T. O. NO. 01-25CN-30

# COLD WEATHER OPERATIONS AND MAINTENANCE INSTRUCTIONS

FOR THE

# P-40N Series AIRPLANES

*Published by authority of the Commanding General, Army Air Forces.*





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# SECTION I
# INTRODUCTION

## 1. GENERAL.

This Technical Order is a supplement to the Handbooks of Flight Operation and Maintenance Instructions and gives the necessary Descriptions and Operating Instructions for the Winterization Equipment which has been installed for Cold-Weather Operation of the Curtiss P-40N series Airplanes. All personnel who are charged with the operation and maintenance of these airplanes will read and be familiar with the contents of this Handbook.

## 2. WINTERIZATION CHECK LIST.

A Winterization Check List, AAF Form No. 263-B containing the list of winterization items is carried in the data case and should be used as a record of all winterization operations performed on the airplane.

# SECTION II
# AIRPLANE EQUIPMENT FOR WINTER OPERATION AND ITS USE

## 1. OIL DILUTION.

All P-40N airplanes are equipped with an oil dilution system. The oil is diluted by fuel obtained from the engine carburetor and admitted into the oil system at the oil Y-drain. The dilution is controlled by the oil dilution valve which is mounted on the fire wall and is operated from the cockpit. (See figure 1.)

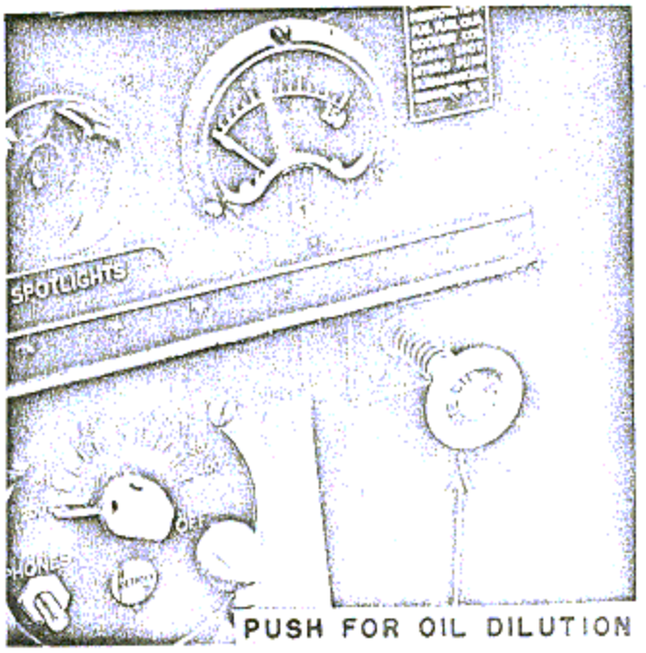



*Figure 1—Oil Dilution Control*

## 2. FUEL AND OIL TANK DRAINS.

*a.* FUEL TANK SUMP DRAINS. *(See figure 2.)*—The fuselage and wing tank sumps are equipped with drain cocks for eliminating water that has collected in the tank sumps. The tank sump drains are accessible through doors installed in the keel fairing. The drains should be checked before and after each flight and at frequent intervals while the airplane is inactive.

*b.* OIL TANK DRAINS. *(See figure 3.)*—The oil tank sump is equipped with a drain cock for eliminating water that has collected in the tank sump. The sump is accessible through the door located left of the airplane center line in the exit duct. The oil Y-drain for draining the oil in the lines to the engine is accessible through the door located at the right of the airplane center line in the exit duct. The oil Y-drain cock is provided with a spring stop which locks the cock in the closed position. The stop must be forced away from the thumb knob of the Y-drain to open the cock. The oil tank sump should be checked for presence of water before and after flight and at frequent intervals while the airplane is inactive.

## 3. OIL AND FUEL TANK VENT LINES.

*a.* OIL TANK VENT LINE. *(See figure 3.)*—The oil tank is vented to the engine. The engine nose section

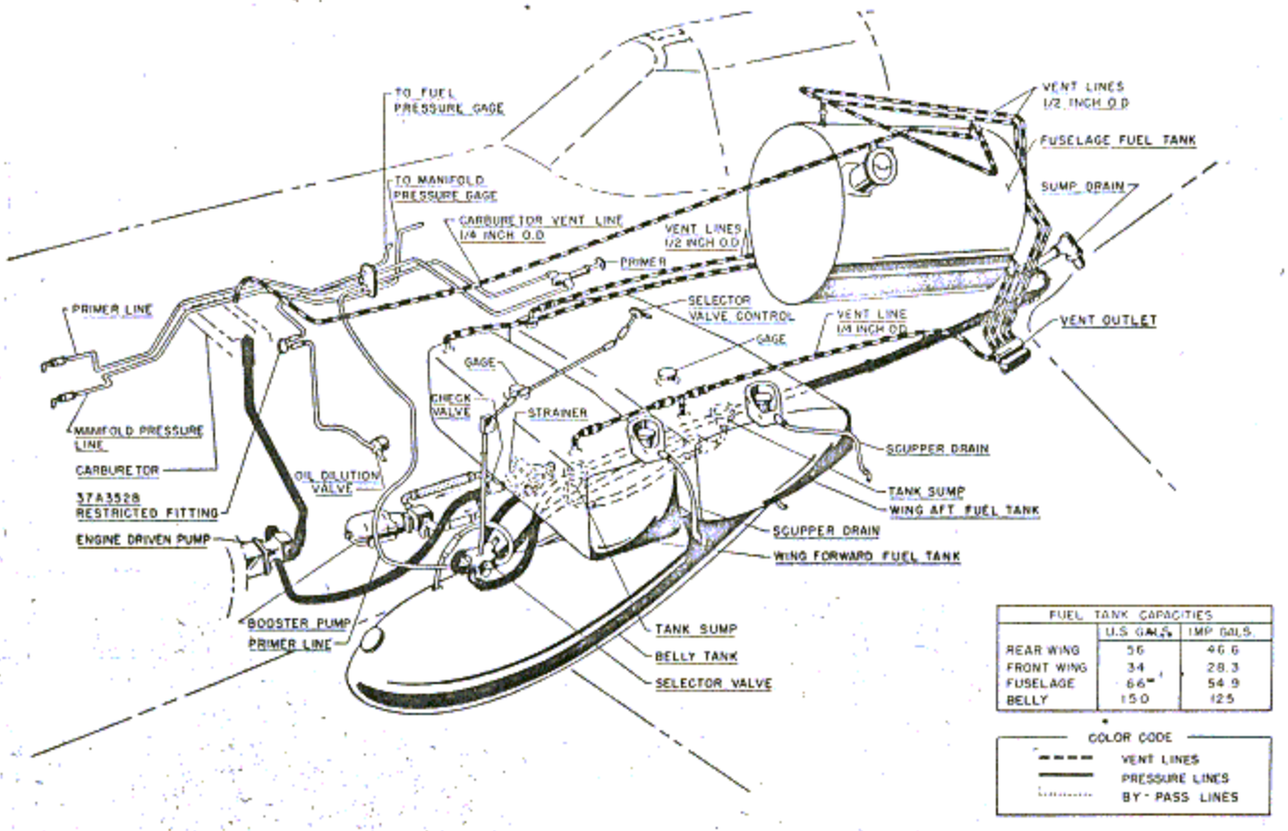



*Figure 2—Fuel System*

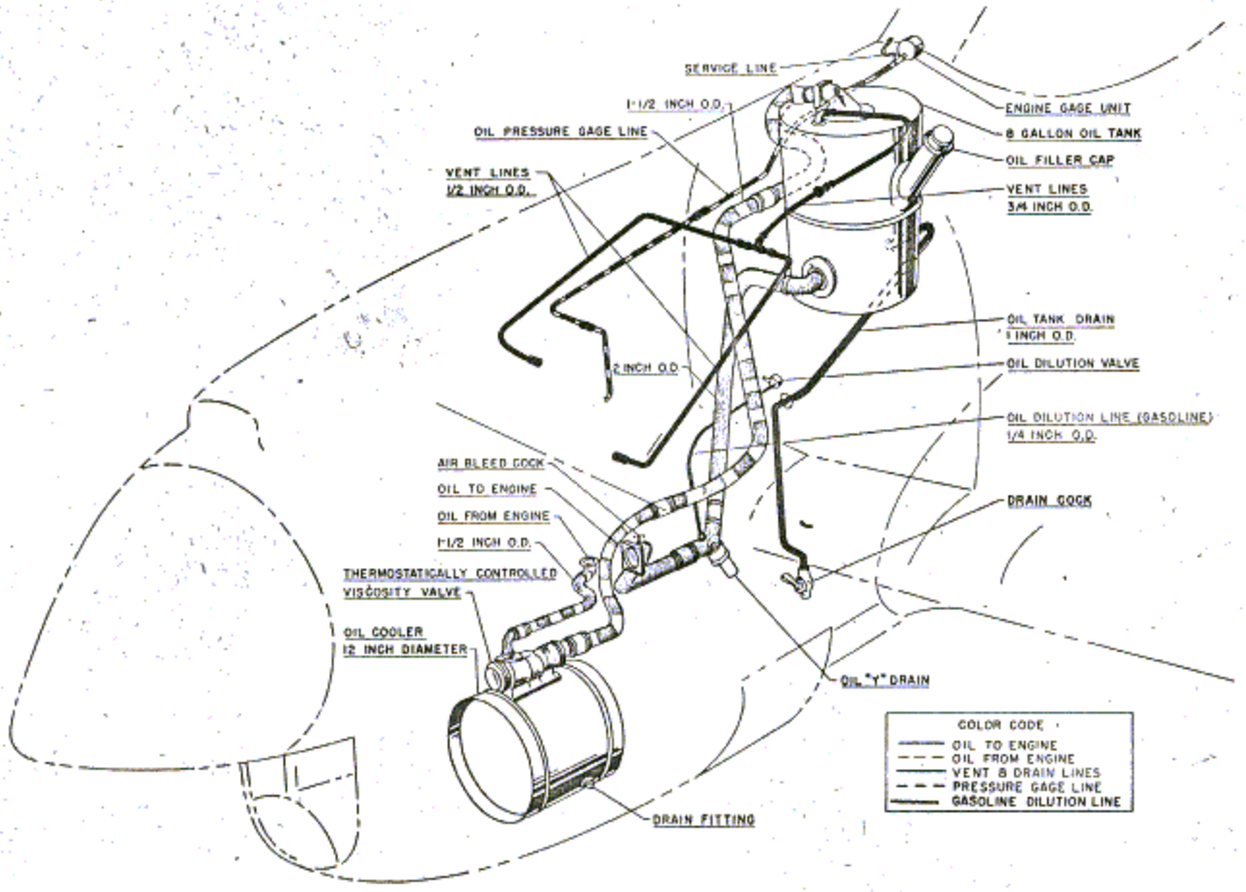



*Figure 3—Oil System*

and the engine rear accessory drive housing are vented to the atmosphere. The vent line for the engine nose section protrudes out the left front wing fillet and the engine rear accessory drive housing vent line vents out the trailing edge of the exit duct. Be sure these vent lines are clear.

*b.* FUEL TANK VENT LINES. *(See figure 2.)*—The fuselage and wing tanks are vented through the outlet assembly which is located on the under surface of the left wing fillet trailing edge. A door, providing access to the vent lines, is located inboard of the outlet assembly. The vent lines and the outlet assembly must be kept clear, otherwise a partial vacuum will be created inside the fuel tank as the fuel level drops and may cause the fuel tank to collapse resulting in damage to the tank. If the tank does not collapse, it is inevitable that the engine will cut out because of the inability of the fuel pumps to supply fuel to the carburetor when a partial vacuum exists above the fuel inside the tank. Always inspect the outlet assembly and vent lines for ice before and after every flight and at frequent intervals while the airplane is inactive. Heater hose may be inserted through the vent line access door when it is necessary to thaw out the lines.

## 4. OIL COOLER SHUTTERS AND SURGE VALVE.

*a.* OIL COOLER SHUTTERS.—Not applicable.

*b.* OIL COOLER BLANKET. *(See figure 4.)*—A 1-inch oil cooler blanket ring, part No. 87-46-721, is provided as loose equipment and is sent under separate cover for flight-delivered airplanes and is boxed with all crated aircraft. The blanket ring is installed simply by placing it inside the oil cooler housing against the front face of the core. The air pressure will hold it in place. The blanket ring prevents the flow of cold air through the outer portion of the oil cooler core and thus keeps the oil warm and permits it to circulate more freely. The oil cooler blanket ring should be installed when the ground air temperature is −9° C (+15° F) or below. If for any reason the engine oil temperature is in excess of 90° C (194° F) the oil cooler blanket should be removed.

*c.* SURGE VALVE. *(See figure 3.)*—Surge protection is provided by a thermostatically controlled, rotary type oil temperature control valve that is mounted on top of the oil cooler. In operation, the Helix bimetal thermostat rotates the valve, allowing the tempered oil to flow through the warm-up passages or to the core section of the oil cooler, depending upon the operating conditions.

## 5. OIL TANK HEATERS.

*a.* EXTERNAL RING HEATERS.

(1) DESCRIPTION.—Provision is made for installing an external ring-type oil tank heater of 110-volt 750-watt capacity beneath the oil tank in all airplanes, AF42-104429 to AF42-105928, inclusive. Space is provided inside the brake cylinder access door on the right side of the fuselage for the heater electric power plug. The electrical power plug connection is the male portion of a conventional 110-volt two-prong push-pull socket. The power required for operating the ring-type heater is 110- to 120-volt ac or dc. The unit will draw 750 watts.

(2) OPERATION.—The length of time to operate this heater will depend on the temperature experienced, the grade of oil in the tank and the amount of oil dilution which has been used prior to stopping the engine. When operating this heater in very cold weather after the oil in the tank has congealed, it may be found that the heat will be applied so fast to the bottom of the tank that the oil in contact with the bottom of the tank will not be able to circulate and will burn. If this condition occurs, it will be necessary to turn the heater "ON" for approximately 2 minutes and "OFF" for 1 minute, then "ON" for 2 minutes, etc. until the oil around the oil heater unit can flow and thus heat more evenly. In severe weather, if the plane is to be kept in "READY" condition, the oil tank heater may be used continuously while the engine is not running.

*b.* IMMERSION HEATERS.—On P-40N airplanes AF42-105929 and subsequent, the oil tank has been modified to admit an immersion heater. Previous airplanes are equipped with oil tanks containing baffles which prevent the use of immersion heaters. All oil immersion heaters require a 110-volt power source. The immersion heater is inserted through the oil filler pipe and plugged into the power source. It must be removed just prior to engine starting. The oil immersion heaters

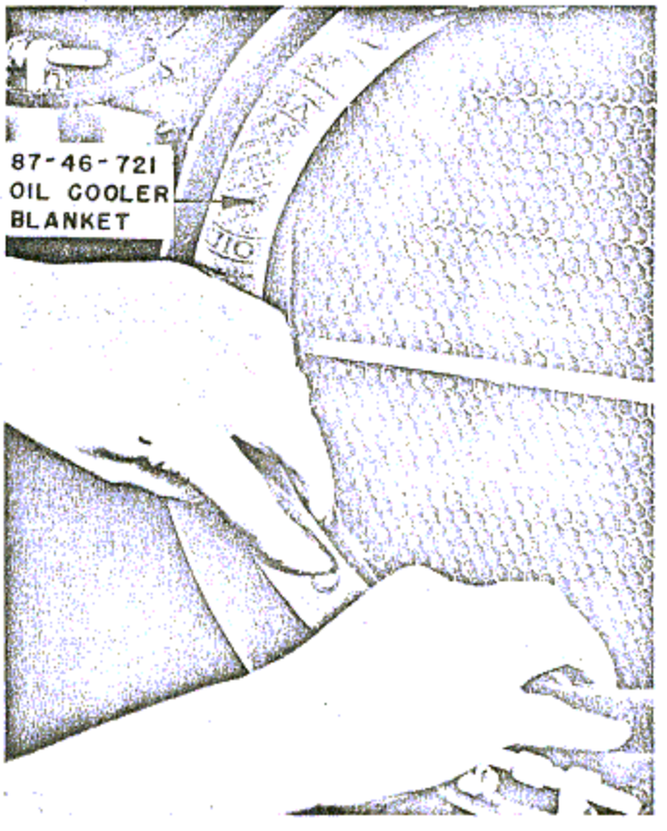



*Figure 4—Installing Oil Cooler Blanket*

are considered ground equipment and are available at the operations base. An immersion heater of 250-watts capacity should be used in the oil tank installed in the P-40N airplane.

