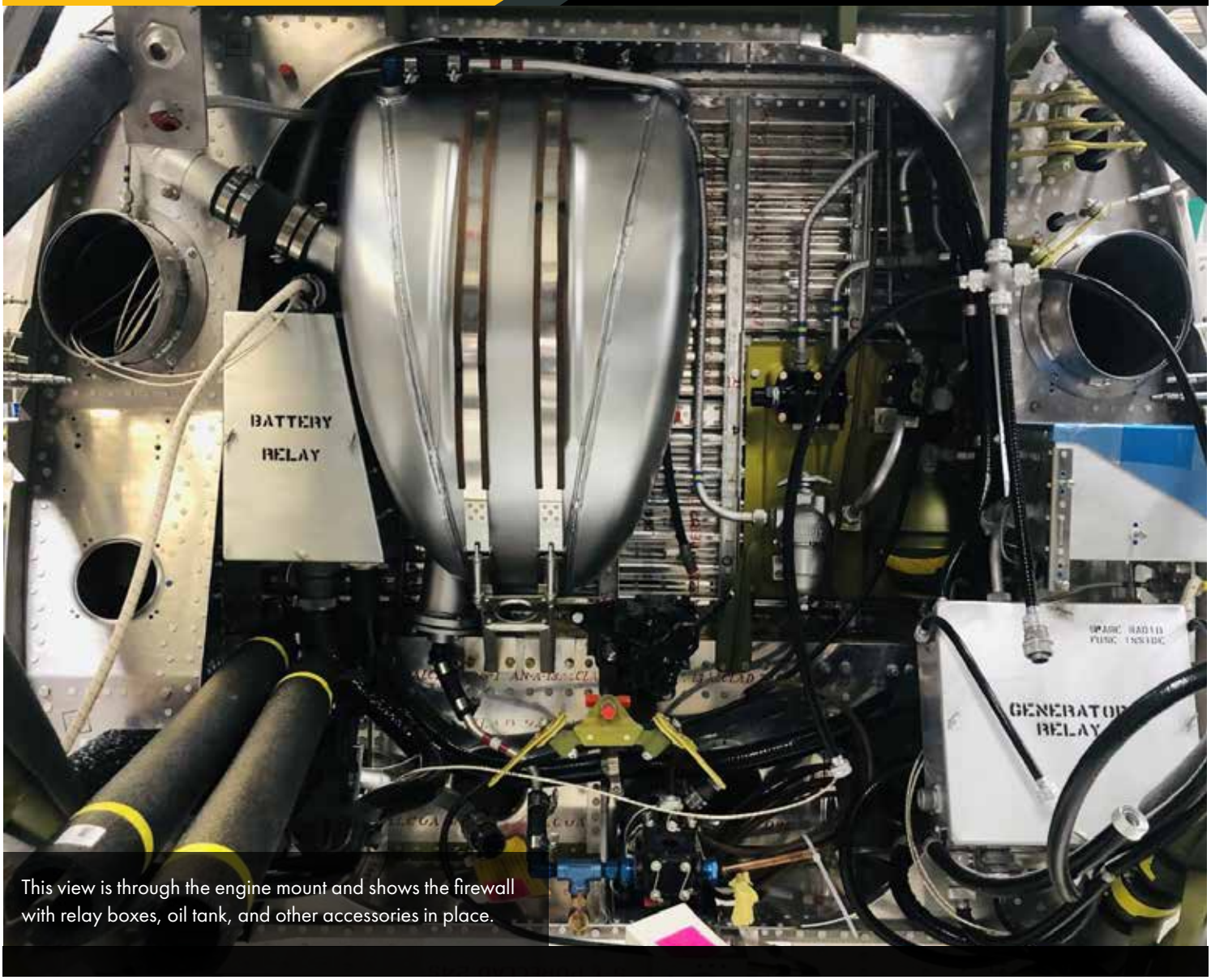
DEC/JAN

Dakota Territory Air Museum's P-47 Update

by Chuck Cravens

AIRCORPS AVIATION



This view is through the engine mount and shows the firewall with relay boxes, oil tank, and other accessories in place.

DAKOTA TERRITORY AIR MUSEUM

Update

This month work on the secondary cowl and turbosupercharger connections began. The modified oxygen bottle brackets were installed. Progress on the wings and cockpit systems continued. This restoration has been a long process, but every little step brings us closer to the test flight of the only Republic built Razorback under restoration.

Secondary Cowl

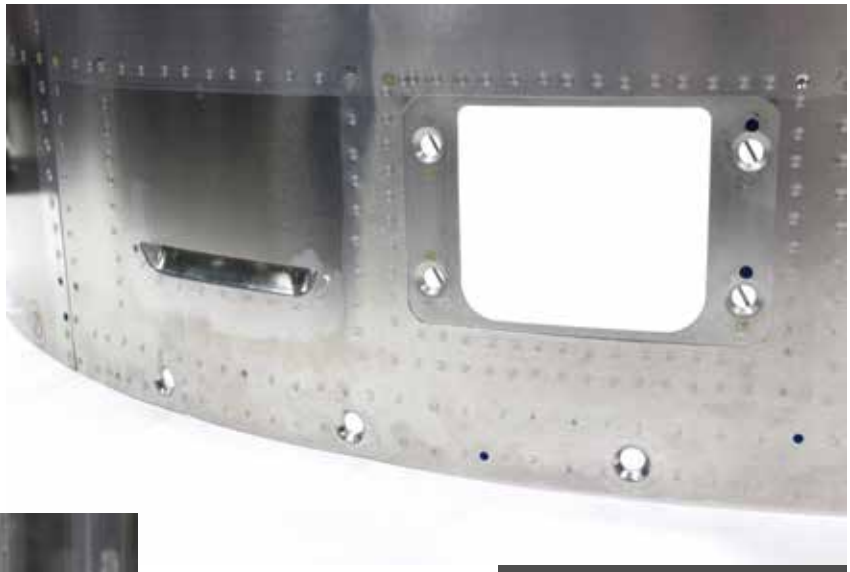
The secondary cowl covers the accessory section forward of the firewall. Several secondary cowl skin panels were fitted this month.

Preheater and secondary cowl skins show in this image.

The black cylindrical part is the dynamotor, and the rectangular silver object with the red label is the modulator for the transmitter.

Both are part of a system that increases voltage to power radio systems. Vacuum tubes in 40's era electronics require higher voltages than modern solid state radios.

One of the secondary cowl sections is all ready to install.



A great deal of careful work goes into panels like these, notice the rivets and chamfered Dzus openings.

Here the back side of the Dzus fittings are visible.

