioning properly. Make sure that the valve dog and the catch are not bent. The catch should ride on approximately one-half on the dog and one-half on the shoe. Also inspect the dog stop (partially dotted in sketch). This must not be bent and must be in a position such that the dog cannot go back of the valve catch because in this position the landing gear cannot be raised.



LET.	PART NO.	NAME	REQ.
A	4007343	Housing	1
B	1007329	Nut	2
C	1024867	Piston	2
D	1007965	Link	2
E	AN-315-5R	NUT	2
F	1005307	Adjusting Screw	2
G	2007339	Tuning Fork	2
H	1C-1373	Clamp Bolt	2
I	1C-1372	Clamp	2
J	AN-315-4R	Nut	2
K	1012452-4-024	Screw	2
L	K-3-L-Norma	Bearing	2

JSS 95827

9-9-42

BRAKE CONTROL VALVE

HEATING SYSTEM 17

HEATING SYSTEM - DOUGLAS

1. Service

A. General

1. In the operation of the system, the fresh air enters an air duct in the nose of the fuselage. This duct has, near the entrance, a butterfly type control valve, which will be referred to as the "Air Supply Nose Valve." The control of the valve is located just below the gas tank selector switch on the First Officer's side of the cockpit. All air entering the passenger and pilot's cabins passes through this duct. The volume is controlled by the opening of the valve; wide open, the valve admits approximately 1200 cubic feet of air per minute. This amount of air is more than the heating system can handle in below zero temperatures - consequently, this valve should be opened to the maximum amount only where a steam pressure of 5 lbs. or above can still be maintained. The next procedure to follow is to open the nose valve until the steam pressure starts to drop slightly below the operating pressure indicated on the steam pressure gauge. When the steam system is functioning properly, the "dropping" of the steam pressure is an indication that the maximum amount of air that the heating system can heat is being admitted. There is no harm done if the nose valve is opened until the steam pressure drops to five pounds. In some instances, it has been found desirable to do this, as it permits more heated air to enter the cabin. In operating the system on low pressure, the pressure, must be watched closely, for if it drops completely, there is danger of freezing the radiator.
2. The air continues through this duct to a "Y" where the duct separates, one duct passing through the steam radiator, the other by-passing the radiator, both ducts coming together at a mixing "Y". Just before reaching this "Y", there is located a butterly valve in each duct mounted on a single shaft with the butterflies at approximately right angles. From the mixing "Y" the air passes into ducts that run along the floor line on both sides of the passenger cabin. These ducts have an outlet at each seat and one in each toilet compartment from which the tempered air is discharged into the cabin.
3. The temperature of the air is regulated from the control panel located in the passenger cabin. The "Air Temperature" control operates the butterfly valves near the mixing "Y". Moving the control to the "Warm" position permits all air entering the main duct to passthrough the radiator. Moving the control to the "Cold" position permits all air to by-pass the radiator. Any position between "Warm" and "Cold" heats only a portion of the air to meet the desired temperature.
4. The steam control is located on the same panel. This control should always be in the "ON" position whenever heat is necessary for maintaining proper cabin temperatures, but may be placed in the "OFF" position if the steam system is not required for either cockpit or cabin.

5. The pilots' cabin has a separate control or mixing valve so that hot or cold air may be directed to the pilots cabin, regardless of the position of the passenger cabin controls.

6. The heating system consists of a flash type boiler, radiator, reserve tank and connecting lines. The reserve tank in the front cargo compartment automatically supplies water to the boiler as required. Since the boiler is of the flash type, no quantity of water is carried in the boiler. As the radiator condenses the steam, the water from the radiator is returned to the system at the header in the right nacelle.

7. The system is regulated to operate on a pressure of 14 to 16 lbs., but it is not necessary to try to maintain this as a constant pressure. The pressure can fluctuate from 5 to 15 lbs. The regulator is set at the Repair Base to 15 lbs. and should be maintained at this setting. The Fisher type regulator is vented to the atmosphere and the gauge pressure reading, when the regulator is properly adjusted, will be 15 lbs., regardless of the altitude.

8. If the pressure builds up to 25 lbs., it is an indication of the pressure regulating valve. The water level should be watched very closely when this occurs, as the pressure relief valve will release this pressure, and it will not take long to lose all of the water. Possible corrections may be made to reduce excess pressure in such cases, first, by tapping on the case of the pressure regulator which may loosen any particles of dirt or scale that might have lodged on the valve seat; second, open the nose valve permitting more air to flow through the radiator; third, shut off valve "D" at pressure regulator and at bottom of tank valve "E", then vent tank at pressure gauge valve "A". After the pressure is released, close valve "A", open pressure regulator valve "D", and then open valve on bottom of tank "E". This rush of steam may dislodge any foreign matter that might be in the regulator.

9. Adjustment of the regulator valve shall only be done by qualified mechanics familiar with this work, as this adjustment is very sensitive. 1/16 of a turn may vary the pressure as much as ten pounds. Flying personnel shall familiarize themselves with the proper method of adjusting the steam regulator valve. If, during a trip, the pressure cannot be held below 20#, the regulator valve shall be adjusted to operate at 18# and a report made in the plane's trip record book so that corrective work may be accomplished at the next service station.

10. Ground air temperature 70° F. or above:

    a. The pilots shall, prior to landing, close nose valve to build up steam pressure and trap water in reserve tank.

    b. Ground crews shall turn planes over to flight crews with water trapped in the reserve tank.

    c. If the water was not trapped prior to landing the system must be drained and refilled to the 3" level in the slight gauge.

11. Ground air temperatures 69° F. or below:

a. Flight crews shall close nose valve to build up steam pressure prior to landing but shall not trap water in reserve tank.

b. Ground crews shall turn planes over to flight crews with water down in the system (not trapped in reserve tank).

c. If the plane will hold on the ground with right engine dead longer than the following temperatures and time limits, the system shall either be drained immediately or the right engine run at sufficiently frequent intervals to build up steam pressure and prevent the system from freezing. After right engine is run and steam pressure built up, it may be shut off and the plane allowed to stand providing the temperature and time limits are not exceeded.

d.

Outside Air Temp.	Drain if Plane will be on field longer than *
+ 30° F	60 minutes
+ 20° F	50 minutes
+ 10° F	40 minutes
0° F	30 minutes
- 10° F	20 minutes

* Pressure must show on steam gauge prior to this period.

12. Heating System - Anti-Freeze

During extremely cold weather conditions, a quart of straight alcohol may be used in our DC-3 steam heating systems to prevent their freezing after they have been drained.

This anti-freeze will be used as follows:

1. Drain heating system in the usual manner.
2. Shut off drain valve and pour in not over one quart of straight alcohol. Vent system so that alcohol will run to lower portion of heating system.
3. When it is desired to use the heating system the quart of alcohol shall be drained and at least one gallon of hot water run thru the heating system allowing it to drain out onto the ground.
4. Safety drain valve after the alcohol is drained and the hot water has been run thru system, add 4 quarts hot water,and steam system up as soon as possible. The drained alcohol may be used over in the heating system as long as it is not too badly diluted; however, any alcohol that has been used in a heating system shall not be used in any other system.

B. Draining.

1. Ground crews shall make every attempt to see that the system is properly and completely drained.

2. To drain heating system - Place valve "G", drain cock located in nacelle, in the open system. If pressure is still in system, care should be exercised to avoid being burned by onrush of steam and water mixture.

3. Place valves "B" and "E" in "open" position, thus permitting all water to drain from system. During freezing weather leave drain valve open until just prior to filling system.

C. To Fill System With Water

1. Plane on ground - System cold and empty:

(a) Close and safety drain cock "G".

(b) Close valve "E" at bottom of reserve tank.

(c) Open air vent valve "A" to vent air from tank while filling.

(d) Open filler neck valve "B" and add four quarts of HOT water during winter season and cold water during the summer season. (Hot water means water at 180° F. or better if possible. NOTE: At stations where freezing weather is not encountered during the winter, use cold water.

(e) Close filler neck valve "B".

2. Replenishing water supply - Plane in flight or on ground - system hot:

(a) Close pressure regulator valve "D".

(b) Close valve "E" at bottom of reserve tank.

(c) Carefully open guage valve "A" allowing steam to escape slowly.

(d) Open filler neck valve "B"; add four quarts of water (three inches in sight gauge).

(e) Close filler neck valve "B".

(f) Open pressure regulator valve "D" and valve "E" at bottom of tank.

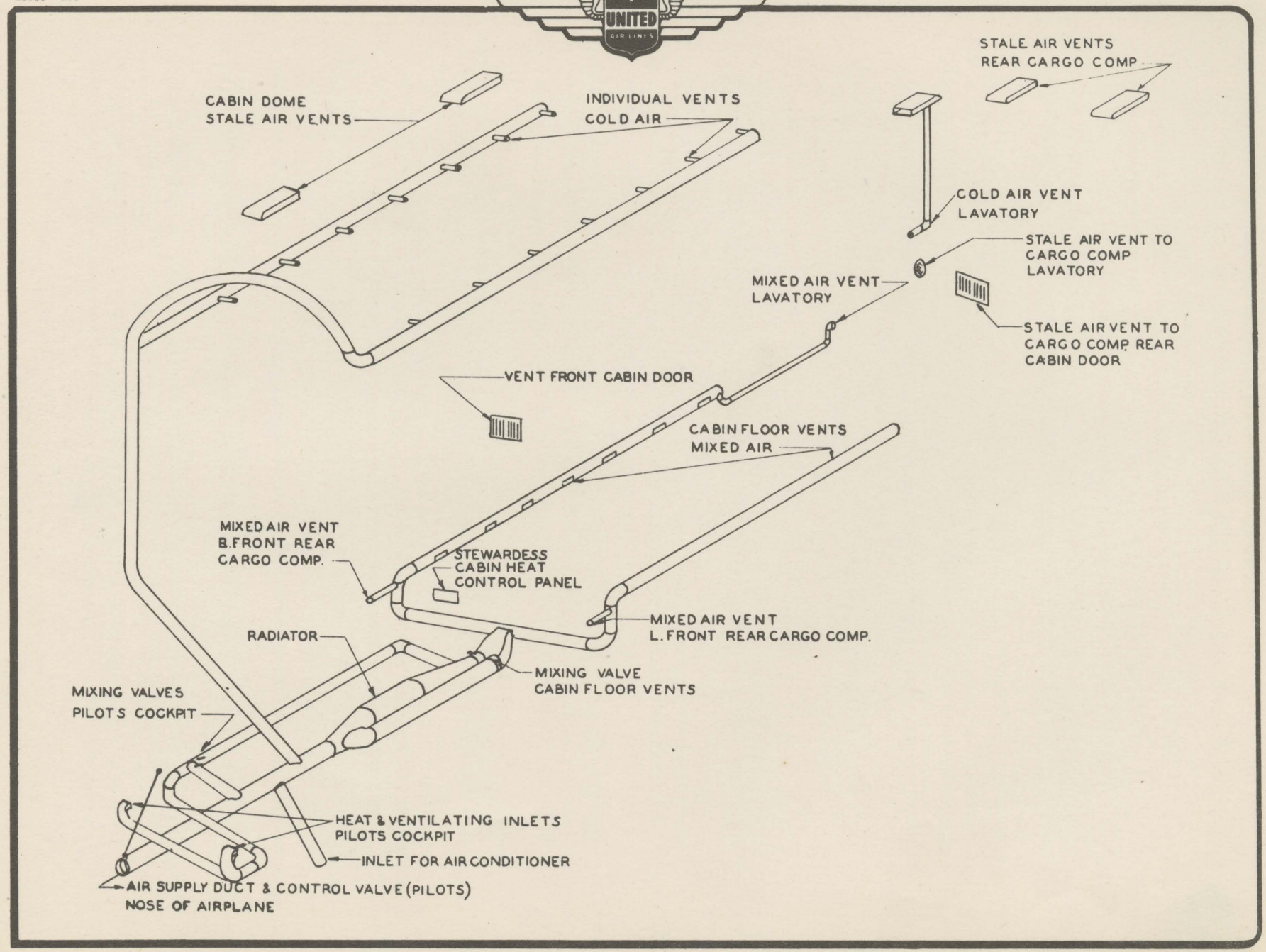
(g) Close air vent valve "A" after air has been forced from tank.

(h) The First Officer shall close the air supply nose valve before replenishing the water supply, then open as required after the system has again started to generate steam.

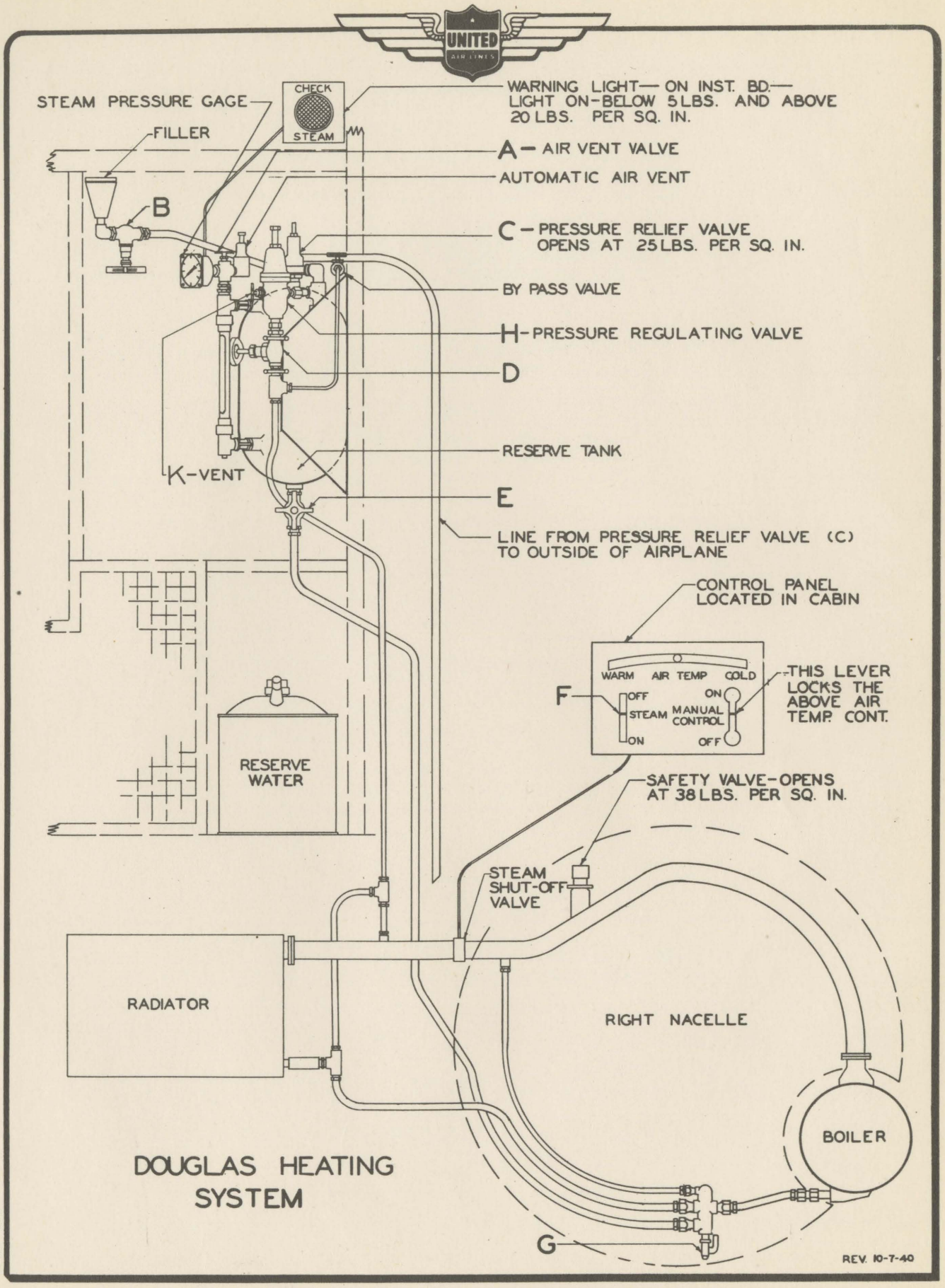
D. Starting a plane from a Terminal Station.

1. During freezing weather, the reserve tank must be filled as close to the starting time of the right engine as is possible, to avoid freezing when water is dropped.

2. After the right engine has been running five minutes, open the air vent valves "A" and "K", then drop water by opening valve "E" at bottom of reserve tank, leaving the air vent valves "A" and "K" open until steam begins to come out of these valves; then close them. Leaving these valves open permits the system to free itself of air more readily. There is a Hoffman air release valve a above the reserve tank for this purpose; since it takes considerable time for



DC-3 HEATING AND VENTILATING SYSTEM



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DC-3 AND DST HEATING SYSTEM

the Hoffman valve to discharge all air from the system, it is desirable to bleed the air by hand. If steam system does not operate within two or three minutes after dropping water, do as follows:

(a) Place filler neck valve in open position and close all other vents.

(b) Place the by-pass valve in the open position.

(c) When steam issues out filler neck, close the filler neck valve.

(d) When pressure on gauge is 10 lbs., close the by-pass valve, and the regulator will then take over and operate the system on a regulated pressure. Always have the by-pass valve closed with pressure is above 10 lbs., as otherwise pressure will build up above 25 lbs., and all the water will be Iost. (Caution never leave heating system unattended while by-pass valve is open).

3. In the event that the heating system should be frozen and the water does not drop when valve "E" is open (due to improper draining or some such circumstance), the following method may be employed for correcting this condition.

(a) Operate engine as outlined above and open air vent valves "A" and "K". Inject one quart of hot water ("use station Graco Gun No. 850, furnished for this purpose) through valve "K". When the steam rapidly comes out of valve "K", drop water through valve "E" and proceed as outlined in Paragraph 2 above.

(b) In case there is stoppage and water cannot be injected into "K", the engine should be stopped and hot water injected into the boiler through drain cock valve "G", with the aid of the Graco Gun; the engine should then be started and another attempt made.

4. If the above procedures do not correct the condition and steam does not rise through valve "K", follow the procedure listed below:

(a) Connect the air conditioner to the heating system and thaw it out in this manner. However, the procedure normally . ould not be necessary if the heating system has been drained properly. When using the air conditioner for thawing out a frozen heating system, always be sure that the plane's air supply nose valve is fully closed.

5. As soon as there is steam pressure, either prior to take-off or during climb, the First Officer may start to open the nose valve.

6. Should there be a delayed departure, the Captain shall be so advised and provided temperatures are such that there is danger of freezing, the system will then be drained with the assistance of the ground crew.

7. At stations where there is at times a shortage of ground personnel, the First Officer shall assist the ground crew in starting the engines and "steaming up" the heating system.

E. Dispatch

1. During the winter months, a plane shall not be dispatched with an inoperative heating system or a leaking boiler. The only exception to this rule will be during the warm weather season when weather conditions are such that no discomfort whatever will be caused to passengers. If a heating system is defective and weather conditions are such as to indicate the need of heat, it will be necessary to delay the trip until a repair or replacement can be made.

F. Plane in flight, system frozen, water level low.

1. If the water supply is permitted to become too low, during low temperatures, the condensation in the radiator will freeze. Whenever the system is thus frozen, the following procedure should be adhered to in order to effect thawing:

(a) Close the air supply nose valve completely.

(b) Add one or two quarts of water to reserve tank, open valve "E" on bottom of tank, leaving gauge valve "A" open until system is free of air and steam begins to come out at pressure gauge valve, then close valve "A".

2. Replacement

A. The 38# and 25# relief valves and the Fisher regulating valves issued to stations for replacement purposes are properly adjusted at the Repair Base. Therefore, it should not be necessary for personnel to adjust these units when installations are made. However, when a regulating valve is replaced, the system should be tested for operation by steaming up the heating system. This will prove whether or not the removed regulator was defective.

B. Service stations are supplied with a spare exhaust tail pipe and short section of steam line. In order to save time on a boiler change, it is advantageous to have the tail pipe and short steam line already installed.

C. All of our heating system boilers are now equipped with jackets which result in increased heating capacity. Spare boilers are supplied from the Repair Base with the jackets installed. If when making replacements spare jackets are not available, remove the jacket from the defective boiler and install it on the serviceable unit.