**CAUTION**

Oil tanks must be sufficiently full to completely submerge the heater in each case.

### 6. ENGINE COWLING OPENINGS FOR GROUND HEATERS.

Two doors are provided in the left side of the lower engine cowl for the air to enter the engine compartment from the portable ground heaters. One door is provided in the top of the oil tank compartment cowl for heating the oil tank compartment by a duct from the portable ground heater. All these doors must be opened before the engine and cockpit covers are installed. (See figures 5 and 6.)

### 7. CARBURETOR HEAT.

*a.* DESCRIPTION.—The exhaust stack shrouds are equipped with covers which direct the flow of rammed air over the exhaust stacks and into the carburetor hot-air duct which conveys the air to the carburetor. The rammed air enters the shrouds just forward of the front exhaust stack. The shroud covers fit around each exhaust stack and are approximately flush with the side engine cowling. (See figure 7.)

*b.* OPERATION.—The carburetor air control lever is located at the right of the instrument panel. An instruction plate mounted on the instrument panel indicates the position to which the lever must be moved to obtain "FILTERED," "HOT," or "COLD" air to the carburetor. (See figure 8.) To operate the lever, push "IN" on the knob at the end of the handle and move the lever to the required setting.

*c.* AUTOMATIC BOOST CONTROL.—All airplanes have incorporated in the throttle linkage an automatic boost control feature which automatically opens or closes the throttle to maintain a constant manifold pressure. Because of this, the carburetor may ice up and cause the automatic boost control to open the throttle until it is fully open. By this time the amount of ice in the carburetor will create a very serious condition as the manifold pressure may drop off and the engine may stop before the pilot can turn on carburetor heat to relieve the condition. For this reason it is best that the pilot always use carburetor heat if there is any doubt as to possible icing condition.

### 8. GLYCOL RADIATOR SHUTTERS.

Not applicable.

### 9. INTERCOOLER SHUTTERS.

Not applicable.

### 10. TURBOSUPERCHARGER.

Not applicable.

### 11. CARBURETOR AIR THERMOMETER.

An AN5790-6 carburetor air temperature gage and an AN5525-2 thermometer bulb are installed on airplanes AF42-105929 and subsequent. The gage is attached to the left side of the instrument panel (figure 9) and the thermometer bulb is installed in the left side of the carburetor elbow (figure 10). The carburetor air thermometer indicates the temperature of the air just before it enters the venturi. The carburetor air temperature gage provides a check on the carburetor air heater control. Whenever a change is made in the position of the carburetor air heat control, observe the change in the carburetor air temperature.

### 12. HIGH CAPACITY BOOSTER COIL.

A booster coil, AF Specification No. 94-32182-A, is installed in the fire wall junction box that is attached to the lower left side of the fire wall on airplanes AF42-104429 through AF42-106028. On airplanes AF42-106029 and subsequent, the booster coil is located

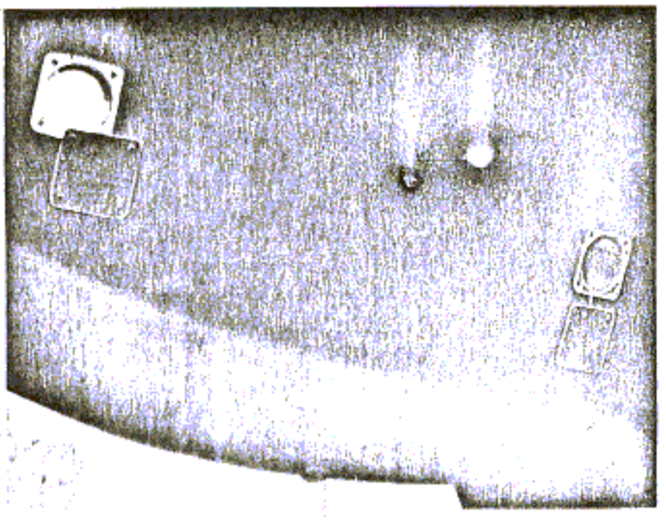


*Figure 5—Engine Ground Heat Openings*

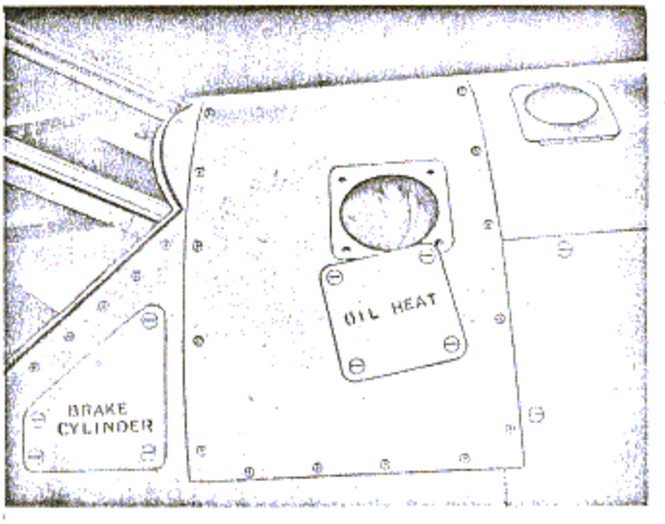



*Figure 6—Oil Tank Ground Heat Opening*

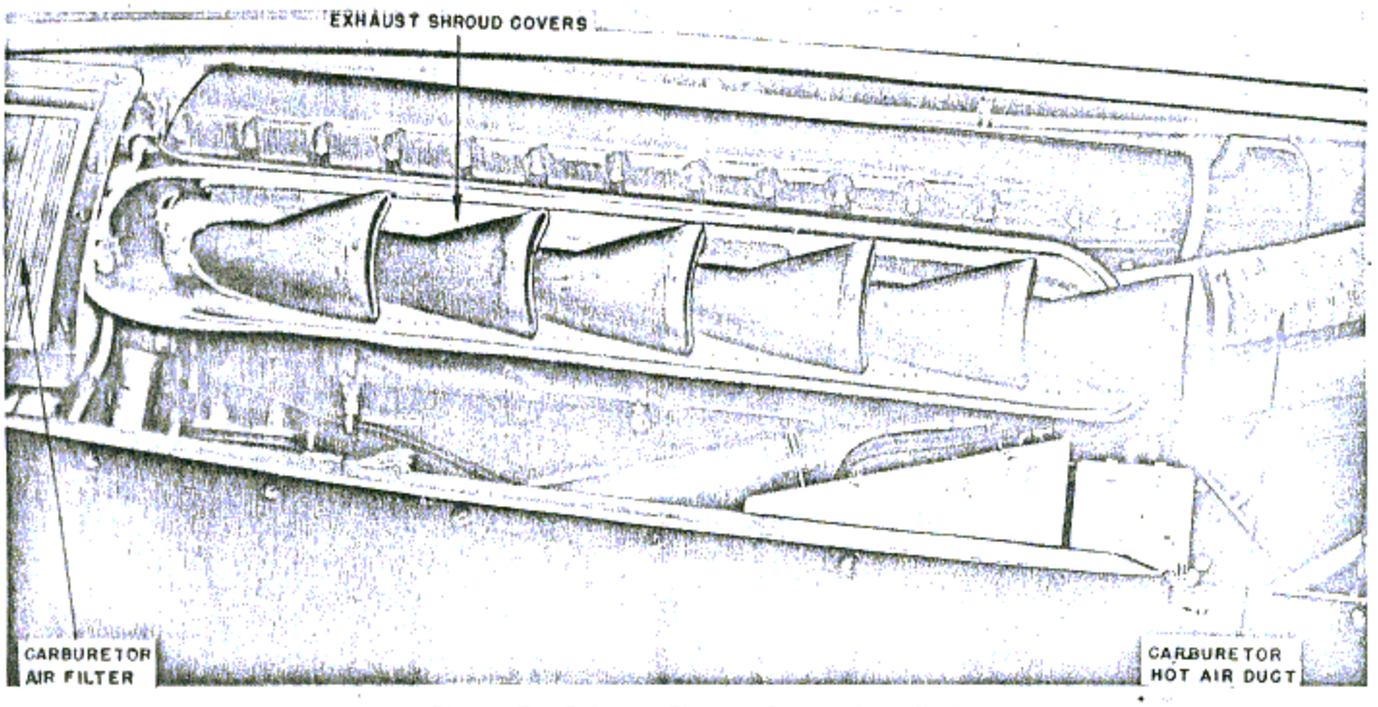



*Figure 7—Exhaust Shroud Covers Installed*

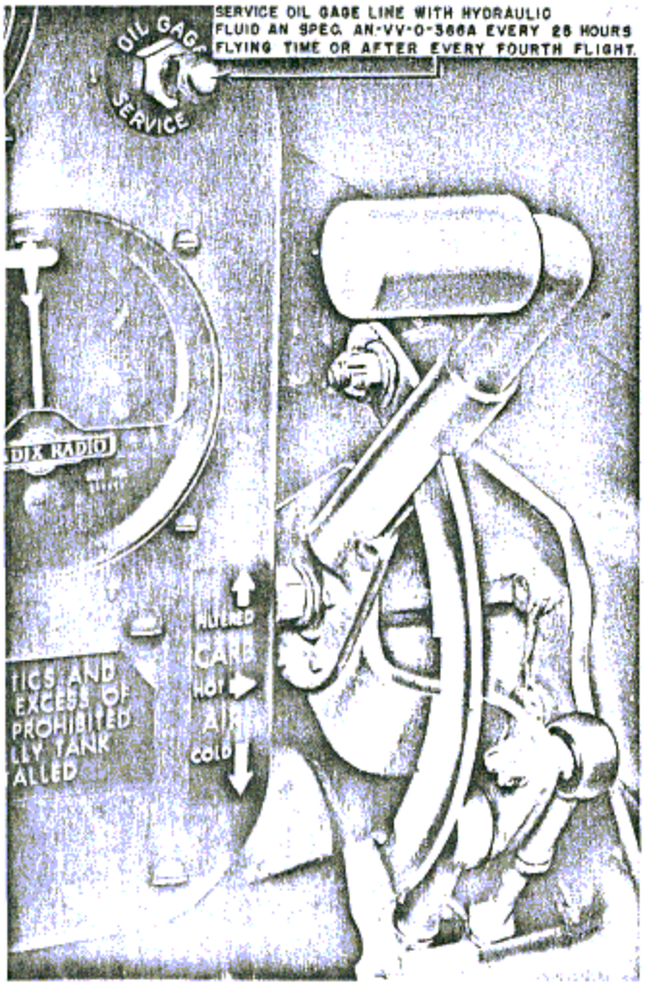



*Figure 8—Carburetor Air Control*

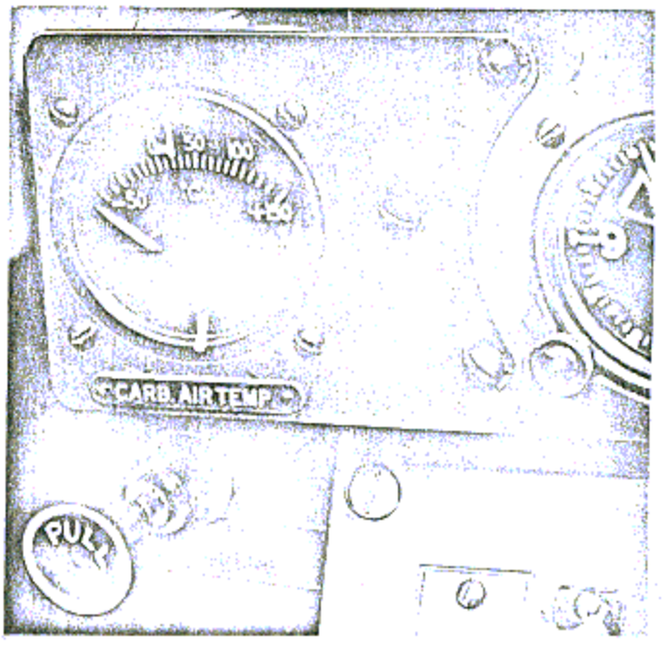



*Figure 9—Carburetor Air Temperature Gage*

in the battery starter junction box that is attached to the engine mount on the left side of the airplane. On airplanes equipped with the hand inertia starter, the booster coil is operated at the same time the starter is engaged with the engine by the "STARTER PULL." On airplanes equipped with the combination hand cranking electric inertia starters, the booster coil is operated ONLY when the starter switch in the cockpit is held in the "ENGAGE" position and *not* when the "STARTER PULL" is used in hand cranking. The

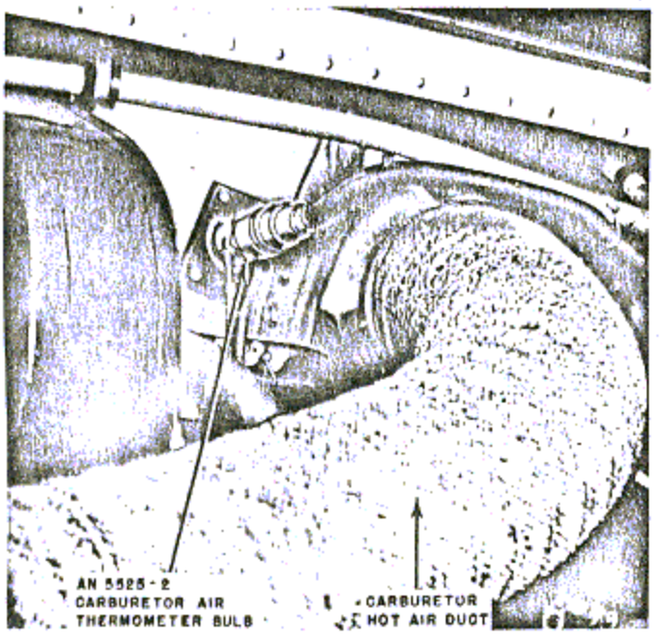



*Figure 10—Carburetor Air Thermometer Bulb Installed*

starter pull for the hand inertia starter and the engage switch for the combination hand cranking electric inertia starter should be held "ON" while starting until the engine is definitely firing.

## 13. PRESSURE TRANSMITTER (DIAPHRAGM TYPE).

For airplanes AF42-105929 through AF42-106428 and AF43-22752 through AF43-23151, the type A-1 diaphragm type oil pressure transmitter is installed and is attached to the right engine mount. (See figure 11.) The purpose of the transmitter is to transmit the engine oil pressure to the gage unit on the instrument panel through a liquid medium having low viscosity. The line between the oil pressure gage and the transmitter is serviced with compass liquid, Specification No. AN-VV-C-551; the line between the transmitter and the pressure connection on the engine is serviced with hydraulic fluid, Specification No. AN-VV-O-366a (red color).

### NOTE

For AF43-23152 and subsequent airplanes, the transmitter is not installed. Instead, the oil pressure line is serviced with hydraulic fluid, Specification No. AN-VV-O-366a. This line is filled by means of a hand gun through the fitting on the instrument panel. (See figure 8.)

## 14. LUBRICATION AND HYDRAULIC FLUIDS.

*a.* ENGINE OIL.—The airplane is serviced with engine lubricating oil AN-VV-O-446 grade 1120 at the factory. However, the airplane will be serviced at "jumping off" points with engine lubricating oil AN-VV-O-446 grade 1100 for Arctic and sub-Arctic operation.

*b.* GENERAL PURPOSE OIL.—The oil used for lubricating hinges, controls, and sleeve bearings is aircraft instrument oil, Specification No. 2-27.

*c.* PROPELLER LUBRICATION.—Curtiss Speed Reducer Oil No. 2 is used on the propeller blade adjusting motor and the speed reducer. The propeller hub is packed with Mobile Grease No. 0, Specification No. 3581, grade B.

*d.* GUN OIL.—The guns are protected with Special Preservative Lubricating Oil, Specification No. AXS-777.

*e.* HYDRAULIC FLUID.—The airplane hydraulic system is serviced at the factory with hydraulic fluid, Specification No. 3586 (blue color) unamended grade B. However, for Arctic and sub-Arctic operation, the hydraulic system will be serviced at "jumping off" points with hydraulic fluid, Specification No. 3586 grade C, which has been diluted by mixing two parts hydraulic fluid with one part normal butyl alcohol, AN Specification No. AN-O-A-391.

*f.* GENERAL PURPOSE GREASE.—The grease used in unsealed and sealed bearings, jack shafts and trim tab controls is Beacon M-285 which conforms to AN Specification No. AN-G-3.

## 15. PROPELLER ANTI-ICING.

Not applicable.