Cockpit Systems

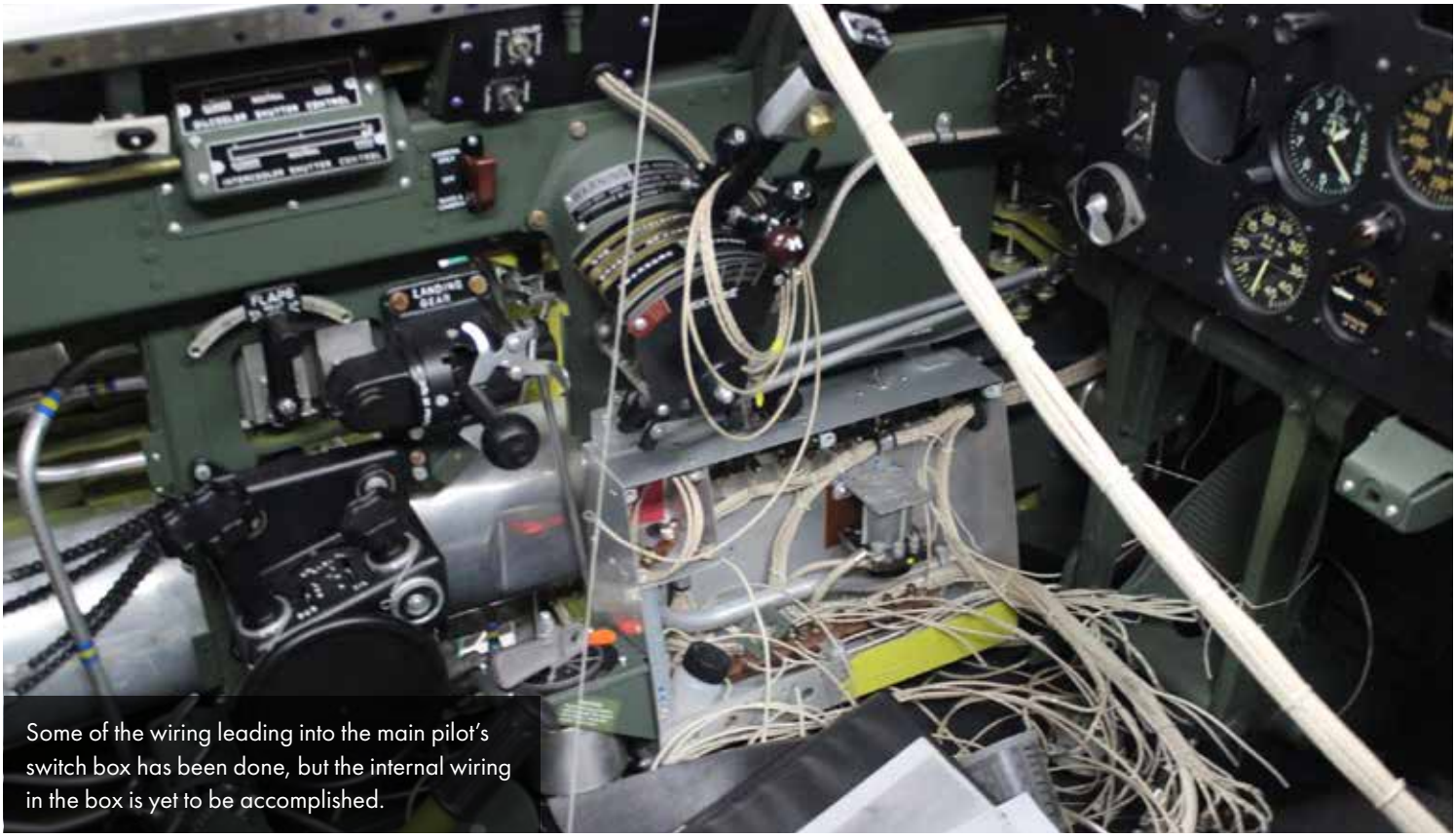
Many of the initial connections to electrical terminals on various switch boxes and control boxes have been made. This month Aaron started putting the connected wires into bundled wiring harnesses.

This is the electrical harness that runs to the recognition light box.

The IFF (Identification, Friend or Foe) control box covers have been repainted and restored.

Beneath the instrument panel, the parking brake handle has been installed.

Aaron is working on bundling the radio wires into a neat harness, just as was done at the Evansville, Indiana Republic Factory.



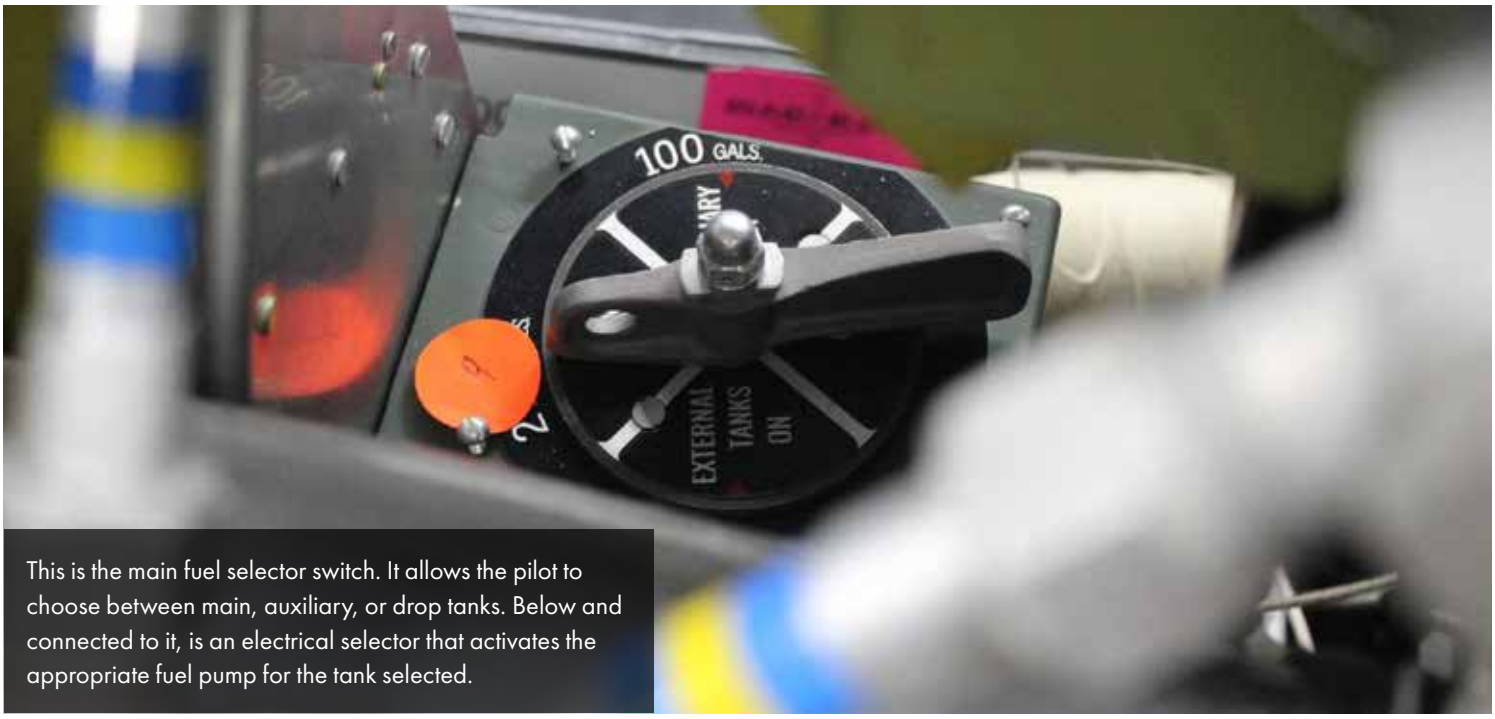
Some of the wiring leading into the main pilot's switch box has been done, but the internal wiring in the box is yet to be accomplished.