D. The steam heating system light goes out at over 5 lbs. and comes on at over 20 lbs.

3. Adjustment

A. Drain system of water.

B. Remove by-pass line from tee just below Globe Valve "D" and connect line to the low pressure side of air regulator (Binks #83-A regulator requipped with gauge). or equivaleht

C. Close valve "D" just below pressure regulator.

D. Close valve "E" at bottom of reserve tank.

E. Turn on air and note the pressure on Binks gauge at which the steam valve in the right nacelle pops off. Adjust so that this will relieve pressure at 38 to 40 lbs. (NOTE: This valve shall operate without requiring any tapping and shall allow a free flow of air.)

F. Open valve "D" and back off on pressure regulator adjustment.

G. Close valves "A" and "B" and gradually increase the air pressure, noting when valve "C" opens. This should be adjusted to relieve at 25 lbs. and close again at 20 lbs. or better. (NOTE: This valve shall operate without requiring any tapping and shall allow a free flow of air through the overflow line).

H. Relieve the pressure on the system, then slowly raise the pressure and set the regulator valve to regulate at 14 to 16 lbs. This valve should maintain 14 to 16 lbs. pressure on the tank gauge when the air pressure on the Binks gauge reads 45 to 50 lbs.

NOTE: The pressure will be approximately 2 lbs. higher with steam than when using air on the system.

4. Testing System for Leaks

A. The simplest way to test the heating system for leaks, provided the cause is not self-evident, is to connect the Binks Air regulator to the bypass line tee just below valve "D", fill entire system full of water, and put approximately 20 lbs. air pressure on the system. If there are any leaks, they will show up very quickly.

B. "B" nuts on steam lines which are difficult to remove because of having been soaked in "water glass" may be freed by soaking them in hot water; this helps to loosen up the hard "water glass".

DEICERS 18

DEICERS

1. SERVICE

(See Maintenance Manual - Radio and Electrical for information on electrical circuits).

A. GENERAL.

Deicers of necessity must be built of soft, flexible rubber stock in order to perform their function of flexing and stretching under relatively low operating pressures. This means that the deicers are not particularly tough, and every precaution must be taken to prevent their being damaged.

B. CLEANING DEICERS.

Engine oil should be removed from the surface of the deicers as soon as a plane comes in from a run. This can be accomplished, preferably by the use of a neutral soap and water solution. If necessary, however, the oil may be removed by wiping the deicer surface lightly with a rag dampened in cleaning solvent. When cleaning solvent is used, the surface should be wiped dry immediately without allowing it to penetrate into the rubber. Also, care should be taken to avoid scrubbing the surface of the deicers as this will tend to remove the special graphite surfacing provided to afford electrical conductivity for the elimination of static.

C. GROUND TEST.

During the ground test of the engines, the control switch should be placed in the "ON" position and the inflation and deflation of each tube in the boots carefully observed. The pressures shown on the gauge should be within the limits shown on the "Ground Runup Chart".

D. On planes so equipped, the deicer system sumps shall be drained on each #2 and #3 check. The sumps to be drained are located on the inboard sides of each wheel-well, approximately one-third the length of the wheel-well ahead of the wing bulkhead. These sumps are of the can type and are equipped with spring loaded weatherhead drain cocks.

2. REPLACEMENT

A. The installation of deicer boots is becoming more and more specialized and requires the use of special materials and procedures. Accordingly, the installation of these boots shall be accomplished at the Repair Base. In extreme cases, however when it is necessary to install them at a service station, personnel experienced in this work will be supplied by the Repair Base to accomplish the job. (Note: See Spare Parts Assignment for stations which are equipped for deicer, boot replacements.

B. When it is found necessary to remove a boot section for a permanent repair or replacement, proceed as follows:

1. A request by wire shall be sent to the Repair Base for a replacement boot, and and the dispatch of a mechanic to assist with the replacement. Detailed information also should be given on the boot to be removed such as location

(light to tip, nacelle to light, etc.) left or right, and boot model number, serial number, and part number (as shown on the stencil of the boot).

2. If the boot is of the new type with flaps extending back over the metal retaining strips, they shall be loosened with Benzol. This must be used sparingly, as Benzol will affect the rubber of the boots.

3. Remove retaining screws with the special Reed and Prince screw-drivers. Remove boot section, disconnect, and plug air supply line.

4. Return defective boot to Repair Base tagged "Emergency Replacement". It must be accompanied by a Repairable Parts Tag which is completely filled out.

5. The plane may be used in service with a deicer boot removed, provided that: It is not to be flown in icing weather; the holes in the wing skin for air supply lines are plugged; that 6-32 screws are installed in the rivnut holes; that the "ON" "OFF" deicer control is secured in the "OFF" position and the instrument panel is placarded "WING DEICERS INOPERATIVE".

6. If the plane is to be flown to another station for replacement of the removed boot, the attaching screws and short metal retaining strips shall be placed in the plane accompanied by a tag which states: "Deicer boot parts - Do not remove from this plane."

   The long metal strips shall be forwarded by Railway Express to the station where the boot replacement is to be made.

C. The new type deicer boots have rubber flaps extending back over and cemented to the metal attaching strips and skin. <u>This type deicer must not be used on a plane equipped with the old type having the exposed metal strip unless the rubber extension flaps are cut off.</u>

The reason for this is that with the new type, ice cannot form on the metal retaining strip as is the case with the exposed metal strip. Thus the aerodynamic characteristics for each wing (or stabilizer) would be different, and this is undesirable.

3. ADJUSMENTS

A. If the deicer system is reported inoperative or if any malfunctioning of the system is noted, it should be tested with the hangar air supply using a pressure regulator valve adjusted to a maximum of ten (10) lbs. in the following manner:

1. DOUGLAS - These planes are equipped with a plug in the deicer line in the right nacelle which can be removed and the hangar air supply connected for a hangar test of the system.

B. When the hangar air supply has been connected to the deicer system, the check valves should be tested to be sure that they are closed and will not permit air to blow back through the vacuum pumps to the gyroscopic instruments.

C. Back off adjusting screw on pressure relief valve (bottom of air separator).

D. Turn air on slowly until only enough volume is obtained to partly inflate the boot.

CAUTION: Care should be used at this point to insure that the boot is not burst by too much pressure.

E. With valve positioned to inflate an outboard boot, adjust the pressure relief valve to give pressure on deicer gauge as shown under maximum reading on Ground Runup Chart. Tighten locknut on pressure adjusting screw.

F. If any parts inflate or deflate slowly, or if any gurgling is noted in the lines, such parts should be disconnected and the lines blown out with air. It is important that inflation and deflation be rapid and complete as this is the governing factor in deicer effectiveness.

G. The surface of the rubber should be inspected for any punctures, and the timing of the system should be tested by timing several complete cycles. If a complete cycle takes more than forty-five seconds, the distributor valve should be inspected to determine the difficulty.

H. Hangar air should now be removed from the oil separator and the vacuum pump supply line connected. The engines should be run and operations of valve and all boots tested again. It may be necessary to readjust pressure relief valve to compensate for greater or less volume of air supplied by pumps.

I. Replace and secure cover on valve adjustment screw. Test pressure relief locknut for tightness.

J. The pressure relief valve should never be bottomed; if this is necessary to raise the pressure to the required value, other trouble is indicated, such as something between relief valve and seat, too much clearance in distributor valve, only one pump functioning, or a leak in the air supply lines.

K. If the spring adjustment on the relief valve is tightened as far as possible, there is no way for oil to leave the oil separator, and the result will be that after the oil separator fills, the oil will then be pumped into the deicer boots.

4. REPAIRS TO BOOTS

A. Any repairs to the deicer boot rubber should be accomplished with the materials supplied in the Goodrich deicer repair kits and in accordance with instructions contained in the kit and which appear below.

B. In general, cold patch repairs are satisfactory for repairing small cuts or breaks in the rubber tubes which are 3/4 inch or less, cuts or tears in the elastic area may be repaired if 2 inches or less. If the damage affects any of the fabric reenforcement of the deicer, or if the damage is across the direction of stretch, the repair should be made with the rubberized fabric provided for this purpose. This fabric is more elastic in one direction than in the other, and the patch should be cut and applied so as to allow stretch across the tube.

C. Any one of the following listed damages will necessitate removal of a deicer boot from service pending repairs or replacement.

1. A cut, hole, or tear in the outside portion of a tube which is greater than 3/4 inch in any one direction.
2. A cut, hole, or tear greater than 2 inches in the elastic portion of the shoe (between a tube and the metal attaching strip).
3. Any cut, hole, or tear in the back wall of a tube (next to the wing leading edge).
4. A re-enforcing strip cut or torn more than one quarter of its width.

D. General procedure.

1. The type of deicer now in service requires a special technique to repair. The reason for this is that the rubber in the new type deicers is softer and has more pliability and elasticity. When Benzol or rubber cement is applied directly to a cut, hole, or tear, the Benzol or cement softens the rubber edges around the hole with the result that the rubber tears and allows the damage to extend to greater dimensions. This action, in addition to the tension of the rubber, may cause the damage to extend beyond the allowable limits for field repair, and in this case would necessitate removal of the entire boot. Therefore, it is necessary to prevent Benzol or rubber cement from coming in direct contact with the edges of the hole. This method of repair will apply to all types of deicers.
2. Clean surface in vicinity of damage with soap and water and allow to dry.
3. Determine size of patch required and select template or buffing shield of corresponding size. Place shield over hole so that cut out portion exposes area to be patched and retain shield in place throughout the following operations:

   (a) Roughen surface with wire rubber.

   (b) By use of emery buffer, remove Prenite-Graphite surface. This will require the removal of approximately .003 inches. Remove buffing shield.
4. Cut a piece of masking tape to the correct size so that the hole or damage may be covered, having it extend over the rubber for 1/8" directly around the damage. Press down firmly. This will prevent the Benzol from coming in direct contact with the edges of the hole or tear.
5. By use of a rag dampened in Benzol, scrub the prepared patch area vigorously and allow to dry. Use no more Benzol than is absolutely necessary. The important part of this operation is to remove all traces of Prenite-Graphite from the area to be patched; otherwise the patch will not stick tightly.
6. Brush on one coat of #1 cement and allow to dry. <u>This must be done while the area directly over the cut or tear is still protected with masking tape.</u> After #1 cement is dried, remove masking tape.
7. Remove starched fabric backing from patch and apply light coat of #1 cement to surface so exposed.

   (a) Keep tacky surface of patch clean after removing fabric and applying cement.

   (b) Allow to dry.

8. Apply patch to deicer.

   (a) Stick center or one edge of patch lightly and work remainder down so that air will not be trapped under the patch.

   (b) Roll patch down securely with metal roller on handle of wire buffer.

   (c) Make certain edges are down firmly.

9. Allow to stand 10 or 15 minutes; then wipe patch and surrounding area lightly with Benzol.

10. Apply a coat of Prenite-Graphite cement on and around patch to restore conductive surface.

11. In the event that the damage cannot be repaired by the standard patches, repair material can be cut to suit from the sheet rubber or rubberized fabric. The sheet rubber can be used on cuts and tears in the direction of stretch, but for cuts and tears at right angles to stretch, the rubberized fabric must be used. In such repairs, the procedure is the same, except that the repair material should be thoroughly cleaned and given two coats of #1 cement before application.

1. SERVICE-PROPELLER DEICERS

A. General.

Propeller deicers do not need any special service work other than inspection for condition.

B. Cleaning.

Every precaution shall be used to prevent cleaning solvents from coming in contact with propeller anti-icer feed shoes. Where necessary they may be cleaned with a mild soap and warm (not hot) water.

C. Ground Test.

(1) With pump switches off, open both needle valves wide open. The rotometer indicators should record approximately one-half scale.

(2) Leave valves open and switch on one pump only. Both indicators should move up above four quarts per hour.

(3) Test opposite pump singly in the same manner. If any pump does not discharge fluid at this rate, there is cause for further investigation as to the trouble, and correction must be made.

(4) While watching the rotometer, check for dirt, flakes, or other foreign material passing through the system which will be cause for complete flushing out of the anti-icer lines.

(5) Visually observe the discharge tubes of both propellers to see that fluid is flowing from them.

(6) See instructions under instruments, flow meters, for procedure for flushing system out.

D. Repair.

Experience shows that the primary reason for removing these shoes in the past is because of splitting on tearing at or near the tips of the shoes and loosening along the edges of the rubber. It is permissible to trim away damaged portions of the rubber feed shoes, providing certain precautions are taken. Any and all shoes can be trimmed and their lengths cut down, providing the difference in length between the longest and shortest shoe is never greater than six inches. For instance, one feed shoe can be cut down to twelve inches if necessary, providing the longest shoes are trimmed to an eighteen-inch length. The damaged portions along the edges of the shoe may also be trimmed, providing a good smooth job is done.

Caution

Do not use a knife for this trimming operation. Use a small sharp nosed pair of scissors. Insert the sharp point of the scissors gently between the feed shoe and the blade, and progress very slowly by short steps, being careful not to raise the parent rubber any more than necessary. If this is done carefully, the parent rubber will pull down tightly again against the blade. After the shoes have been

trimmed, seal the edges with an oil-proof paint. Each service station shall requisition from Cheyenne a half-pint can of this oil-proof paint for this purpose.

E. Removal.

In the event trimming does not return the shoes to serviceability, all three shoes must be removed from that propeller. These shoes cannot be re-used, so they shall be removed without the use of solvents. Work up the edges of the tip and apply a steady pull over the width of the shoe, progressing towards the hub. Use reasonable precautions and return all shoes removed to Cheyenne for inspection. Remove the cement from the propeller by use of Benzol, or a good paint remover.

F. Replacement of Anti-Freeze Feed Shoes.

A. Planes not equipped with propeller anti-freeze feed shoes shall not be dispatch patched into known icing conditions. When time does not permit replacing shoes prior to dispatch under such conditions, it will be permissible to install spare propellers which are equipped with feed shoes. Such installations shall be properly recorded in the log books whenever accomplished. LG, CG, AND SF shall be set up to replace Anti-freeze feed shoes on propeller blades.

B. The instructions and sketch show how anti-freeze feed shoes are to be installed Care must be used in locating and installing these shoes to make sure that they are properly installed and to assure that they will adhere properly.

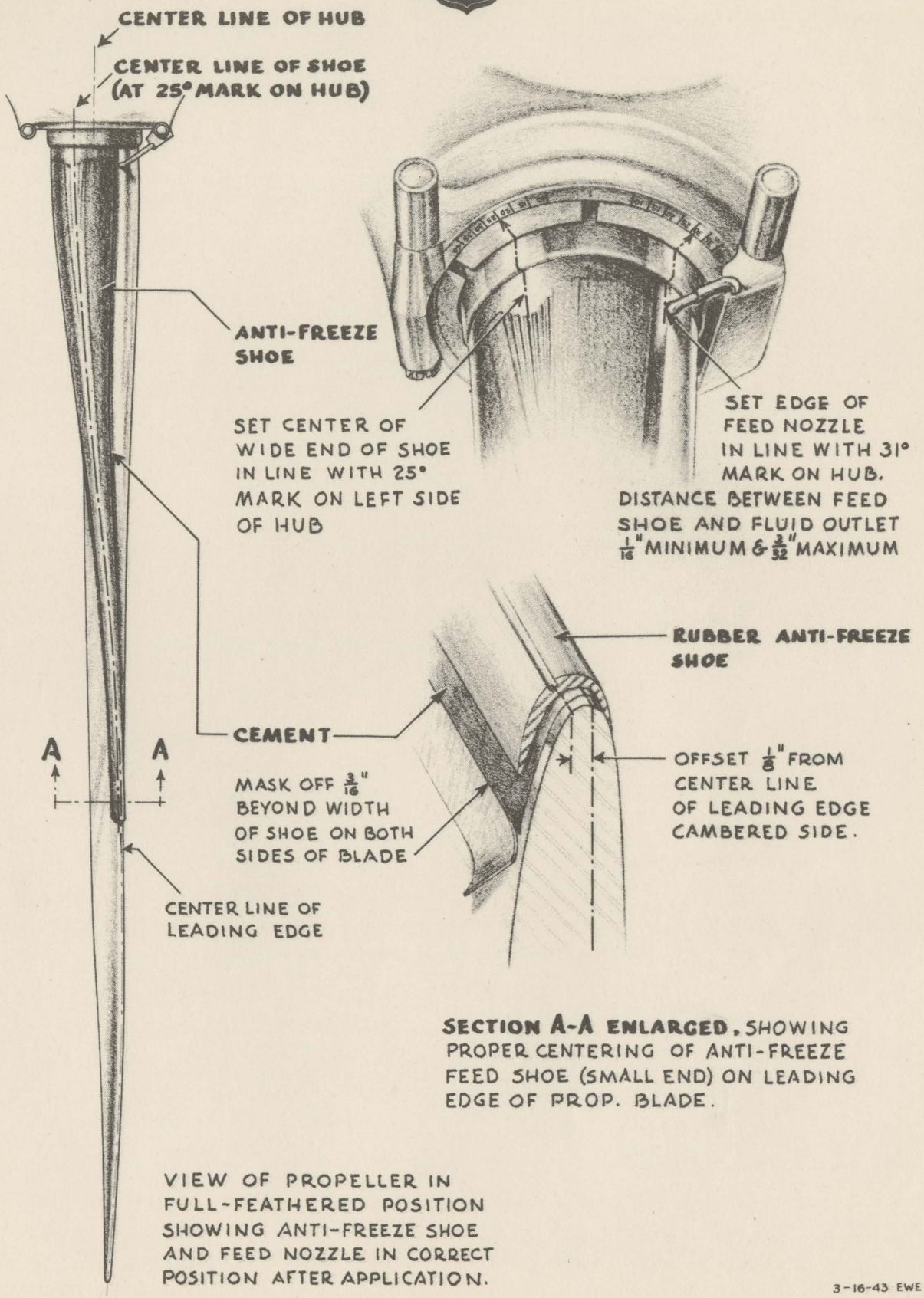
NOTE: Buffing or roughening propeller blades in an effort to have feed shoes adhere is prohibited and must <u>never</u> be done!

1. Prepare a suitable template of 2" adhesive tape cut to the length and contour of the feed shoe.
2. Locate the centerline of the template at the hub end of the blade to coincide with the 25° mark on the hub <u>with the blade in the full feathered position.</u> (See sketch) The end of the feed shoe apron shall be located 1/8" from the edge of the micarta ring in the hub.
3. Apply the masking template along the leading edge of the blade and center at the hub on the centerline as marked. (See sketch).
4. Mask off with masking tape an area 3/16" on each side of the template and 3/4" beyond the end of the template.
5. Remove the template from the blade.
6. Clean the masked-off area with a suitable solvent (Benzol or Naphtha) and wipe dry immediately to avoid film. Do NOT buff or roughen surface of blades.
7. Brush on uniformly one generous coat of Bostik precoat #624-N to the masked-off area of the blade.
8. Allow this coat to dry for 45 minutes in summer to 60 minutes in winter.

9. Brush on uniformly one generous coat of Bostik #M-50 cement over the precoat. (NOTE: The Bostik #M-50 is furnished in quantities of 40 parts Part A to 1 part Part B. Mix thoroughly before using. After once being mixed, this cement must be used within eight hours).
10. Allow this cement to dry from 15 minutes in summer to 45 minutes in winter.
11. At the same time as (10), clean the underside of the synthetic shoe with a solvent, such as Benzol or Naphtha, and apply uniformly one generous coat of Bostik cement #M-50.
12. When the cement on the blade has dried for the proper length of time, position the shoe on the blade starting at the hub end with the centerline of the shoe on the centerline marked on the blade. (See sketch) Sighting along the blade and at the centerline marked on the underside of the shoe, position the shoe outwardly from the hub so that the centerline of the shoe is 1/8" to the cambered side of the leading edge at the point where the blade begins to assume aerodynamic shape, and maintain this 1/8" offset to the end of the shoe. While thus positioning the shoe, tack along the centerline with the fingers. If during positioning, the shoe is allowed to get off the desired line, it may be pulled up by a quick motion and replaced properly.
13. Roll along the centerline with a heavy hand roller.
14. Roll outwardly from the centerline to the edges of the shoe with the hand roller, being careful to avoid puckers at the edges. If puckers occur, they can be removed by pulling the shoe away from the cement locally and working down with the fingers.
15. To complete installation and insure the best adhesion, roll all over with heavy hand roller.
16. Remove masking tape.
17. Allow to stand for one hour before putting into service or if convenient, allow to stand for one day in order that the cement may completely set and a bond of maximum effectiveness be assured.