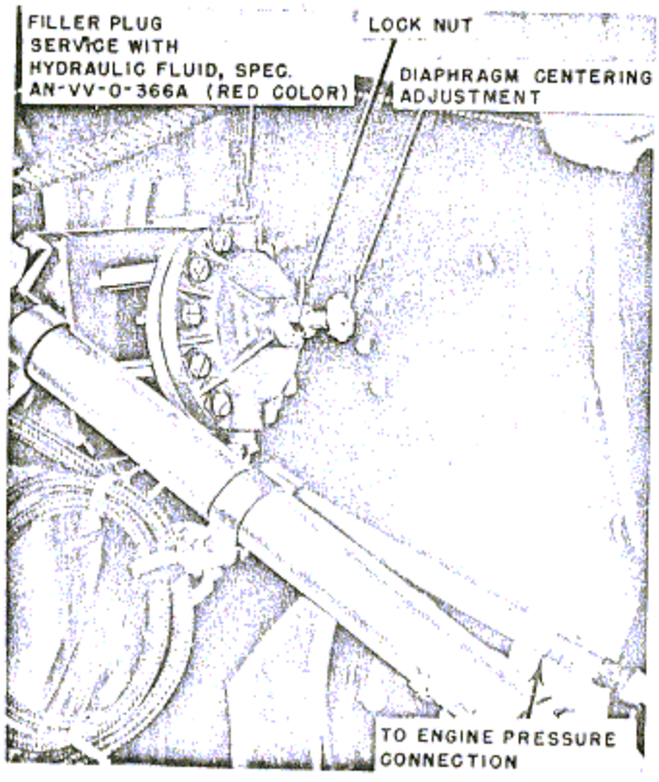



*Figure 11—Type A-1 Oil Pressure Transmitter*

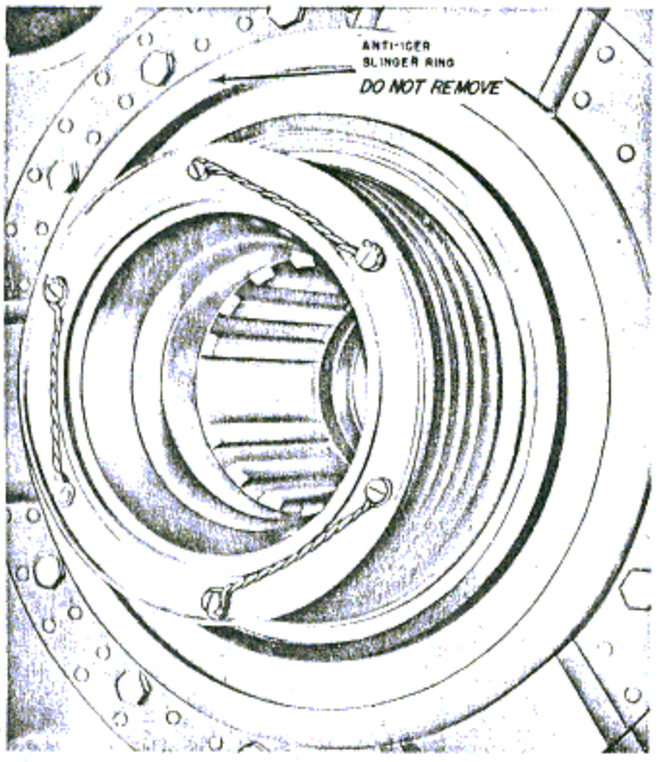



*Figure 12—Propeller Anti-Icer Slinger Ring*

**NOTE**

All P-40N airplanes are equipped with a propeller anti-icing slinger ring. (See figure 12.) The slinger ring CANNOT BE REMOVED without modifying the propeller spinner bulkheads.

## 16. WING, ENGINE, AND PROPELLER COVERS.

*(See figures 13 and 14.)*

*a.* Wing and propeller covers are provided as loose equipment for special allocated airplanes that are designated by the Air Service Command.

*b.* Engine and cockpit covers are provided as loose equipment on *all* crated airplanes.

*c.* Engine and cockpit covers are stocked for disposition by the Air Service Command for flight-delivered airplanes.

## 17. LANDING GEAR.

*a.* OLEO STRUT.—The landing gear and tail gear oleo struts are equipped with Garlock packing No. 7815 which is an approved type for cold-weather operation. The packing is comprised of a hard rubber base seal impregnated with fine asbestos fibre. Neoprene filler is used in the V-groove. The packing unit incorporates the male and female adapter rings as an integral part.

*b.* WHEELS AND BRAKES.—The main landing gear wheels and brakes are protected to the temperature of −54° C (−65° F).

*c.* VALVE CAPS.—The air valves on the oleo struts and tires are protected by winterized valve caps which have been laquered yellow. Valve caps installed on the oleo struts and tires are either the Schrader, part No. 2525, or Dill, part No. 637.

*d.* HYDRAULIC FLUID.—The oleo strut is marked with a small plate which is soldered to the oleo strut cylinder just below the "Service Warning" name plate, and reads, "USE FLUID 3586 BLUE COLOR." The oleo struts are serviced at the factory with hydraulic fluid, Specification No. 3586, unamended grade B. However, for Arctic and sub-Arctic operation the oleo struts will be serviced at the "jumping off" points with hydraulic fluid, Specification No. 3586 grade C, which has been diluted by mixing two parts hydraulic fluid with one part normal butyl alcohol, AN Specification No. AN-O-A-391.

## 18. SNOW AND ICE TIRES.

Tires with steel inserts in the tread are shipped as loose equipment *only* with Russian allocated airplanes. These tires are designed to grip the ice and stop the airplane in a shorter landing run. Install these tires when the runways are icy.

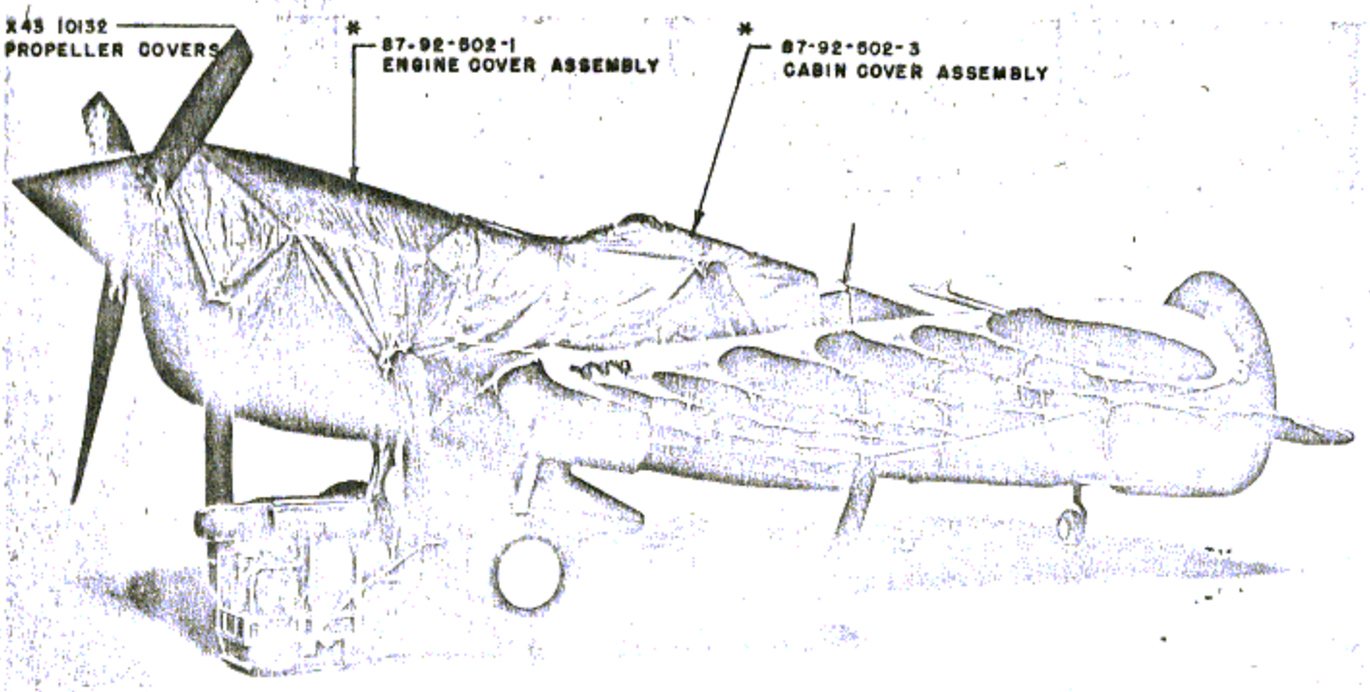
## 19. LOW TEMPERATURE HOSE.

The hose used in the P-40N airplane is Flex-O-Tube 9480 which is tentatively approved for low temperature operation by the Materiel Command as indicated by the *white* "DOT-DASH" stripe on the side of the hose.

## 20. COCKPIT HEATING.

*a.* The cockpit is heated and ventilated by air from the coolant radiator and oil cooler air exit duct. The hot air from the exit duct is conveyed through two ducts which open into the cockpit at the floor line. Incorporated in the two hot air ducts are mixing chambers where the hot air from the exit duct is tempered with cold air obtained through the two openings, one on each side of the fuselage, in the leading edge of the wing. The mixing chambers are provided with flapper-type valves which are operated by the cockpit heat control handle located at the right of the main switch box. (See figure 15.) When the cockpit heat control handle is pushed all the way "IN," the *hot*-air intake duct of the mixing chamber is closed off, and only *cold* air is admitted to the cockpit; when the handle is pulled all the way "OUT," the *cold*-air intake duct is closed off and only *hot* air is admitted to the cockpit. Thus any desired mixture of hot and cold air may be obtained by adjustment of the cockpit heat control. The control is locked in any position, by twisting the handle.

*b.* Additional heat for the pilot is obtained by conveying hot air, from the radiator and oil cooler air exit duct, through a 2-inch diameter flexible duct which extends aft along the left side of the cockpit and is held by a clip beside the pilot's seat. (See figure 16.) A shutter attached to the end of the tube is the *only* device for controlling the flow of hot air through the tube. The flexible duct may be moved to any position in the cockpit.




* NOTE: FOR AF43-23752 AND SUBSEQUENT AIRPLANES, ENGINE COVER ASSEMBLY, PART NO. 87-92-504-1 AND CABIN COVER ASSEMBLY, PART NO. 87-92-504-20 ARE PROVIDED, EXCEPT FOR RUSSIAN ALLOCATED AIRPLANES WHEN ENGINE COVER ASSEMBLY, PART NO. 87-92-504-30 AND CABIN COVER ASSEMBLY, PART NO. 87-92-504-40 ARE PROVIDED.

*Figure 13—Airplane Covers Installed—¼ Front View*

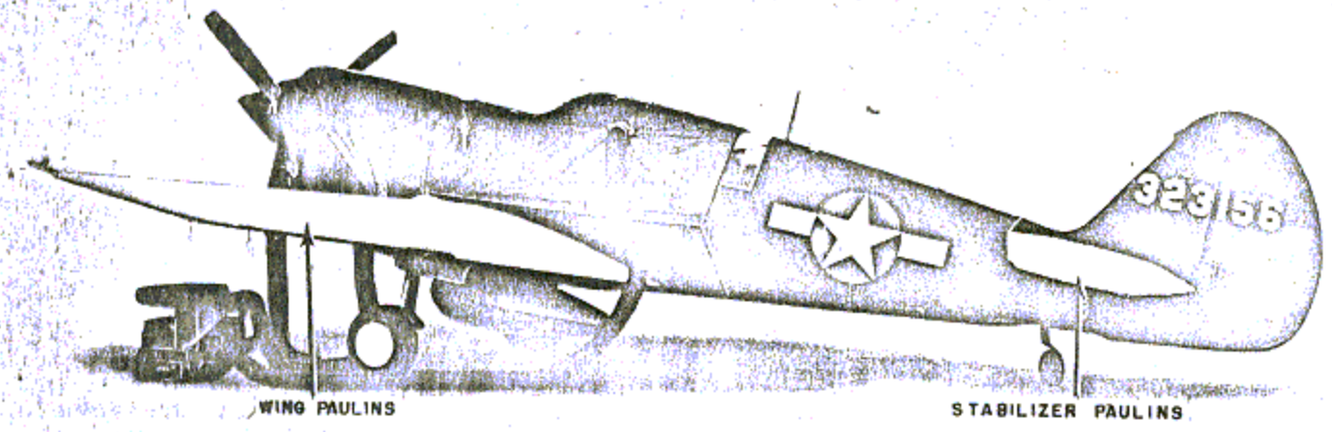



*Figure 14—Airplane Covers Installed—¾ Rear View*

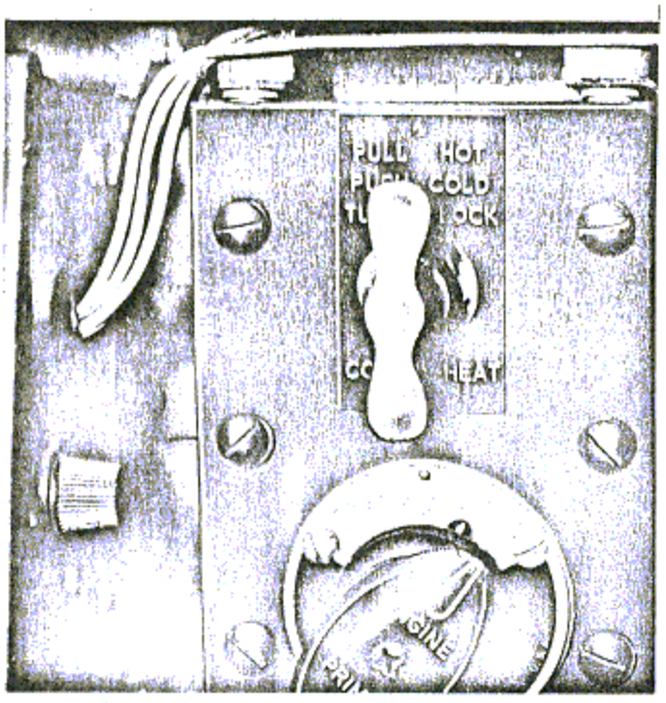



*Figure 15—Cockpit Heat Control*

## 21. ELECTRIC SUIT RHEOSTATS Q-1A.

Not applicable.

## 22. WINDSHIELD DEFROSTING.

The flexible tube for additional cockpit heating is provided with a clip which holds the tube in a set position for windshield defrosting during taxing or flying operations where severe icing conditions are encountered. (See figure 17.)

## 23. CLEAR VIEW PANEL.

*a.* For airplanes AF42-104429 through AF42-106428 and AF43-22752 through AF43-23251, a clear vision panel is installed in the left side of the windshield assembly. This consists of a small section of the windshield side panel which may be opened inward to obtain as nearly as possible an unobstructed forward view. Owing to the air flow around the cockpit enclosure, air is drawn out through the clear vision panel instead of being blown in as might be expected. A small latch secures the clear vision panel in the closed position while a small clip holds the panel in the open position. (See figure 18.)

## 24. WING DE-ICERS.

Not applicable.

## 25. PREPARATION OF ACCESSORY EQUIPMENT WITHIN THE AIRPLANES.

*a.* MARKING.—LOOK FOR THE YELLOW OR WHITE DOT. All items of equipment or units that are modified for satisfactory operation over the temperature range of −65° to +160° F (−54° to +71° C) are marked with a yellow dot, not smaller than ¼ inch in diameter, located in a conspicuous space. Airframes have the yellow dot located over the Air Forces acceptance date, which is on the left side of the fuselage, when lubricated with low-temperature grease. Marking is done at the factory, modification center or the depot where the modifications necessary to meet the requirements are made. Lack of the yellow dot on a piece of accessory equipment is not, during the transition period, an indication of lack of approval for use of the equipment, but indicates merely that the equipment has not been thoroughly tested for operation in the temperature range. (Any equipment that has received *tentative* approval from the Materiel Command for cold-weather operation is indicated by a WHITE dot.)