The rectangular red box is the manual self destruct control for the IFF system. There is also an inertial switch that is intended to set off an explosive charge to destroy the IFF transmitter in case of a crash. This manual control is used in case the internal switch fails or isn't set off in an emergency landing behind enemy lines.

This close up shows some of the detail on the IFF manual self destruct control. This part is a NOS (new old stock) part that was located in its original box, untouched since it was manufactured during the war.

The control box in the upper left of this image is the transmitter control box. It is also NOS.

The grey box with the single knob in the center of this photo is the FL-8 filter switch used by the pilot to switch between communications radio and VOR navigation frequencies.



This is the main fuel selector switch. It allows the pilot to choose between main, auxiliary, or drop tanks. Below and connected to it, is an electrical selector that activates the appropriate fuel pump for the tank selected.

Wings

The wings gained some skin panels, extrusions around the gear openings, and inspection panels this month.

The underside of a P-47 wing has many inspection panels.

Several of these panels already have their covers installed - like the ones on the yellow zinc chromated reinforcing plate on this image. The line of rectangular openings in the skin angling across the upper right of the photo are for inspection access covers for the flaps and ailerons.

Corey works on inspection hole covers that will cover the openings visible in front of the flap and aileron positions near the top of this photo.

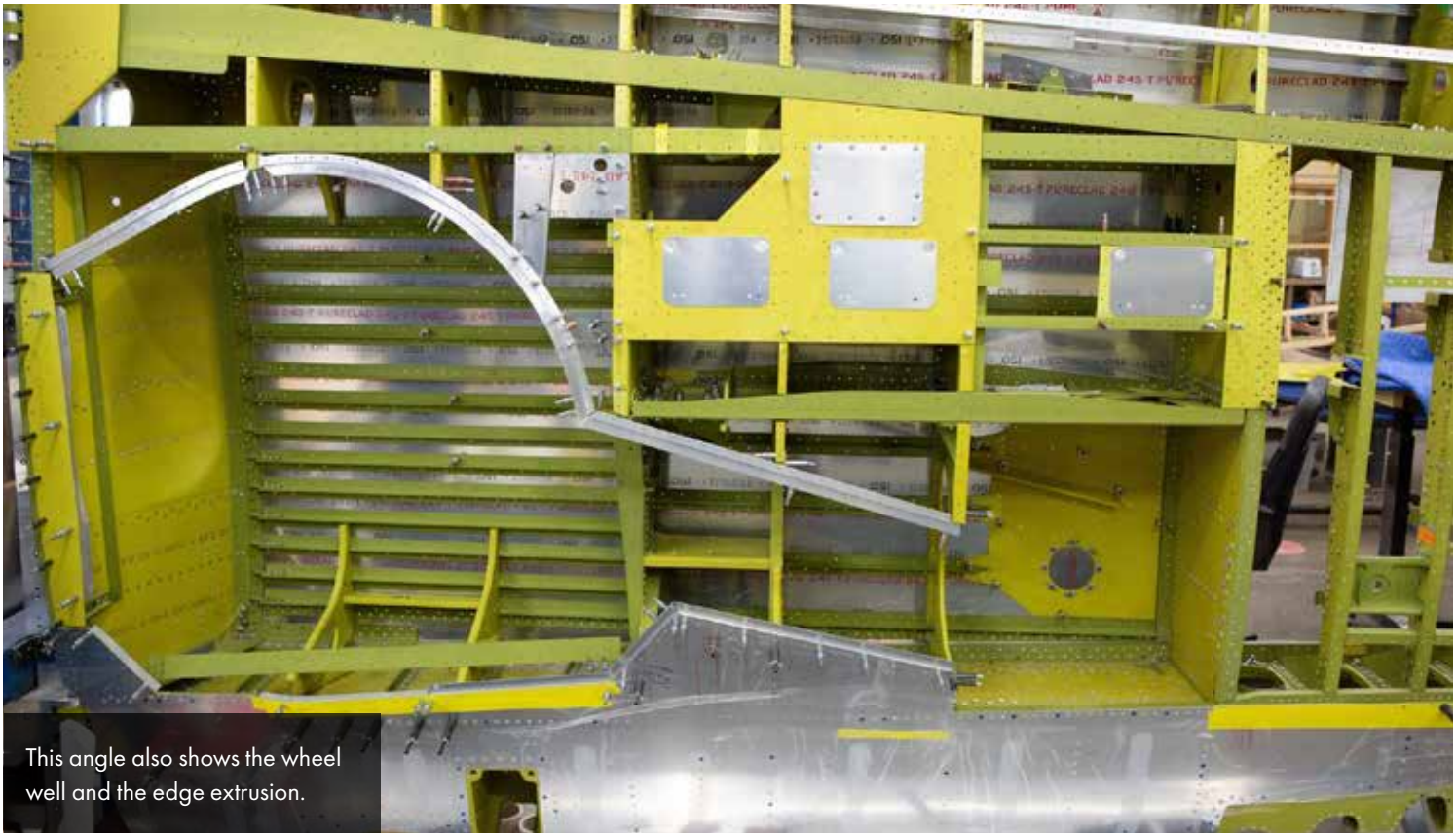
All of the inspection covers have to have the Dzus fitting holes countersunk.

More skin has been fitted to the underside of the right wing.