C. The following material is needed for the installation of feed shoes:

1. Synthetic propeller anti-freeze feed shoes. (These to be cut to 37" and properly trimmed by CX).
2. Bostik precoat #624-N cement.
3. Bostik #M-50 cement. (40 parts Part A to 1 part Part B).
4. 1" paint brush.
5. Hand roller (Suitable for rolling propeller blade anti-freeze feed shoes).
6. In addition a steel tape, masking tape, scissors, cloths and solvent (Benzol or Naphtha), will be needed.



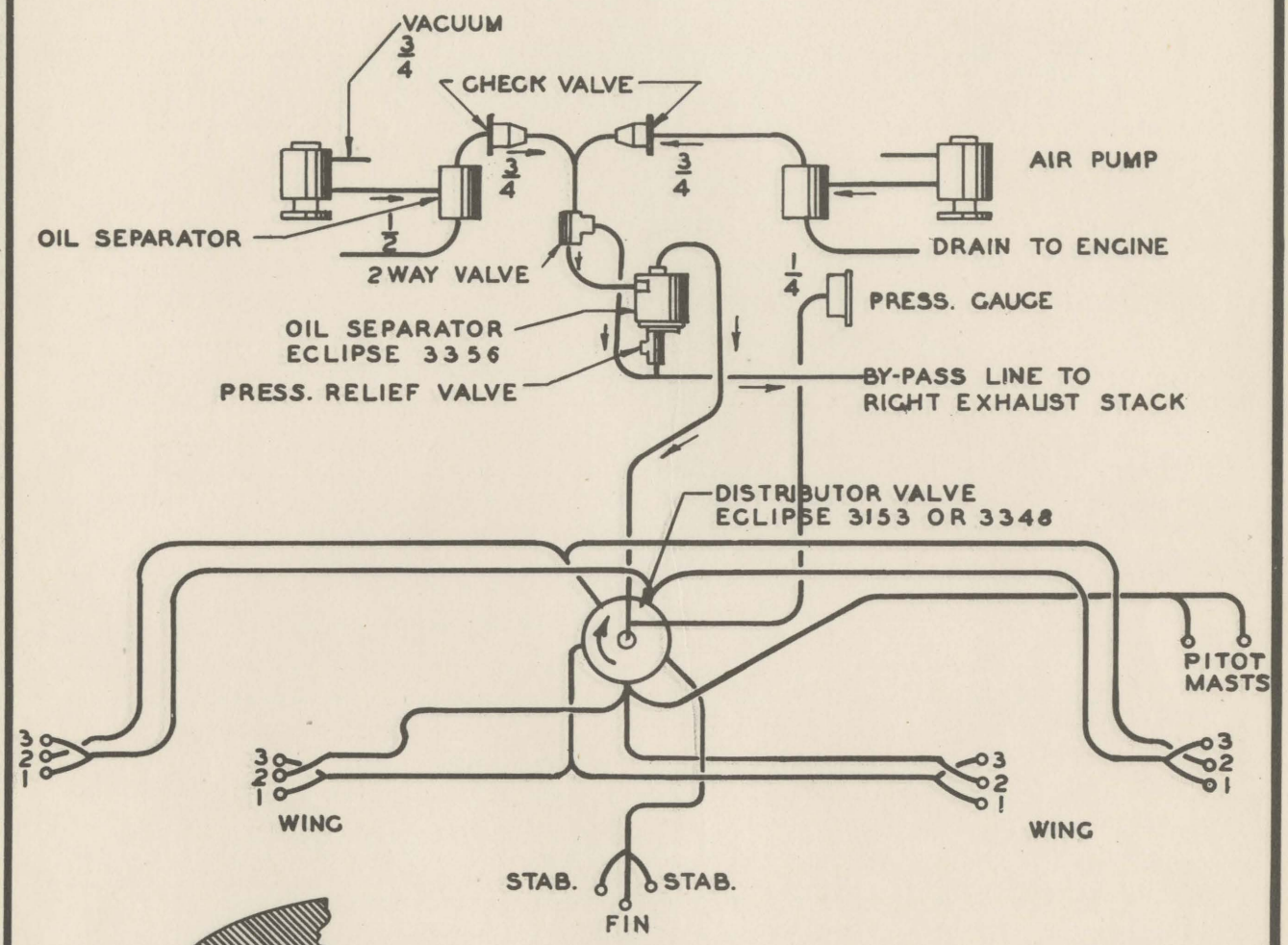
JSS 95827

APPLICATION OF ANTI-FREEZE FEED SHOE ON PROPELLER BLADE

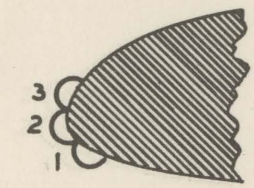
1. PITOT MAST DEICERS

A. General.

Pitot mast deicers are installed on all Douglas planes. These deicers shall be tested in accordance with the standard procedure and shall be repaired in the same manner as our wing and stabilizer deicers, and the same careful treatment shall be given to them. (Caution: Do not leave the pitot heaters switched "on" on the ground, as the generation of heat in the pitot heater may cause damage to the mast deicers.)



FIVE PORT INSTALLATION



TUBE DESIGNATION

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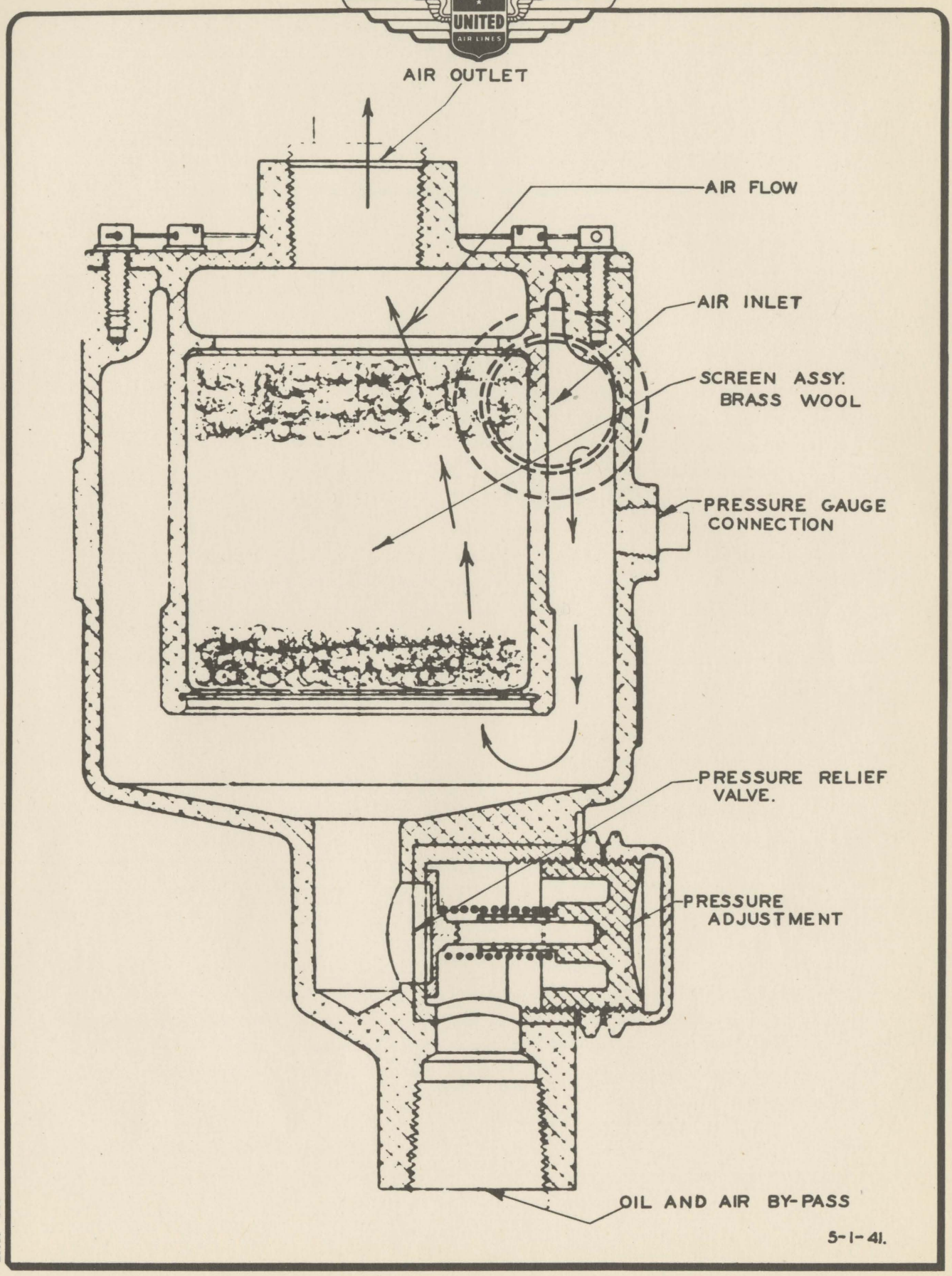
ISS 95827

DEICER INSTALLATION—DC3-A AND DST-A



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ECLIPSE DEICER OIL SEPARATOR—TYPE 3356

DOUBLE WINDSHIELDS OPERATION- PROCEDURE

It has been found that reflections increase if these windshields are dirty or dusty.

Because they have many desirable features, every effort should be made to keep them in the best possible condition. The cleaning method is given below.

Crew chiefs, who inspect a plane to see that it is properly cleaned, are expected to pay particular attention to the condition of these windshields. Do not let them go out dirty.

(NOTE: Chart below and illustration following show the proper valve settings and must be followed closely to prevent fogging).

Cleaning

1. Disconnect electrical connection at compass; unhook shock cord and carefully hang compass upside down.
2. Remove the two lower hinge pins and swing glass upward. The entire glass may be removed, if desired, by also removing the two upper hinge pins.
3. Spray "Stynamite" glass cleaner, which has been properly diluted, on surfaces inside and out and wipe clean with a clean soft rag.
4. Replace inner glass, connect compass up, and test compass light.

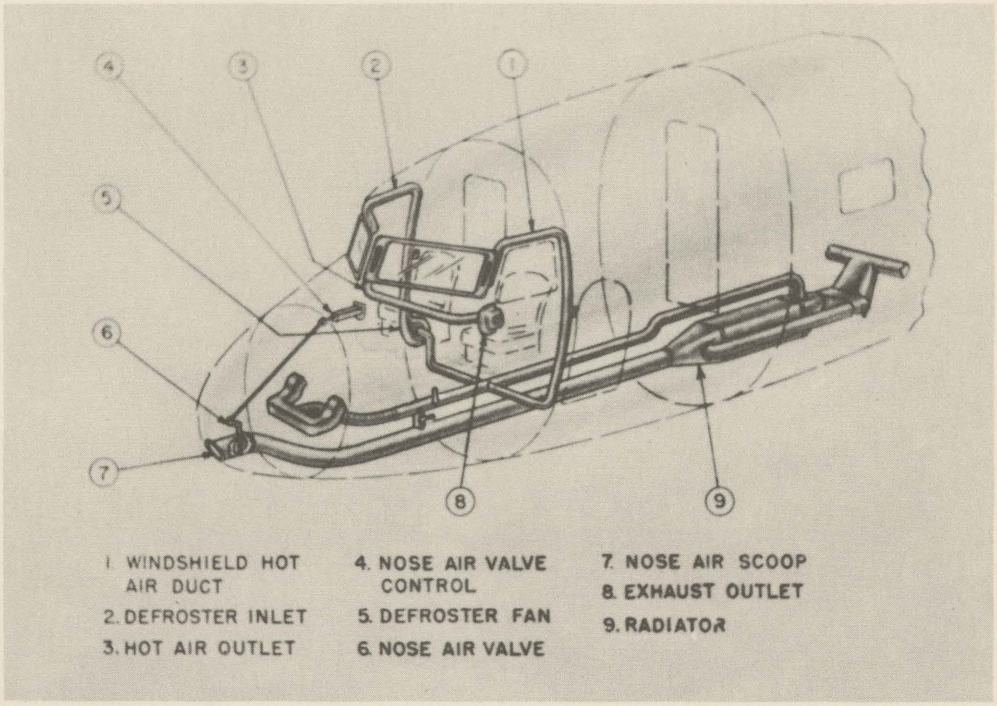
(NOTE: Plastic glass is no longer used in double windshields; therefore, stynamite cleaner will be used for all cleaning.)

VALVE SETTINGS FOR OPERATING WINDSHIELD DEICING SYSTEM

VALVE NO.	CONDITION			
	Flight in Icing Overcast	Landing & Ground Taxiing	Cruise Flight No Ice	Inner Pane Removed- Any Cond.
1 Defroster Fan SW.	Off	On	Off	Optional
4 Inlet Valve	Open	Open	Optional	Closed
5 Outlet.	Open	Closed	Closed	Closed
6 Nose Air Valve.	Open Full	2 Turns Open	Optional	Optional
7 Defroster Valve	Open	Open	Optional	Optional

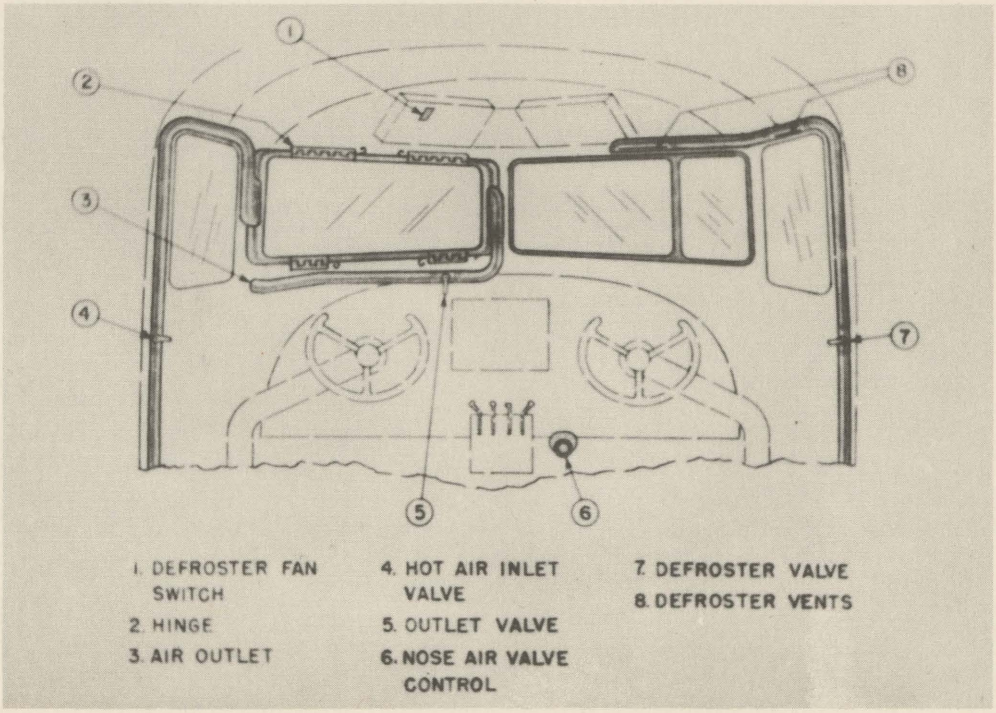
NOTE:

1. Under extreme icing conditions an increased amount of heat can be directed to the windshield by placing the cabin air valve in the full cold position in addition to using the above settings.



1. WINDSHIELD HOT AIR DUCT
2. DEFROSTER INLET
3. HOT AIR OUTLET
4. NOSE AIR VALVE CONTROL
5. DEFROSTER FAN
6. NOSE AIR VALVE
7. NOSE AIR SCOOP
8. EXHAUST OUTLET
9. RADIATOR

U. A. L. DOUBLE WINDSHIELD—HOT AIR SYSTEM



1. DEFROSTER FAN SWITCH
2. HINGE
3. AIR OUTLET
4. HOT AIR INLET VALVE
5. OUTLET VALVE
6. NOSE AIR VALVE CONTROL
7. DEFROSTER VALVE
8. DEFROSTER VENTS

U. A. L. DOUBLE WINDSHIELD—COCKPIT AIR DUCT SYSTEM

OXYGEN 19

OXYGEN SYSTEM

1. General

A. The oxygen installation shall be considered as part of the emergency equipment and will be signed for on the Form UO-78 under that heading.

B. All cylinders carrying oxygen are manufactured under close inspection, are provided with proper safety devices, and are given most severe tests, as required by the Interstate Commerce Commission. Consequently, they are considered safe for the purpose intended, but it is necessary to prevent their abuse or mishandling. All bottles and other oxygen equipment must be handled with extreme care, by experienced personnel only, and all valves, hoses, lines, fittings, etc., must be kept clean and in first class condition at all times.

(NOTE: Any "Air Cruiser" bottles found with "A3T" stamped on the bottom end shall have all pressure released, be red tagged and shipped to Cheyenne for disposition as they are not serviceable.)

2. Servicing

A. Each station having a manifold recharging outfit shall arrange to make up a small wooden saddle which will hold a large oxygen bottle at approximately a 45° angle. All incoming oxygen bottles shall be placed in this rack, valve down, and allowed to remain for fifteen or twenty minutes. After this time the main valve shall be cracked open and allowed to permit a small amount of oxygen to escape. If, during this time, moisture is found to be dripping from the valve, it shall be left open until the water has stopped dripping. This procedure shall be repeated after a short interval until no moisture is present in the bottle. If this test shows no moisture to be present, then the bottle may be installed in the manifold and used for recharging.

B. To Refill Plane Oxygen Bottles from Pressure Manifold:

1. Only the men necessary to accomplish the refilling operation shall be permitted near the refilling rack while the bottles are being refilled.

2. Close valve on top of plane's bottle and, if not already done, remove regulator assembly.

3. Make sure that all bottles, lines and fittings are clean and free from all signs of oil, grease, dust or any other foreign material. If bottles, threads, couplings or lines have any sign of foreign material on them, they must be thoroughly cleaned with a caustic soda solution (ratio one pound to one gallon of water) before the bottles are connected.

4. After the large bottles have been connected to the manifold and before the plane bottle is connected to the manifold, the valve on the large bottle with the lowest pressure should be just cracked open for a few seconds to blow any dirt or moisture out of the manifold.

5. Connect the plane's bottle to the system making sure that all connections are tight.

6. Open valve on top of plane's bottle.

7. Consult the temperature conversion table and fill bottle to the pressure given in the table for the temperature of the room at the time the bottle is filled.

8. In the interest of economy it is necessary always to refill the plane's bottle by utilizing the gas which is in the large bottle with the lowest pressure, provided this pressure is above that in the plane's bottle.

9. As soon as the oxygen pressure in the lowest bottle equalizes with the plane bottle, shut off the valve ont the top of the large bottle and open the valve on the large bottle with the next highest pressure. Continue this procedure until the bottle is filled according to the temperature table.

10. When the plane's bottle has been brought up to the proper pressure, close the valve on top of the large bottle and on top of the plane bottle, then disconnect the manifold line on top of the plane bottle and plug line with fitting supplied. Upend each plane oxygen bottle after it has been properly charged and allow it to rest in the inverted position for a few minutes, subsequently cracking the valve to allow any water to escape. On any bottle found to contain water, this procedure must be repeated until no further dripping occurs when the valve is cracked. Attach the regulator assembly onto the plane bottle, making sure that the regulator is set at the proper angle.

11. Test the connection between the bottle and regulator by painting this joint with a soapy water solution.

CAUTION: This connection must be absolutely leak-proof before the bottle is installed in the plane.

C. Temperature Conversions Table No. 1

Temperature Degrees F.	Rank Press. Lbs. Sq. In.
130	2000
120	1970
110	1935
100	1900
90	1870
80	1835
70	1800
60	1765
50	1730
40	1695
30	1665
20	1630
10	1595
0	1560

ABOVE PRESSURES ARE MAXIMUM FOR REFILLING BOTTLES.

D. Temperature Conversions Table No. 2

Temperature Degrees F.	Tank Press. Lbs. Sq. In.
130	1780
120	1750
110	1720
100	1690
90	1660
80	1630
70	1600
60	1570
50	1540
40	1510
30	1480
20	1450
10	1420
0	1390

BOTTLES SHOULD BE REMOVED FOR REFILLING WHEN TANK PRESSURE FOR CORRESPONDING AIR TEMPERATURES IS BELOW ABOVE LISTED PRESSURES.