The following items of equipment installed on the airplane have been modified for cold-weather operation and are marked with the yellow dot:

Type G-6 Starter
Main Landing Gear Wheels
Main Landing Gear Brakes
Main Landing Gear Oleo Struts
Tail Wheel
Tail Wheel Oleo Strut
Airframe

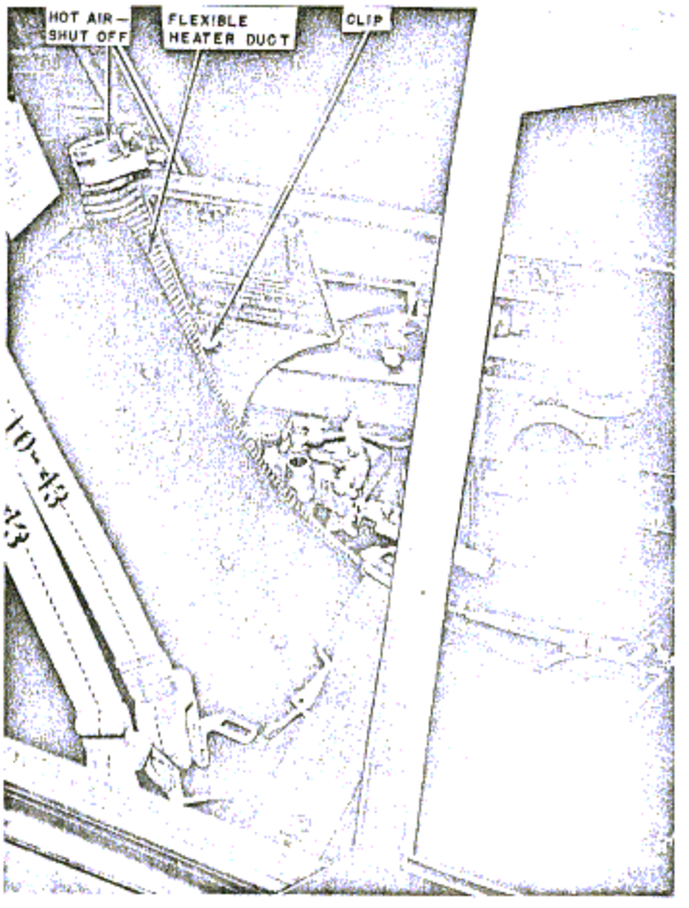



*Figure 16—Cockpit Flexible Heater Duct*

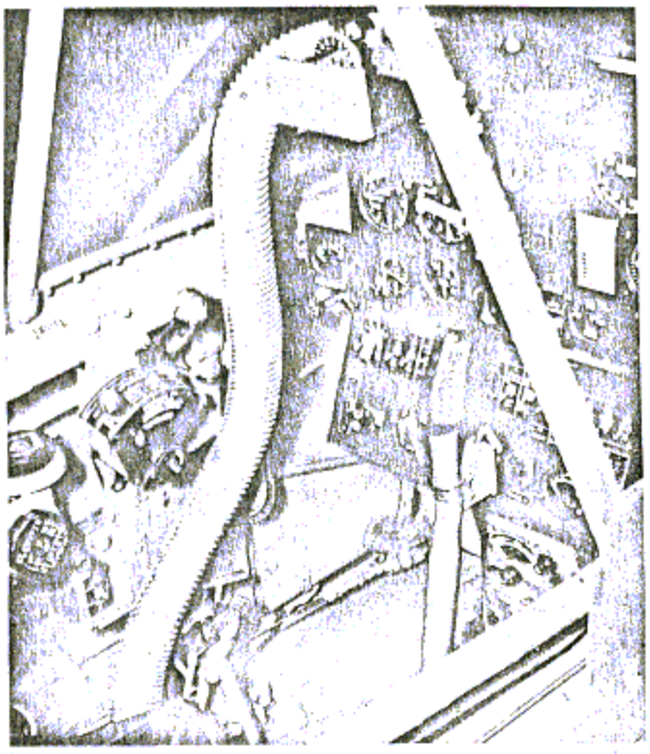


*Figure 17—Cockpit Heater Duct in Position for Defrosting Windshield*

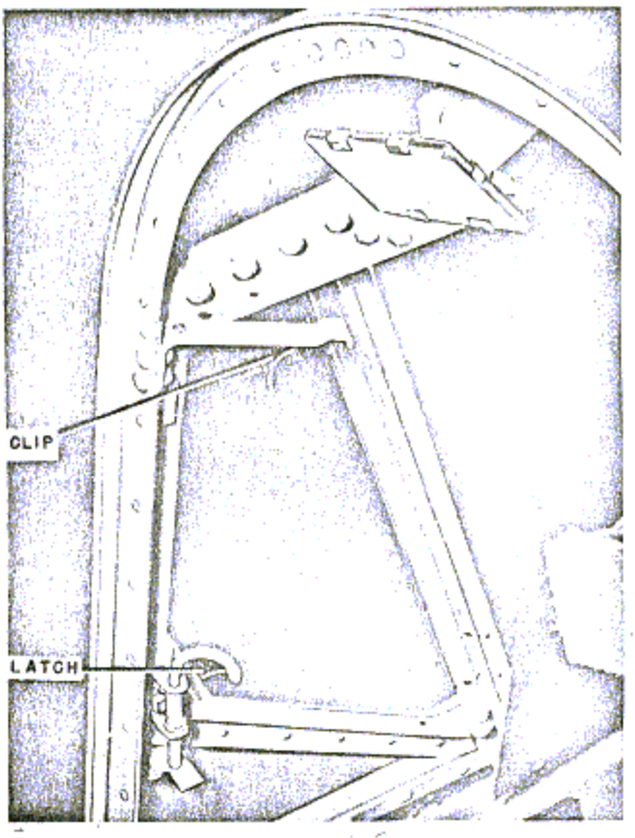



*Figure 18—Clear View Panel*

*b.* VOLTAGE REGULATOR.—All P-40N airplanes which are modified for cold-weather operation are equipped with carbon pile voltage regulators, Delco Remy, part No. 118401, or Eclipse Aviation, part No. D-106107.

*c.* GUN BARREL SEALS.—The gun barrels are sealed by placing scotch masking tape over the blast tube opening. This tape will be shot off with the first bullet that is fired. This tape must be installed at all times to keep dirt and moisture from entering the gun barrel. The scotch masking tape is carried in the duffle bag.

*d.* GUN COMPARTMENT INSULATION.—The gun compartments have a 1/4-inch thick layer of insulating material cemented to the sides and to the inner surface of the gun bay door. This greatly reduces the heat lost through these surfaces and keeps the gun bay much warmer. This insulating material must be inspected whenever the gun bay door is open to see that it has not jarred loose or become water soaked. Leave the doors open to allow the compartment to dry out if the insulating material is damp. Figure 19 shows the gun bay with insulating material installed.

*e.* FULL CLOSING COWL FLAPS. *(See figures 20 and 21.)*—The air exit duct is sealed when the cowl flaps are fully closed, by a felt bumper strip that is attached to the exit duct. This assists engine warm-up and safeguards against overcooling during flight operation by fully controlling the quantity of air flowing through the oil cooler and coolant radiators. No air will pass out the exit duct when the cowl flaps are fully closed.

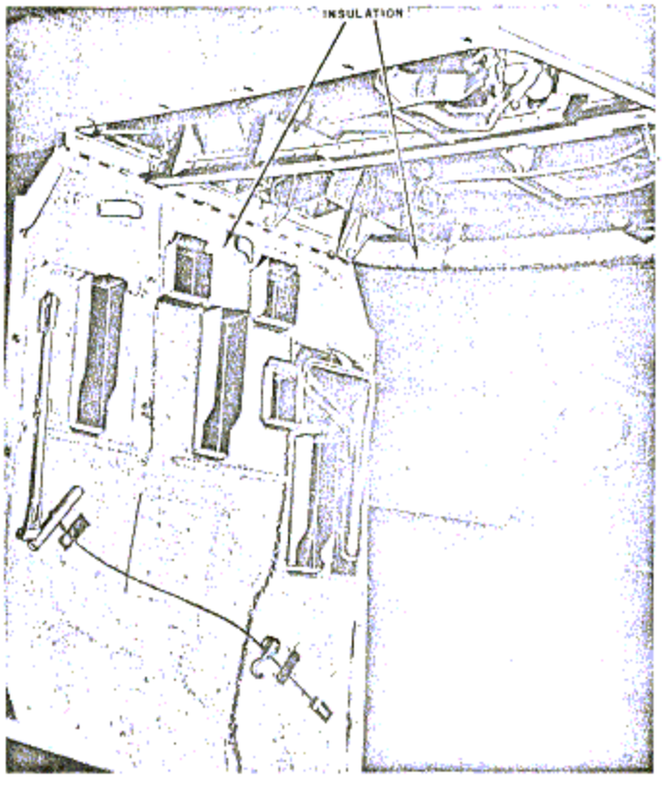



*Figure 19—Gun Compartment Insulation*

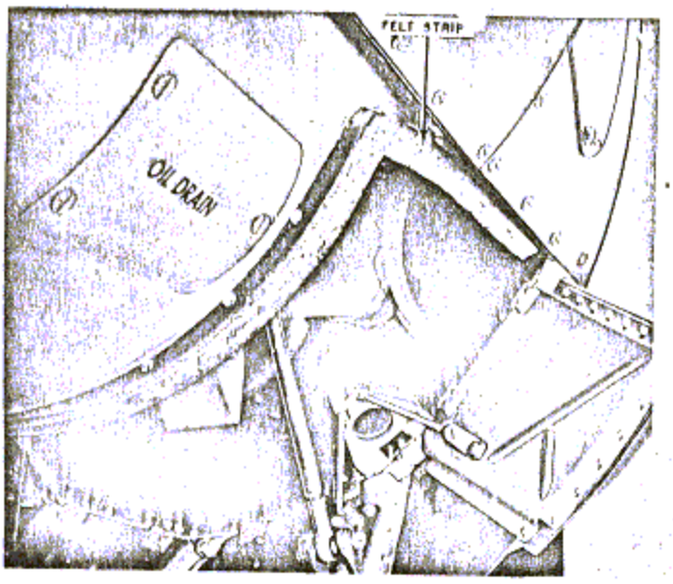



*Figure 20—Full Closing Cowl Flaps—Open*

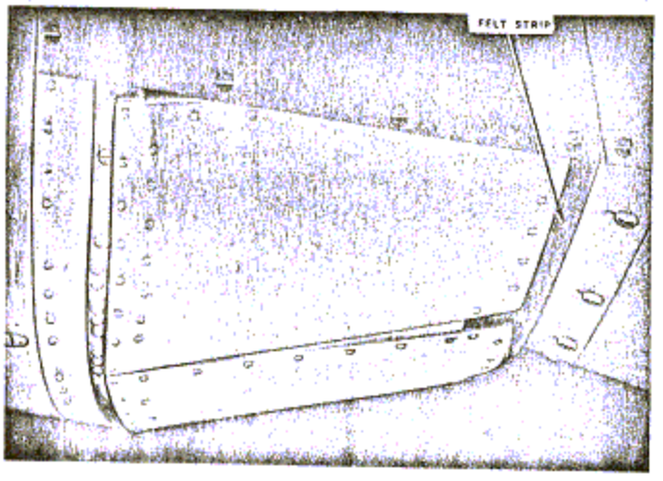



*Figure 21—Full Closing Cowl Flaps—Closed*

## 26. EXTERNAL ELECTRIC POWER CART RECEPTACLE.

For airplanes AF42-105640 through AF42-106028, an electric power cart plug receptacle is installed below the battery junction box opposite the fuselage access door.

For airplanes AF42-106029 and subsequent, the external electric power cart receptacle is installed adjacent to the battery starter junction box on the left side of the engine compartment. The access door is stenciled, "EXTERNAL ELECTRIC POWER CART PLUG—24V." (See figure 22.)

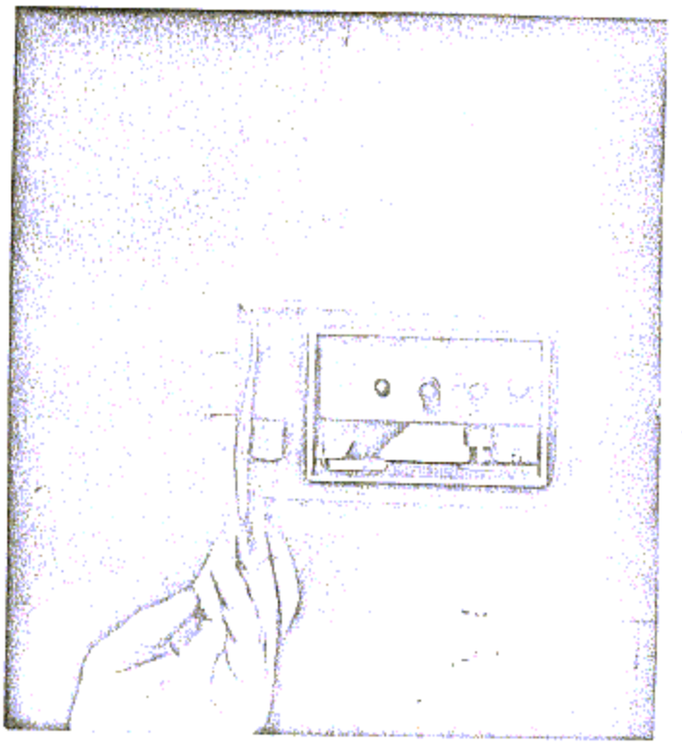


*Figure 22—Electric Power Cart Plug Receptacle*

The receptacle is provided so that power from the battery cart may be plugged into the airplane electrical system for starting the engine and test-operating the electrical equipment. Power from the airplane battery must *not* be consumed for ground operation of the airplane equipment. A British type cart plug adapter, S42B6927, is carried in a clip located on the right side of the fuselage opposite the access door.

## 27. PAMPHLETS ON COLD-WEATHER OPERATION.

*a.* The "Winterization Check List" AAF Form No. 263-B and the "Handbook of Cold-Weather Operations and Maintenance for the P-40N Airplane" Technical Order No. 01-25CN-30 are included in the loose equipment box which is given to the pilot.

*b.* In addition to the "Winterization Check List" and the "Handbook of Cold-Weather Operations and Maintenance for the P-40N Airplane" mentioned above, the "Instructions for Arctic Operation" Technical Order No. 00-60-3, and the "Preflight, Flight, and Post-Flight Instructions" are included in specially allocated airplanes.

# SECTION III

# GROUND MAINTENANCE, PREFLIGHT, FLIGHT, AND POST FLIGHT PROCEDURE

## 1. GROUND MAINTENANCE.

*a.* PARKING.—In parking an airplane on snow or ice in Arctic regions, it is essential to provide a layer of fabric, grass, straw, green boughs, or other insulating material under the wheels to prevent freezing into the surface. Lack of such precautions frequently results in tearing off large chunks of rubber from the tires when the airplane is again moved.

*b.* MOORING.—To provide mooring anchors, a log or heavy branch to which the mooring line is attached should be buried in the ground. Sacks, boxes, or other containers may, under certain conditions, be filled with sand and gravel and used as anchorage points. Frozen ground must be thawed by fire, and after the "DEAD-MAN" is placed in the hole thus formed, snow should be added to the earth or gravel covering. The warmth of the pit will melt the snow and as the pit cools will cause the covering to freeze, thus forming a firm anchorage.

(1) Running water for use in freezing anchors is rarely found in the far North during the winter, and melting snow over a fire is a long and tedious job. Ice, in climates of extremely low temperatures, is so brittle that without special tools, it would be exceedingly difficult to bore or chop the holes necessary for a firm anchorage, but throughout Alaska and Canada, trees or boulders are usually available.

(2) Mooring lines should be tight to prevent the airplane from rocking in the wind, as this may cause the airplane to break loose from its mooring. A slack line is of little value. Mooring lines should not be tight when wet or damp, as they will shrink with consequent stress or strain on fittings.

*c.* FROST PREVENTION FOR WINDOWS.—When the airplane is parked for the night, the cockpit canopy should be left partly open. This is to permit the CIRCULATION OF AIR inside the cockpit enclosure, and prevent the windows from frosting. The windows are certain to frost up in cold weather if no air is permitted to circulate in the cockpit.

*d.* PARKING BRAKES.—Brakes should be "ON" on all parked airplanes to prevent leakage through the brake seals. However, do not set brakes until after the oil dilution has been accomplished, so that the brakes will have had time to cool, and will not freeze ON.

*e.* IMMERSION HEATER.—Normally immersion heaters are never necessary and should not be used unless difficulties are encountered with full dilution as instructed. If used, proceed as follows:

(1) It is not necessary to run the immersion heater continuously. Two-to four-hour periods of operation with similar off periods will be sufficient to maintain fluid oil in the tank. The use of immersion heaters in no way eliminates the necessity for diluting the oil as indicated under paragraph 4. of this section.

(2) The use of immersion heaters will not assist in starting an engine or providing fluid oil in the oil lines to the engine.

*f.* USE OF POWER CART FOR GROUND OPERATION.—No electrical equipment should be operated while the airplane is on the ground except when power is obtained from an external source. The type C-10 (24-volt) engine-driven generator unit is provided at all Army Airfields and should be used when external power is required. Be sure that the generator voltage output does not exceed 28.5 or damage to the electrical equipment may result.

