

Hang That Engine

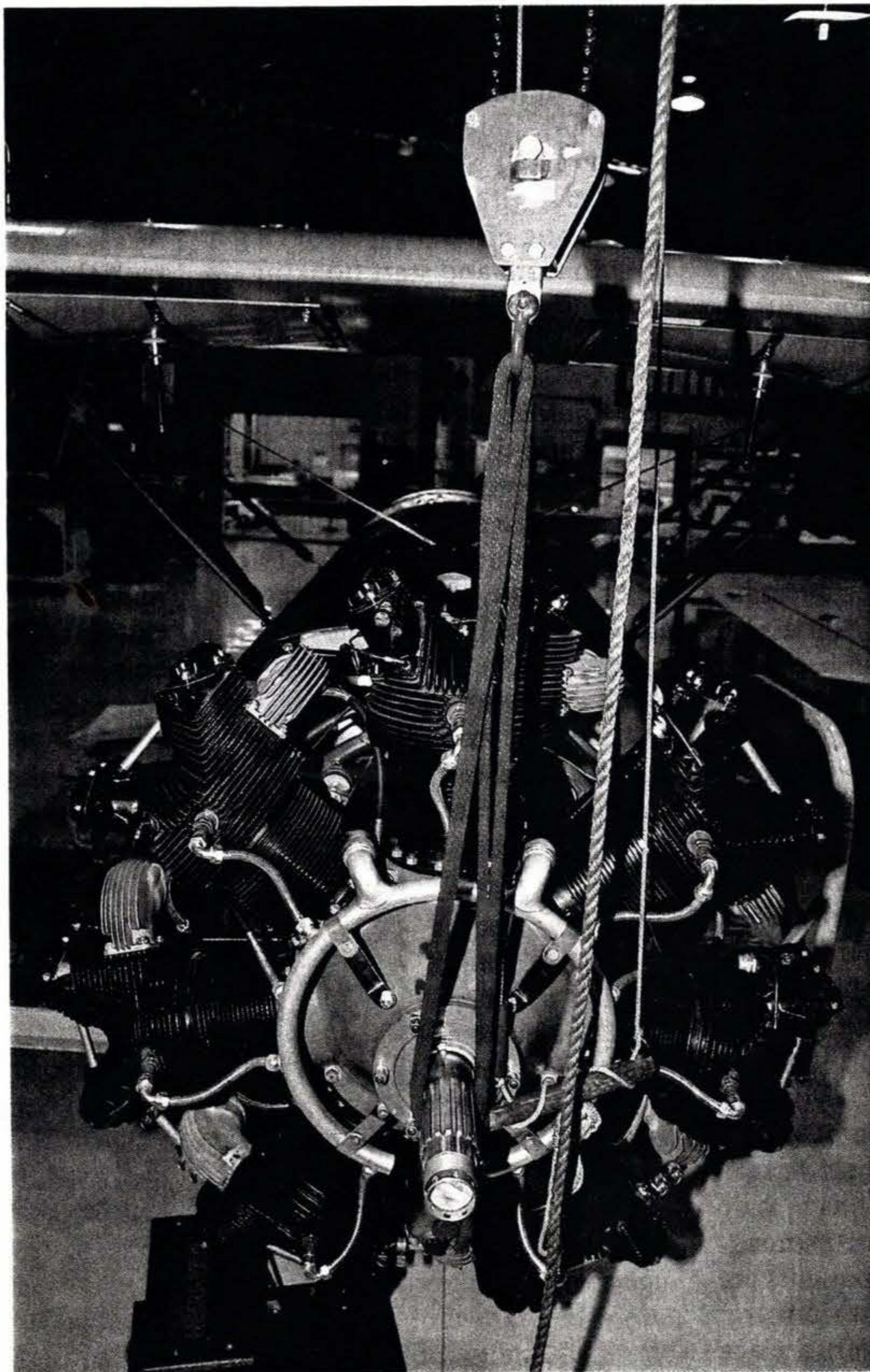
Marrying the engine and airframe

RON ALEXANDER

Now that the engine is hanging on the airframe all the hard work is done—right? Afraid not.

You've made your final preparations, and you're ready, finally, to hang that engine on your airplane and hook it up. The day of the first flight is not far away. So far in our series on engines we've discussed how to select an engine for an amateur-built airplane and what to do when your engine arrives at your shop, and we've itemized all of the items you should think about before installing the engine on the airframe. Now it's time to connect these two major components.

The big question is, How do you get the engine on the airplane? This requires some careful thought, and like everything else you've done on your airplane, you want to prepare for this properly. Think through what you are going to do before you start and follow these six steps.