E. To Test System for Leaks:

1. Close valves of all individual outlets.
2. Open oxygen regulator until the gauge indicates approximately one-half of scale.
3. Close oxygen regulator so that pressure on the flow gauge remains at half scale.
4. If the gauge drops to zero, a leak is indicated, and it should be located and corrected. The leak will probably be in one of the valves or in the low pressure rubber hose to the regulator. These may be individually tested by application soap suds.

3. Replacement

A. To remove bottle from plane:

1. Close the high pressure valve on top of the bottle.
2. Disconnect the low pressure oxygen line at the regulator.
3. Loosen the clamps and remove the bottle.

B. To install bottle in plane:

1. Place bottle in position and tighten clamps.
2. Connect low pressure line.
3. Fully open high pressure valve.
4. Tap gauge lightly when checking pressure in planes to be sure gauge is not sticking.

4. Precautions

A. KEEP OXYGEN CYLINDERS AND FITTINGS AWAY FROM OIL OR GREASE: OIL OR GREASE IN PRESENCE OF OXYGEN UNDER PRESSURE MAY IGNITE VIOLENTLY. Oil or greasy substance must be kept away from cylinders, cylinder valves, couplings, regulators, hose and apparatus. Do not handle oxygen cylinders or apparatus with oily hands or gloves.

B. Do not drop oxygen cylinders or handle them roughly.

C. Do not use a hammer or wrench to open oxygen cylinder valves. If valves cannot be opened by hand, notify the supplier in case of a large bottle; if a plane bottle, return to the Repair Base.

D. The CYLINDER VALVE SHOULD BE OPENED SLOWLY. If the high pressure is suddenly released, it is likely to damage the regulator and pressure gauge.

E. Never tamper with or attempt to repair oxygen cylinder valves.

F. When working in a confined space, be sure of proper and adequate ventilation, by natural means or by an air fan or blower. Never feed oxygen from a cylinder into a confined space. It is unsafe to do so.

G. In order to eliminate the possibility of rust internally, the large refilling oxygen bottles or the plane oxygen bottles shall never have the valves opened and the contents fully discharged.

H. If any plane oxygen bottles are found in service which contain water, they shall be immediately removed from service, the contents released, and the bottle shall be returned immediately to Cheyenne with a green tag showing the complete story as to approximate amount of water found therein.

5. Spare Bottles

A. Keep spare bottles in the place provided and do not allow them to sit around the hangars.

B. The valves on all spare bottles must be kept closed when the bottles are removed from the airplanes, except during the time they are being refilled.

C. The valves are equipped with two seals, one to seal when the valve is closed, the other to seal when the valve is fully opened. Therefore, it is necessary that the valve be either fully opened or fully closed and not left at any point in between; otherwise, the valve may leak.

CAUTION: At all times when plane oxygen system is not in use, turn the regulator valve adjusting screw counter-clockwise to maximum "Out" position. This is to eliminate any unnecessary strain on the regulator diaphragm.

D. Spare bottles shall be kept in serviceable condition at all times to prevent delays when their use is necessary.

E. Most service stations and some intermediate stations are equipped to refill the plane bottles. When any other station removes a bottle for refilling, it shall be properly packed in the container provided and shipped via plane to the nearest refilling station.

F. The refilling station upon receipt of the empty bottle shall refill it promptly and return it by plane to the proper station.

NOTE: When any station has occasion to ship on oxygen bottle, regardless of whether it is full or empty, it must be properly packed in the wooden box provided, in order to prevent damage.

6. Storage of Oxygen Cylinders

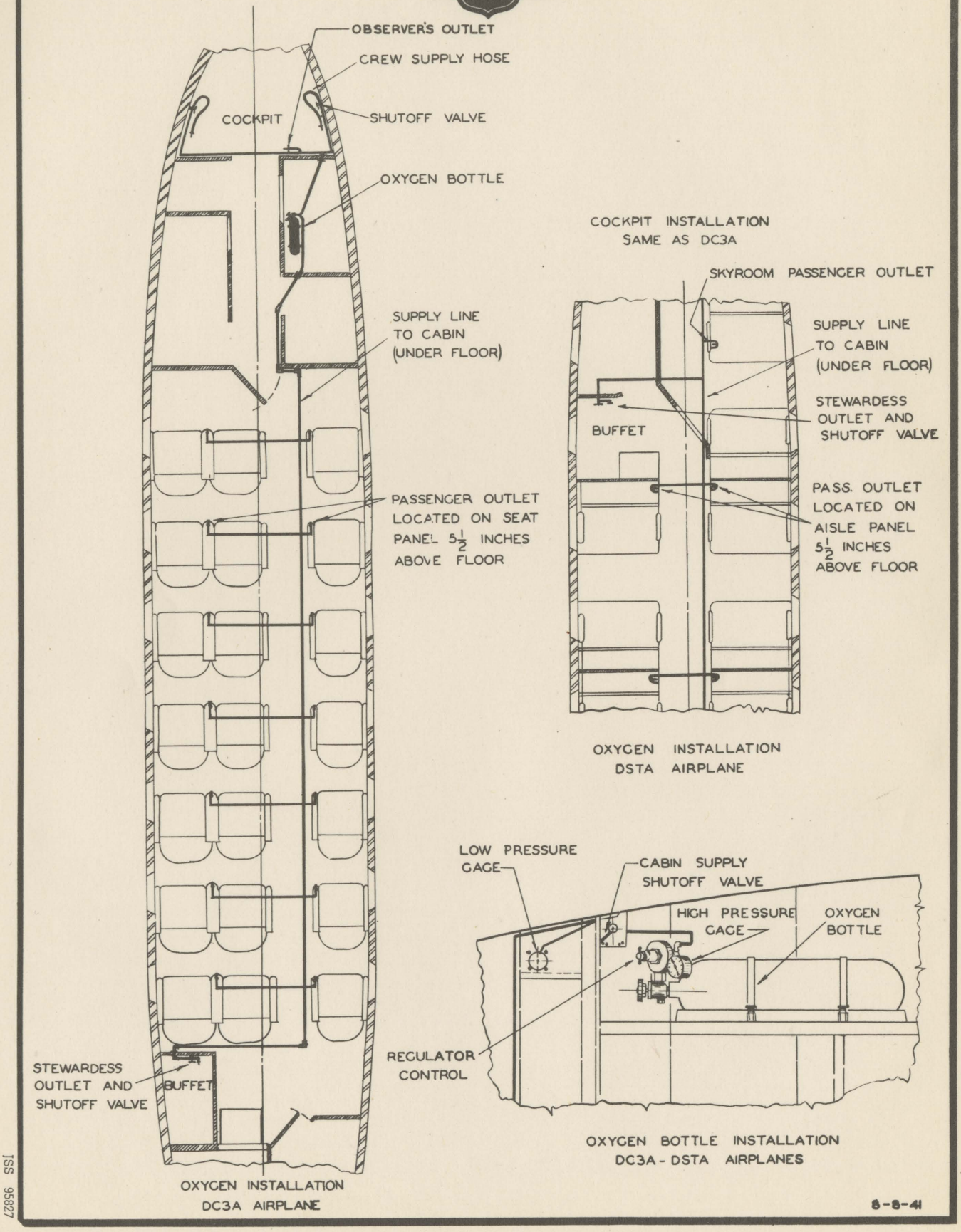
A. Cylinders stored inside buildings should be kept away from radiators and any other sources of heat.

B. Cylinders should be stored in definitely assigned places where they will not be knocked over or damaged by passing or falling objects.

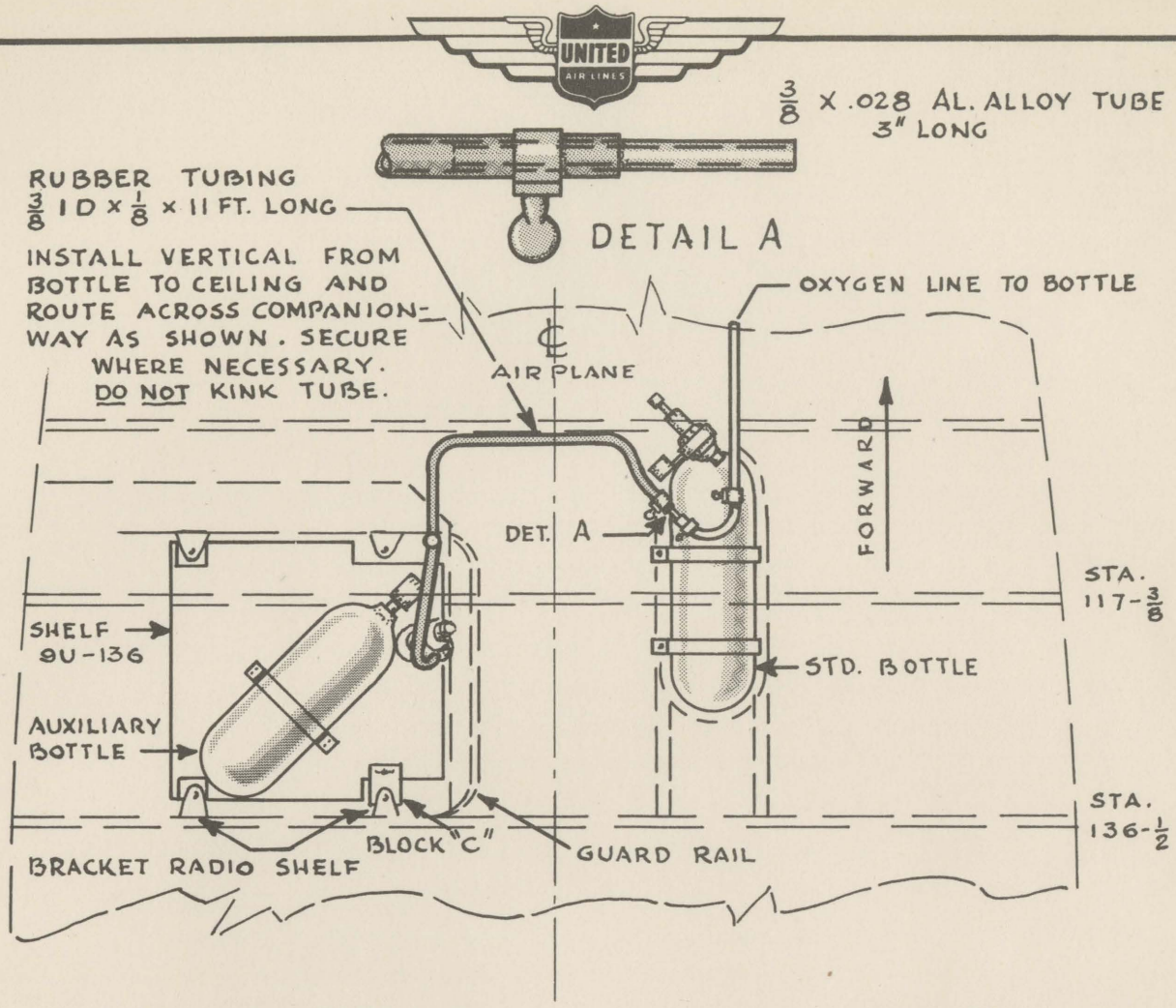
C. Where cylinders are stored in the open, they should be protected from accumulation of ice and snow and from the direct rays of the sun, and cylinders containing one gas should be stored well away from cylinders containing another gas.

D. Always close valves of empty cylinders or cylinders in storage.

E. Never use cylinders as rollers or supports, even if considered empty.



DC3-A DST-A OXYGEN INSTALLATION



TO INSTALL AUXILIARY BOTTLE -

1. Install shelf 9U-136 first, on top of aisle radio shelf brackets so it protrudes part way into aisle.

2. Install bottle and secure with strap.

3. Slide assembly into radio compartment until spacer blocks on shelf are underneath radio shelf brackets. (Block "C" must be at right angles to position shown.)

4. Rotate block "C" under bracket and secure with wing nut.

5. Attach 3/8 rubber tube to bottle and route as shown. End at standard bottle to be left loose until necessary.

6. The weight of the bottle and shelf must be added to the front cargo load.

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INSTALLATION-AUXILIARY OXYGEN BOTTLE

EMERGENCY EQUIPMENT 20

EMERGENCY EQUIPMENT

1. Emergency Exits

A. In the Douglas planes four emergency exits are provided; one in the roof of the cockpit, two located on the left and one on the right side of the passenger cabin.

B. Unless these exits are reported as leaking water or air, it will not be necessary to service them between overhaul periods. They should be inspected, however, to see that they are properly closed. In the Douglas planes the release mechanism is covered by a special fireproof pyralin material. If one of these covers becomes damaged or cracked it should be replaced with the approved covers which are furnished by the Repair Base.

2. First Aid Kits

A. A first aid kit is provided in each of our planes with their locations as follows:

DC3-A - Rear wall of lavatory.

B. These kits, except when in use, are to be kept sealed at all times with #35 white cotton sewing thread and lead seal. During each regular inspection the seal shall be inspected and if found broken, the kit shall be inspected, the missing items replaced, and the kit resealed. The list following is for the contents of one kit.

LaGuardia, Chicago, and San Francisco shall stock a sufficient quantity of each item called for on the following list to cover their needs for refill purposes. The spares should be Johnson and Johnson products, in order to keep the kits standard:

3 each - Paper drinking cups
1 each - Exmarch Triangular Bandage
1 each - Carton 6 each 3 x 3 Picric Acid Gauze Pads
1 each - Large Bandage Compress - Size 4 x 4 with bandage attached 4 x 72 sterile
2 each - Packages - one yard square Absorbent Gauze
1 each - One ounce package absorbent cotton
3 each - Gauze Bandages, 2 inch x 10 yards
1 each - Gauze Bandage - 1 inch x 10 yards
2 each - Cotton Roller Bandages, 2 inch x 5 yards
1 each - Waterproof Adhesive Plaster, 1/2 inch x 5 yards
1 each - Bottle Aromatic Spirit of Ammonia, 1/2 ounce
1 each - Tube Burn Ointment, 1-1/4 ounce
1 each - Tourniquet
1 each - Pair scissors - 5 inch
1 each - Pair Tweezers
1 each - First Aid Book
1 each - Applicator and bottle Alcoholic Solution of Iodine, one ounce
1 each - Metal Box Band Aids - 3 Doz.
6 each - Smallest size, Compressed bandages.

3. Fire Extinguishers

A. General

1. The Douglas planes carry a large LUX CO_2 bottle weighing between 18 and 19 lbs. when charged. This bottle is equipped with a "seat type" valve. The older type bottles incorporating the "disc type" valve are being converted to the "seat type" as the planes go through overhaul.

   (a) In each case the exact weight of a fully charged LUX bottle shall be determined by the weight which is stamped on the valve body. If the difference between the specified weight of the bottle and its actual weight is more than 4 ounces, the bottle must be recharged.

2. No plane is to be dispatched under any circumstances without having a fully charged and fully serviceable LUX bottle installed in the plane. The bottles shall be considered to be in a serviceable condition if the telltale indicator on the top of the bottle is not visible and if the red indicating disc on the right side of fuselage is intact. If either the red indicating disc is gone or the telltale on the bottle is visible, the bottle should be removed and weighed to determine whether or not it is discharged.

3. The Pyrene extinguishers located one each in the cockpit and the cabin should never be removed except in an emergency or when testing or filling. They should be replaced in their proper brackets making sure that the retaining devices work freely and that they may be removed with ease. Seal extinguisher by threading #28 soft copper wire around base of handle and then through safety hole in filler plug. Secure with lead seal.

B. Replacing LUX Bottles

1. Unless a Lux Bottle has been discharged, its removal for inspection will not be necessary between plane overhauls. The bottle will be removed, tested, and recharged at the Repair Base at each overhaul.

2. To replace a plane Lux bottle proceed as follows:

   (a) Douglas Planes

      (1) Remove the screws and the cover over the trip cable on the forward side of the head.

      (2) Disconnect the trip cable by removing the screw at the arm.

      (3) Disconnect the packing nuts on the cable housing and on the main discharge line at the head. Disconnect safety discharge line.

      (4) Remove the bolt from the clamp that holds the bottle in place and remove the bottle.

      (5) Reset operating lever as per instructions on the plate secured to the head.

      (6) To install bottle, secure it in place and tighten clamp. Install pull cable housing nut, connect trip cable, safety the discharge and discharge lines.

4. Parachute Flares

A. Douglas

1. WILEY type A-8 parachute flares are used for Douglas planes. They have an in intensity of 300,000 to 400,000 candle power and burn for a minimum period of three (3) minutes. These flares should be handled with extreme caution, because if inadvertently ignited during installation or while handling, serious injury to personnel and damage to property may result. The release handles located above the cockpit door are connected to the flare release cover slides by means of cables. These cables are run through small aluminum tubes to prevent the accidental discharge of a flare during inspection or while working on the plane. The flare cover sides are held in place by two small detent springs which protrude through slots in the flare case. During inspection, see that the detent springs protrude through the slots far enough to prevent the flare release slide from vibrating out. Test the springs for tension and make sure that they are not broken or oxidized.
2. In replacing a flare it should be remembered that the eye bolt which connects the striking cable to the container lid should be left free to turn. This will prevent the striking cable from becoming kinked. The eye bolt nut should be riveted or staked with a center punch to prevent it. from backing off.
3. WILEY type A-8 parachute flares are drop tested at each engine change period, therefore, this is not necessary at service stations.

5. Ten-Minute Safety Fuses

All planes are equipped with three (3) ten-minute fusees. On the Douglas planes they are located on the partition back of the Captain's seat. Each of the three fuses will burn approximately ten minutes. Directions for lighting are carried on the side of each fusee.

6. Navigational Aids

A. These consist of the following, with their respective locations shown:

1. Douglas	Location
Airport and Course Data Book	Companionway
Sectional May Case	DC3-A Companionway
D/F Plotting Boards	In pocket behind 1st Officer
Pilots Check List	In pocket behind 1st Officer
Radio facilities list (List of Boardcast stations)	Cockpit - Below compass
Blind flying hood	Back of First Officer's seat.

B. The six D/F Boards must be arranged with the index side of each board, facing toward the front in the following order: NY-CG, CG-DV, DV-OA, SL-SA, SA-OA and OA-SQ. The milky white plastacele covering is to be cleaned with a rag dampened in carbon tetrachloride.

C. The Sectional Map Case is sealed and should be left intact. If, however, the seal is broken, the contents must be inspected for the following maps: 1M, 6M, 7M, 8M, 9M, 10M, 11M, thru 17M. If any is missing, note the Trip Record Book stating which is missing. The Communications Department will then arrange to have the necessary maps installed in the plane.

CLEANING 21

CLEANING

1. APPROVED CLEANING MATERIALS

A. No abraisive polishes of any nature will be used except as approved herein. The anodized and alclad surface is very thin and soft and can be worn through in a very short time if improper cleaning methods are used.

B. The following are approved cleaning products:

(1) Carbon Tetrachloride - Cleaners Special Refined. For the removal of grease spots on cloth material. The approved grade may be obtained from the Repair Base on requisition.

(2) Ivory Soap - For cloth materials.

(3) Turco Composition #400 - For cleaning of plane exteriors and interiors.

(4) Turco Plaudit and Oleum Spirits - For cleaning landing gear, under side of center section.

(5) Min-mum - Turco Product - A wax polish for plane exteriors.

(6) Spray Wax (Clinton's) - A wax polish for plane exteriors.

(7) Stynamite - For window cleaning, inside and out.

(8) Burnishine - A metal cleaner.

C. Standard Cleaning Mops.

The following mops will be considered as standard:

(1) TU-WAY Double duty dust mops

Part #1016 - 16" frame and cotton mop head
Part #1019 - 19" frame and cotton mop head
Part #1023 - 23" frame and cotton mop head

NOTE: When requisitioning a complete mop assembly (handle, frame, and mop head), the above part number complete is to be used. When the mop head alone is required, only the "length" desired should be specified, as: (½ doz. 19" cotton mop heads).

2. PLANE EXTERIOR

General.

(a) Before any exterior cleaning is started, be certain that all ventilators and access doors are tightly closed.

(b). In washing, avoid directing water pressure into ventilators, inspection or access doors and landing lights. Direct the water pressure with the overlap of the fuselage seams, not against them.

(c) If mud, or other abrasive material adheres to the surface, it shall be washed off with clear water or "Turco 400" and water, applied with a soft brush.

(d) Soap and water should not be used for regular washing for it removes the wax, opens the pores in the metal and assists oxidation.