*g.* PROTECTION OF PARKED AIRPLANES.—Cover wings, tail surfaces, windshields, and propellers with available covers and tarpaulins to prevent ice, snow, and frost accumulation. Under some conditions it may be necessary to taxi out to take-off position before removing all the covers, since frost formation is very rapid at certain times. Form-fitting wing covers are available and should be used to prevent formation of frost on wings when this condition exists. Evergreen boughs may be used for brushing off light snow.

*h.* HANDLING OF TOOLS AND METAL WHEN COLD.—Do not grasp tools or other metal articles with the bare hand during sub-zero weather, as the skin will freeze to the article and result in painful tearing of flesh. Care should be exercised when making emergency repairs or in replacing equipment which is very cold not to use too much tension when tightening nuts, bolts, cables, etc. These will expand upon warming-up and may "freeze" or snap. Parts dropped into snow are very hard to find, and unless spares are available extreme caution should be exercised to avoid loss of essential parts in this manner.

*i.* PROLONGED LAY-OVER INSTRUCTION.

(1) When extreme cold is encountered and an airplane lay-over is necessary, the dilution procedure outlined in paragraph 4. of this section may be increased to provide additional fluidity and safety in accordance with the experience of operating personnel. After several days

lay-over, during which time the engine has been started and diluted several times, it is advisable to ground-run the engine for at least ½ hour at normal temperatures prior to take-off. It is also desirable to check the oil level which may have fallen considerably because of evaporation of gasoline. This will tend to eliminate any excess dilution which might otherwise cause oil discharge through the breathers or loss in oil pressure during high power take-off or operation.

(2) When extreme cold is encountered, and adequate heating facilities are not on hand to assure engine starting, and the airplane must be kept on the alert, it may be necessary to run the engines periodically throughout the lay-over period. The coolant temperature should be kept above 0° C (32° F).

(3) For long lay-overs the battery should be removed and stored in a warm place, and the oil and coolant systems may be drained. If, during the lay-over, the temperature rises above 0° C (32° F) drain all fuel system and oil tank drains immediately of condensate, before the temperature drops and the water freezes.

*j.* REMOVAL AND CARE OF BATTERY.—When the ambient temperature is below —18° C (0° F) the battery should be removed from the airplane and stored in a warm place where the temperature is at least above —1° C (30° F). If a portable ground heater is available, it may be used to keep the battery warm without removing the battery from the airplane. DO NOT ATTEMPT TO KEEP THE BATTERY WARM BY CHARGING as continued overcharging is detrimental to its life. When available, always use external power for cranking the engine; save the airplane battery for flying operations.

The specific gravity of a fully charged battery should be 1.275 to 1.300. This is important in cold climates in order to prevent the battery from freezing. There is little danger of the electrolyte freezing in a fully-charged battery, even at extremely low temperatures. The electrolyte in a one-third discharged battery (1.240 specific gravity) will freeze at approxi. ately —47° C (—52° F) and that of a two-thirds discharged battery (1.200 specific gravity) will freeze at approximately —27° C (—16° F). A battery that is one-third discharged (1.240 specific gravity) should be removed from the airplane and replaced with a fully charged battery.

Flight in cold weather should always be started with the specific gravity of the battery 1.250 or over after correcting the reading for temperature, because the battery will not charge as rapidly when it is cold. This is because chemical action takes place much more slowly at low temperatures, and the internal resistance of the battery is higher.

*k.* REMOVAL AND CARE OF OIL AND COOLANT.

(1) OIL.—It should never be necessary to drain oil when the proper dilution procedure has been accomplished, except when it is expected that ground heating facilities will not be available at starting and that temperatures will be below —20° C (—4° F). All AAF airfields in area requiring them, will be equipped with ground heating equipment and auxiliary power supply. With these two facilities and proper dilution, starts have been made down to an outside air temperature of —54° C (—65° F). When it is expected that external heat will not be available for starting, or dilution cannot be accomplished, drain the oil into clean containers and store the oil in a sheltered location where the temperature will not be lower than freezing. Where warm storage is not available, the oil must be heated on a stove or other heat source until free flowing and then poured back into the oil tank immediately before starting the engine. Oil should be heated to 70° or 80° C (158° to 176° F) if possible.

There are three places from which the oil must be drained: the oil cooler, the oil Y-drain, and the tank sump drain. (See figure 3.) The oil cooler drain plug is accessible through the access door marked, "OIL DRAIN - COOLANT DRAIN" on the bottom of the "bathtub" cowl, and the oil Y-drain and the oil tank sump drain are accessible through the two access doors, marked "OIL DRAIN" that are located in the air exit duct just aft of the cowl flaps.

(2) COOLANT. *(See figure 23.)*—If the recommended antifreeze mixture of glycol and water is used, it is not necessary to drain the cooling system. The recommended antifreeze mixture for cold-weather operation consists of 80 percent ethylene glycol, AN Specification No. AN-E-2, and 20 percent water. Warm coolant mixtures may be used to assist in starting a cold engine. If the coolant is drained from the system, care should be exercised to use clean containers and keep them closed while they contain the coolant mixture. The reason for this precaution is that ethylene glycol absorbs moisture from the air, particularly if left exposed in open containers in areas of high humidity, and this increase in water content lowers the boiling point of the antifreeze mixture which may result in overheating and consequent engine damage.

If it is desired to drain the cooling system, there are three places from which the coolant must be drained: the two coolant radiators and the coolant pump drain. The coolant radiator drain plugs are accessible through the two access doors, one marked "COOLANT DRAIN —OIL DRAIN" and the other marked "COOLANT DRAIN," in the bottom of the "bathtub" cowl. The left aft side cowl must be removed to reach the coolant pump drain plug.

*l.* GROUND HEATERS.—The D-1 heater weighs 250 pounds, has a capacity of 80,000 Btu per hour, an 8-hour gasoline supply tank, and is mounted on retractable wheels with auxiliary sled runners.

**CAUTION**

In sub-zero temperatures no attempt should be made to start this heater engine until the engine crankcase and fuel blower have been preheated to insure proper lubrication.

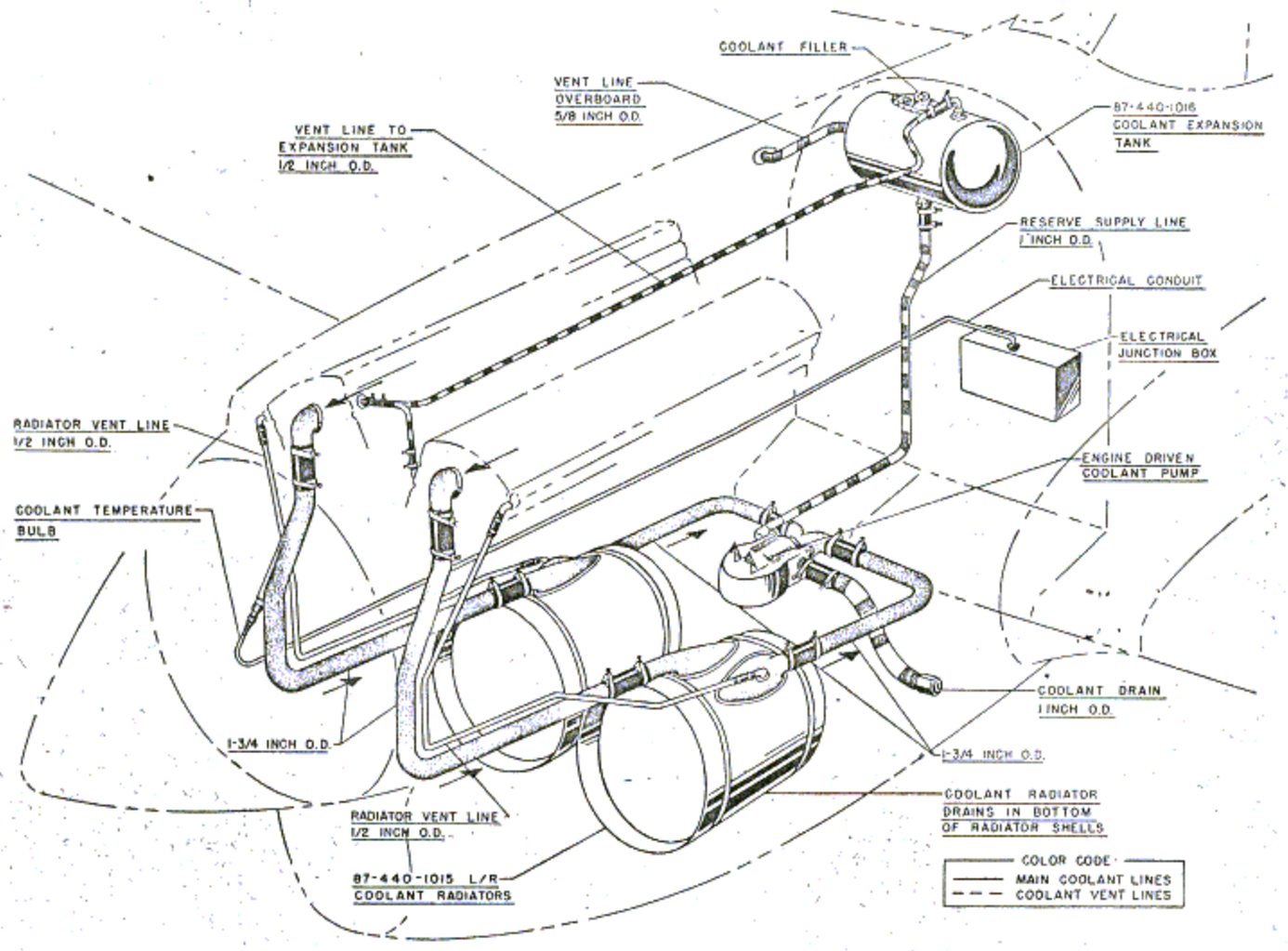



*Figure 23—Cooling System*

Both the type D-1 and the type F-1 portable ground heaters are of major importance in cold-weather operations. Therefore, too much care cannot be taken in careful maintenance of the units and careful following of the operational instructions printed on the heaters themselves. The large type F-1 portable ground heater has a capacity of 250,000 Btu per hour.

**NOTE**

If D-1 or F-1 heaters are not available, such heaters as open flame fire pots, if used with ingenuity and care, are better than nothing.

*m.* HAND-OPERATED HEATER. — The Stewart-Warner hand-operated heater has a 2-hour gasoline supply tank, weighs 10 pounds, is ignited manually, and has an output of 30,000 Btu per hour at 1,200 rpm. It is particularly valuable for quick warming of small mechanisms, instruments, etc. At —29° C (—20° F) or below, this heater will not burn any gasoline other than 100 octane aviation gasoline.

**WARNING**

Under no conditions should this hand-operated heater be used to heat shelters or occupied enclosures as air delivered by this heater is NOT free from carbon monoxide.

*n.* SERVICING THE OIL PRESSURE TRANSMITTER.—Refer to the diagram for servicing the oil pressure transmitter, figure 24.

(1) To fill the transmitter chamber with compass liquid, unscrew the lock nut "A" from the threaded portion of the shaft. Then push the shaft IN to the full limit towards the center of the transmitter assembly. Turn the thumbwheel "B" clockwise until the backing plate at the end of the shaft is set firmly against the diaphragm as shown in the diagram.

(2) To gain access to the bleeder cap "C" of the oil pressure gage line, remove the two retaining screws in the top of the instrument panel and tip the panel assembly aft to obtain sufficient hand space.

(3) Remove the bleeder cap "C" and install a threaded bleeder tube "D" in place of the cap just removed. Allow the other end of the bleeder tube to terminate in a small bleeding liquid receptable "E."

(4) Fill the small hand gun "F" with compass

liquid, Specification No. AN-VV-C-551 and attach at "G" on the transmitter. Slowly operate the hand gun to force the liquid up through the transmitter and the oil pressure gage line and out through the bleeder tube into the receptacle. With the bleeder tube below the surface of the liquid in the receptacle, operate the hand gun until all air is expelled from the line and the compass liquid flows evenly out the bleeder tube. Disconnect the bleeder tube "D" and reinstall the cap "C." Disconnect the hand gun from the filler connection "G" of the transmitter and replace the cap.

(5) Return the diaphragm backing plate to its normal position by turning the thumbwheel "B" counterclockwise until the shaft can be pulled out. Tighten the lock nut "A."

(6) Return the instrument panel to its original position and install the retaining screws.

(7) To fill the transmitter chamber on the opposite side of the diaphragm and the engine oil pressure inlet line with hydraulic fluid proceed as follows:

*(a)* Disconnect the engine oil pressure inlet line "H" at the connection on the engine.

*(b)* Remove the plug "I" at the top of the transmitter front chamber, and using a hand oil squirt can containing hydraulic fluid, Specification No. AN-VV-O-366a (red color), inject the fluid into the transmitter chamber allowing it to flow through the chamber and out the oil pressure line.

*(c)* When the fluid flow is established and clean, reconnect the engine oil pressure line "H," and continue to inject the fluid until the chamber and the line are filled. Replace the plug "I" and safety wire. The transmitter is now ready for operation.

(8) The transmitter must be serviced every 50 hours flying time with a new diaphragm and fluid in both chambers.

**CAUTION**

To prevent possible damage to the diaphragm, the pressure used to inject the compass liquid must not exceed 20 pounds per square inch. The use of compressed air filling tanks is not advised, as air entering the system with the liquid will cause malfunctioning in service.

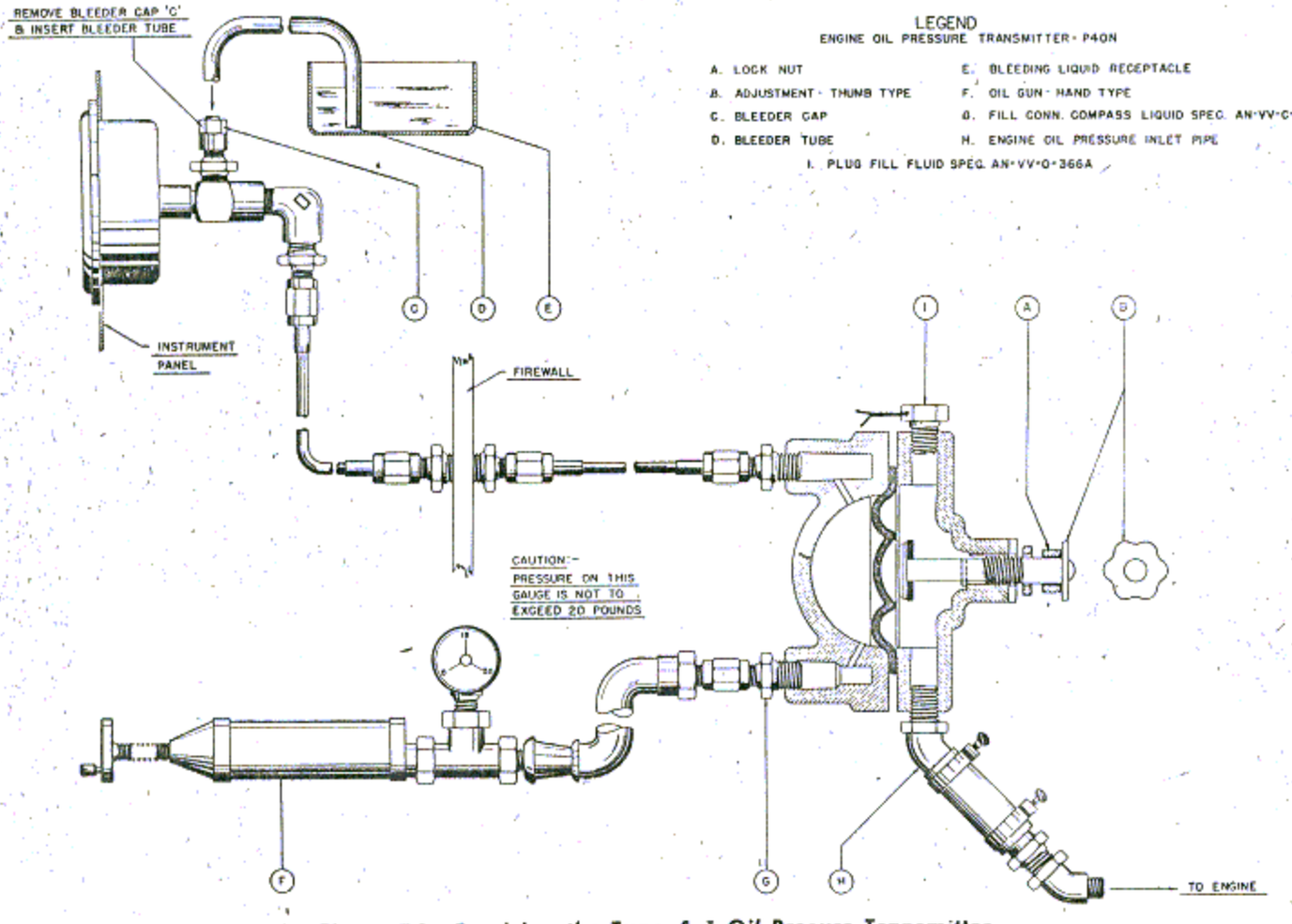



*Figure 24—Servicing the Type A-1 Oil Presure Transmitter*

## 2. PREFLIGHT INSTRUCTIONS AND PROCEDURE.

*a.* USE OF EXTERNAL POWER.—Always use an external power source for starting and for running the engine or operating electrical equipment on the ground. Army airfields are equipped with C-10 generator carts. For starting, the generator should show a charge of from 26 to 28 volts. The chances of starting without an external power source are remote and chances of damaging the battery are excellent.