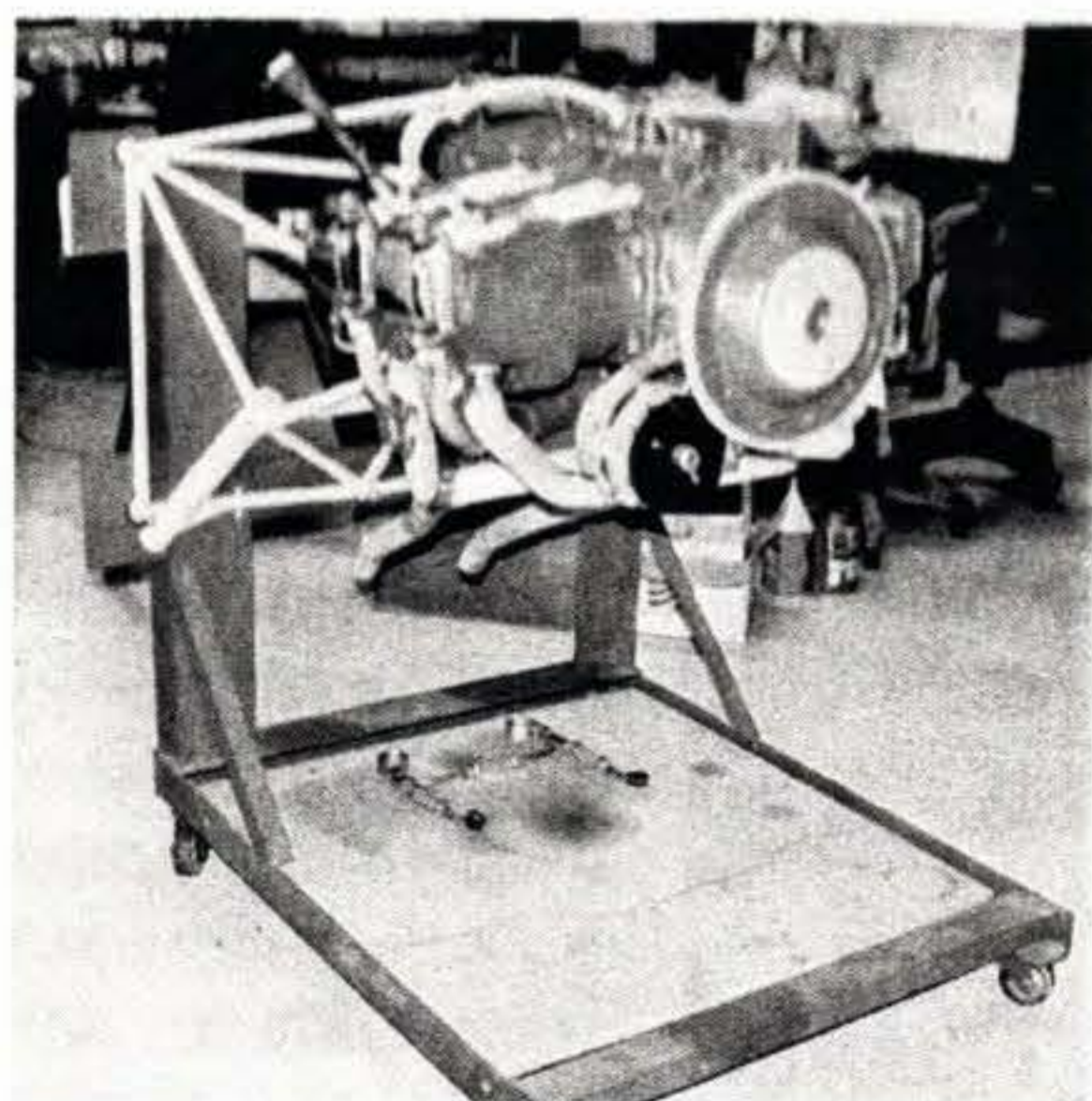


Step 1—Be sure you have mounted all the necessary components on the firewall, items like the gascolator, voltage regulator, etc. You may not have room to install these items once the engine is in place.

Step 2—For the same reason, make sure you've drilled all the necessary holes in the firewall. If you're building a composite airplane, be careful not to tear the Fiberfrax firewall material. Using a Unibit to drill the larger holes is handy. Make nice, clean cuts, and make sure you have the appropriate firewall grommets on hand.

Step 3—Pre-fit the engine mount to the firewall. Make sure everything is right, all the holes are properly drilled, and that you have the necessary hardware on hand.

