Figure 5-4. Propeller anti-ice discharge nozzle and blade boot.

blade station. The feed shoes are molded with several parallel open channels in which fluid flows from the blade shank toward the blade tip by centrifugal force. The fluid flows laterally from the channels over the leading edge of the blade. ***(Figure 5-4)***

The anti-icing fluid used with this system must readily blend with moisture and produce a solution with an extremely low freezing point to prevent ice build up. Isopropyl alcohol is used in some anti-icing systems because of its availability and low cost. Phosphate compounds are comparable to isopropyl alcohol in anti-icing performance and have the advantage of reduced flammability. However, phosphate compounds are comparatively expensive and, consequently, are not widely used.

To determine proper system operation, the technician should follow maintenance and testing procedures published in the appropriate maintenance manual. It may be necessary to inspect or replace filters and other system components. Aside from determining general operation, a flow test may be used to determine whether the delivery to the propeller complies with specifications. The odor of isopropyl alcohol provides ample evidence of the existence of system leaks on units serviced with that fluid.

The propeller anti-icing system has disadvantages in that it requires several components that add weight to the aircraft, especially the anti-ice fluid contained in the tank. Also, the duration of anti-ice operation available is confined to the amount of fluid on board and the rate of fluid discharge. This system is not used on many aircraft

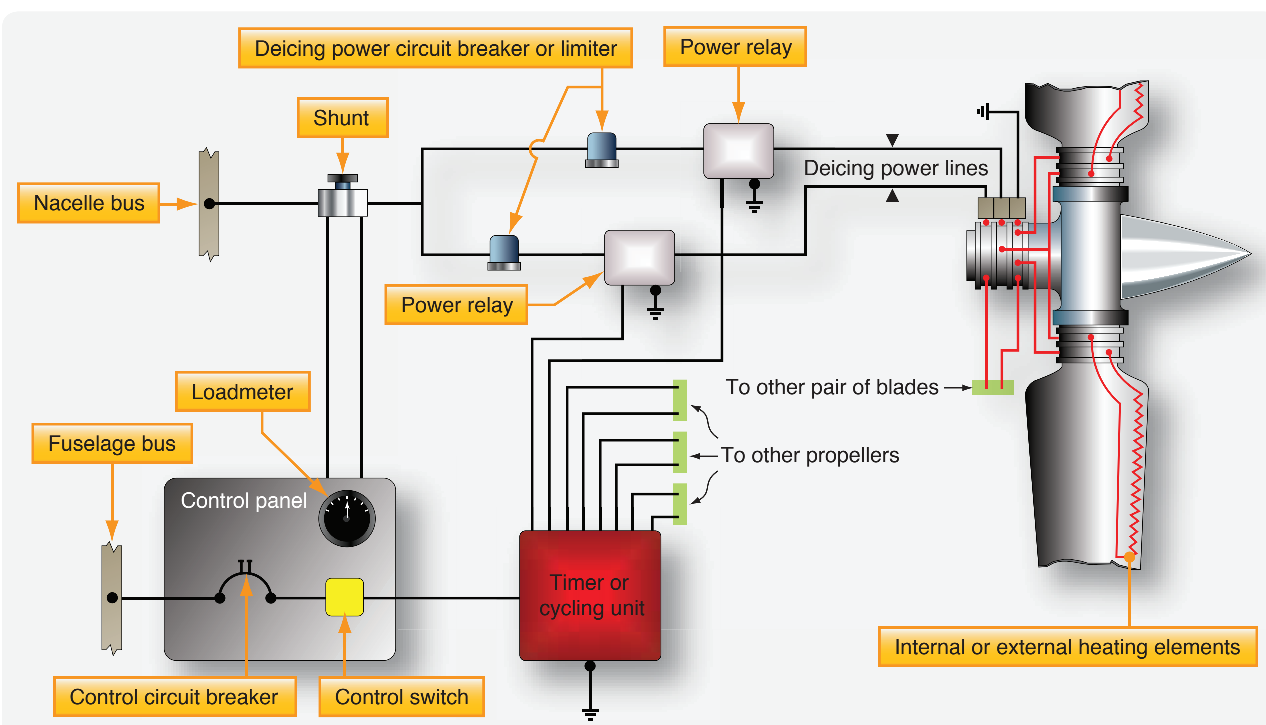

Figure 5-5. Electrical de-icing system.

because of these limitations. Instead, electric de-icing systems have been developed that provide ice protection for the entire duration of the flight, if necessary.