(e) An oily surface may be cleaned with soap and water or cleaning solvent, but if this is done, it must be followed by the application of MIN-MUM."

(f) When using soap to clean planes outside of hangar, rinse off the soap immediately after applying. Do not allow it to dry, especially in the sun. After thoroughly rinsing the plane in clear water, place it inside the hangar as quickly as possible.

(g) It is preferred that all exterior cleaning be done inside the hangar whenever facilities permit.

(h) Cleaning shall progress in such a manner as to have entire components finished, rather than doing a little "here and there" on the airplane.

(i) High quality cloths should be provided for it is a false economy and a waste of time in sorting and using low quality rags. Cloths should be kept separate for this use and no other purpose.

(j) The Chief Mechanic shall be responsible for the following:

1. See that all employees so assigned are kept on exterior cleaning at all times when planes are available.
2. Study his individual plane routing and arrange for cleaning crews to work when planes are available for the longest period of time.
3. Appoint one cleaner from each crew to act as lead man, whose duty shall be to see that his crew works systematically and efficiently. He shall be responsible to his crew chief and shall coordinate cleaning with service work so that planes shall be ready for schedule when needed.

3. INSTRUCTIONS FOR THE USE OR "CLINTON'S SPRAY WAX".

A. PREPARATION OF SURFACE.

1. The surface shall be thoroughly cleaned with "BURNISHINE", though caution is urged in the use of this abrasive metal cleaner. Remove all cloudiness and traces of this cleaner, or it will dull the appearance when waxed.

B. APPLICATION.

1. Clinton's Spray Wax shall be applied with an external mix paint spray gun, using 35 to 45# air pressure. The nozzle should at all times be kept clean and in good operating condition.
2. Use only sufficient wax to thinly cover the surface, as an excessive amount decreases the efficiency. NOTE: Use "spray-wax" as it is received from the vendor. Shake container to mix well before using.
3. To properly apply, hold gun from 18 to 24 inches from the surface, and "wave" gun in continual motion to avoid an excessive amount of wax in any one spot.

4. As the wax is applied, a thin film, or coating, of white dust appears. This is an indication that the surface is suffiently waxed. It may be necessary to look "along" the surface to detect this "dust coating".

5. To polish, do not rub. Light strokes in one direction should be used. If surface streaks, it is an indication that too much wax has been used.

4. FUSELAGE AND EMPENNAGE

NOTE:--Whenever appearance indicates, the entire exterior of the airplane shall be cleaned with "Burnishine", and waxed with "Clinton's Spray Wax".

A. During each #3 check, the entire exterior surface shall be washed with a solution of six parts water to one part "MIN-MUM". This cleans and replaced a slight amount of wax in the one operation.

B. The #3 check is not considered complete until this entire operation is finished. If time does not permit the completion of this cleaning job, it must be noted in the Trip Log Book and it shall become the responsibility of the next station to complete this work.

5. WINGS

(a) The top portion of the center section and the top and under portion of the wings shall be treated the same as the fuselage.

(b) When the top side of the wings are merely dusty, they may be wiped off with a long handled mop. Care shall be taken that no hard portion of the mop or handle comes in contact with the wing surface.

(c) After refueling, dirt and footmarks shall be wiped clean from the wing and around tank filler covers.

6. NACELLE COWLING

(a) Removable nacelle and engine cowlings shall be cleaned either with a spray gun using oleum spirits, or wiped off inside and out with a cloth moistened with oleum spirits and dried with a dry cloth. The entire nacelle cowling including the engine cowl, may be polished and waxed with "spray-wax".

7. INSIGNIAS

(a) Wash insignias and lettering with clear water, clean and brighten with Berry Bros. #405 Cleaner. Never wash painted portion with a soap solution, or with Burnishine.

8. LANDING GEAR AND WHEEL WELLS

(a) For the landing gear, wheel wells and the under side of the center section, a mixture of six parts Oleum Spirits and one part of Turco "Plaudit" shall be used. This mixture should be applied with a brush or with a Hudson-Clipper one-gallon hand spray gun, the latter being the most economical method of application.

The solution should then be allowed to remain on the surface of the grease and oil covered parts for several minutes and then washed off with water, preferably warm water if available.

(b) When washing planes during freezing weather, care must be used to prevent water from freezing in mechanical latches, retracting parts, and brakes. The water should be blown off before freezing can occur.

9. ENGINES

(a) Engines shall be washed down with a spray gun, using Oleum Spirits or equivalent cleaning fluid. Gasoline shall not be used. Care should be exercised that the exhaust ring has cooled sufficiently to eliminate fire hazard before starting spray operations.

(b) In all cases when engines are being sprayed, fire extinguishers must be immediately available.

(c) Care shall be taken during the spraying not to direct the spray on the ignition shielding, magnetos or any wiring.

10. PROPELLER

(a) After all engine servicing is completed, the propeller shall be wiped off with a cloth moistened with Oleum Spirits and dried with a dry cloth. Keep Oleum off propeller blade anti-icer shoes.

11. WINDOW GLASS - INSIDE AND OUT

(a) All windows shall be cleaned with "Stynamite" Glass Cleaner. This product, and the sprayers to apply the liquid, may be had on requisition from San Francisco, Chicago, or the Repair Base.

(b) Procedure for use of "Stynamite" Window Cleaner:

1. "Stynamite" shall only be stored in oak barrels or glass containers whether in concentrated or diluted form.
2. Dilute one part "Stynamite" concentrate to five parts water, making a solution to last approximately one week.
3. Spray the fluid on the window glass, using the standard spray dispenser, and rub the glass with clean cloth until dry.
4. After cleaning windows, wipe sills clean.
5. Bon-Ami must not be used on window glass or inside of cabin for any purpose.
6. When cleaning windshields, wipe dirt from antenna insulator where it goes through the skin on top of fuselage.
7. When it is necessary to walk on wings alongside of fuselage to clean the windows, the cleated canvas cover provided shall be used. This is an added safety

for the workman beside preventing scratches from shoes and other damages to the covering. With the use of these canvas covers, employees shall be careful to place their weight over the walk structure as much as possible.

PLANE INTERIORS

1. PILOTS' COCKPIT

(a) The leather covered walls shall be wiped off with a damp cloth. The cloth covered walls shall be cleaned with a vacuum cleaner or soft brush.

(b) The floor should be thoroughly cleaned with a damp cloth or vacuum cleaner.

(c) The control column shall be wiped off with a rag wrung out as dry as possible after being immersed in a mild soap solution of Turco "400" and water.

(d) Empty and clean ash trays.

(e) Clean pilots' seats. Seat back covers shall be replaced at Service Stations when found soiled. It will not be necessary to replace these every trip, but they should be kept in a reasonably white and fresh condition. Should grease spots be found on the seat belts, these should be removed with cleaner's carbon tetrachloride.

2. PASSENGER CABINS

(a) Mechanics shall avoid entering cabins with greasy, dirty coveralls and avoid placing dirty hands on seat upholstery or cabin walls.

(b) The mechanics inspecting or working on cabin fixtures or in pilots' cabin must have clean coveralls or remove them before entering the cabin.

(c) The cloth covering on the cabin walls shall be cleaned with a vacuum cleaner. The leather or doped fabric covering on the cabin walls and spars shall be cleaned with a light Ivory Soap solution in the following manner: Work up a good suds, saturate a clean sponge and squeeze out excess water leaving sponge damp, and use with a polishing motion until it is clean. Then go over it with a dry cloth.

(d) Seat cushions, seat backs, arm rests, seat belts and the carpet shall be cleaned with a vacuum cleaner. Small grease spots shall be removed with a cleaner's special refined carbon tetrachloride. Care must be taken that no ring discoloration in the cloth results.

(e) Soiled Window curtains should be replaced.

(f) Metal parts of the seats should be cleaned with sop solution.

(g) Replace any soiled or used refuse containers.

(h) Empty ash trays.

(i) When time permits, ash trays shall be washed in a soap solution.

(j) Wipe off window frames with a dry rag.

3. WINDOW GLASS - INSIDE

1. Same as outside.

4. TOILET COMPARTMENT

(a) Wipe walls and floor with a damp cloth. Remove and clean toilet container if necessary. The container should be filled with a deodorant solution consisting of two teaspoonsful of the "National Powder" concentrate in one quart of water.

(b) Clean and polish mirror, wash bowl and water container. Refill water container.

(c) If necessary, replenish the supply of toilet paper, paper towels, Kotex and soap.

(d) See that fly swatter and whisk broom are in place.

(e) See that blankets and pillows are clean and in place in blanket compartment.

5. STEWARDESS' CABINETS

A. Replenish supply of spare refuse containers.

DEODORANT

1. PROCEDURE IN PASSENGER PLANES AT SERVICE STATION

A. The interior of all passenger planes, particularly the cabins and washrooms, shall be thoroughly and completely deodorized whenever time allows, before being dispatched from any service station.

B. The deodorant to be used is known as "National Powder". For deodorizing cabins mix three teaspoonsful of the powdered concentrate in one gallon of water. The small type Hudson Clipper sprayer furnished for the purpose shall be used for cabin deodorizing at all times as it is important to properly atomize the solution.

C. A moderate spraying of the cabin, including the toilets, is all that is necessary, except where it has been necessary to clean up as a result of air sickness, sputum secretions, or anything else in which bacteria in large quantities may exist. After spraying, the cabin should be closed tightly for approximately fifteen minutes to allow time for the deodorant to do its work. The deodorizing completed, the cabin door should be opened for airing of the cabin before dispatching plane.

D. Whenever using the sprayer, be sure that there is sufficient air pressure pumped up to properly atomize the solution. At the same time, do not exceed sixty pounds pressure as this is the most efficient pressure for the unit. Detailed instructions for operation will be found on the side of the sprayer.

E. When it is evident that spraying is insufficient, the surface will be wiped with a cloth saturated with the deodorant.

F. This deodorant is very excellent with reference to odor control and has minor "disinfecting" qualities - it is absolutely harmless.

2. THE "NATIONAL POWDER" CONCENTRATE IS TO BE USED IN THE FOLLOWING MANNER:

A. Interior of Passenger Planes

Solution of three teaspoonsful of "National Powder" concentrate in one gallon of water. This solution shall be used in the small type Hydson Clipper sprayer furnished for this purpose.

B. Toilet Containers

Two teaspoonsful of "National Powder" concentrate in one quart of water, this entire one-quart supply to be placed in the container.

3. STORAGE OF "NATIONAL POWDER" DEODORANT

When National Powder is in the dilute form; that is, when it is mixed with water, it will lose some of its effectiveness within approximately two weeks' time if exposed to light or air. It is purchased from the vendor in the concentrate or powdered form and will last indefinitely in this manner. Accordingly, only the amount required for approximately one week's use should be mixed at any one time for service use. When in diluted form, it should be stored in sealed metal containers. If a supply of deodorant has been made up and is not used by the end of the week, it should be poured out and a fresh supply prepared.

4. DEODORANT FOR USE BY STEWARDESS

(a) It shall be the responsibility of all service stations as a part of their regular inspection, to see that the DeVilbiss Sprayer is in place in the Stewardess cabinet and filled with the special non-freezing National Powder Solution. This sprayer must be plainly labeled DEODORANT.

(b) Since this solution is carried in the cabin and will be subjected sometimes to freezing temperatures, it is mixed with alcohol to prevent its solidifying. Solution consists of three teaspoonsful of "National Powder" concentrate to one gallon of water and one gallon of Isopropyl Alcohol; Do Not Use Glysol which is a mixture of Glycerine and Solox.

CAUTION: For Isopropyl Alcohol, the present "Solox" as supplied to stations may be used. However, when using Solox for this purpose, care must be taken so that PURE Solox is used and not some mixture prepared for other uses.

5. STORAGE OF SOLUTION CARRIED FOR STEWARDESS' USE

(a) The proper solution for use by the stewardesses will be made and stored in an absolutely clean and suitable one gallon container.

(b) These one-gallon containers in which the solution is stored must be plainly labeled NATIONAL POWDER, WATER AND ALCOHOL - DEODORANT.

DISINFESTANTS FOR USE IN AIRPLANE CABINS

1. GENERAL

(a) To properly guard against the entrance of vermin such as roaches, moth larvae, etc., into airplane cabins, it is necessary to disinfest the plane cabins at regular intervals. Accordingly, LaGuardia, Chicago, Salt Lake, San Francisco and Seattle will be equipped with the necessary sprayer and insecticide for this purpose.

(b) The sprayer to be used is of the electric compressor type including an automatic time shut-off switch and the dispensing container. Full instructions for the mechanical operation and maintenance are supplied with each unit. The sprayer operates from any 110-120 volt AC or DC outlet. During operation of the sprayer, a very fine mist or fog is produced which floats in the air and enters all corners and crevices of the cabin interior.

(c) The fluid used is known as "Top" insecticide and is supplied by the Pesticide Company, Chicago. This fluid has the odor of carbon-tetrachloride, and is definitely non-toxic. However, prolonged inhalation will produce a slight dizziness and during disinfesting cabins personnel should remain outside until the operation is completed.

(d) This fluid may be obtained by requisition from Chicago.

2. PROCEDURE FOR USE

(a) Accomplish disinfesting of the airplane at each #3 check.

(b) Close the front and rear doors of the cabin. Close cockpit windows and the two vents in the ceiling. Open the lavatory and all buffet doors.

(c) Fill the glass jar on automatic sprayer unit with liquid disinfestant which is premixed and ready for use. Set time switch to 10-minute position and place sprayer unit in aisle opposite second row of seats from front with spray nozzle pointing to rear of cabin. Plug cord into standard 110 volt AC or DC outlet.

(d) The unit will automatically operate and shut-off after 10 minutes. The cabin should be left closed for an additional 5 minutes in order to allow the disinfestant to do its work properly.

(e) Open all doors and vents. The cabin will clear of the fog in 8 to 10 minutes. Any oil deposit on window frames and other metal surfaces will evaporate in 20 to 25 minutes. If necessary, due to lack of time to permit complete evaporation, the excess oil deposit may be wiped off with a cloth.

EQUIPMENT AND
MAINTENANCE

FUEL - GASOLINE

1. RESPONSIBILITY

A. ONLY AIRPLANE FUELS MEETING OUR CORRECT SPECIFICATIONS AND FREE FROM WATER, SEDIMENT, AND OTHER CONTAMINATION, ARE TO BE DELIVERED INTO THE TANKS OF OUR AIRPLANES.

B. STATION MANAGERS WILL BE HELD STRICTLY RESPONSIBLE FOR THE HANDLING OF AIRPLANE FUELS AT THEIR RESPECTIVE STATIONS, AND FOR THE STRICT COMPLIANCE WITH THESE INSTRUCTIONS.

C. STATION MANAGERS ARE RESPONSIBLE FOR THE PROPER TRAINING AND INSTRUCTION OF THE PERSONNEL IN THEIR DUTIES AND PARTICULAR ATTENTION SHOULD BE GIVEN TO THE TRAINING OF PERSONNEL NEWLY ASSIGNED TO HANDLING FUELS.

D. IN CERTAIN INSTANCES OUR PLANES ARE FUELED BY PERSONNEL NOT IN OUR OWN EMPLOY. STATION MANAGERS WILL BE HELD AS STRICTLY RESPONSIBLE FOR THESE FUELING OPERATIONS AS THOUGH THEY WERE PERFORMED BY OUR OWN EMPLOYEES. STATION MANAGERS SHOULD FULLY ACQUAINT THIS OUTSIDE PERSONNEL WITH THESE INSTRUCTIONS AND VERIFY THEIR COMPLIANCE WITH SAME.

E. WHILE CERTAIN MECHANICAL SAFEGUARDS ARE INCORPORATED IN SOME OF THE EQUIPMENT USED, THEY MUST NOT BE DEPENDED UPON. THOROUGH TRAINING AND EXTREME CARE AND THOROUGHNESS ON THE PART OF ALL CONCERNED IN CARRYING OUT THESE INSTRUCTIONS, IS THE ONLY SAFEGUARD UPON WHICH RELIANCE CAN BE PLACED.

2. TURNOVER OF STOCKS

A. GASOLINE DETERIORATES AFTER IT HAS BEEN IN STORAGE AN EXCESSIVE LENGTH OF TIME. GASOLINE SHOULD BE DRAWN FROM STORAGE SO THAT THERE IS A QUICK TURNOVER OF STOCKS AS CIRCUMSTANCES WILL PERMIT. AT POINTS WHERE MORE THAN INE TANK IS USED FOR THE STORAGE OF THE SAME PRODUCT, GASOLINE SHOULD BE DRAWN FROM THE TANK CONTAINING THE OLDEST STOCK.

3. GASOLINE TEST SAMPLES

A. AT SIX-MONTH INTERVALS STATIONS WILL BE FURNISHED WITH A CAN TO BE FILLED WITH GASOLINE FROM THEIR TANKS AS OUTLINED BELOW AND SENT TO THE REPAIR BASE FOR TESTING. AFTER THE TEST, IF THE SAMPLE FROM ANY ONE STATION DOES NOT COME UP TO SPECIFICATIONS, ARRANGEMENTS WILL BE MADE TO HAVE ANOTHER SAMPLE OF GASOLINE FURNISHED FROM THAT PARTICULAR STATION. IF THE SECOND TEST CONFIRMS THE FIRST IN THAT THE GASOLINE IS STILL FOUND TO BE BELOW THE STANDARD SPECIFICATIONS, ARRANGEMENTS WILL BE MADE TO HAVE THE SUPPLY OF GASOLINE ON HAND REMOVED.

B. THE PROPER WAY TO OBTAIN A GASOLINE SAMPLE IS AS FOLLOWS:

(1) FASTEN THE SAMPLE CAN TO THE END OF A POLE AND THRUST THE CAN QUICKLY BELOW THE SURFACE OF THE GASOLINE IN THE STORAGE TANK. WHEN THE CAN IS FILLED, QUICKLY REMOVE AND IMMEDIATELY SCREW THE CAP ON SECURELY.

C. HOWEVER, THIS METHOD CANNOT OFTEN BE FOLLOWED, AND THE SAMPLE MAY BE TAKEN DIRECTLY FROM THE HOSE IF THE FOLLOWING ARE TAKEN TO PREVENT LOSS OF VAPOR:

(1) TAKE THE SAMPLE IMMEDIATELY AFTER SERVICING AN AIRPLANE, WHILE THE GASOLINE IN THE HOSE IS FRESH AND COOL.

(2) DURING HOT WEATHER, TAKE THE SAMPLE AT NIGHT.

(3) AVOID "DRIZZLING" THE GASOLINE INTO THE CAN - I.E. FILL THE CAN AS QUICKLY AND WITH AS LITTLE TURBULENCE AS POSSIBLE.

(4) INDICATE ON ATTACHED FORM THAT THE SAMPLE WAS TAKEN FROM HOSE SO THAT THE MAN MAKING THE TEST WILL MAKE ALLOWANCE FOR SAME WHEN CHECKING THE VAPOR PRESSURE OF THE SAMPLE.

4. LEADED GASOLINE

A. ALL OF OUR GASOLINES NOW IN USE CONTAIN TETRAETHYL LEAD. THE HANDLING OF LEADED GASOLINE REQUIRES PRECAUTIONARY MEASURES BECAUSE IT SHOULD NOT COME IN CONTACT WITH THE BARE SKIN. SPECIAL CARE SHOULD BE EXERCISED WHILE LOADING AND UNLOADING TO SEE THAT LEADED GASOLINE DOES NOT GET ON THE HANDS OR OTHER PARTS OF THE BODY. IF IT DOES, EMPLOYEES SHOULD IMMEDIATELY WASH IT OFF WITH SOAP AND WATER.

B. REGULATIONS ISSUED BY THE SURGEON-GENERAL'S OFFICE PROVIDE THAT "LEAD WARNING" SIGNS BE ATTACHED TO ALL EQUIPMENT FROM WHICH LEADED GASOLINES ARE SOLD. THESE SIGNS SHOULD BE ATTACHED IN A CONSPICUOUS PLACE ON ALL STATION TRUCKS, PITS, AND OTHER DISPENSING EQUIPMENT. A SUPPLY OF THESE SIGNS MAY BE OBTAINED FROM OUR PRESENT SOURCE OF GASOLINE SUPPLY.