Step 4—Install as many of the necessary engine accessories as possible to the back

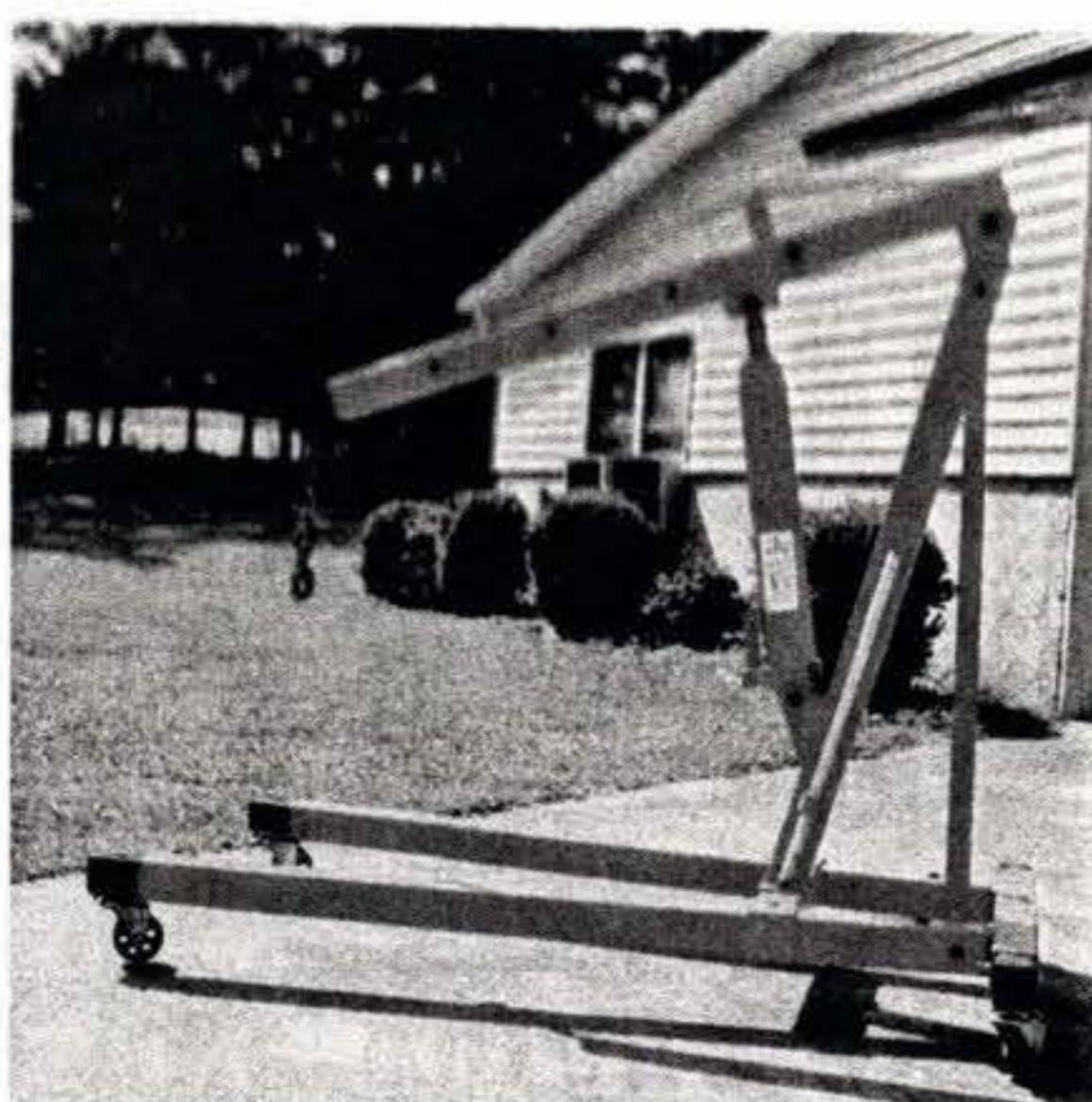


Mounting the engine to an engine stand will give you an opportunity to check the fit of the various fluid lines, controls, and electrical connections, and hook up components that will be hard to access once the engine is mated to the firewall.

of the engine. This will save you time, effort, and the frustration of trying to work inside a small area when the engine is attached to the airframe. And some of the items attached to the engine's accessory case may be inaccessible when the engine is on the airplane.

Step 5—With an engine hoist (or another means of lifting the engine) and plenty of help, raise the engine off its storage bed. Performing this step carefully is critical. Engines don't like to be dropped. Install the mount on the engine. Some engines are easier to install when the mount is already attached to the airframe, but, generally, attaching the mount to the engine first is easier because it allows unrestricted movement of the mount while you're attaching it. Be sure you have all of the mounting hardware and grommets on hand before you lift the engine.

Step 6—Bolt the entire assembly to the firewall. Again, make sure you have all the necessary hardware in easy reach before you start. If you're building a taildragger, attaching the engine/mount combination is easier if you put the airframe in a horizontal or level flight position. Nosewheel or taildragger, in any case you'll have to do some engine and airframe rearranging before the two components are perfectly aligned. Once they are, slide the engine mount into place



An engine hoist is indispensable for lifting a heavy powerplant. A few strong neighbors or husky fellow Chapter members would be helpful, too.

and secure it properly.