DE-ICING SYSTEMS

An electric propeller icing control system consists of an electrical energy source, a resistance heating element, system controls, and necessary wiring. A typical electrical de-icing system is presented in ***Figure 5-5***.

The heating elements are mounted internally or externally on the propeller spinner and blades. Electrical power from the aircraft system is transferred to the propeller hub through electrical leads that terminate in slip rings and brushes. Flexible connectors are used to transfer power from the hub to the blade elements.

A de-ice system consists of one or more on-off switches. The pilot controls the operation of the de-ice system by turning on one or more switches. All de-ice systems have a master switch, and may have another toggle switch for each propeller. Some systems may also have a selector switch to adjust for light or heavy icing conditions or automatic switching for icing conditions.

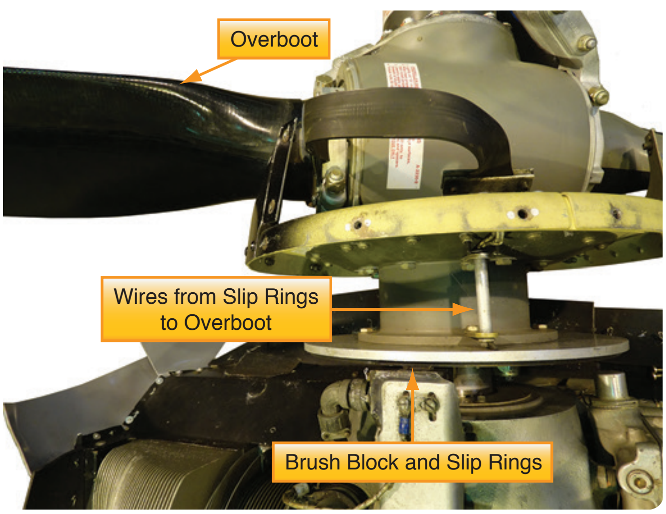

Figure 5-6. Electrical propeller de-icing installation.

The timer or sequencer unit determines the sequence of which blades (or portion thereof) are currently being de-iced, and for what length of time. The sequencer timer applies power to each de-ice boot, or boot segment, in a sequence or all on order.

A brush block, which is normally mounted on the engine just behind the propeller, is used to transfer electricity to the slip ring. A slip ring and brush block assembly is shown in ***Figures 5-6 and 5-7***. The slip ring rotates with the propeller and provides a current path to the blade de-ice boots. A slip ring wire harness is used on some hub installations to electrically connect the slip ring to the terminal strip connection screw. A de-ice wiring harness is used to electrically connect the de-ice boot to the slip ring assembly.

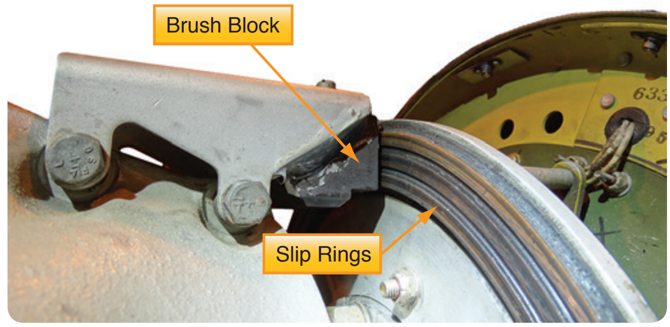

Figure 5-7. Slip rings and brush block.

A de-ice boot contains internal heating elements or dual elements. ***(Figure 5-8)*** The boot is securely attached to the leading edge of each blade with an adhesive.