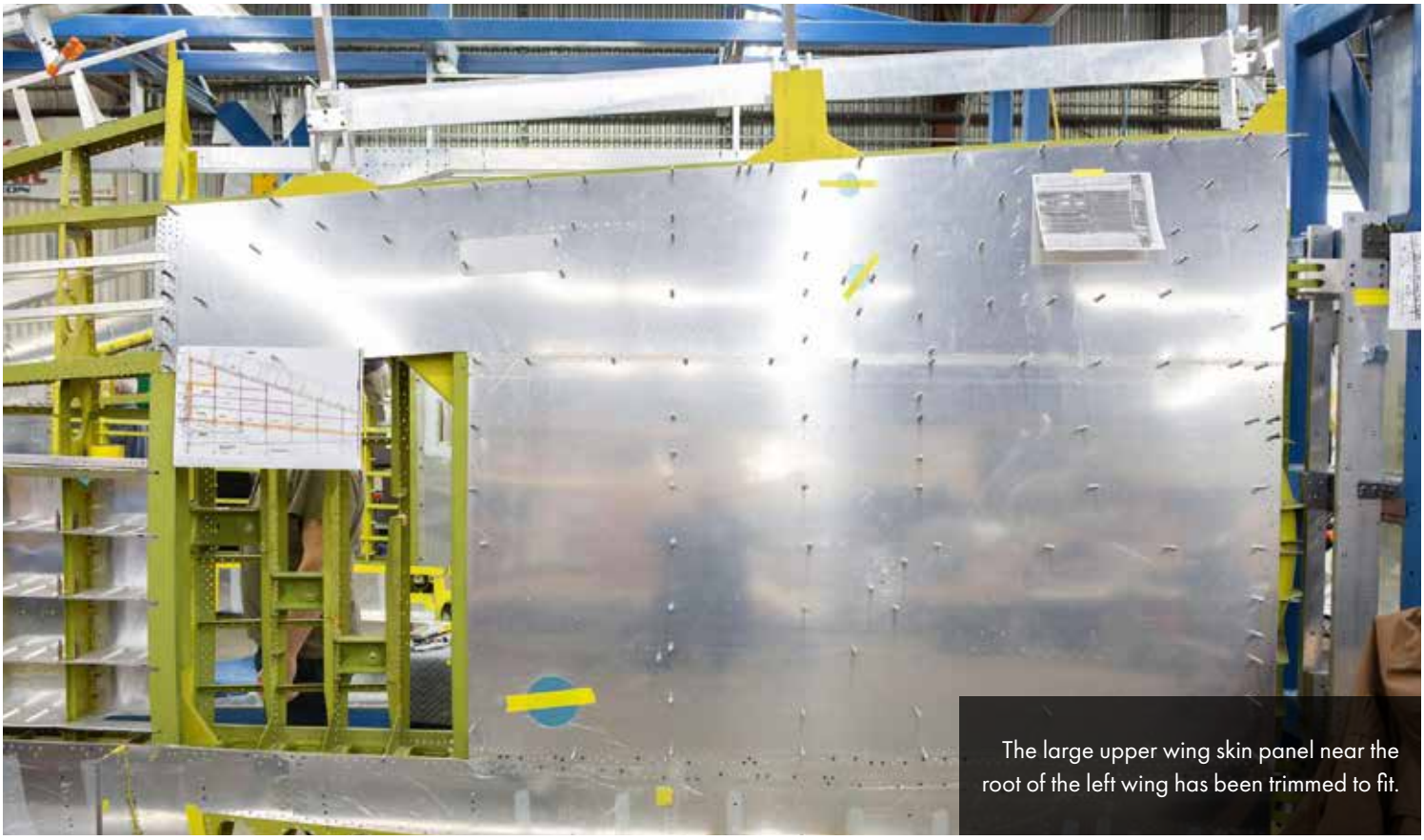
This later photo shows more skin fitted along the inner rear edge of the wing, with the ammunition bay cover removed.

Corey is countersinking a rivet hole in the spar.

The aluminum extrusions that form the edge of the wheel well openings have been installed.



This angle also shows the wheel well and the edge extrusion.



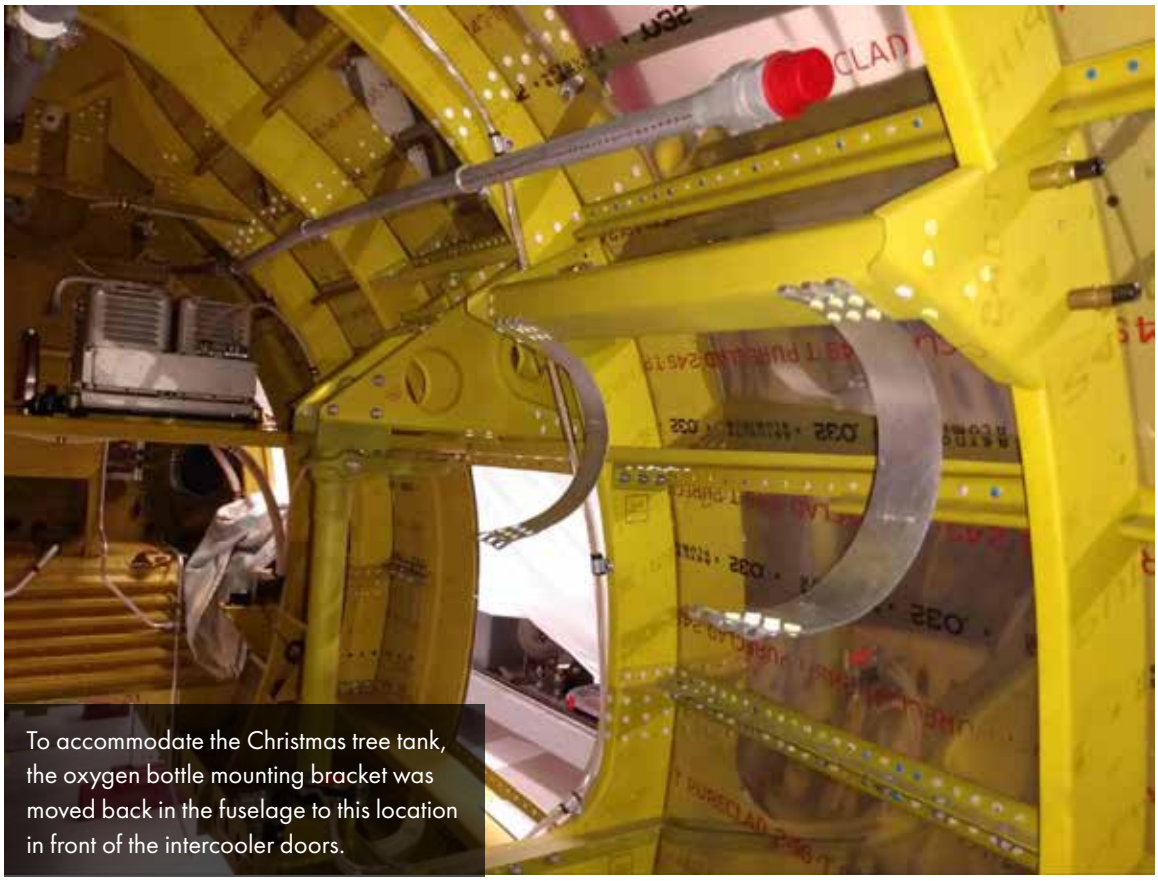
The large upper wing skin panel near the root of the left wing has been trimmed to fit.