*b.* USE OF EXTERNAL HEAT.—In cold weather starting external heat should be applied when outside air temperatures are below 0° C (32° F). Apply heat to both the front end of the engine and to the accessory section, until coolant temperatures reach 20° C (70° F). Standard engine covers are provided with sleeves for attachment of heater hoses at the strategic points. If sufficient heat or means are not available for effectively heating the entire engine, concentrate on the rear accessory section with second priority going to the nose gearing and propeller hub. Suitable canvas covers or snug fitting, reasonably airtight tarpaulin makeshifts, are essential to secure satisfactory engine heating.

*c.* CLEANING SHOCK STRUTS.—Before take-off the shock strut piston tubes must be wiped clean of all snow, ice, and dirt, after which the piston should be wiped with a rag soaked in the type hydraulic fluid used in the strut.

*d.* DRAINING Y-DRAIN AND OIL TANK SUMP. Check the Y-drain and oil tank sump drain for fluid oil. If no oil comes out it is an indication that the drains are clogged with ice or congealed oil. Apply heat to thaw the drains. Be sure the oil tank sump drain cock is lockwired and the Y-drain cock is locked by the spring stop after the water is drained and oil flow occurs. Check the oil cooler drain for fluid oil and be sure that the water and ice is removed and the oil flow is established before starting the engine.

*e.* FUEL TANK DRAINS.—During extremely cold-weather, condensation of moisture inside the fuel tanks occurs, and this necessitates frequent draining of the tank sumps. All fuel tanks are equipped with a sump drain which is fitted with a shut-off cock. The belly tanks have two sump drains, one which is used when the airplane is in level flying position and the second which is used when the airplane is in the three-point position. The fuel strainer is also provided with a drain cock and should always be checked for presence of water whenever the fuel tank sumps are checked. Be sure to lockwire the drain cocks after making the checks.

*f.* FUEL TANK VENTS. — Inspection should be made to assure that fuel tank vents are free from ice, since condensation may permit droplets of water to form in the vent line, which upon freezing results in a stoppage, causing collapsing of the tank.

*g.* REMOVAL OF SNOW AND ICE FROM THE AIRPLANE. — When there are sharp changes from moderate to extreme cold, condensation will cause ice to form inside the wings and fuselage as well as outside. Careful inspection must be made to insure freedom of all controls and mechanism. Removal of such ice is difficult and generally can be accomplished only by application of heat, since chipping frequently results in damage to the airplane. For the same reason hot water should never be used for removing ice or frost. Never attempt a take-off with snow, ice, or frost on the wings. Even loose snow cannot be depended upon to blow off and only a thin frost layer is necessary to cause loss of lift and very treacherous stalling characteristics. In some conditions of extreme icing it may be necessary to leave some covers on while taxying to the take-off position. Evergreen boughs or light slats may be used for brushing off snow and frost.

*h.* STARTING THE ENGINE.

(1) During extremely cold weather, if the engine is too stiff to be turned over by hand, it will be necessary to heat the oil and the coolant mixture before attempting a start and to apply local heat to the inertia starter. Heating may be accomplished as shown in figure 25.

(2) After preheating, remove the engine and cockpit and the propeller covers, if installed. Keep the wing and stabilizer covers on until ready for take-off, if rapid frosting conditions prevail.

(3) Connect external 24-volt power supply into the battery cart receptacle.

(4) Carburetor air on "COLD."

(5) Cowl flaps fully "CLOSED."

(6) Fuel selector cock on "FUS."

(7) With the throttle lever approximately ¾-inch advanced from the fully closed position, ignition switch off, and mixture control in "IDLE CUT-OFF," pull the propeller through about eight complete turns.

(8) All circuit breakers "ON."

(9) Propeller selector switch on "AUTO CONSTANT SPEED."

**NOTE**

For airplanes NOT equipped with AUTOMATIC propeller governor control, set the propeller governor control at take-off rpm.

(10) With the mixture control in "IDLE CUT-OFF" operate the electric fuel pump to obtain a fuel pressure of 14 to 16 pounds per square inch and then turn off the pump.

(11) Quickly move the mixture control from "IDLE CUT-OFF" to "FULL RICH" to "IDLE CUT-OFF." This will provide a quantity of atomized fuel in the induction system. It is important that this action be performed quickly and *not* extended over a period of several seconds.

(12) Resume operation of the electric auxiliary fuel pump and pull fuel primer handle full out.

(13) Energize starter at least 15 seconds. It is recommended that the starter be fully energized and running as fast as possible prior to engaging, in order to eliminate as much as possible, the necessity of a re-

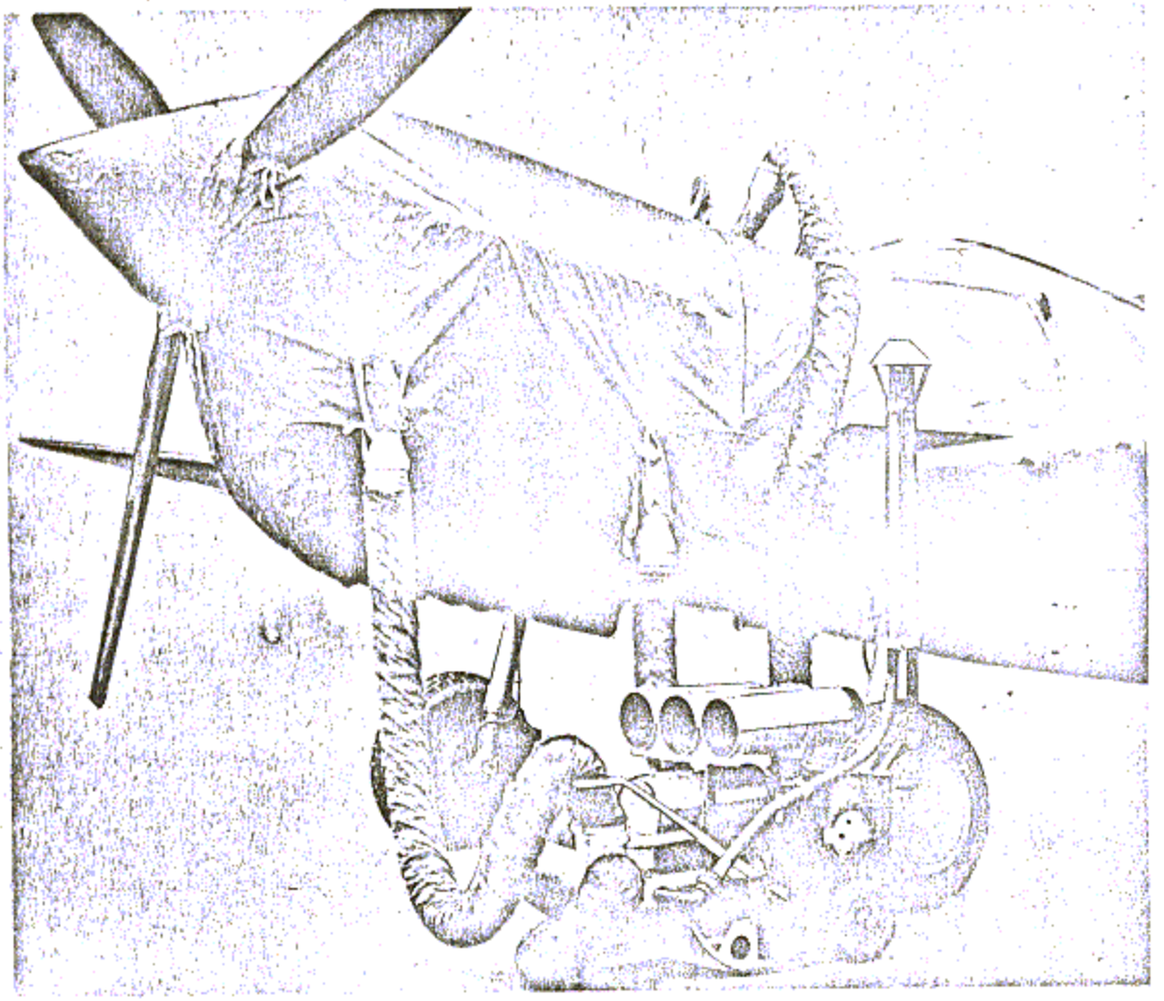


*Figure 25—Ground Heating the Engine*

start resulting from insufficient starter momentum.

(14) With one hand on the primer pump, turn the magneto switch to "BOTH," engage the starter, and operate the hand primer pump slowly as soon as the propeller begins to rotate. The operation of the primer at this stage is more important than the movement of the mixture lever to the "AUTO-RICH" position. With a little experience it will be possible to make the engine start quite readily on the priming charge. The operator must be able to tell whether or not the start is successful before he moves the mixture lever from the "IDLE CUT-OFF" position. Do not use the electric auxiliary fuel pump with the mixture control out of "IDLE CUT-OFF" position when the engine is not firing. If the mixture lever is moved before the engine fires fairly evenly on the priming charge, the operator is liable to temporarily "drown" the engine.

**NOTE**

The more experienced operator will find it very helpful to permit the engine to commence rotation before turning the magneto switch to "BOTH." This will lessen the possibility of "kick-backs."

**CAUTION**

If the engine does not fire, return the mixture control to "IDLE CUT-OFF" immediately.

(15) If the engine does not start readily in sub-zero temperature, inspect for frosted spark plugs.

(16) Hand starting of the engines is accomplished in a similar manner to electric starting as outlined above, except that the starter is hand cranked instead of being electrically energized before engaging. A knob is provided on the end of the starter motor for lifting the brushes. Be sure to lift the starter brushes before hand cranking.

**CAUTION**

Personnel should *not* manually crank the starter during extremely cold weather because this type of exertion is injurious to health. Exertion of this kind at temperatures below −34° C (−30° F) may cause frosting of the lungs.

(17) In starting the engine, a normal start should be made without regard to the oil dilution system. After

starting the engine, if a heavy viscous oil is indicated by oil pressure that is too high, or by oil pressure that fluctuates or falls back when the engine rpm is increased, the dilution control may be pushed momentarily several times to decrease the viscosity of the oil as a means of correcting this condition. This procedure must be used with caution as it is possible to cause an engine failure by supplying the engine pump with pure gasoline in case the oil is sufficiently viscous or stopped by ice so as not to permit flow; the oil pressure gage may indicate sufficient pressure due to the gasoline to cause operating personnel to believe oil is flowing, which may not be the case. This method is suggested only if time and extreme temperature conditions do not permit engine warm-up in the normal manner.

(18) If there is no oil pressure after 30 seconds, or oil pressure drops after a few minutes ground operation, check:

*(a)* For blown lines or oil cooler.

*(b)* Y-drain for congealed oil or ice.

*(c)* Oil tank sump drain. If no oil flows, heat must be applied and water drained when heat has thawed the ice.

*(d)* Oil strainer for foreign material which might indicate that engine failure is cause of low pressure. If the oil tank sump or Y-drain is frozen or oil lines or coolers are blown, the pilot did not properly follow shut-down instructions.

*i.* USE OF COWL FLAPS AND CARBURETOR HEAT.

(1) The cowl flaps should be closed for starting in cold weather and not opened until rise in the coolant and oil temperature occurs. The cowl flaps should then be set to maintain normal operating oil and coolant temperatures.

(2) Warm-up is somewhat facilitated if carburetor air is put on "HOT" as soon as the engine is firing regularly. If icing conditions prevail, carburetor air should be on "HOT" during the warm-up period prior to take-off to insure that the carburetor is free from ice. DO NOT take off with the carburetor air on "HOT."

## 3. FLIGHT INSTRUCTIONS AND PROCEDURE.

*a.* TAKE-OFF.

(1) OIL DILUTION.—If oil dilution was used on previous shut-down, take-off can be made as soon as oil is normal and oil temperature shows a slight rise.

(2) COWL FLAPS.—Keep cowl flaps open on take-off and closed in flight as temperature control may require.

(3) CARBURETOR HEAT.—DO NOT USE CARBURETOR HEAT DURING TAKE-OFF. Use of carburetor heat during take-off may cause detonation and loss of carburetor air ram which will result in loss of take-off power. If icing conditions prevail, place the carburetor air control on "HOT" during the warm-up period just prior to take-off. This will prevent any ice from forming in the carburetor. Place the carburetor air control on "COLD" for take-off and when a safe altitude is attained use carburetor heat if it is necessary. If there is any doubt as to whether or not icing conditions exist during flight, use carburetor heat.

(4) USE OF BATTERY.—Never turn on any electrical equipment not absolutely needed, until the generators are operating. Storage batteries are of little or no value at sub-zero temperatures and attempted use may ruin the battery or electrical system. It is advised that no electrical equipment, even radio, be used until the airplane is in the air, unless an auxiliary power source is in operation.

(5) TAKING-OFF.—If deep, heavy snow interferes with the take-off, but permits the airplane to taxi, move slowly up and down the take-off course several times to pack down a runway before attempting the actual take-off. The depth and hardness of the snow together with the airplane wheel size, will determine whether take-off or landing is practicable. When taking off on a narrow strip of clear ice, cross winds are particularly dangerous, owing to the loss of maneuverability caused by lack of traction.

(6) GENERAL.—Following take-off from a snow or slushcovered field, operate the landing gear and flaps, through a complete cycle two or three times to preclude freezing in the "UP" position.

*b.* FLIGHT.

(1) CARBURETOR HEAT.—After take-off carburetor heat may or may not be employed, depending upon icing conditions and the procedure the pilot would normally use. Carburetor icing is apt to occur in an atmosphere of high humidity or free moisture and when the carburetor air temperature is between −5° to +15° C (23° to 60° F). A safe rule is to keep the carburetor air temperature between 15° and 40° C (60° and 104° F). Under extreme conditions of cold, carburetor icing is less likely to occur than when free air temperature is between −7° and +16° C (19° and 61° F). It is, however, good practice to apply carburetor heat for 1 to 2 minutes every ½ hour during flight to preclude the possibility of carburetor icing. Likewise, constantly check to make sure carburetor air temperature is either above or below the icing range. Because of the automatic boost control on these airplanes there will be no drop in the manifold pressure which would warn the pilot of carburetor icing conditions until the condition has become serious. It is good practice to increase propeller speed by about 200 rpm every ½ hour to assure continued governing at extremely low temperatures. Return to the desired cruising rpm as soon as the tachometer shows that the cycle is completed.

(2) CRUISING LEAN.—When flying with mixture control in "CRUISING LEAN," sufficient carburetor heat should be applied to maintain carburetor air temperature just below −5° C (23° F) or above 15° C (59° F). Application of carburetor heat should be made in order to effect full vaporization. Exceeding

40°C (104°F) carburetor air temperature may cause the engine to detonate, and, therefore it is recommended that carburetor heat be applied only until the engine operates smoothly.

(3) THROTTLE.—It is good practice to operate the throttle frequently during flight to insure that the linkage will not be iced over and make it impossible to operate.

(4) OIL PRESSURE.—An engine equipped with oil dilution which suddenly shows a loss in oil pressure or throws oil out of the breather during flight will be checked upon landing to insure that the oil dilution valve is in the "CLOSED" position and fully seated. If equipped with an electrically operated valve it may be momentarily turned "ON" and "OFF" in an attempt to complete the seating of the valve. If dilution is the cause of the trouble, satisfactory operation will be resumed when the viscosity of the oil is restored by running the engine and evaporating the gasoline in the oil.

(5) CARE OF EQUIPMENT.—No special instructions are necessary for the operation of the equipment and the instruments installed in the airplane.

*c.* LANDING.