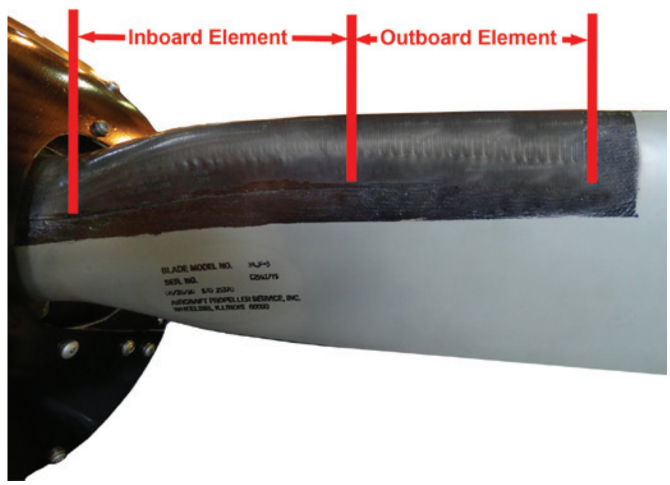

Figure 5-8. De-icing boots or overshoes.

Icing control is accomplished by converting electrical energy to heat energy in the heating element. Balanced ice removal from all blades must be obtained as nearly as possible if excessive vibration is to be avoided. To obtain balanced ice removal, variation of heating current in the blade elements is controlled so that similar heating effects are obtained in opposite blades.

Electric de-icing systems are usually designed for intermittent application of power to the heating elements to remove ice after formation but before excessive accumulation. Proper control of heating intervals aids in preventing runback, since heat is applied just long enough to melt the ice accumulation in contact with the blade. If heat supplied to an icing surface is more than that required for melting just the inner ice accumulation, but insufficient to evaporate all the water formed, water will run back over the unheated surface and freeze. Runback of this nature causes ice formation on uncontrolled icing areas of the blade or surface.

As ice is melted or softened, centrifugal force slings the ice from the propeller blades. This often results in the ice striking the side of the fuselage or other parts of the aircraft. The noise associated with this action is disturbing to passengers. To prevent or minimize this scenario, some pilots prefer to activate the de-icing system before the accumulation of ice. They activate the de-icing system when conditions are favorable for ice formation. Under such operations, the system is being used as an anti-icing system.

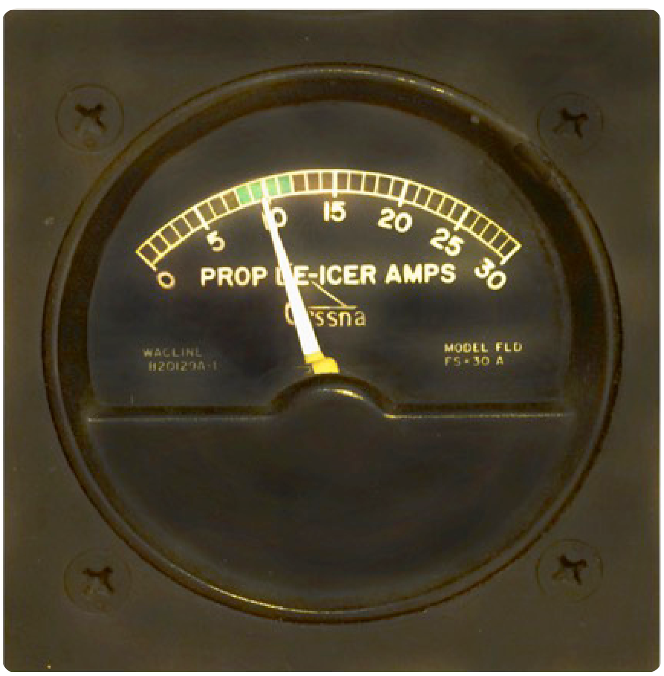

Figure 5-9. Propeller de-icer ammeter. Heating elements should draw green arc current.

Sequencing timers are used to energize the heating element circuits for periods of 15 to 30 seconds, with a complete cycle time of two minutes. A sequencing timer is an electric motor driven contactor that controls power contactors in separate sections of the circuit. Controls for propeller electrical de-icing systems include on off switches, ammeters or loadmeters to indicate current in the circuits, and protective devices, such as current limiters or circuit breakers. The ammeters or loadmeters permit monitoring of individual circuit currents and reflect operation of the timer. The ammeter should indicate a green arc level of current draw. ***(Figure 5-9)***

As the system changes from one heating element to the next, the ammeter will show a quick deflection in the needle toward zero and back to showing the current draw on the subsequent element receiving power. The normal sequence of heat application begins with the outboard segment of the heating element. Next, the inboard segment is heated. On twin engine aircraft, the propeller on one engine will be de-iced and the system will shift to the other engine after which the sequencer returns to the first engine and the cycle repeats itself.