Oxygen Bottles

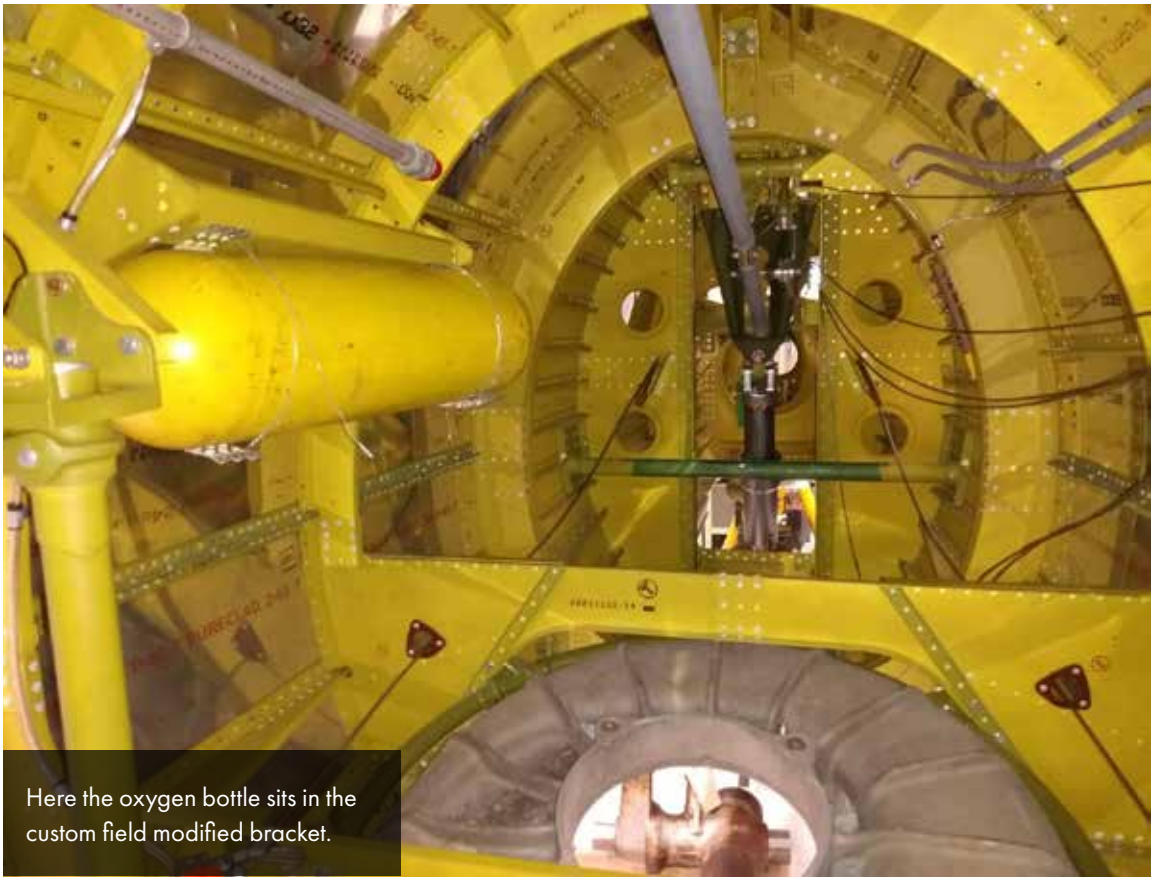
42-27609 has a non standard location for the oxygen bottles that was necessitated by the field installation of the Christmas tree fuel tank.

This is the oxygen bottle holder that was part of the field modification and is a part original to 42-27609.

An oxygen bottle in the mounting bracket.

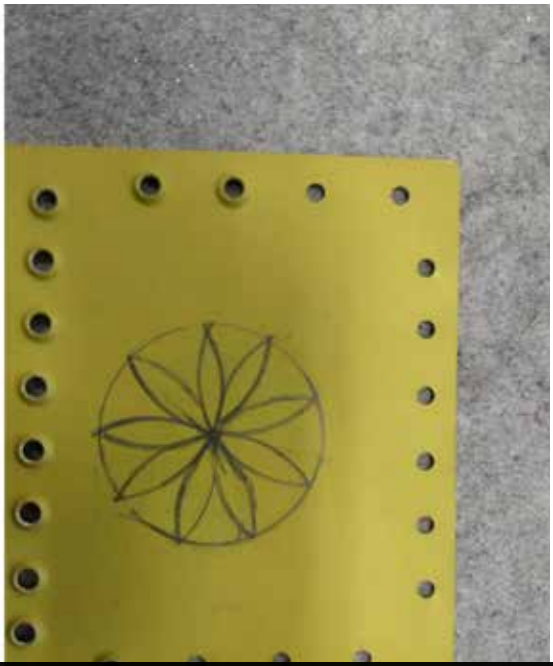


To accommodate the Christmas tree tank, the oxygen bottle mounting bracket was moved back in the fuselage to this location in front of the intercooler doors.



Here the oxygen bottle sits in the custom field modified bracket.

Here, the final installation of the oxygen bottle with its historically accurate stencils can be seen.



This interesting bit of artwork was found on the cover for the auxiliary fuel tank. It was almost certainly done by a factory worker to leave his or her little personal mark on this P-47 back in 1944. Aaron duplicated the scratched in markings after the auxiliary tank cover was repainted.

This is a cover plate for the IFF self destruct test indicator lights. It will be mounted on the radio shelf in the aft fuselage.

This is the back side of the IFF self destruct test indicator showing the light bulb sockets.

Shown here is the box that contains the IFF test indicator lights.

Turbosupercharger

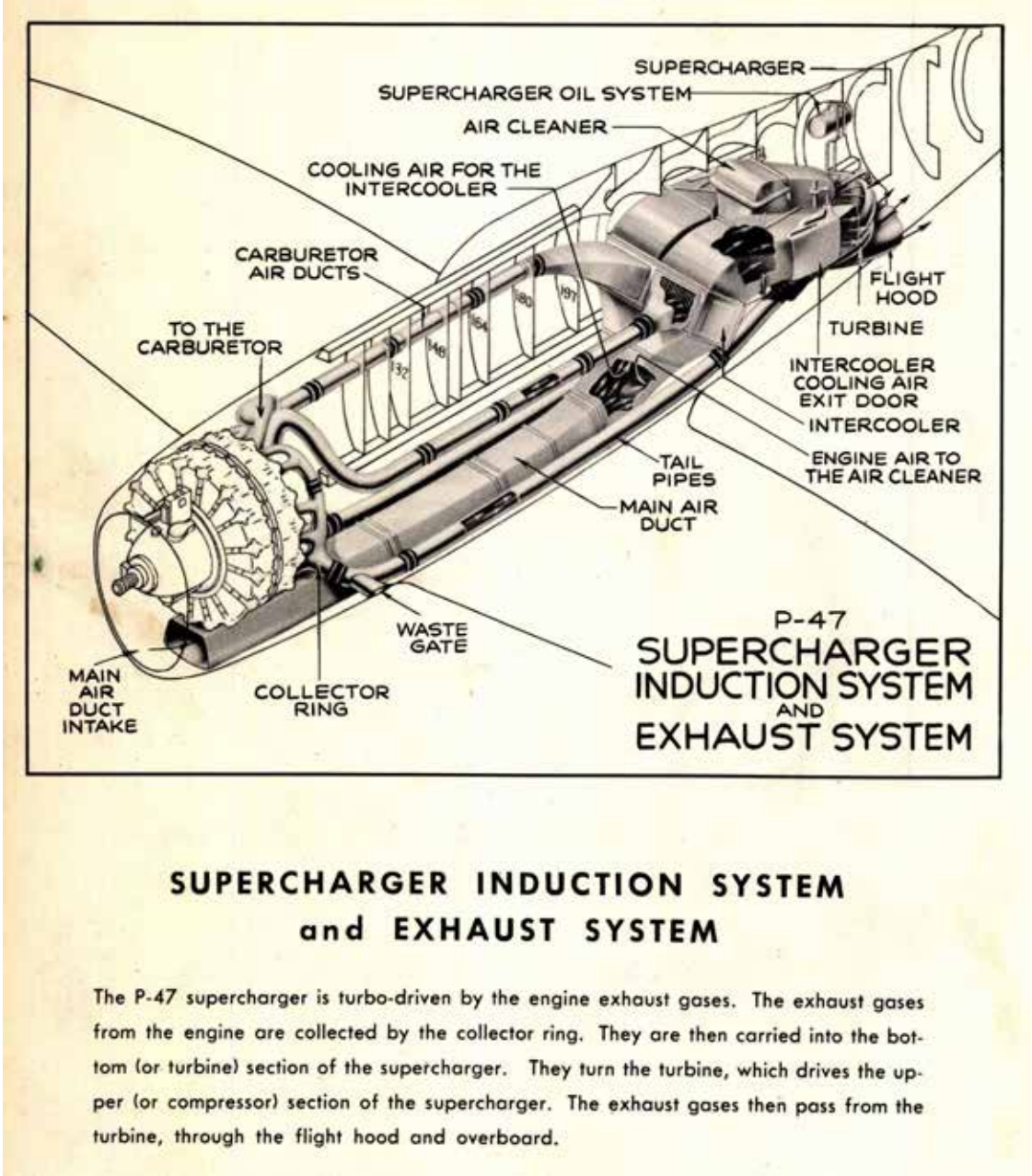
The turbosupercharger inlet shown from the front side of the fuselage.