5. APPROVAL FOR CHANGES

(A) NO CHANGES IN THE EQUIPMENT, PIPING, OR ARRANGEMENT THEREOF, OF TRUCKS OR OTHER FACILITIES, ARE TO BE MADE BY THE STATIONS WITHOUT THE APPROVAL OF THE ENGINEERING DEPARTMENT. REPAIRS MAY BE MADE WHERE NECESSARY WITH THE AUTHORITY OF THE STATION MANAGER WITHOUT APPROVAL, PROVIDED THE DEFECTIVE PARTS ARE REPLACED WITH OTHERS OF EXACTLY THE SAME KIND AND THE ARRANGEMENT, LAYOUT, AND MECHANICAL FEATURES OF THE EQUIPMENT AFTER THE REPAIRS OR REPLACEMENT OF DEFECTIVE PARTS HAVE BEEN MADE, REMAIN THE SAME AS BEFORE THE REPAIRS WERE MADE.

6. TESTING FOR WATER

(A) THE STATION MANAGER WILL APPOINT A MAN AND PROVIDE FOR HIS RELIEF ON HIS DAYS OFF, TO CHECK DAILY THE STATION GASOLINE TANKS, SCREENS AND/OR WATER SEPARATORS, AND THE REFUELING TRUCK IF ONE IS PROVIDED FOR THE PRESENCE OF WATER. THIS CHECK IS TO BE MADE AS FOLLOWS:

1. PLACE A PIECE OF LITMUS PAPER APPROXIMATELY FOUR INCHES LONG, ON THE BOTTOM END OF THE TANK GAUGE STICK, HAVING THE BOTTOM END OF THE PAPER FLUSH WITH THE LOWER END OF THE STICK.

2. INSERT THE STICK INTO THE TANK AND RUSH IT DIRECTLY TO THE BOTTOM.

3. HOLD IN THIS POSITION FOR APPROXIMATELY THIRTY SECONDS AND REMOVE.

4. WRITE ON THIS PAPER THE TANK IDENTIFICATION AND THE DATE AND FILE IN A DRY PLACE IN THE STATION OFFICE FOR A PERIOD OF AT LEAST 90 DAYS AFTER WHICH TIME THEY MAY BE DESTROYED.

(B) WATER INDICATOR IS SENSITIVE TO WATER AND WILL INDICATE ITS PRESENCE BY CHANGING COLOR WHEN IT COMES IN CONTACT WITH SAME. BECAUSE OF ITS SENSITIVENESS, IT SHOULD BE KEPT DRY BEFORE USE. IMMEDIATELY BEFORE USING EACH INDIVIDUAL PIECE FOR TESTING, A SMALL AREA SHOULD BE MOISTENED WITH WATER TO INSURE THAT IT HAS NOT LOST ITS SENSITIVENESS.

(C) AFTER ANY TANKS OR TRUCK COMPARTMENTS HAVE BEEN FILLED, OR PRODUCT ADDED TO CONTENTS, OR ANY OF THESE CONTAINERS OPENED FOR REPAIRS, TESTS FOR WATER SHALL BE MADE AT ALL POINTS ON THE PARTICULAR PIECE OF EQUIPMENT BEFORE ANY GASOLINE IS DELIVERED TO AIRCRAFT FROM THE PARTICULAR PIECE OF EQUIPMENT INVOLVED.

7. TANK CAR SHIPMENTS

(A) ARRANGEMENTS SHOULD BE MADE TO HAVE THE RAILROAD AGENT GIVE PROMPT NOTICE OF THE ARRIVAL OF TANK CARS.

(B) TANK CARS SHOULD BE UNLOADED PROMPTLY TO AVOID DEMURRAGE CHARGES.

(C) WHERE TANK CARS ARE UNLOADED THROUGH DOME, DIFFICULTY MAY BE EXPERIENCED IN PUMPING DURING A VERY HOT DAY, PARTICULARLY AT HIGH ALTITUDES. IN THESE CASES, THE TANK CAR SHOULD BE ALLOWED TO STAND OVERNIGHT AND UNLOADED EARLY THE FOLLOWING MORNING.

(D) WHEN TANK CARS ARE PLACED, EMPLOYEES WILL SEE TO IT THAT BRAKES ARE SET AND WHEELS BLOCKED, SO THAT THERE WILL BE NO CHANCE OF CAR MOVING WHILE BEING UNLOADED.

(E) IF UNLOADING TRACK IS CONNECTED WITH OTHER TRACKS AT BOTH ENDS, SIGNS READING "STOP - TANK CAR CONNECTED", WILL BE PLACED IN THE CENTER OF TRACK, APPROXIMATELY TEN FEET FROM EACH END OF CAR. IF UNLOADING TRACK IS CONNECTED WITH OTHER TRACKS AT ONLY ONE END, ONLY ONE SIGN IS NECESSARY TO BE PLACED AT THE END CONNECTED. THESE SIGNS MUST REMAIN WHILE CAR IS CONNECTED WITH PIPE LINES. IF FOR ANY REASON PUMPING IS DISCONNECTED, PIPE LINE SHOULD BE DISCONNECTED, OUTLET VALVE CLOSED, VALVE AND DOME COVER REPLACED AND SIGNS REMOVED. BEFORE PIPE LINES ARE AGAIN CONNECTED, SIGNS SHOULD BE REPLACED. THIS IS A PROVISION OF THE INTERSTATE COMMERCE COMMISSION AND MUST BE OBSERVED.

NOTE: WHERE GRAVITY FEED IS EMPLOYED, THE SAME PROCEDURE WILL GOVERN.

(F) THE SIGNS TO BE USED AS OUTLINED IN THE ABOVE PARAGRAPH ARE AS FOLLOWS:

1. 12" X 15" METAL SIGN, MOUNTED ON STEEL ROD 4 FEET LONG FOR DRIVING IN GROUND IN CENTER OF TRACK. SIGN TO HAVE WHITE LETTERS ON A BLUE BACKGROUND, WITH THE WORD "STOP" IN LETTERS AT LEAST FOUR INCHES HIGH AND THE WORDS "TANK CAR CONNECTED" IN LETTERS AT LEAST TWO INCHES HIGH.

(G) ALL SEALS WILL BE INSPECTED AND NUMBERS RECORDED. IF SEALS SHOW EVIDENCE OF HAVING BEEN TAMPERED WITH, OR IF THERE IS ANY INDICATION THAT THERE HAS BEEN LOSS OF PRODUCT BY LEAKAGE OR OTHERWISE, THE RAILROAD AGENT SHOULD BE NOTIFIED AND EVERY EFFORT MADE TO HAVE HIM VERIFY THE OUTTURN CHECK OF THE CONTENTS OF THE CAR. IN ORDER TO ASSIST IN INVESTIGATING COMPLAINTS, THE FOLLOWING WILL BE OBSERVED.

1. WHEN THE TANK CARS ARE RECEIVED WITH PRODUCT IN BAD CONDITION OR NOT INTACT, THE STATION MANAGER WILL TELEGRAPH THE PURCHASING AGENT, FURNISHING ALL PERTINENT INFORMATION SUCH AS ORDER NUMBER, CAR NUMBER, APPROXIMATE CONDITION OF THE PRODUCT OR AMOUNT OF SHORTAGE, AND AWAIT FURTHER INSTRUCTIONS BEFORE UNLOADING CAR.

(H) GREAT CARE MUST BE USED IN REMOVING THE DOME COVER OF THE CAR. IF THERE IS ANY GAS PRESSURE, THE DOME COVER SHOULD BE LOOSENED JUST ENOUGH TO PERMIT THE GAS TO ESCAPE. THE DOME COVER SHOULD NOT BE REMOVED UNTIL THE GAS PRESSURE HAS BEEN RELIEVED. IF GAS PRESSURE IS

EXCESSIVE, ARRANGEMENTS SHOULD BE MADE TO COOL THE TANK CAR BY USE OF WATER, AND IF THIS DOES NOT RELIEVE THE GAS PRESSURE, ALLOW THE CAR TO STAND OVERNIGHT AND UNLOAD VERY EARLY IN THE MORNING, FOLLOWING THE SAME PROCEDURE ON RELIEVING GAS PRESSURE. IF IT IS FOUND THAT THE GAS PRESSURE CANNOT BE RELIEVED, THE STATION MANAGER WILL NOTIFY THE LOCAL REPRESENTATIVE OF OUR SOURCE OF GASOLINE SUPPLY.

(I) AFTER PRESSURE IS RELIEVED, THE REMOVAL OF DOME COVER SHOULD BE HANDLED IN THE FOLLOWING MANNER:

1. SCREW TYPE COVER MUST BE LOOSENED BY PLACING A SHORT PIECE OF 2x4 LUMBER OR OTHER WOODEN BAR BETWEEN DOME COVER LUG AND KNOB. AFTER TWO COMPLETE TURNS, SO THAT VENT OPENINGS ARE EXPOSED, THE OPERATION MUST BE STOPPED, AND IF THERE IS ANY SOUND OF ESCAPING VAPOR, INSTRUCTIONS ABOVE SHOULD BE FOLLOWED. WHEN PRESSURE HAS BEEN FULLY RELIEVED, THE DOME COVER CAN THEN BE REMOVED. EXERCISE CARE IN HANDLING THE COVER WHEN THE THREADS HAVE BEEN DISENGAGED IN ORDER TO PREVENT THE RUBBING OF METAL TO METAL, THUS AVOIDING THE POSSIBILITY OF CAUSING SPARKS.

2. HINGED AND BOLTED TYPE COVERS MUST BE LOOSENED BY UNSCREWING ALL NUTS ONE COMPLETE TURN. THE OPERATION MUST THEN BE STOPPED AND IF THERE IS ANY SOUND OF ESCAPING VAPOR, INSTRUCTIONS OUTLINED ABOVE SHOULD BE FOLLOWED. AFTER THE PRESSURE HAS BEEN RELIEVED, THE NUTS SHOULD BE UNSCREWED SUFFICIENTLY TO OPEN THE COVER.

(J) THE CONTENTS OF EVERY TANK CAR MUST BE DETERMINED BEFORE IT IS UNLOADED. TO DETERMINE THE OCTANE GRADE OF THE PRODUCT, REFERENCE SHOULD BE MADE TO THE SHIPPING PAPERS. IF THERE IS ANY DOUBT AS TO THE IDENTITY OF THE CONTENTS OF THE CAR, THE STATION MANAGER SHOULD COMMUNICATE WITH THE PURCHASING AGENT BEFORE UNLOADING.

(K) TANK CARS WILL BE UNLOADED FROM TOP OR BOTTOM, ACCORDING TO FACILITIES PROVIDED.

(L) IF TANK CAR IS TO BE UNLOADED FROM TOP, UNLOADING PIPE WILL BE INSERTED AND PIPE LINES WILL BE CONNECTED. AUXILIARY DOME COVER WILL BE PLACED ON DOME OF CAR AND SURROUNDED BY WET BURLAP FOR PROTECTION AGAINST SPARKS. THIS AUXILIARY DOME COVER MUST REMAIN IN POSITION WHILE CONTENTS OF CAR IS BEING PUMPED.

(M) IF TANK CAR IS TO BE UNLOADED FROM BOTTOM, VALVE ROD HANDLE OR CONTROL IN DOME MUST BE MOVED BACK AND FORTH A FEW TIMES TO SEE THAT OUTLET VALVE IN BOTTOM OF TANK IS PROPERLY CLOSED AND SEATED BEFORE REMOVING OUTLET CHAMBER CAP. BEFORE REMOVING OUTLET CHAMBER CAP, THE 2" PLUG THEREIN SHOULD BE LOOSENED TO ASCERTAIN EXTENT OF ANY LEAKAGE. IF LEAKAGE SHOWS UPON STARTING REMOVAL OF OUTLET CHAMBER CAP OR PLUG, NEITHER SHOULD BE ENTIRELY REMOVED, BUT SUFFICIENT THREADS SHOULD BE LEFT ENGAGED AND SUFFICIENT TIME ALLOWED TO PERMIT ESCAPE OF ANY ACCUMULATION OF LIQUID

IN THE OUTLET CHAMBER BEFORE COMPLETE REMOVAL OF CAP OR PLUG. A PAIL SHOULD BE USED TO CATCH ANY LEAKAGE. IF LEAKAGE CONTINUES AND FURTHER EFFORTS TO SEAT VALVE FAIL, VALVE CAP SHOULD BE SECURELY TIGHTENED AND TANK UNLOADED THROUGH DOME. IF LEAKAGE CEASES, CAP OR PLUG MAY BE REMOVED AND PIPE LINES CONNECTED.

(N) THE DOME OF TANK CAR BEING UNLOADED FROM BOTTOM MUST BE COVERED WITH A PIECE OF GUNNYSACK OR SIMILAR MATERIAL MOISTENED WITH WATER. DO NOT REPLACE THE DOME COVER WHILE PUMPING CONTENTS. IF RELIEF IS NOT PROVIDED THE TANK WILL COLLAPSE.

(O) IN THE EVENT WATER HAS COLLECTED IN OUTLET VALVES AND HAS FROZEN, PREVENTING THE FREE MOVEMENT OF THE VALVE, A STEAM JET, HOT WATER OR HOT CLOTHS SHOULD BE USED FOR THAWING THE ICE. IF STEAM FACILITIES OR EQUIPMENT FOR HEATING WATER ARE NOT AVAILABLE, CALCIUM CHLORIDE IN CRYSTAL FORM MAY BE USED TO THAW OUT THE ICE SO THAT THE VALVE MAY BE RAISED. PLACING THE CRYSTALS AROUND THE VALVE INSIDE THE CAR MAY BE DONE BY THE USE OF A PIECE OF 1" PIPE LOWERED THROUGH THE DOME OF THE CAR TO THE OUTLET VALVE, CAREFULLY PLACED SO THAT THE CRYSTALS WHEN DROPPED THROUGH THE PIPE WILL LIE DIRECTLY ON THE ICE AROUND THE VALVE. A FLASHLIGHT MAY BE USED TO ADVANTAGE TO PLACE END OF PIPE AT THE VALVE. ABOUT THREE MINUTES WILL BE REQUIRED FOR THE CALCIUM CHLORIDE CRYSTALS TO THAW OUT THE ICE AND FREE THE VALVE. AFTER FREEING THE VALVE IT SHOULD BE RAISED, AND ABOUT TWO POUNDS OF CRYSTALS PUT DOWN INTO THE OUTLET LEG TO THE VALVE FOR THE PURPOSE OF THAWING OUT THE ICE IN THE OUTLET LEG. THE CAR SHOULD THEN BE COMPLETELY CLOSED UP AND AFTER FIVE OR SIX HOURS IT WILL USUALLY BE FOUND THAT THE OUTLET VALVE AND THE OUTLET LEG ARE COMPLETELY THAWED OUT.

(P) THE CALCIUM CHLORIDE SOLUTION BEING MUCH HEAVIER THAN GASOLINE IT CAN BE EASILY DRAINED OUT OF THE CAR BEFORE THE CAR IS CONNECTED UP FOR UNLOADING, SO THAT IT DOES NOT GET INTO THE LINES OF STORAGE TANKS. THIS METHOD OF THAWING OUT FROZEN TANK CARS SHOULD BE USED AT POINTS WHERE NEITHER STEAM NOR HOT WATER ARE AVAILABLE. IN THE EVENT STEAM OR HOT WATER ARE AVAILABLE IT IS PREFERABLE TO USE ONE OF THESE METHODS FOR THAWING OUT THE CAR. CALCIUM CHLORIDE CRYSTALS MAY BE PURCHASED LOCALLY FROM ANY DRUG STORE. UNDER NO CIRCUMSTANCES SHOULD ANYTHING BUT THE ABOVE METHODS BE USED FOR THAWING VALVES AND OUTLET LEGS. CAREFUL EXAMINATION SHOULD BE MADE TO PREVENT LOSS OF PRODUCT FROM CRACKED OUTLET CHAMBER. IF ANY CRACKS ARE FOUND OR IF FOR ANY REASON THE VALVE CANNOT BE PROPERLY SEATED THE LOCAL REPRESENTATIVE OF OUR SOURCE OF GASOLINE SUPPLY SHOULD BE NOTIFIED.

(Q) WHEN LADING REQUIRES IT, "INFLAMMABLE" PLACARDS AND SHIPPING CARDS MUST BE REMOVED BY PARTY UNLOADING THE CAR. WHERE CARS ARE EQUIPPED WITH METAL REVERSIBLE "INFLAMMABLE" PLACARDS, THEY MUST BE PROPERLY ADJUSTED. DOME CAUTION PLACARDS AND RAILROAD DEFECT CARDS MUST NOT BE REMOVED.

(R) DOME COVERS, OUTLET CHAMBER CAPS, REDUCERS AND PLUGS MUST BE SECURELY REPLACED BY THE USE OF A WOODEN BAR, WRENCH, OR OTHER SUITABLE TOOL. DOME COVER AND OUTLET CAP GASKETS SHOULD BE SECURELY REPLACED.

(S) TANK CARS MUST BE COMPLETELY EMPTIED. NO PART OF CONTENTS WILL BE RETURNED IN CAR EXCEPT ON SPECIAL AUTHORITY FROM THE PURCHASING AGENT. WHEN TANK CARS ARE UNLOADED THROUGH THE DOME, IT WILL GENERALLY BE FOUND THAT THE PUMP OR SUCTION PIPE HAS FAILED TO PICK UP THE LAST FEW GALLONS. SMALL QUANTITIES OF PRODUCT REMAINING IN THE TANK CAR SHOULD BE REMOVED THROUGH THE OUTLET LEG AT THE BOTTOM OF THE CAR.

(T) TANK CARS MUST NOT BE ALLOWED TO STAND WITH UNLOADING CONNECTIONS ATTACHED AFTER UNLOADING IS COMPLETED.

(U) STATION MANAGERS WILL SEE TO IT THAT ALL EMPLOYES WHO ACTUALLY HANDLE THE UNLOADING OF TANK CARS ARETHOROUGHLY FAMILIAR WITH THE INSTRUCTIONS CONTAINED IN "REGULATIONS FOR THE HANDLING OF PRODUCTS DESIGNATED AS DANGEROUS BY THE INTERSTATE COMMERCE COMMISSION."

(V) GROUND AT SIDING AROUND UNLOADING CONNECTIONS MUST BE FREQUENTLY COVERED WITH FRESH DRY EARTH OR SAND, ESPECIALLY IF OIL OR GASOLINE HAS BEEN SPILLED.

(W) GASOLINE SHOULD NOT BE PUMPED FROM TANK CARS DURING SEVERE ELECTRICAL STORMS.

8. TANK TRUCKS

(A) UPON ARRIVAL AT TRUCK FILLERS AND BEFORE DOME COVERS ARE REMOVED, THE STATIC WIRE ON TRUCK SHOULD BE CONNECTED TO A BARE METAL PART OF THE GASOLINE PIPE SYSTEM FROM WHICH DELIVERY OF THE PRODUCT WILL BE MADE.

(B) STATIC ELECTRICITY BUILT UP IN A TRUCK FROM ANY CAUSE WILL BE DISCHARGED THROUGH THE FIRST CONDUCTOR THAT COMES IN CONTACT WITH

THE TRUCK. SHOULD THE FILLER PIPE CONNECTION BE MADE BEFORE THE GROUNDING WIRE IS ATTACHED TO THE FAUCET, THERE IS DANGER OF PRODUCING A SPARK AT THE DOME OF THE TRUCK, WHICH IS THE MOST DANGEROUS POINT AND SERIOUS RESULTS MAY FOLLOW.

(c) SMOKING OR CARRYING LIGHTS WITH OPEN FLAMES ON OR IN THE VICINITY OF TANK TRUCKS IS PROHIBITED.

(D) WHEN WORKING IN FUEL PITS, SPRAY CARBON TETRACHLORIDE OVER THE FLOOR OF THE PIT AND HAVE A WOOLEN BLANKET HANDY FOR THE PROTECTION OF PERSONNEL.

PREHEATING AND PRECOOLING

1. STATIONARY COOLING SYSTEMS

A. A NUMBER OF OUR STATIONS ARE EQUIPPED WITH AIR CONDITIONING SYSTEMS FOR USE IN PRECOOLING AND PREHEATING THE PLANES.

B. THE STATIONARY PART OF THE SYSTEM OPERATES IN THE FOLLOWING MANNER: A MOTOR DRIVEN COMPRESSOR COMPRESSES THE GASEOUS AMMONIA REFRIGERANT INTO A LIQUID STATE. THIS LIQUID THEN PASSES INTO THE WATER COOLED CONDENSER WHICH REMOVES THE HEAT OF COMPRESSION. THE AMMONIA THEN PASSES ON OVER TO AN EXPANSION VALVE AND INTO A COOLING COIL AROUND WHICH IS CIRCULATED THE BRINE ITSELF. AS THE AMMONIA EXPANDS, THE TEMPERATURE DROPS, COOLING THE BRINE AROUND THE COIL. THE AMMONIA THEN PASSES BACK AND RE-ENTERS THE COMPRESSOR FOR ANOTHER CYCLE.