(1) CARBURETOR HEAT AND COWL FLAPS.—Always make the landing approach and landing with the cowl flaps closed. When icing conditions prevail, use carburetor heat during the landing approach, but BEFORE making the final glide, place the carburetor air control on "COLD." This practice will make it possible to apply engine power without danger of detonation in case of a mislanding. Keep the carburetor air temperature below 40°C (104°F) to avoid loss of power resulting from excessive heat. Open the cowl flaps as required to maintain normal operating oil and coolant temperatures. The ship should be taxied to the line with the carburetor heat on. Temperature inversions are common in winter in Arctic regions, and the ground air may be 15° to 30°C (27° to 54°F) colder than at altitude. Therefore, care must be taken to avoid rapid cooling when letting down. Lower the landing gear and use partial flaps to reduce the air speed while descending. Maintain considerable power and regulate the cowl flaps as required to avoid cooling the engine excessively. If possible maintain the coolant temperature above 85°C (185°F) and the oil temperature above 35°C (95°F) during all let downs.

(2) ELECTRICAL EQUIPMENT.— Every effort should be made to reduce the use of electrical equipment in order to save the battery when the rpm is reduced and the generator cuts out.

(3) LANDING AND BRAKES.—While on the down-wind leg the pilot should lower the landing gear, and at the same time pump the brake pedals several times to insure circulation of the sluggish hydraulic fluid in the brake system. When landing or taking off on a narrow strip of clear ice, cross winds are particularly dangerous, owing to the loss of maneuverability caused by the lack of traction. The airplane may, if the wind is gusty, be blown completely off the ice before control can be regained. Brakes should be used sparingly and not until absolutely necessary after setting the airplane down. Wheels should not be locked, especially on icy runways.

## 4. POST FLIGHT INSTRUCTIONS AND PROCEDURES.

*a.* PARKING, MOORING, AND USE OF PARKING BRAKES.—Instructions for parking and mooring the airplane and for use of the parking brakes are given in paragraph 1., Ground Maintenance, in this section.

*b.* OIL DILUTION PROCEDURE.

(1) GENERAL.—Before stopping the engine when a cold-weather start is anticipated, set the throttle to between 800 to 1200 rpm and hold the oil dilution control in the "ON" position for a period of time, as follows:

| Dilution Time in Minutes | | |
|---|---|---|
| 4.0° to —12°C | —12° to —29°C | —29° to —46°F |
| (40° to 10°F) | (10° to —20°F) | (—20° to —50°F) |
| 4 min | 8 min | (See Note) |

**NOTE**

A dilution period beyond 8 minutes, to provide the required dilution for extreme low temperatures, is excessive for this airplane. External heat is required in addition to the maximum permissible dilution. More dilution can be obtained by increasing the time period, but by doing so, excessive amounts of gasoline are added to the oil system which raises the oil temperature above 50°C (122°F), and also reduces the oil capacity.

*(a)* The dilution of the engine while the oil temperatures are above 50°C (122°F) is not particularly effective. If oil dilution is to be accomplished and engine oil temperatures are too high, stop the engine and after the oil has cooled to below 40°C (104°F), restart the engine and proceed with oil dilution. In some instances, particularly during sub-zero temperature where a long dilution period is required, the engine oil temperature may rise above the maximum desired values for oil dilution, 50°C (122°F). If this occurs, it may be necessary to dilute the oil in two or more short periods. Breaking up the oil dilution period into several short periods is neither detrimental nor beneficial to the general dilution procedure. If it is necessary to service the oil tank, the dilution procedure must be divided so that some dilution is accomplished before servicing the oil tank, and the remainder is accomplished after the oil tank is serviced. After dilution has been accomplished, shut off the engine in normal manner, continuing to hold dilution valve on until the engine stops.

(2) In starting the engine, a normal start should be made without regard to the oil dilution system. After starting the engine, if a heavy viscous oil is indicated by oil pressure that is too high, or by oil pressure that fluctuates or falls back when the engine rpm is increased, the dilution control may be pushed momentarily several times to decrease the viscosity of the oil as a means of

correcting this condition. This procedure must be used with caution as it is possible to cause an engine failure by supplying the engine pump with pure gasoline in case the oil is sufficiently viscous or stopped by ice so as not to permit flow; the oil pressure gage may indicate sufficient pressure, due to the gasoline, to cause operating personnel to believe oil is flowing, which may not be the case. This method is suggested only if time and extreme temperature conditions do not permit engine warm-up in the normal manner.

(3) If desired, it is safe to make immediate take-offs, after oil dilution has been used, without the normal warm-up, provided there has been a rise in oil temperature, oil pressure is steady, and the engine is running smoothly. Cold oil properly diluted has the same viscosity as hot undiluted oil and, therefore, the same ability to circulate and properly lubricate the engine.

(4) When an engine oil scavenging arrangement is inadequate or critical, oil dilution may have an adverse effect. The term "overdilution" has been used to indicate any amount of dilution which causes the engine scavenging system to break down and discharge oil through the engine breathers. This condition is serious, as it may be possible to completely lose all engine oil in a short period of time due to the breakdown in the scavenging system. These difficulties will not normally occur if the outlined procedure, care, and judgment are exercised by the operating personnel. High percentages of dilution have no serious effect on engine bearings if the oil pressures remain normal. If oil discharge occurs under cold conditions, it may best be stopped by reducing power and rpm immediately. Consideration should be given to what has been found satisfactory dilution in the past by the operating personnel under similar conditions of engine and anticipated weather temperatures. Whenever engines have been previously diluted and have not been flown, the engines should not be given a full dilution until 30 minutes operating time with oil temperatures above 50°C (122°F) have been obtained.

**NOTE**

It is necessary to operate an aircraft engine at normal operating temperatures for approximately ½ hour to permit the fuel in the oil supply to evaporate and cause the oil to resume its normal viscosity. High temperatures will shorten this time period slightly.

(5) Engines which suddenly show a loss in oil pressure or throw oil out of the breathers during flight, will be checked upon landing to insure that the oil dilution valve is in the "CLOSED" position and fully seated. If equipped with an electrically operated valve, it may be momentarily turned "ON" and "OFF" in an attempt to complete the seating of the valve. The fuel pressure gage should drop when the switch is on. If dilution causes the loss of oil pressure, satisfactory operation will be resumed when the viscosity of the oil is restored by running the engine and evaporating the gasoline in the oil.

(6) When extreme cold is encountered and an airplane lay-over is necessary, the dilution procedure outlined above may be increased to provide reduced viscosity and safety in accordance with the experience of operating personnel. After several days lay-over, during which time the engine has been started and diluted several times, it is advisable to ground-run the engine for at least ½ hour at normal take-off to check the oil level which may have fallen considerably due to evaporation of gasoline. This will tend to eliminate any excess dilution which might otherwise cause oil discharge through the breathers or loss in oil pressure during high power take-off or operation.

*c.* OIL SCAVENGING SYSTEM.—The term overdilution has been used to indicate any amount of dilution which causes the engine scavenging system to break down and discharge oil through the engine breathers. This condition is serious as it may be possible to completely lose all engine oil in a short period of time because of the breakdown in the scavenging system. Overdilution will not normally occur if the diluting operation is done immediately after flight, while the engine oil is warm. Overdilution may cause combustible fumes to flow from the breather, which constitutes a fire hazard under certain unusual conditions. To prevent overdilution, operating personnel must exercise care and judgment. Consideration should be given to that which has been found to be satisfactory dilution in the past under similar conditions of engine and anticipated weather temperatures. Whenever the engine has been previously diluted and has not been flown, the engine will not be rediluted until either the operating time since the last dilution period totals 20 minutes or an oil temperature of 70°C (158°F) or more has been indicated for 5 minutes.

**NOTE**

Observing this precaution will permit fuel in the oil supply to evaporate and cause the oil to resume its normal viscosity.

Dilution of the oil may be accomplished during the cooling period of the engine provided the oil temperature is 50°C (122°F) or less.

*d.* CLEANING SHOCK STRUTS.—The following instructions for cleaning the shock struts are given in case the shock strut boots become damaged: Immediately after dilution the shock strut piston tubes must be wiped clean of all snow, ice, or dirt, using a rag soaked in the same type of hydraulic fluid used in the strut. If hard dirt or grit is encountered and difficulty is experienced in cleaning, kerosene shall be used as a solvent to remove the grit, and the piston again lubricated as above. This procedure should be repeated before take-off. Shock absorber packings are quickly cut and spoiled by ice and grit, especially at extremely low temperatures when much of their resilience has been lost. Even if the shock strut boots are in excellent condition, the shock strut piston tubes should be inspected frequently to insure that no frost or ice has formed inside the boot.

*e.* DRAINING Y-DRAIN AND OIL SUMP.—The oil tank sump and the Y-drain must be drained before moisture in it freezes.

# SECTION IV
# PERSONNEL CONSIDERATIONS

## 1. CLOTHING.

The clothing supplied to the personnel of the Army Air Forces is the product of 100 years of experimentation by the men, both white and brown, who have lived in the "Far North," plus the discoveries of modern science. The problem of supplying body protection to armed FORCES is, however, a far greater one than mere ground protection. MECHANIZATION HAS THROWN A MONKEY WRENCH into the temperature chart. The pilot in his reach for the stratosphere and the mechanic steering his steel monster across the Arctic tundra are facing a temperature range on the cold side of from —17° to —58°C (—0° to —72°F). No clothing devised can cope with such a condition when sedentary occupations are combined with long periods of cold, unless the wearer keeps his clothing in the best condition possible and manipulates it to suit his physical condition at the moment, as well as the surrounding temperatures. Suitable and adequate clothing should be worn at ALL times. The greatest danger from freezing is in the spring when the sun shines brightly, and the temperature rises to —10° or —4°C (15° or 25°F) during the day. During this kind of weather a person is tempted to go out wearing less clothes than usual. At sundown the temperature will drop rapidly, although many hours of daylight may be left. During the night the temperature may drop as low as —46°C (—50°F).

## 2. EMERGENCY KITS.

Emergency kits developed for pilots, crew members, and ground forces of the Army Air Forces fall into three basic groups, mainly: the personal kits which are attachable to the pilots and crew members of an airplane, the airplane kits which are carried in the airplane, and the dropping kits which are transported by an airplane to the scene of disaster. Weight and space requirements limit the components of emergency kits to the essential items required for subsistence. To prevent duplication of items as much as possible, the development of emergency kits has been based on the assumption that all flying personnel have the basic parachute back or seat pad emergency kit. Starting with this basic parachute kit small "Snap On," supplemental ration or water kits and a pocket size "Escape Kit" were developed. For large airplanes, in addition to the "Personal Kits," the "Airplane Kits" were developed. These kits contain implements and rations to sustain life for extended periods when such aircraft are forced down in isolated territory. Since theaters of operation of the Army Air Forces are located in all parts of the world, several types of kits have been developed. Each type has been developed for use in a particular climate. Airplanes operating mainly over Alaska and Greenland should carry "Arctic-Type Kits." A group of kits has been developed for the purpose of dropping to stranded personnel from a searching airplane. These kits come under the heading "Aerial Delivery Kits." They come in the form of a free falling container or as a parachute-type container.

## 3. FORCED LANDINGS.

Stay on prearranged flight course at all times, so searchers will be able to find you if you are forced down. Except in case of extreme emergency, land or crash-land the airplane rather than bail out. Frozen lakes afford the most suitable landing places, although many valleys, slopes, and ice floes may be suitable for crash landings. After taking all necessary precautions to assure easiest possible starting of engines, if airplane is still flyable after being forced down in a remote section, look at once to your protection. Personnel are directed to REMAIN IN THE VICINITY OF THE AIRCRAFT to conserve energy, to avoid exertion, and to simplify rescue, as it is impossible to traverse normal Arctic terrain except under the most favorable circumstances. Do not attempt to travel unless you have adequate equipment and have had previous Arctic experience. The only exceptions are:

*a.* When you are positive of your position and know that shelter or assistance is within easy reach.

*b.* You know that searchers are not likely to reach you.

## 4. OVEREXERTION AND SWEATING.

*a.* OVEREXERTION.—The secret of safety is dryness, and above all, watchfulness. Body excretions added to perspiration destroy the insulating properties of woolens, but overexertion is equally dangerous unless sufficient clothing is removed to keep down perspiration. "Watch your step" is a good Arctic slogan, for a constant watch should be kept on one's physical activity. Unless a heavy wind is encountered during a period of extreme cold, the Air Force clothing will furnish ample heat and its interchangeable layers will provide the variations of protection needed for all contingencies. When the temperature is —32°C (—25°F) or below, there is danger of freezing the lungs through overexertion followed by deep breathing. If you unknowingly overexert and start gasping large breaths of air, PUT YOUR HEAD DOWN AND BREATHE FROM INSIDE YOUR CLOTHING UNTIL THE HEAVY BREATHING STOPS.

*b.* SWEATING.—Sweating is always dangerous in sub-zero temperatures. If your feet or other parts of your body perspire, make sure that your clothing and body are absolutely dry before you go outside in severe weather conditions. Ice will form in the clothing and damp portions of the body will freeze almost immediately.

## 5. SHELTER.

Light tent shelters or heated nose hangars must be

provided to enable maintenance crews to work efficiently with tools and equipment. Shelter may be provided in various ways. Hardpacked snow drifts may be hollowed out to accommodate one or two men. Tents are valuable, but must not be pitched in locations where they will be covered by drifting snow. A windbreak of snow blocks or timber should be constructed on the windward side and immediately adjacent to a tent. Windbreaks and tents may be formed from tarpaulin, engine covers, or other fabric. A leanto can be constructed from a framework or poles covered thickly on three sides with evergreen boughs, twigs pointing downward. Any type of heater, whether it burns wood, gasoline, or oil, can produce dangerous monoxide fumes if burned in an unventilated shelter. *Carbon monoxide gas is odorless* and monoxide poisoning is frequently fatal. *Provide ventilation.*

## 6. FOOD.

In Arctic regions food supplies consist largely of meat of seals, caribou, and fish. Fresh meat alone if it contains considerable fat will provide adequate nourishment for an indefinite period. When prepared for eating, meat should be cooked rare and fat should not be removed. Excess animal fat should be used for lamps and heaters. Eat meat rare whether you like it or not. Excessive cooking is to be avoided since scurvey results from the destruction of vitamins during long exposure of the food to heat. Rabbits provide a welcome addition to the diet, but because of the lack of fat a man will become extremely weakened if forced to subsist on a diet of rabbit alone for over a week. A considerable amount of sugar and animal fat is required for maintaining proper health over a long period in a cold climate. You can survive many days without food if you relax and get plenty of sleep to prevent exhaustion. Panic *must* be avoided. Conserve your energy. Be prepared to fire your signal pistol or set up a smoke smudge, if an airplane passes overhead.

## 7. CAMP SITES.

Establish the best possible camp that the locality offers, with the following advantages in mind:

*a.* Closeness to airplane.
*b.* Conspicuousness and signalling advantages.
*c.* Natural shelter, wood, and water.

## 8. SIGNALS.

*a.* Tramp distress signals in snow if not too deep. Make letters at least 200 feet high and outline with evergreen boughs if available.

*b.* Signal with colored parachute flares when aircraft is heard at night.

*c.* Flame and black smoke can readily be produced by throwing chunks of congealed oil or animal fat, inner tube, rubber hose, or floor mats. Always keep a fire going and have a large supply of wood on hand.

## 9. FROSTBITE.

Frostbite must be avoided. The hands, feet, nose, cheeks, chin, and forehead are most frequently affected. Frostbite is evidenced by a grayish or whitish appearance of the skin. The face may be thawed by placing a hand over the frozen area until circulation is restored. *Do Not Rub.* The rubbing of frostbitten parts with snow is destructive. Use of hot water or intense heat should be avoided.

## 10. HANDLING METAL AND GASOLINE.

Gasoline spilled on the hands or clothing in sub-zero temperatures has an effect similar to that of liquid air; it will freeze flesh in a few seconds after contact.

DO NOT TOUCH ANY METAL PARTS OF THE AIRPLANE WITHOUT GLOVES. The moisture on your hands will freeze to the metal surface, or the cold metal may freeze the part of the hand in contact with it.

## 11. EXPOSURE.

The hazards of injury by exposure are increased by:

*a.* Inadequate or tight clothing.
*b.* Moisture on skin, clothing, or in air.
*c.* Wind.
*d.* Impaired circulation.
*e.* Stupor prior to freezing, such as becoming sleepy.
*f.* Poor nutrition.
*g.* Previous injury by cold.
*h.* Lack of sun glasses.