The turbosupercharger and associated ducting is the reason for the deep fuselage on the P-47.

Some of the hydraulic lines have been connected to the turbosupercharger.

Above the turbosupercharger case, the intercooler door openings are visible.

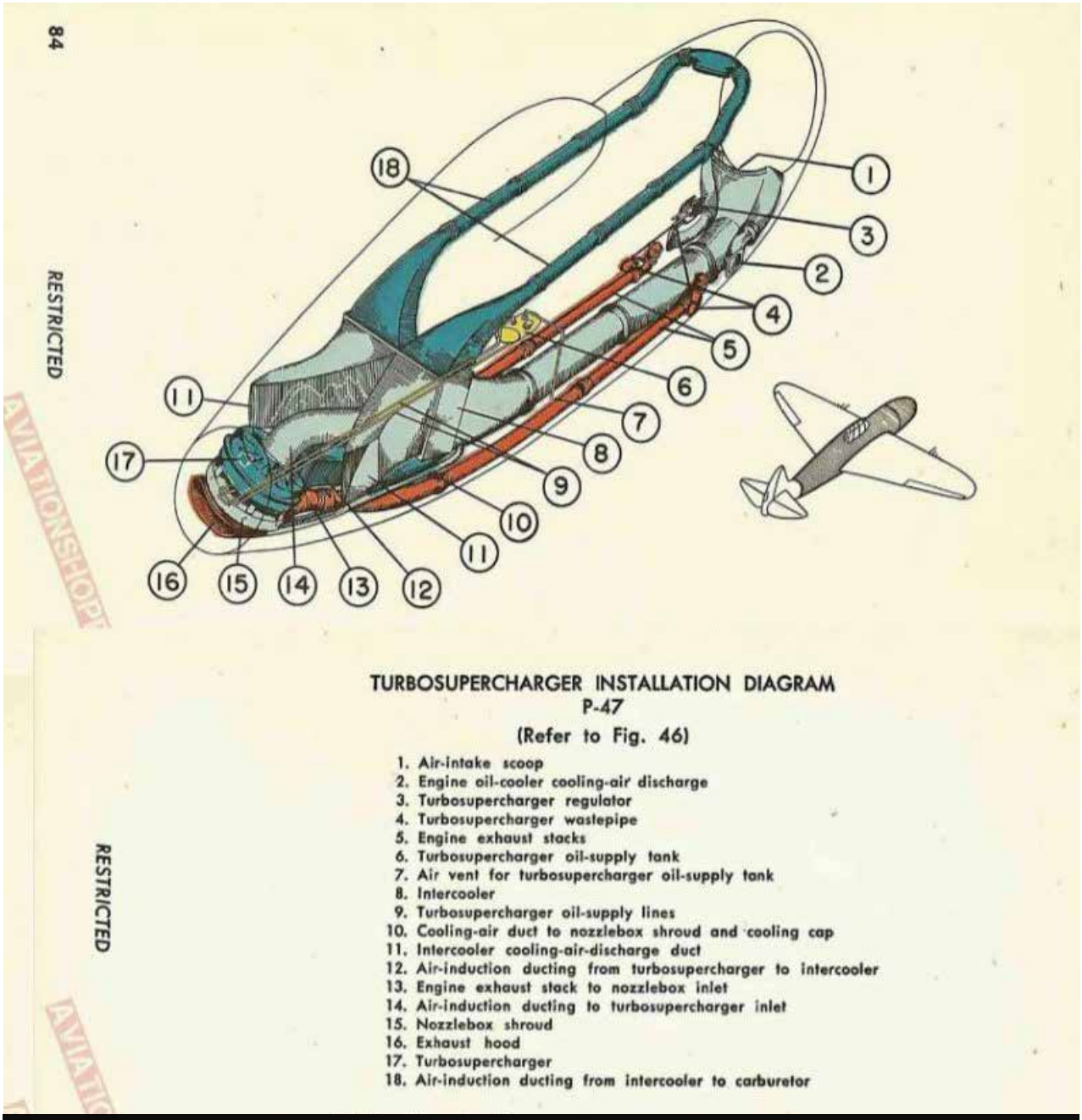
The Complex Turbosupercharger System



Supercharger Diagram from T.O. EX 00000 manual

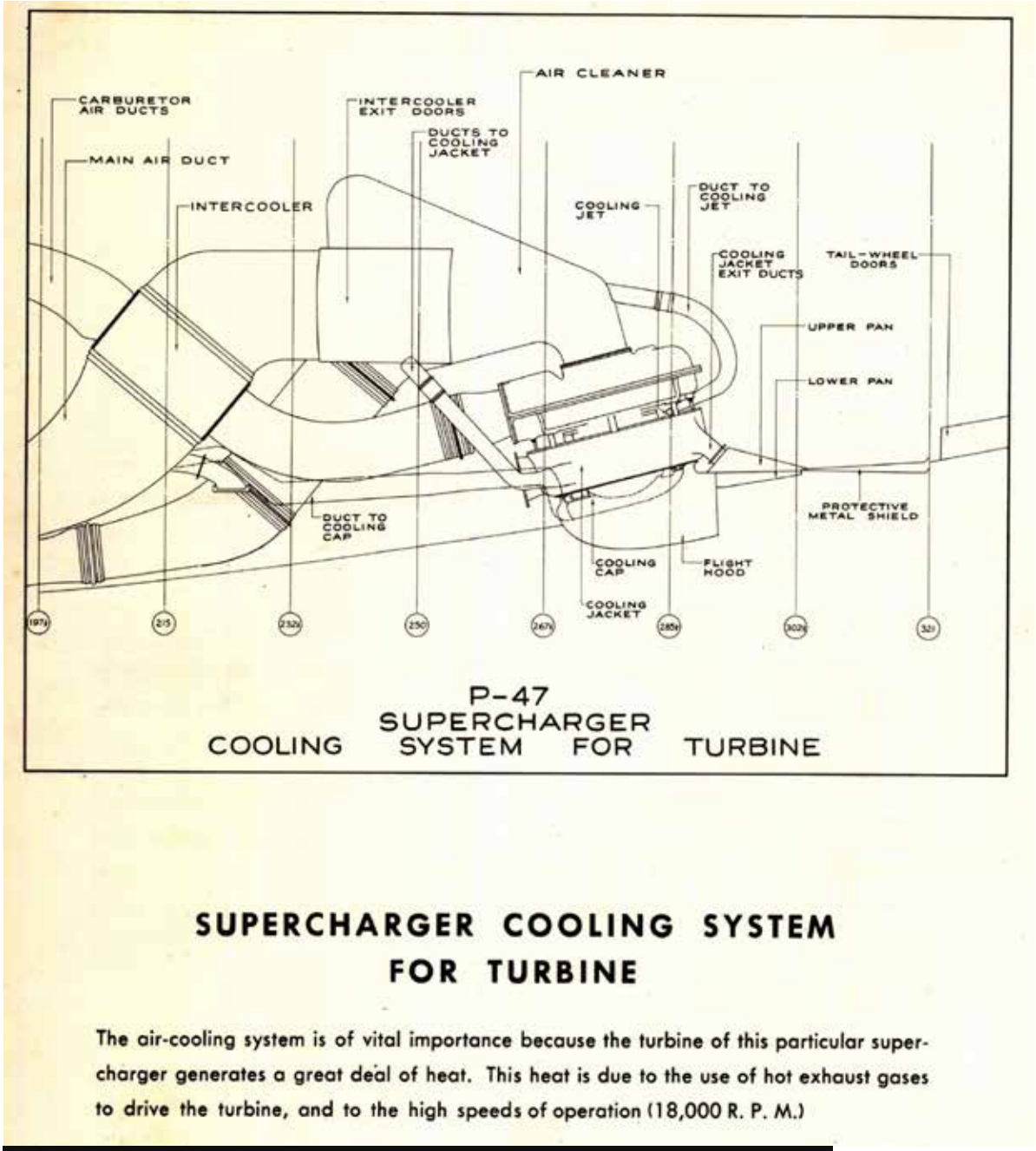
The P-47 had the ability to perform well at high altitudes as an escort fighter or in air to air combat, but it also could operate at low altitude as a fighter bomber with great success. That flexibility was attributable to its Pratt & Whitney Double Wasp R-2800, twin-row, 18-cylinder radial engine and a complicated turbosupercharger system.

The turbosupercharger system made the P-47 Thunderbolt a complex fighter for the time period, perhaps the most complex single engine fighter in the American arsenal.



This is a diagram of a P-47 turbosupercharger system from the Turbosupercharger Field Service Manual (General Electric), GEJ-1630, Aug-1945, manual from AviationShoppe.com collection.