C. THE SYSTEM IS ENTIRELY CLOSED. THE INLET SIDE OF THE COMPRESSOR PULLS A VACUUM ON ONE SIDE OF THE EXPANSION VALVE. THE EXHAUST SIDE OF THE PUMP KEEPS A PRESSURE ON THE OTHER SIDE OF THE VALVE. THE GREATER THIS PRESSURE DIFFERENCE, THE GREATER THE EXPANSION AND THE GREATER THE COOLING EFFECT.

D. INSTRUCTIONS ON THE PROPER CARE AND MAINTENANCE OF THE STATIONARY COOLING SYSTEMS AND A LIST OF THE PARTS ARE CONTAINED IN THE PAMPHLET ISSUED BY THE CARBONDALE MANUFACTURING COMPANY ENTITLED "REFRIGERATION COMPRESSORS," PAMPHLET #1102.

2. PREPARING STATIONARY UNITS FOR WINTER SHUT DOWN

A. BEFORE FREEZING WEATHER ARRIVES OPERATE THE SYSTEM IN THE NORMAL MANNER UNTIL THE GAUGE ON THE SUCTION LINE SHOWS ABOUT ZERO PRESSURE. STOP THE COMPRESSOR AND CLOSE ALL VALVES AT THE COMPRESSOR MANIFOLD. ALSO CLOSE THE KING VALVE (THE VALVE IN THE AMMONIA LINE WHERE IT LEAVES THE CONDENSER TO CARRY THE COMPRESSED AND COOLED AMMONIA TO THE EVAPORATOR). OPEN THE TWO VALVES IN THE BY PASS LINE AROUND THE AUTOMATIC EXPANSION VALVE NEAR THE EVAPORATOR. THE OBJECT OF THIS IS TO STORE ALL AMMONIA POSSIBLE IN THE EVAPORATOR AND EQUALIZE PRESSURE THROUGHOUT THE AMMONIA CIRCULATING SYSTEM.

B. BREAK THE TWO WATER LINE UNIONS WHICH ARE NEAR THE FLOOR LEVEL, BELOW THE BOTTOM OF THE CONDENSER AND REMOVE THE LOWER CONDENSER HEAD. REMOVE PIPE PLUGS IN TOP HEAD AND BLOW OUT WITH COMPRESSED AIR, THIS WILL FORCE ALL LIQUID OUT OF THE CONDENSER AND PREVENT ANY DAMAGE DUE TO FREEZING.

NOTE: BEFORE SYSTEM IS AGAIN PUT INTO COMMISSION IN THE SPRING THE TOP CONDENSER HEAD SHOULD BE REMOVED AND ALL TUBES CLEANED OF ANY ACCUMULATION OF RUST OR FOREIGN MATERIAL.

C. WIRE BRUSH OR SCRAPE AWAY ALL RUST ACCUMULATION AND REPAINT WHEREVER NECESSARY. ALSO MAKE ARRANGEMENTS TO WHATEVER REPAIRS ARE OBVIOUSLY NEEDED TO INSULATION LAGGING, PIPING, ETC.

PORTABLE AIR CONDITIONING UNITS

1. General Description

(a) The Caldwell Portable Plane Conditioning Unit is designed for summer cooling and dehumidifying service as well as for winter heating service. The air conditioning unit medium is calcium chloride brine.

(b) When used as a precooler, the brine is cooled to a temperature of from 25 to 40 degrees below zero Fahrenheit; at the lower temperature the unit will operate continuously over a two hour period without recharging and supply conditioned air at from 40 to 46 degrees Fahrenheit when the atmospheric temperature is 100 degrees Fahrenheit and the relative humidity is 50%.

(c) When used as a preheating unit, the brine is heated to a temperature of from 140 degrees Fahrenheit, the normal minimum, to 210 degrees Fahrenheit, the normal maximum. The conditioner may be operated over a continuous three hour period in a 25-30 degree temperature before requiring a "re-heat". In zero weather, the continuous operating capacity is two hours when fully "charged".

(d) The unit is composed of a supporting truck, an insulated brine storage tank with a capacity of 250 gallons, a fill pipe connection and fill valve, a 17" gauge glass and an air vent line (copper tube) terminating under the left rear section of the truck frame, a welded steel, aluminum finned air heating coil through which is pumped the hot calcium chloride brine by the circulating pump. A special pressure type blower draws cold air in through the fresh air louvres down through the heating coil and then forces the heated air up through the air tube which terminates on the side of the truck and to which is attached the six inch metal hose for conducting the heated air to the plane cabin. The motor driven centrifugal circulating pump draws brine from the bottom of the insulated brine storage tank and forces the brine upward through the heating coil, through the control valves and thence to the brine distributing head in the top of the brine tank. The steam heating coil which is mounted on a steel plate is bolted to the rear manhole opening in the brine tank; the ends of this "U" shaped steam heating coil terminating in an upper steam header and a lower RETURN header with piping connections extending to the outside of rear panel, equipped with railroad type couplers for receiving the companion couplers mounted on the steam and return hose connecting the unit to the steam supply,

(e) The unit can be used for both preheating and precooling purposes, its operating principles remaining the same. With the exception that the steam heating coil is not required when the unit is used as a precooler and the minor differences in operating characteristics listed below, the functions of the unit as a cooler or a preheater depend chiefly on the temperature of the brine with which the unit is charged.

2. MAINTENANCE

(A) THE BRINE CIRCULATING PUMP HAS TWO BALL BEARINGS, THE FRONT MOTOR BEARING HAVING A SCREW PLUG. REMOVE AND INSERT ZERK GREASE GUN INTO OPENING AND GIVE THREE TO FOUR SHOTS FOR EACH SIX MONTHS OF OPERATION. THE REAR MOTOR BEARING IS ADJACENT TO THE PUMP PACKING GLAND AND IS EQUIPPED WITH A 45 DEGREE ZERK FITTING. GIVE THIS BEARING FOUR TO FIVE SHOTS FOR EACH SIX MONTHS OF SERVICE. THE PUMP PACKING GLAND IS EQUIPPED WITH A ZERK FITTING AND SHOULD BE GREASED AT LEAST ONCE EACH MONTH.

(B) THE PACKING GLAND OF THIS PUMP IS PACKED WITH FOUR RINGS OF GARLOCK PACKING, SET TO RUNNING FIT WHEN CONDITIONER IS PLACED INTO SERVICE. (THE BRINE CIRCULATING PUMP IS AN INGERSOL-RAND #1RVF TYPE OF PUMP.) WHEN THE PACKING GLAND LEAKS, IT WILL BE APPARENT FROM THE BRINE DRIPPING FROM UNDER THE CENTER OF THE TRUCK, THROUGH THE TUBE FROM THE SUMP UNDER THE PUMP. WHEN THIS DRIPPING IS NOTICED, THE PACKING GLAND SHOULD BE TIGHTENED UP IMMEDIATELY BY SETTING UP EACH ONE OF THE TWO NUTS THEREON 1/2 TURN AT A TIME SO AS TO INSURE AS EVEN A PRESSURE ON THE PACKING, AND THUS STOP THE LEAK, AS IS POSSIBLE, WITH A MINIMUM AMOUNT OF PRESSURE ON THE PUMP SHAFT.

(C) FILL FAN MOTOR GREASE CUPS ONLY ONCE EVERY SIX MONTHS BUT GIVE GREASE CUPS 1 1/2 TURNS EACH 30 DAYS. USE GREDAG.

(D) BE SURE THAT BOTH FRONT PANELS OF MACHINE COMPARTMENT ARE SECURELY TIGHTENED SO AS TO PREVENT AIR SEEPAGE INTO THE FAN COMPARTMENT, AS THIS WILL GREATLY REDUCE THE CAPACITY AND EFFICIENCY OF THE CONDITIONER.

(E) KEEP ALL VALVE AND GAUGE COCK PACKING GLANDS SUFFICIENTLY TIGHT TO PREVENT LEAKAGE OF BRINE.

(F) SHOULD THE ALUMINUM FIN AIR COOLING COIL SHOW A FROST ACCUMULATION FOR A GREATER DISTANCE OUT FROM THE HEADER THAN 1 1/2", PROCEED TO OPEN BRINE BY-PASS VALVE TWO OR THREE TURNS AND CLOSE THE BRINE VALVE TWO TO THREE TURNS. THIS WILL BY-PASS PART OF THE BRINE FROM THE DISCHARGE SIDE OF THE AIR COOLING BACK TO THE PUMP WITH A CONSEQUENT RAISE IN COIL TEMPERATURE SO THAT THE FROST WILL THEN BE MELTED BY THE AIR STREAM.

(G) IN EXTREMELY HOT WEATHER, KEEP BRINE VALVE WIDE OPEN AND BY-PASS VALVE TIGHTLY CLOSED.

(H) THE TWO GATE VALVES WHICH CONTROL THE BRINE FLOW SHOULD BE INSPECTED MONTHLY AND THE STEM PACKING GLANDS KEPT TIGHT ENOUGH TO PREVENT LEAKAGE.

(I) THE PACKING GLAND NUTS ON THE GAUGE COCKS SHOULD ALSO BE KEPT TIGHT. IN EVENT THE GAUGE GLASS SHOULD BE BROKEN, CLOSE BOTH GAUGE COCKS.

(J) THE STEAM AND RETURN COUPLERS ON THE STEAM COIL ARE EQUIPPED WITH RUBBER BUSHINGS. WHEN LEAKAGE OCCURS, THE BUSHINGS SHOULD BE PROMPTLY REPLACED.

(K) THE REAR TIRES OF THE CONDITIONER SHOULD BE INFLATED TO 75 POUNDS AND THE FRONT TIRES TO 45 POUNDS PRESSURE.

(L) ALL PORTABLE AIR CONDITIONERS WILL BE OPERATED WITH AIR FILTERS IN PLACE AND SHOULD BE REPLACED AFTER 60 DAYS OF SERVICE OR OFTENER IF FOUND TO HAVE ACCUMULATED AN EXCESSIVE AMOUNT OF DIRT. WHEN REQUIRED, REQUISITION FROM CHEYENNE, 16" X 25" SPUN GLASS AIR FILTERS AS MANUFACTURED BY THE ILLINOIS OWENS GLASS COMPANY.

3. RUST PREVENTION

(A) TEST THE CALCIUM CHLORIDE BRINE IN THE MAIN BRINE TANK AT 30 DAY INTERVALS WITH BLUE LITMUS PAPER AND IF PAPER TURNS PINK OR RED, IT INDICATES AN ACID CONDITION WHICH WILL CAUSE CORROSION. TO RETURN THE BRINE TO AN ALKALINE AND NON-RUST PRODUCING CONDITION, ADD ONE GALLON OF SODIUM SILICATE (WATER GLASS) TO CONTENTS OF MAIN BRINE TANK, THEN AGAIN TEST FOR ACIDITY. IF ACIDITY PERSISTS ADD MORE SODIUM SILICATE (A QUART AT A TIME) UNTIL BLUE LITMUS PAPER REMAINS BLUE.

4. NEW BRINE

(A) WHEN IT IS NECESSARY TO MIX NEW BRINE THE FOLLOWING SOLUTION WILL BE MIXED:

CALCIUM CHLORIDE BRINE MIXED SO AS TO HAVE A SPECIFIC GRAVITY OF 1.30 USING SOLVAY OR EQUAL, 77-80% PURE FLAKE COC. 4 1/4 POUNDS CALCIUM CHLORIDE TO ONE GALLON OF WATER.

5. PRECOOLING - CHARGING UNITS

(A) CHARGE THE UNIT WITH PRE-COOLED BRINE FROM THE STATIONARY REFRIGERATED BRINE TANK BY CONNECTING THE BRINE LINE HOSE TO THE LOWER (BOTTOM) RAILROAD TYPE COUPLER AT REAR OF THE UNIT, AND THEN SET THE BRINE SUPPLY LINE VALVES PER INSTRUCTIONS THEREON FOR FILLING THE PORTABLE CONDITIONER.

(B) OPEN THE BRINE FILL VALVE MARKED "FV" AND THEN START THE MOTOR-PUMP AT MAIN BRINE STORAGE TANK - THEN IMMEDIATELY TAKE POSITION WHERE THE GAUGE GLASS CAN BE CONSTANTLY OBSERVED. WHEN BRINE LEVEL REACHES A POINT 3" FROM TOP OF GAUGE GLASS BEGIN CLOSING BRINE FILL VALVE "FV" AND WHEN BRINE REACHES A POINT ONE INCH BELOW TOP OF GLASS,

CLOSE VALVE "FV" TIGHTLY; THEN PROCEED TO REVERSE THE SETTING OF VALVES AT MAIN BRINE TANK SO THAT A VACUUM WILL BE PULLED ON THE BRINE LINE TO CONDITIONER, THUS DRAWING ALL BRINE FROM HOSE AND PIPING BACK INTO BRINE STORAGE TANK - WHILE CHARGING PUMP IS STILL PULLING A VACUUM PROCEED TO BREAK THE HOSE AIR BRAKE COUPLER CONNECTION AT THE CONDITIONER. THE CONDITIONER WILL THEN BE READY FOR COOLING SERVICE.

(C) WHEN THE BRINE TEMPERATURE RAISES TO 20 TO 25 DEGREES FAHRENHEIT AS SHOWN ON BRINE TEMPERATURE INDICATOR, PROCEED TO RECHARGE BY CONNECTING TO BRINE LINE FROM STORAGE TANK AND SET VALVES TO PULL A VACUUM, THUS DISCHARGING WARM BRINE INTO WARM COMPARTMENT OF STORAGE TANK; THEN PROCEED TO RECHARGE WITH COLD BRINE FROM COLD COMPARTMENT OF MAIN STORAGE TANK.

6. PREHEATING - CHARGING UNITS

(A) BRINE TANK OF UNIT MUST BE FILLED TO POINT WHERE LIQUID SHOWS 3/4 FULL IN THE GUAGE GLASS IF THE FULL CAPACITY OF THE UNIT IS DESIRED. WHEN BRINE SHOWS IN THE GAUGE GLASS, THE TANK CONTAINS 150 GALLONS. EACH 1" SHOWN IN GAUGE GLASS REPRESENTS SIX GALLONS ADDITIONAL BRINE IN THE TANK, OR A TOTAL OF 250 GALLONS WHEN GAUGE GLASS SHOWS FULL.

(B) TO PUT THE CONDITIONER ON "HEATING-UP" CHARGE, CONNECT THE STEAM HOSE TO THE TOP COUPLER AND THE RETURN HOSE TO THE COUPLER IMMEDIATELY BELOW.

(C) FOR QUICK HEATING-UP, START THE CIRCULATING PUMP WITH THE STEAM SUPPLY AT 2 TO 3 POUNDS PRESSURE; THE BRINE WILL HEAT FROM 140 DEGREES THE NORMAL MINIMUM, TO 210 DEGREES, THE NORMAL MAXIMUM, IN FROM 1½ TO 2 HOURS TIME. HIGHER STEAM PRESSURE WILL REDUCE THIS HEATING-UP PERIOD; LOWER STEAM PRESSURE WILL INCREASE IT CORRESPONDINGLY. FOR SLOW HEATING UP, THE RUNNING OF THE PUMP MAY BE DISPENSED WITH BUT ABOUT ONE HOUR ADDITIONAL TIME WILL BE REQUIRED FOR HEATING BRINE UP TO MAXIMUM TEMPERATURE.

(D) TO OBTAIN THE TRUE BRINE TEMPERATURE, THE CIRCULATING PUMP MUST BE OPERATED FOR FROM 1 TO 3 MINUTES, OR UNTIL THE TEMPERATURE REMAINS ABOUT CONSTANT.

(E) THE CONDITIONER MAY BE OPERATED OVER A CONTINUOUS THREE HOUR PERIOD IN A 25-30 DEGREE TEMPERATURE BEFORE REQUIRING A "RE-HEAT". IN ZERO WEATHER, THE CONTINUOUS OPERATING CAPACITY IS TWO HOURS WHEN FULLY CHARGED. WHILE STANDING IDLE IN A 30 DEGREE TEMPERATURE, THE HEAT LOSS OF THE BRINE WILL BE ABOUT ONE DEGREE PER HOUR AND IN ZERO TEMPERATURE THE LOSS WILL BE ABOUT TWO DEGREES PER HOUR. IF THE UNIT IS EXPOSED TO HIGH WINDS, THE LOSS WILL BE HIGHER. KEEP IN PROTECTED POSITION WHEN POSSIBLE.

(F) IN EVENT THAT EXTREMELY COLD WEATHER IS ENCOUNTERED, REMOVE THE UPPER FRONT (LOUVRE) PANEL AND COVER 3/4 OF THE OPENING WITH CARDBOARD AND REPLACE THE LOUVRE PANEL; THIS WILL REDUCE THE VOLUME OF AIR TO BE HEATED AND WILL CORRESPONDINGLY INCREASE THE TEMPERATURE OF THE CONDITIONED AIR. THIS WILL BE OF MATERIAL ASSISTANCE IN SPEEDING UP THE HEATING OF PLANE ENGINES.

(G) WHERE THE AVERAGE STEAM PRESSURE SUPPLIED TO THE CONDITIONER DOES NOT EXCEED TEN POUNDS GAUGE PRESSURE, THERE IS NO NECESSITY OF CONNECTING THE THERMOSTAT AS THE BRINE CANNOT BE HEATED UP TO THE BOILING POINT.

7. PRECOOLING - TEMPERATURES

(A) CONNECTING UNIT TO PLANE:

1. PLACE CONDITIONER IN POSITION TO ATTACH FLEXIBLE HOSE TO PORTHOLE PROVIDED IN THE LEFT SIDE OF THE FUSELAGE FOR 247-D AND DC-3 PLANES. IN THE CASE OF THE DST PLANES, CONNECT TO PORTHOLE PROVIDED IN THE UNDERSIDE OF THE FUSELAGE IN THE NOSE SECTION.

2. ATTACH HOSE TO PLANE. STRAIGHTEN HOSE AS MUCH AS POSSIBLE. START FAN. THE SPEED OF THE FAN SHOULD BE REDUCED AT ANY TIME THAT THE TEMPERATURE OF THE CABIN REACHES A COMFORTABLE TEMPERATURE.

(B) THE PLANE PORTABLE AIR CONDITIONING UNITS WILL BE USED WHEN THE CABIN TEMPERATURE IS 75° F OR OVER AND SHOULD REMAIN ATTACHED AND RUNNING UNTIL THE PLANE IS READY FOR DEPARTURE.

(C) DURING THE COOLING, THE PLANES CABIN DOORS WILL ONLY BE OPENED WHEN ABSOLUTELY NECESSARY FOR PASSAGE OF "BOARDING PASSENGERS" AND "EMPLOYEES" ONLY, OTHERWISE ALL CABIN DOORS AND CABIN VENTILATORS WILL REMAIN CLOSED. THE CABIN VENTILATORS ARE TO REMAIN CLOSED UNTIL THE PLANE HAS REACHED THE TAKE-OFF POSITION. THIS PROCEDURE APPLIES ONLY TO 247-D AND DC-3 PLANES. IN THE CASE OF THE DST PLANES, IT WILL BE NECESSARY TO COMPLETELY CLOSE THE VALVE IN THE FRESH AIR INLET AIR DUCT IN THE NOSE OF THE PLANE AND TO OPEN ALL INDIVIDUAL FRESH AIR OUTLETS IN THE CABIN. IF THE BERTHS ARE MADE UP, IT WILL BE NECESSARY TO OPEN THE INDIVIDUAL OUTLETS IN THE UPPER BERTHS LOCATED INSIDE THE CURTAIN IN THE CEILING. PARTICULAR ATTENTION SHOULD BE GIVEN TO THE PROCEDURE OUTLINED HEREIN FOR PRE-COOLING THE DST PLANES, BECAUSE IF THIS METHOD IS NOT FOLLOWED, THERE WILL BE NO FREE FLOW OF AIR THROUGH THE CABIN.