Freezing to death results only after prolonged exposure, coupled with lack of food, and exhaustion. Exhaustion is frequently caused by forcing oneself to keep awake or keep moving when a rest should be taken. Persons experienced in Arctic travel insist that sleep and rest are absolutely essential. The sleeper will, unless exhausted, awaken before he freezes and may reestablish circulation by light exercise. In temperatures below —30°F, avoid extreme exercise, as deep breathing sometimes causes frosting of the lungs. When the temperature is —30°F or below, there is danger of freezing the lungs through overexertion followed by deep breathing. If you unknowingly overexert and start gasping large breaths of air, PUT YOUR HEAD DOWN AND BREATHE FROM INSIDE YOUR CLOTHING UNTIL THE HEAVY BREATHING STOPS. This is not fatal but will incapacitate an individual for several days during which time he must rest quietly and remain warm.

## 12. KEEPING DRY.

The importance of prevention of wetting of the extremities and immediate corrective measures should this occur, cannot be over emphasized. A wet foot may freeze, producing irreparable damage, in 30 minutes, whereas a dry foot under the same conditions would endure for many hours.

## 13. FACE PROTECTION.

Face protection is of great importance, particularly when the snow clouds are flying before a strong wind. Men should not wear beards. Frost from the breath accumulates on beards and freezes the skin. Men should shave frequently or else keep the beard closely trimmed with clippers. After shaving, it is good practice to use a preparation of oil or grease, to supplement the normal skin oil in protecting the skin against the weather.

WAR DEPARTMENT
HEADQUARTERS OF THE ARMY AIR FORCES
WASHINGTON

TECHNICAL ORDER
No. 01-25CF-42

September 7, 1942

AIRPLANES AND MAINTENANCE PARTS

CURTISS - INSTALLATION OF WINTERIZATION EQUIPMENT - P-40E

NOTE: The provisions of AC Circular 15-60 will be complied with in this case, these instructions being entered on AAF Forms 60-A for the airplanes affected. The work directed herein will be accomplished when necessary by service activities with the aid of sub-depots or at depots as arranged with the control depot. This Technical Order contains specific instructions for pilots and should be available for transition flying training as contemplated in AC Circular 50-4.

1. Airplanes operating in the Arctic regions require certain modifications which are necessary in order that airplanes may overcome icing conditions as well as other effects to extreme cold weather. This is also true of the special ground equipment, such as heaters, starters, wing covers, and shelters. Certain winterization features will be incorporated in the manufacture of aircraft, thus eliminating the necessity of major overhauling when the modifications are made. The work directed in paragraph 2. will be accomplished on P-40E airplanes transferred to extremely cold climates.

2. The instructions for accomplishing this work are as follows:

a. The oil installation system will be modified as shown on AF Drawing No. 42H5374 and drawing No. SAAD42G847. These drawings show the installation of U.A.P. oil coolers, part No. U-6511D8, which are the diffusion type and are equipped with type D-8 valves. The shutters, U.A.P., part No. U-3560-11, and U.A.P., part No. U-3560-13, for the oil cooler and prestone cooler will be installed in the rear of the coolers. The shutter control is mounted on the right side of the cockpit at station 3. Control, part No. AN4010, will be reworked as shown on AF Drawing No. 42B5383. For ground, take-off, and climbing conditions, the oil cooler and radiator shutter may be left in the full open position and the cowl flaps operated in accordance with the existing instructions. In flight, the cowl flaps should be closed as far as possible, (that is, in the streamlined position as a stop is installed on the control lever at that point, and the desired control of the prestone and oil temperature is obtained by the use of the shutters which are operated by control units located on the right side of the cockpit).

b. The cowl flaps will be altered to prevent 100 percent closure in which case the control lever stop will have to be changed as shown on AF Drawing No. 42D5380.

c. Due to the condensation of the moisture collecting in the oil tank sump, a drain valve plug, part No. 42A4846, will be installed in the lowest part of the oil tank sump as shown on AF Drawing No. 42B4844.

d. Oil dilution, as referred to in T. O. No. 02-1-29, is not sufficient when operating under severe low temperatures, since the diluted oil is rapidly used up while bulk of oil in tank remains solid. To overcome this condition, the oil tank will be equipped with a 750 watt, 110 volt, immersion heater, located as near to sump outlet as possible in accordance with drawing No. SAAD42-608. It may be necessary to energize the heaters from three to five hours before the oil will have reached a fluid condition depending upon whether the temperature of the oil is 0 degrees F or -40 degrees F or the heater may be left energized while the airplane is parked. It is very important that there is sufficient oil in the tank to completely submerge the heating element of the heater.

e. In order that all movable surfaces, controls, and items of equipment will operate at a temperature of -60 degrees F the following group of moving bearings will be lubricated with either Beacon M-285, or grease meeting AF Specification No. AN-G-3.

(1) Bearing, antifriction hinges, rods, bell cranks, or pulleys.

(2) Bushings, hinges.

(3) Actuating or adjusting screws.

(4) Gear boxes or housings.

(5) Universal joints.

(6) Slip or sliding joints.

(7) Continuous hinges.

f. Reference is made to T. O. No. 29-1-3 for the cleaning, inspecting, and replacement of lubricant. Bearings will be lubricated using tool, part No. 37B-5054, or similar purpose tools.

g. Priming system will be modified in accordance with AF Drawing No. 41D2549, and drawing Nos. SAAD42B818 and SAAD42B659, in order that special priming fluids can be used.

h. Additional heat will be provided to the carburetor and guns as shown on AF Drawing No. 42K6849. A resistance bulb (figure 2, on Specification 94-27321) will be installed in the carburetor air intake stack and connected up with the type F-9 indicator located in pilot's cockpit. The carburetor heat may be controlled throughout the range from full cold to full hot. A slight drop in manifold pressure will be apparent at any fixed throttle position if







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the control is moved from full cold position. The carburetor air inlet temperature should be maintained between +15 degrees C and +25 degrees C, and the engine operated at not less than 75 percent power, if there is any indication or possibility that carburetor ice may be encountered. If it is impossible to maintain +15 degrees C carburetor air inlet temperature with the control set full hot, the control should be moved to the full cold position. This should not occur in atmospheric conditions in which ice is at all probable as the use of air inlet temperatures between -18 degrees C and +15 degrees C may produce an icing condition in the induction system. Therefore, if operating in any kind of precipitation or clouds, carburetor air inlet temperatures should be maintained at +15 degrees C to +30 degrees C or below -18 degrees C. Full carburetor heat may be applied to remove ice if formed, but the temperature should be reduced to the +15 degrees C to +30 degrees C range as soon as possible.

i. See T. O. No. 03-5E-4 for installation of either type LS-85 or C34S ceramic spark plugs in Allison engines installed on P-40E airplanes.

j. Engine oil will be changed to comply with T. O. No. 06-10-1.

k. The oil pressure gage lines will be filled with light oil in accordance with T. O. No. 05-40-10.

l. When encountering temperatures as low as 35 degrees F, it may be necessary to preheat the engine using engine heater and canvas hood, part No. 40k6385. A suitable heater to use is the Stewart-Warner model 782Z. In this operation, great care will be exercised to prevent accidental ignition of the gas fumes eminating from the engine breathers due to vaporization of the gasoline in the oil.

m. To prevent oil from congealing in the oil lines, the inlet and return oil lines will be lagged with 1/16 x 1 inch asbestos tape, and then covered with cotton tape, 1 inch wide, Specification AN-BB-T-91. After wrapping, one coat of water glass is applied over all.

n. To enable engine starters to develop the maximum speed at subzero temperatures, the starter will be disassembled and thoroughly flushed and relubricated as follows:

(1) Starter lubricant will consist of a mixture by volume of one part Acheson No. 38 Graphite with one part Uniflow oil, S.A.E., No. 10, for clutch, a small amount of Gredag No. 32, (AF Specification 3592), grease brushed on the gears and a thin coat of grease 375, Specification 3650B grease on the ball bearings.

(2) In lubricating starters for cold weather operation, the grease must be used sparingly; a thin coating over the gears is sufficient. Do not fill the gear teeth. Excessive grease in the starter retards free running of the parts and reduces the efficiency considerably.

o. The cockpit heating system will be modified to furnish additional heat to the windshield and cockpit. The ducts leading from the prestone and oil cooler radiators to the heating and vent chamber are shown on drawing No. SAAD42G810. An adapter will be attached to the heat and vent chamber for attaching the two flexible ducts in the cockpit. One of these ducts leads to the air space between the windshields from a vent attached to lower part of the windshield. The other flexible duct is long enough for the pilot to use on any part of the windshield inside the cockpit. The end of the duct is held in place with a spring when not in use. The installation of these parts is shown on drawing No. SAAD42-567. Reference is made to T. O. No. 01-25CF-38 for windshield modifications.

p. Bulkhead spinners will be reworked as shown on drawing No. SAAD-42B183 and SAAD42B644.

q. Installation of the propeller hub seals will be made in accordance with T. O. No. 01-25C-77.

r. The lubricant as ordinarily used in the propellers is too heavy. This grease will be removed and the propeller cleaned and replenished with Texaco No. 00.

s. The external power plug will be installed in connection with the battery junction box located forward from station No. 124 as shown on drawing No. SAAD42-571. Details of receptacle are shown on drawing No. SAAD42G277.

t. A type C-4 cockpit light, Specification 94-32294, will be installed aft of station 4 and connected to the junction box, part No. 87-66-586, with a No. 18 cable, Specification 94-32006, 65 inches long in accordance with AF Drawing No. 42D4949.

u. The propeller anti-icing system consists of the following:

(1) Reservoir for holding anti-icer fluid, Specification 14082, electric driven pump with rheostat and propeller slinger rings. The tank, part No. 42G4192, is constructed from aluminum .064 thickness, Specification 57-151-1, and is installed on the right-hand side of the airplane behind the cockpit with brackets, part No. SAAD42-597, and straps, part No. SAAD42-599 between stations 7 and 8. The pump is mounted underneath and in front of the tank on the support, part No. SAAD42-598. The lines leading from the tank to the slinger rings are 1/4 inch diameter copper tubing x .032 wall, Specification WW-T-799. Optional tubing is aluminum 1/4 inch O.D. x .032 wall, Specification WW-T-783. The same type of tubing is used for the drain and overflow lines. The rheostat switch, part No. 42D5150, is mounted in the pilot's cockpit, and is used to control the speed of the motor. The tank has a capacity of two (2) gallons. The amount of fluid pumped depends

upon the speed of the motor. The two gallons of de-icing fluid should be sufficient for the cruising area of the airplane. An opening is cut on the right-hand side of vision glass, Curtiss, part No. 87-21-569, to allow for the filling of the anti-icer tank. This opening is fixed with a hinge cover operating from the inside. This change is shown on drawing No. SAAD42D798. A Parker check valve, part No. 404-HST-4D, 1/4 inch tube, outlets, should be installed in the 1/4 inch diameter line a short distance from the slinger rings. Fluid is pumped to the slinger rings where the centrifugal force spreads it out over the propeller blades.

(2) The slip ring assembly is disassembled from the hub and slinger ring, part No. 106090, replaces the spinner mounting flange, part No. 104330. The seal, part No. 104836, remains in the assembly. On the clamp ring for blade retention, the clevis pin is removed and collector assembly, part No. 106004, added to each of the three (3) blades. Special bolt, part No. 106049, replaces the existing bolt, part No. AN-5000-10. Nut, part No. 101757, holds the collector assembly in place. The tubes, assembly No. 106091, are attached to the slinger ring in each of the three (3) outlet bosses.

(3) Feed shoes installed on the propeller blade distribute the anti-icer fluid over the blades. The distribution of the anti-icer fluid over the propeller blade is improved by cementing Goodrich Feed Shoes, mold No. 37572 to the blades. Instructions for the installation of feed shoes are made in accordance with Goodrich Drawing No. B-188E. The feed shoes are used in connection with the collector ring, Curtiss part No. 106004, which has the tube from the collector "bucket" or well to deposit the fluid in the grooves of the feed shoes. "Inloid" oil proof cementing is used as a seal along the edges of the feed shoes.

3. Drawings and parts required.

a. The following drawings are required to accomplish this installation:

(1) Installation External Power Plug.

| | |
|---|---|
| 42G4274 | 42G4277 |
| SAAD42-571 | 42B4278 |
| 42D4276 | 42A4279 |

Goodrich B-188E

(2) Installation Carburetor and Gun Hot Air Duct.

| | | |
|---|---|---|
| 42K6849 | 42D6851M | SAAD42A688 |
| 42B6426M | SAAD42A703 | SAAD42A699 |
| SAAD42D719 | 42D6850 | 42G6422M |
| SAAD42B670 L/R | 42G6421M | 42B6423M R/L |
| 42D6857 | SAAD42A700 | SAAD42A687 |

(3) Installation Radiator and Oil Cooler Shutters.

| | |
|---|---|
| 42H5374 | SAAD42A634 |
| SAAD42A645 | 42B5398 |
| 42K5399 (Duct Assembly Cooler) | SAAD42-544 |
| 42D5382M | 42B5383 |
| SAAD42A655 | SAAD42-583 |
| 42D5381M | |

(4) Installation Cockpit Heating System.

| | | |
|---|---|---|
| SAAD42G810 | SAAD42A661 | SAAD42B662 |
| SAAD42B660 | SAAD42A646 | SAAD42A664 |
| SAAD42A663 | | |

(5) Installation Propeller Anti-Icing Equipment.

| | | |
|---|---|---|
| SAAD42-602 | SAAD42D813 | SAAD42-597 |
| SAAD42D798 | 42D5236 | SAAD42B644 |
| 42B5150 | SAAD42-566 | SAAD42-598 |
| SAAD42-599 | SAAD42A640 | 42G4193 |

(6) Installation Priming System.

| | | |
|---|---|---|
| 41B2549 | SAAD42B659 | SAAD42B818 |

(7) Installation Winterization Equipment.

SAAD42G847

(8) Installation Oil Tank Immersion Heater.

SAAD42-608

(9) Installation Windshield Defrosting Assembly.

SAAD42-567

(10) Installation Cowl Flap Control Lever Stop.

42D5380

(11) Installation Type C-4 Cockpit Lamp.

42D4949

b. The following parts are required per airplane to accomplish this installation. Service activities desiring to accomplish this work may obtain parts by requisition on the control depots.

| Quantity | Stock No. | Part No. | Nomenclature | Class | Source |
|---|---|---|---|---|---|
| 1 | 4840-U-6511D8 | | Cooler - Oil, U. A. P. | 03-1 | AF Stock |
| 1 | 4840-U-3560-11 | | Shutter - Oil assembly temp. regulator | 03-1 | AF Stock |
| 2 | 4840-U-3560-13 | | Shutter - Assembly coolant radiator | 03-1 | AF Stock |

| Quantity | Stock No. | Part No. | Nomenclature | Class | Source |
|---|---|---|---|---|---|
| 1 | | D8300-13-4 | Pump Assembly Metering Fluid Series J4.0-24-1/8 P.T. | 03-I | AF Stock |
| 1 | | 7979 | Strainer | 03-1 | AF Stock |
| 1 | | R10-1500 | Heater - Oil immersion chromalox, E. L. Weigand Co. | 03-F | AF Stock |
| 1 | | AN4010 | Shutter Control | 03-F | AF Stock |
| 3 | 0104-106004 | | Collector - Curtiss part number | 01-C | AF Stock |
| 3 | 0104-106091 | | Tube - Curtiss | 01-C | AF Stock |
| 1 | 0104-106636 | | Slinger Ring - Curtiss | 01-C | AF Stock |
| 3 | 0104-106049 | | Bolt - Curtiss | 01-C | AF Stock |
| 3 | 0104-101757 | | Nut - Curtiss | 01-C | AF Stock |
| 3 | | | Shoe-Feed Propeller (with cement) Mold No. 37572 | 04-B | AF Stock |
| 1 | 6100-033170 | 106806 | Bulb - Resistance carburetor air thermometer, Specification 94-27321, figure 2 | 05-D | AF Stock |
| 1 | 4202-42B3738 | | Receptacle - Battery chart | 03-C | AF Stock |
| 1 | 4200-371850 | G32294C4 | Lamp Assembly Cockpit Type C-4, Specification 94-32294 | 03-C | AF Stock |
| 1 | 4200-615130 | | Rheostat - Variable resistance, 50 watt, 15 ohm, Specification 94-32259 | 03-C | AF Stock |

c. Other parts, not listed above as noted on drawings, will be obtained from local stock or requisition as required.

By Command of Lieutenant General ARNOLD:

H. J. F. MILLER,
Major General, U. S. A.,
Commanding General, Air Service Command.