It may be helpful to think of an aircraft turbosupercharger (#17 in diagram) as a big air pump. It takes in cool intake air (light blue in the diagram), and pressurizes it. That air, now hot from the heat of pressurization (dark blue in the diagram) is pumped through an intercooler (#11) to bring the temperature down, because cooler air is denser. Passing through the intercooler, the hot air is cooled and continues on to the carburetor. When it arrives, it is mixed with fuel, and the mechanical supercharger pushes it into the cylinders of the R-2800 via the intake manifold and intake valves.



SUPERCHARGER COOLING SYSTEM FOR TURBINE

The air-cooling system is of vital importance because the turbine of this particular supercharger generates a great deal of heat. This heat is due to the use of hot exhaust gases to drive the turbine, and to the high speeds of operation (18,000 R. P. M.)

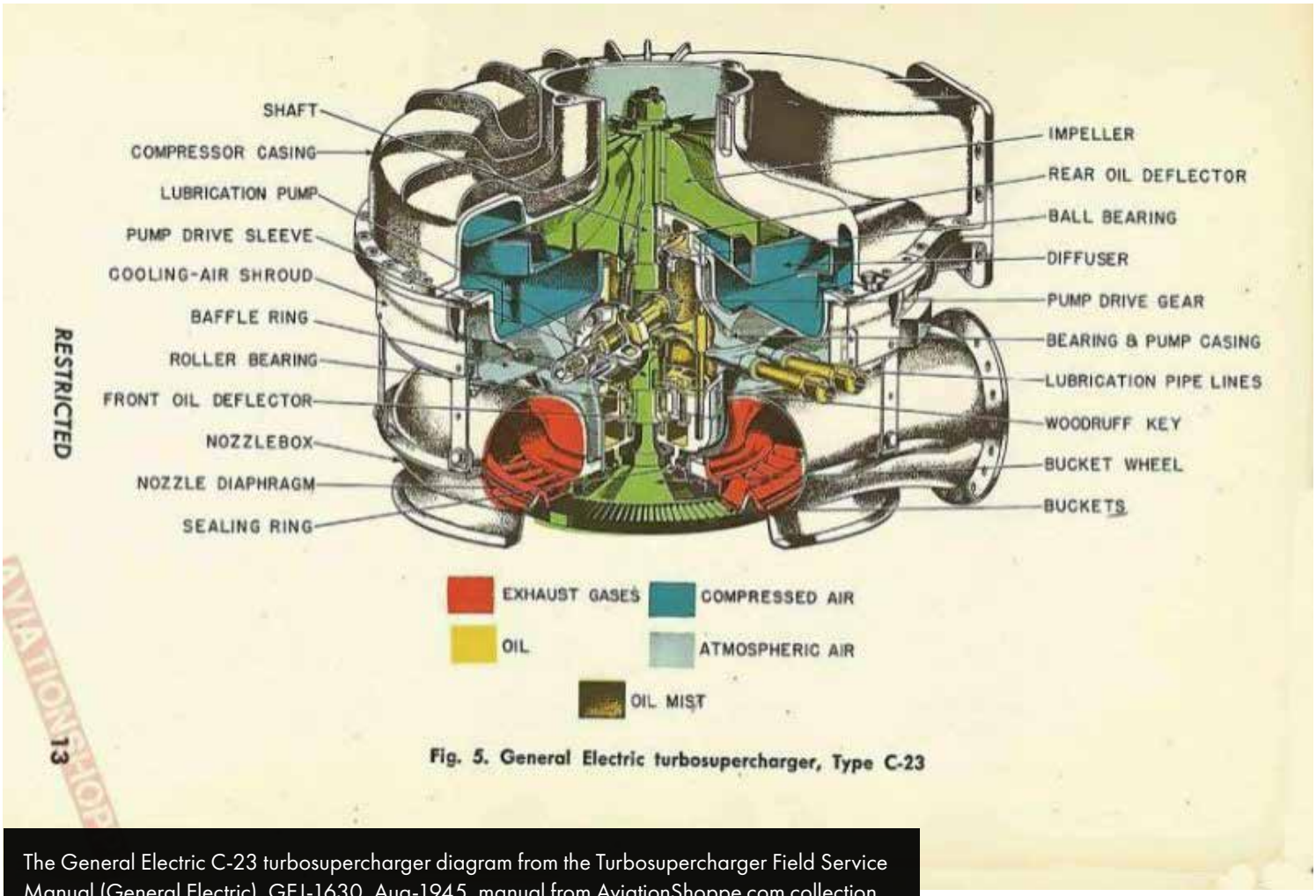
This diagram gives an idea of how the heat from the turbosupercharger was dissipated. Diagram from T.O. EX 00000 manual (Page G26)

The ideal air/fuel mixture for a normally aspirated gasoline internal combustion engine is around 14.7 parts air to 1 part fuel by mass. When an engine is supercharged, it can produce maximum power at a somewhat richer ratio of roughly 12.5-13 to 1. It is critical to always have sufficient air coming into the engine to maintain the correct ratio.