(D) THE ABOVE SPECIFIED 75° F CABIN TEMPERATURE, CANNOT, OF COURSE, BE APPLIED TO ALL STATIONS AND ALL CONDITIONS SO THAT IT WILL BE LEFT TO THE JUDGMENT OF THE STATION MANAGER OR HIS REPRESENTATIVE IN CHARGE, WHEN THE QUESTION ARISES AS TO WHETHER OT NOT THE PRE-COOLING UNITS ARE TO BE USED.

(E) PLANE CABINS SHOULD NOT BE COOLED TO A TEMPERATURE OF LOWER THAN 10° F BELOW THE PREVAILING OUTSIDE TEMPERATURE. AVOID OVERCOOLING.

8. PREHEATING - TEMPERATURES

(A) THE PLANE PORTABLE CABIN PREHEATING UNITS WILL BE USED WHEN THE CABIN TEMPERATURE IS 50° F OR LOWER, OR, WHENEVER THE TEMPERATURE DROPS TO NEAR 50° F AND STRONG WINDS OR DAMPNESS MAKES THEIR USE DESIRABLE FROM THE STANDPOINT OF PASSENGER COMFORT. THE PORTABLE PREHEATING UNITS SHOULD REMAIN ATTACHED TO THE PLANE AND RUNNING UNTIL DEPARTURE TIME.

(B) WHENEVER THERE IS A QUESTION AS TO WHETHER OR NOT THE PREHEATING UNITS ARE TO BE USED, DECISION WILL BE LEFT TO THE JUDGMENT OF THE STATION MANAGER.

(C) DURING THE HEATING OF THE CABINS, THE CABIN DOORS WILL ONLY BE OPENED WHEN ABSOLUTELY NECESSARY FOR PASSAGE OF "BOARDING PASSENGERS" AND "EMPLOYEES" ONLY, OTHERWISE, ALL CABIN DOORS AND CABIN VENTILATORS WILL REMAIN CLOSED. THE CABIN VENTILATORS ARE TO REMAIN CLOSED UNTIL THE PLANE HAS BEEN DISPATCHED AFTER WHICH THEY MAY BE REGULATED TO PASSENGERS COMFORT.

(D) PLANE CABINS ARE TO BE HEATED TO AS NEAR 80° F AS POSSIBLE. AVOID OVERHEATING.

(E) THE SAME PLANE CONNECTIONS IN ATTACHING THE PREHEATING UNIT TO THE FUSELAGE, WILL BE USED AS IN THE CASE OF PRECOOLING, OUTLINED ABOVE IN PARAGRAPH 7 (A).

SERVICE EQUIPMENT

1. ENGINE SERVICE STANDS

A. ENGINE SERVICE STANDS ARE PROVIDED AT FIELDS CHARGED WITH THE SERVICING AND CHANGING OF ENGINES. KEEP CASTERS LOCKED WHEN STAND IS IN USE OR NEAR THE PLANE.

B. DC-3 ENGINE SERVICE STANDS ARE DESIGNED TO BE PLACED ON TOP OF THE STANDARD ENGINE SERVICE STANDS AND ARE PROVIDED TO STATIONS CHARGED WITH THE SERVICING OF DC-3 PLANES.

2. GASOLINE TRUCKS

REFILLING GASOLINE TRUCKS.

A. BEFORE STARTING TO REPLENISH SUPPLY OF GASOLINE IN TRUCK -

(1) SHUT OFF THE ENGINE
(2) GROUND TRUCK WITH GROUNDS PROVIDED.
(3) HAVE FIRE EXTINGUISHING EQUIPMENT IMMEDIATELY AVAILABLE.
(4) IF RAINING OR SNOWING PROVIDE A SUITABLE COVER FOR THE TANK OPENING DURING REFUELING.
(5) CAUTION: ALWAYS STAND ON THE CATWALK PROVIDED. WHILE REFILLING MECHANICS SHOULD REFRAIN FROM WALKING ON TOP OF THE TANKS. THIS IS NECESSARY TO PREVENT ANY POSSIBILITY OF SPARKS NEAR THE TANK OPENING CAUSED BY NAILS IN MECHANICS SHOES STRIKING OR SLIDING ON THE STEEL TANK. ALSO PREVENT INJURY TO PERSONNEL DUE TO SLIPPING OR FALLING FROM SMOOTH TANK SURFACE.

B. A NUMBER OF STATIONS ARE SUPPLIED WITH LARGE GASOLINE TRUCKS FOR SERVICING PLANES. ONE MAN (INTERESTED IN THE APPEARANCE AND CONDITION OF THE TRUCK) SHOULD BE DESIGNATED AT EACH OF THESE STATIONS TO BE RESPONSIBLE FOR THE PROPER MAINTENANCE OF THIS EQUIPMENT TO THE END THAT OUR PLANES WILL NEVER BE DELAYED BECAUSE OF THE FAILURE OR MALFUNCTIONING OF SOME UNIT ON THE TRUCK. THE GASOLINE TRUCKS AND THEIR COMPONENT PARTS MUST BE WATCHED AND INSPECTED CLOSELY SO THAT WHEN REPAIRS OR ADJUSTMENTS ARE NECESSARY, THESE WILL BE ACCOMPLISHED IN AN EFFICIENT, WORKMANLIKE MANNER SO THAT WE MAY RECEIVE THE SAME DEPENDABLE PERFORMANCE FROM THESE UNITS AS IN THE CASE OF OUR FLYING EQUIPMENT.

C. WHILE ALL OF THE TRUCKS ARE BASICALLY THE SAME, THERE ARE A FEW MINOR DIFFERENCES IN EACH SET. HOWEVER, THE PRINCIPLE OF OPERATION IS AS FOLLOWS:

(1) IN THE BOTTOM OF EACH GASOLINE COMPARTMENT ARE VALVES WHICH ARE CONTROLLED HYDRAULICALLY FROM THE CENTER OPERATOR IN THE REAR OF THE TRUCK. MOVING THIS HANDLE DOWN OPENS THE VALVES IN ALL TANKS AND ALLOWS THE GAS TO FLOW TO THE HYDROFOLDS LOCATED ON EITHER SIDE UNDER THE FRONT TANKS. IMMEDIATELY BELOW THE RIGHT AND LEFT OPERATORS IS A SELECTOR VALVE WHICH PERMITS THE MECHANIC TO SELECT ANY ONE OF THE THREE TANKS. AFTER THIS SELECTION IS MADE, HE PULLS THE HANDLE

DOWN ON THE OPERATOR IN QUESTION, WHICH IN TURN OPENS THE CORRESPONDING VALVE IN THE HYDROFOLD AND ALLOWS GAS TO FLOW FROM THE TANK HE SELECTED TO THE PUMP, AIR SEPARATOR AND METER, AND FINALLY TO THE HOSE REEL AND NOZZLE.

D. EACH TRUCK IS EQUIPPED WITH TWO GAS PUMPS AND ONE POWER DRIVEN OIL PUMP. THE GAS PUMPS ARE DRIVEN SEPARATELY THROUGH POWER TAKE-OFFS FROM THE ENGINE AND ARE CONTROLLED BY THE TWO LEVERS ON EITHER SIDE OF THE GEAR SHIFT LEVER.

E. THE RIGHT POWER TAKE-OFF SHAFTS ON THE EAST END TRUCKS ARE EQUIPPED WITH DISC CLUTCHES CONTROLLED THROUGH LEVER IN THE RIGHT FRONT HOSE COMPARTMENT WHICH PERMIT THE USE OF EITHER OR BOTH THE RIGHT GASOLINE PUMP OR THE OIL PUMP AT ONE TIME. ON THE WEST COAST AND SALT LAKE TRUCKS, IT IS NECESSARY TO RUN THE RIGHT GAS PUMP IN ORDER TO USE THE OIL PUMP AND VICE VERSA.

F. ALL TUCKS ARE EQUIPPED WITH A SUCTION HOSE TO PERMIT GASOLINE TO BE PUMPED OUT OF THE PLANE OR STORAGE TANK INTO THE RIGHT FUEL PUMP AND THENCE THROUGH THE METER AND OUT THE NOZZLE SO THAT IT CAN BE PUT INTO ANOTHER PLANE OR BACK INTO THE TRUCK AS DESIRED. THE HYDRAULICALLY CONTROLLED VALVES MUST BE KEPT CLOSED DURING THIS OPERATION.

G. ON THE REAR END OF EACH TRUCK JUST INSIDE THE REAR DOOR IS AN EMERGENCY SWITCH CONNECTED IN SERIES WITH THE ENGINE IGNITION SWITCH, WHICH IN CASE OF EMERGENCY MAKES IT POSSIBLE FOR THE MECHANIC TO QUICKLY STOP THE ENGINE AND PUMP FROM THE REAR WITHOUT GOING CLEAR AROUND TO THE CAB.

H. THE OIL TANK AND THE OIL HOSE AND METER COMPARTMENTS ARE EQUIPPED WITH 110 VOLT ELECTRIC HEATERS WHICH ARE CONTROLLED BY VAPOR PROOF SWITCHES AT THE REAR OF THE TRUCK. YOU SHOULD PROVIDE A #12 THREE CONDUCTOR CORD (ONE WIRE OF WHICH IS TO BE USED FOR A GROUND) WHERE THE TRUCK IS NORMALLY GOING TO BE HOUSED SO THAT IT WILL BE AVAILABLE FOR HEATING THE OIL WHENEVER IT IS NECESSARY.

I. THESE TRUCKS SHOULD BE KEPT UNDER COVER, OUT OF THE WEATHER, WHENEVER PRACTICABLE. GREASING AND MECHANICAL CARE WILL BE DONE AT INTERVALS AS RECOMMENDED BY THE MANUFACTURER AND COVERED BY THE HAND BOOK SUPPLIED WITH THE TRUCKS.

J. EACH TRUCK SHOULD BE INSPECTED DAILY FOR THE FOLLOWING:

(1) PROPER OIL LEVEL IN THE CRANKCASE.
(2) FUEL LEVEL.
(3) TIRES.
(4) CLEANLINESS.
(5) LIGHTS.
(6) THE WATER INDICATORS SHOULD BE CHECKED DAILY FOR WATER.
(7) ALL TANKS, VALVES, PIPE FITTINGS, HOSE, ETC., SHOULD BE INSPECTED FOR LEAKS.
(8) SMOKING WILL NOT BE PERMITTED IN OR AROUND THE TRUCK AT ANY TIME.

(J) THE FOLLOWING ITEMS ARE TO BE CHECKED EVERY THIRTY DAYS:

1. CHECK BATTERY - KEEP WELL CHARGED AND FILLED TO THE PROPER LEVEL WITH ELECTROLITE.
2. TRANSMISSION - SEE THAT A SUFFICIENT QUANTITY OF THE CORRECT LUBRICANT IS IN THE TRANSMISSION, BOTH DURING SUMMER AND THE WINTER SEASONS.
3. REAR END - SEE THAT A SUFFICIENT QUANTITY OF THE CORRECT LUBRICANT IS IN THE REAR END, BOTH DURING SUMMER AND THE WINTER SEASONS.
4. GREASE ENTIRE UNIT INCLUDING GASOLINE PUMPS, USING GREDAG #32 GREASE.

NOTE: THE CRANKCASE OIL SHOULD BE CHANGED IN ALL OF OUR GASOLINE SERVICING TRUCKS AT INTERVALS EQUIVALENT TO APPROXIMATELY 500 MILES.

3. GENERAL UTILITY STANDS

(A) GENERAL UTILITY STANDS ARE FURNISHED FOR THE DC-3 PLANES AND PROVIDE A STAND FOR MISCELLANEOUS WORK ABOUT THE PLANE, SUCH AS WORK IN THE NOSE COMPARTMENT, MISCELLANEOUS WORK ON ENGINES AND ANY OTHER WORK WHICH CANNOT BE REACHED FROM THE REGULAR ENGINE SERVICE STANDS.

4. HOLD DOWN LINKS

(A) ALL SERVICE STATIONS ARE PROVIDED WITH CABLES AND PINS FOR SECURING THE TAIL OF THE DC-3 TO THE TIE-DOWN LOCATED IN THE GROUND. THIS WILL AVOID THE NECESSITY OF REMOVING THESE ITEMS FROM THE PLANES.

5. JACKS

(A) TRIPOD JACK STANDS WITH A HYDRAULIC CYLINDER AND PISTON INSTALLED AS PART OF THE TRIPOD ARE PROVIDED FOR RAISING PLANES IN CASE OF FLAT TIRES, CHECKING WHEELS OR BRAKES, OR CHECKING THE LANDING GEAR.

(B) WHEN JACKING DC-3 PLANES IT WILL BE NECESSARY TO BOLT THE BRACKET PROVIDED ON THE UNDERSIDE OF THE WING BEFORE THE PLANE CAN BE RAISED. WHEN JACKING ONLY ONE SIDE OF THE PLANE AT A TIME IT WILL BE NECESSARY TO INSTALL THE SPECIAL ADAPTER #6U-79 TO TAKE CARE OF ROLLING MOTION OF THE PLANE WHILE BEING RAISED. WHEN JACKING BOTH SIDES OF THE PLANES AT ONCE IT IS NECESSARY ONLY TO INSTALL THE ADAPTERS TO ALLOW THE CYLINDERS TO FIT INTO THE SOCKETS ON THE UPPER BRACKETS.

CAUTION: THE SPECIAL SAFETIES SHOULD BE INSTALLED BEFORE THE LANDING GEAR IS RAISED OR THE WHEELS REMOVED.

6. MAIL AND BAGGAGE TRUCKS

(A) MAIL AND BAGGAGE TRUCKS ARE DESIGNED TO BE OF ADEQUATE SIZE FOR SMALL STATIONS. LARGER STATIONS WILL BE PROVIDED WITH SUFFICIENT OF THESE TRUCKS TO MEET THEIR REQUIREMENTS. A MODIFIED TRUCK EQUIPPED WITH A PLATFORM HIGH ENOUGH TO PERMIT ACCESS TO THE FRONT BAGGAGE COMPARTMENT OF THE DC-3 PLANE IS PROVIDED TO STATION WHERE THIS EQUIPMENT WILL NORMALLY BE LOADED.

7. PASSENGER STEPS

(A) PASSENGER STEPS ARE PROVIDED FOR ALL STATIONS. ONE REMOVABLE STEP IS PROVIDED FOR THE STANDARD PASSENGER LOADING STEP FOR STATIONS THAT HANDLE BOTH THE DC-3 AND 247-D PLANES. THE LARGER STATIONS ARE PROVIDED WITH SPECIAL LOADING STANDS TO BE USED ONLY ON THE DOUGLAS PLANES.

8. SERVICE LADDERS

(A) DC-3:

1. SERVICE LADDERS FOR DC-3 PLANES, WHILE PRIMARILY INTENDED FOR SERVICING THE PLANE WITH GAS AND OIL, ARE INTENDED FOR USE BY ANYONE DOING WORK ON TOP OF THE WING.

2. CANVAS WING WALKS WILL BE KEPT ATTACHED TO ALL THESE GASSING LADDERS AND SHOULD BE USED AT ALL TIMES WHEN GASSING OR CLEANING WINDOWS, OR DOING OTHER WORK ON TOP OF THE WINGS ADJACENT TO THE FUSELAGE. THESE WALKS HAVE RUBBER CLEATS SEWED INTO THEM TO HELP KEEP THE MECHANICS AND PORTERS FROM SLIPPING, AS WELL AS PROTECTING THE WING SURFACES.

(B) 247-D:

1. THIS LADDER IS PRIMARILY INTENDED FOR SERVICING THE 247-D PLANE WITH GAS AND OIL.

9. STATION STARTERS

(A) THE ECLIPSE STATION STARTERS, WITH WHICH ALL STATIONS ARE EQUIPPED ARE TO BE USED FOR STARTING ALL S1H1G ENGINES. TO OPERATE, THE FOLLOWING PROCEDURE WILL GOVERN:

1. BE CERTAIN THAT THE STARTER IS PROPERLY FITTED INTO THE STARTER SHAFT.

2. MECHANIC HANDLING STARTER WILL BE CERTAIN THAT HIS FOOTING IS SECURE.

3. AFTER INERTIA STARTER HAS BEEN RUN UP TO PROPER SPEED, OPEN SWITCH AND DETACH THE STARTER BEFORE ENGAGING ENGINE. BE SURE THAT STARTER IS CLEAR OF THE PROPELLER BEFORE ENGAGING ENGINE.

4. DO NOT RUN STARTER WITHOUT LOAD. THE DESIGN OF THE UNIT IS SUCH THAT IF RUN FREE WITHOUT LOAD, IT WILL ATTAIN TERRIFIC SPEED AND IS SURE TO RESULT IN DAMAGE.

5. THE CLUTCH SHOULD OPERATE SMOOTHLY AND NOT GRAB OR STICK. A CLUTCH THAT DOES GRAB OR STICK STRESSES THE GEARING OF THE INERTIA STARTER BEYOND ITS DESIGNED STRENGTH AND IS A HAZARD TO THE MECHANIC HANDLING THE STARTER. DEFECTIVE STARTERS WILL BE FORWARDED TO THE REPAIR BASE IMMEDIATELY FOR REPAIR.

6. THE STARTER CIRCUITS ARE TO BE FUSED WITH 15 AMPERE FUSES AT ALL TIMES WHEN 15 AMPERES WILL OPERATE THE UNIT. IN COLD WEATHER IT IS LIKELY THAT 15 AMPERE FUSES WILL NOT BE SUFFICIENT AND A SUPPLY OF 20 AND 30 AMPERE FUSES WILL BE KEPT ON HAND FOR THESE EMERGENCIES. ON BLOWING A 15 AMPERE FUSE, A 20 AMPERE FUSE WILL BE INSERTED. IF THIS IS BLOWN, A 30 AMPERE FUSE WILL BE INSERTED. ALWAYS USE A FUSE OF THE LOWEST POSSIBLE AMPERAGE. WHEN 30 AMPERE FUSES ARE USED, MECHANICS WILL EXERCISE CARE IN HANDLING THE STARTER, BEING CAREFUL THAT THEIR FOOTING IS SECURE AND HOLDING THE UNIT IN SUCH A MANNER AS TO PREVENT INJURY TO THEMSELVES.

7. EACH STATION HAS BEEN PROVIDED WITH AN ADAPTER CABLE FOR USE AT EMERGENCY FIELDS WHERE TWO-WAY OUTLETS ONLY ARE AVAILABLE. THESE ADAPTERS ARE PROVIDED WITH AN EXTERNAL GROUND WIRE TO BE ATTACHED TO ANY CONVENIENT GROUND CONNECTION.

→10. Tow Bars

A. General

1. ALL PLANES ARE EQUIPPED WITH THE BUTTON TYPE TOWING LUGS IN THE TAIL WHEEL AXLES. THE NEW TYPE TOW BAR #15-SK-28 AND THE REVISED TYPE TOW BAR #9SK-30 ARE INTERCHANGEABLE FOR USE ON EITHER THE DOUGLAS OR BOEING PLANES.

11. FLASHLIGHTS

1. A SPARK FROM A BROKEN FLASHLIGHT BULB OR FROM THE FLASHLIGHT SWITCH CAN IGNITE GASOLINE VAPOR. QUOTED BELOW IS A PARAGRAPH TAKEN FROM A LETTER RECEIVED FROM THE UNDERWRITERS LABORATORIES:

   "ARCING PARTS OF THE SWITCH OF A FLASHLIGHT, UNLESS PROPERLY SAFEGUARDED, MAY BECOME A SOURCE OF IGNITION WHEN OPERATED IN AN ATMOSPHERE CONTAINING GASOLINE VAPOR. FURTHER, IN CASE THE LIGHT BULB BURSTS OR IS BROKEN, THE HOT FILAMENT, UNLESS PROPERLY SAFEGUARDED, MAY ALSO IGNITE GASOLINE VAPOR."

2. AFTER AUGUST 1ST, 1941 ONLY AN UNDERWRITERS APPROVED FLASHLIGHT, WHICH IS VAPOR PROOF AND KEPT IN GOOD REPAIR, SHALL BE USED BY PERSONNEL WHEN WORKING IN OR AROUND AIRPLANES, IN HANGARS, SHOPS, AND ON AUTOMOTIVE OR REFUELING EQUIPMENT. FLASHLIGHTS MAY BE OBTAINED BY REQUISITION THROUGH THE REPAIR BASE ON REGULAR PAYROLL DEDUCTION FOR APPROXIMATELY $1.75 EACH.