The sequence of removing ice from the outboard section before heating the inboard element allows the ice on the slower rotating inboard section to sling off the propeller without interference from the ice that would otherwise be accumulated on the outboard section of the de-icing boot. To prevent element overheating, the propeller de-icing system is used only when the propellers are rotating and for short test periods of time during the takeoff check list or system inspection. When the blades are not rotating, there is a lack of cooling air flow passing over the heating elements. Follow testing procedures provided by the manufacturer to determine proper operation.

INSPECTION, MAINTENANCE, AND TESTING ANTI-ICING SYSTEM

Propeller anti-icing systems function by wetting the inboard portions of the propeller blades with an anti-icing fluid (e.g., MIL-F-5566 superseded by TT-I-735A). The fluid mixes with the moisture and greatly reduces the freezing temperature of the water, thereby preventing the formation of ice. A number of maintenance and testing procedures are used to determine proper operation.

Inspection of the system begins with the reservoir. ***(Figure 5-1)*** Check for proper anchoring of the tank and adequate sealing by the filling cap. A strong odor will be present should the tank or plumbing possess a leak and the system contains isopropyl alcohol. It may be necessary to drain and flush the tank on a periodic basis. If draining the system, verify that the quantity indicator reads empty when the tank is depleted. When refilling the tank, check the quantity indication by filling the tank to the ½ level and reading the gauge and rechecking the gauge when the tank is full. ***(Figure 5-10)*** Check or replace filters as prescribed in the maintenance instructions. Inspect the pump and any associated check valves for leaks, security of installation, and other defects. Check the plumbing to the slinger rings and discharge nozzles. Inspect the overshoes for condition and proper bonding to the propeller blades.

Figure 5-10. Anti-ice fluid quantity indicator.

For systems with variable delivery rates, a check of the rheostat is performed during the flow check. Airplanes with an anti-icing system may also use the anti-icing fluid for windshield anti-icing operations. Applying anti-icing fluid on the windscreen may have an impact on the available duration of the fluid in the tank. In some systems, when the windshield anti-ice system is activated, the pump runs at the maximum delivery rate, regardless of the position of the rheostat, and anti-icing fluid may be diverted from a propeller (e.g., right propeller) during windshield anti-icing operation. Refer to the appropriate technical data for the aircraft being tested.

To verify fluid consumption perform the flow test, or similar check, as dictated in the maintenance instructions. In this example a twin-engine aircraft has a three U.S. gallon anti-icing fluid tank (384 fluid ounces or 11.4 liters). The rheostat provides a means whereby the pilot may vary the flow through the system based on possible icing conditions. The minimum flow rate for the system provides the maximum duration interval of 3.5 hours of operation. The maximum flow, or minimum duration, is one hour. With the mark on the rheostat knob lined up with the NORM position indicator, two hours of operation are provided by the system. ***(Figure 5-11)*** To check the operation of the system, three flow rates are measured. Before testing the system ensure that an adequate quantity of fluid is contained in the tank. Take precautions to prevent fires and have on hand fire fighting equipment should a fire break out. Beware that alcohol fires may be difficult to visually detect.

Figure 5-11. Rheostat control on anti-ice with variable flow.

Disconnect the delivery lines going to the slinger rings of each engine. Divert the outputs from the delivery lines to separate containers. Activate the system and capture the output from each system. When turning on the anti-ice system, it is often recommended to initially run the pump at the maximum flow rate for a brief period to establish steady flow before setting the desired rate of delivery.

Rather than running the systems until the tank is depleted, conduct the test for a limited measure of time and calculate flow in units of hours or any other suitable timeframe. In this test, flows will be gathered over six-minute intervals and the flow rate determined by multiplication. At maximum flow rate, each engine should receive 19.2 U.S. fluid ounces (0.57 liters). Using mathematics, 19.2 ounces per engine provides a total delivery of 38.4 ounces over a six-minute period. Multiplying 38.4 ounces by 10 to determine flow rate