As an airplane climbs, the air becomes much thinner, and as a result, weighs less per unit of volume. The fuel volume also expands somewhat, but to a far lesser degree. At higher altitudes a larger volume of air must be pushed through the engine in order to maintain proper fuel/air ratio. This need for increased air volume is why the use of either a turbocharger or the second stage of a two stage supercharger is needed at altitudes above approximately 15,000 feet.

What Drives the Two Superchargers?

Superchargers need to be powered in some fashion by the engine, and most were directly spun by mechanical connection to the engine. The R-2800 in the P-47 has a single-stage, single-speed, centrifugal type supercharger connected to the back of the engine. But it also has the turbosupercharger. While a mechanical driven supercharger needs to utilize some of the power produced by the engine, the power it produces more than makes up for it. An exhaust driven turbosupercharger system produces some power consuming back pressure, but again, gains far outweigh losses incurred by driving the turbo.



The General Electric C-23 turbosupercharger diagram from the Turbosupercharger Field Service Manual (General Electric), GEJ-1630, Aug-1945, manual from AviationShoppe.com collection

The turbosupercharger is spun by exhaust gasses (red in the diagram) ducted to a "bucket wheel" in the lower half of the C-23 General Electric turbosupercharger. In turn, that bucket wheel turns the impeller. The impeller takes in cool air in the center and by centrifugal force spins it outward, pressurizing and pushing it out through ducting to the intercooler.

The Design Elements That Make a P-47 Look Like a Milk Jug

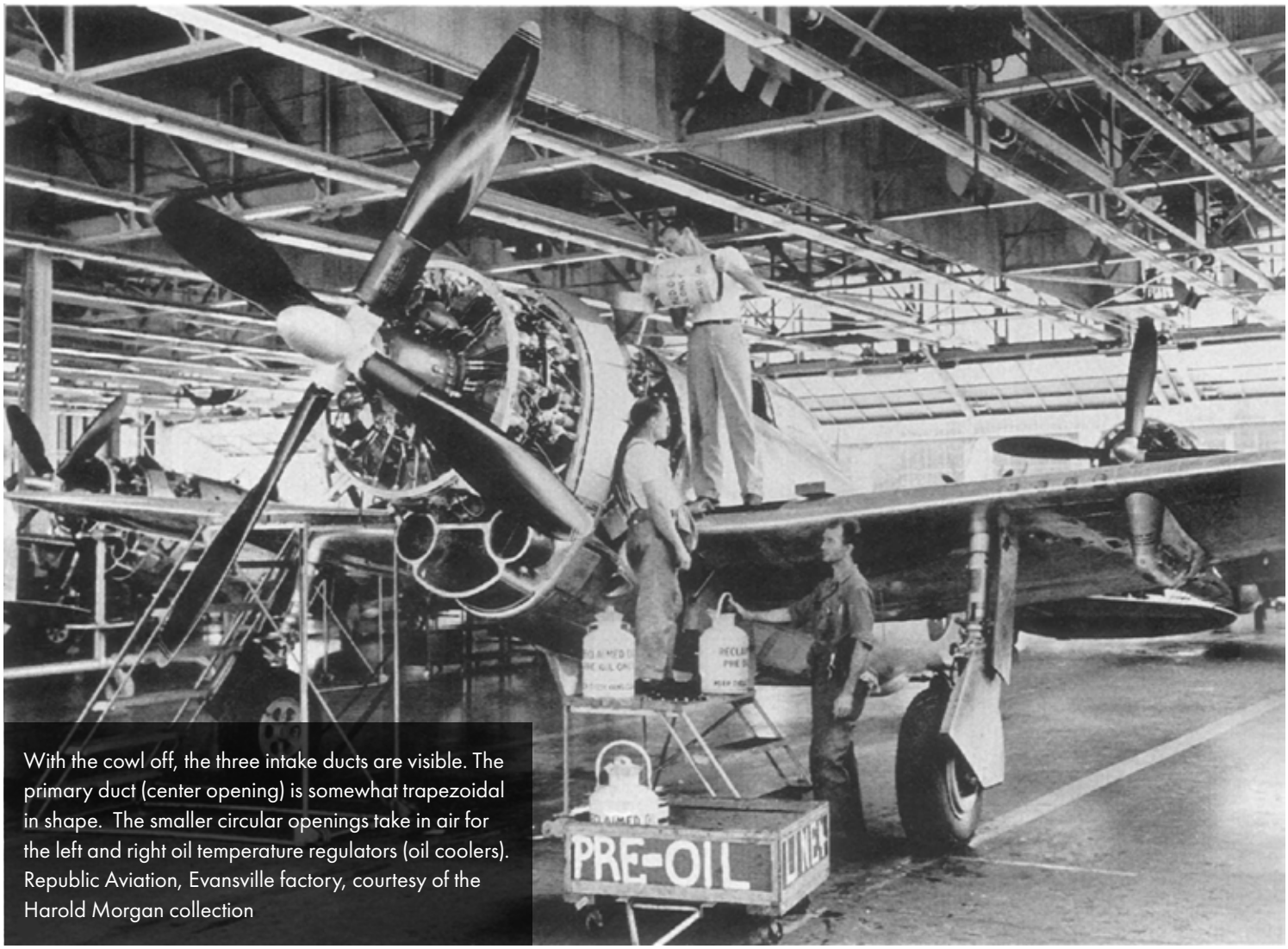
One nickname often heard attached to the P-47 is "Jug". The origin or the name is frequently disputed and otherwise explained. But one of the more popular origin stories is that the name came from the resemblance between the deep bellied Thunderbolt fuselage and a milk jug of the forties.

Forties era milk bottle

The milk bottle shape was part of the many design decisions made by Republic engineers, and was largely dictated by the turbosupercharger system in the P-47 fuselage. The oval cross section fuselage looks bulky because the belly curves from the engine back to the turbosupercharger. It was necessary to design it this way to allow room for the large R-2800 and the ductwork, intercooler, and turbocharger hardware enclosed within the fuselage.

The oval shaped cowl and curved belly are clear in this image. The air intake is the area at the bottom of the cowl. Republic Aviation, Evansville factory courtesy of the Harold Morgan collection

Even the unique ovoid shape of the cowl opening is related to the turbocharger. The main air duct intake opening is located in the lower cowl, so the cowl had to be designed around it. That's why the P-47 cowl isn't basically circular like other R-2800 powered fighters.



With the cowl off, the three intake ducts are visible. The primary duct (center opening) is somewhat trapezoidal in shape. The smaller circular openings take in air for the left and right oil temperature regulators (oil coolers). Republic Aviation, Evansville factory, courtesy of the Harold Morgan collection