Now that the engine is hanging on the airframe all the hard work is done—right? Afraid not. The fun is just beginning. Now you must connect everything needed to operate the engine, but before you do, step back and look at your airplane. It finally looks like it might fly. Okay that's long enough. Now let's get back to work and start hooking up all of those fluid lines, controls, electrical connections, etc.

There's no set rule about what you hook up first. It's a matter of choice, and you can take the following steps in virtually any sequence, with a few exceptions. Installing the exhaust system is the primary exception because you'll have to route all cables, fuel lines, etc. around it.

Exhaust System

Attach the exhaust system to the engine. We discussed the types of exhaust systems and their proper installation in the August issue of *Sport*

On most horizontally-opposed engines, a lifting attachment provides a centered "hook-on" point for the hoist.

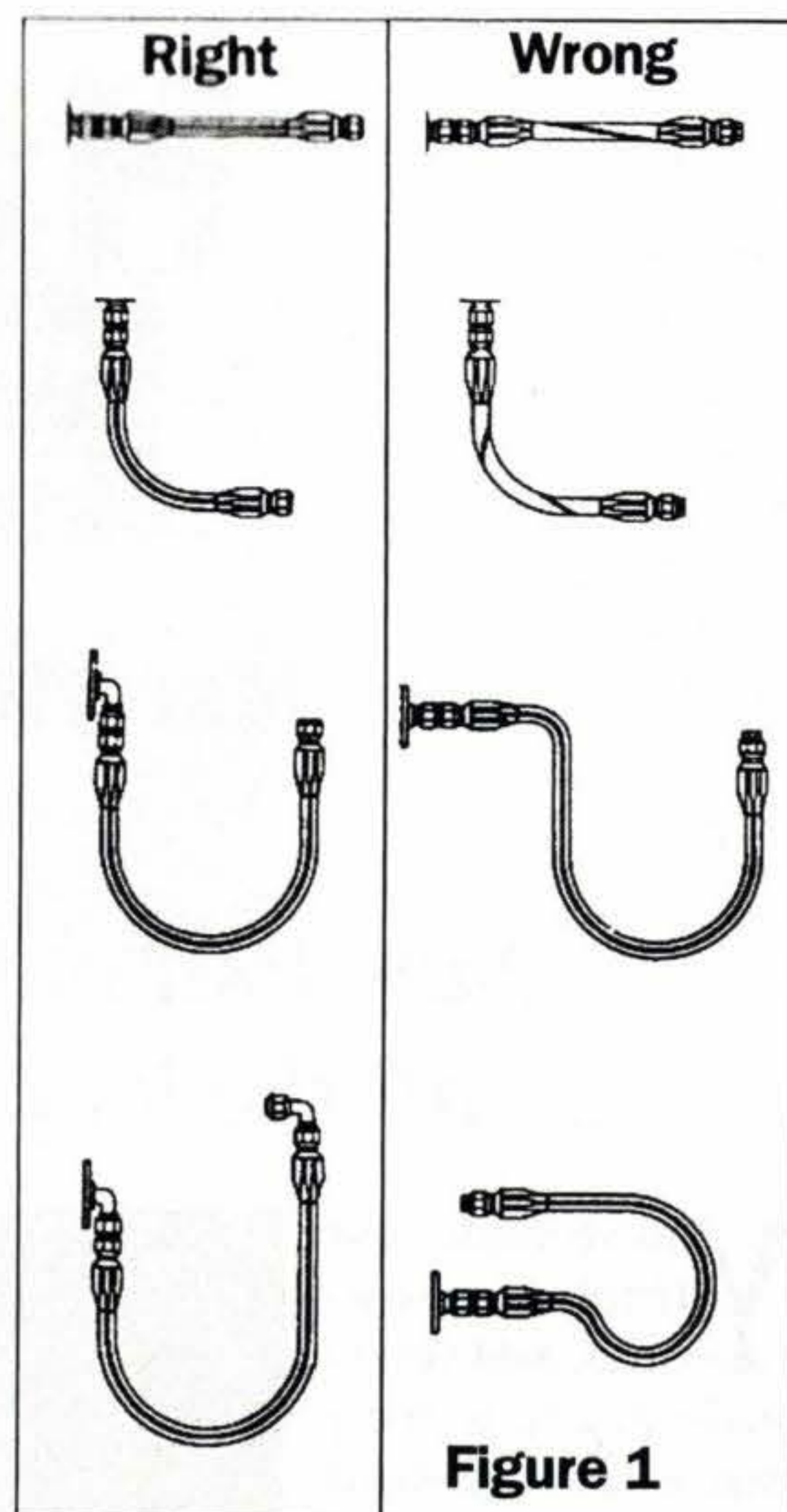
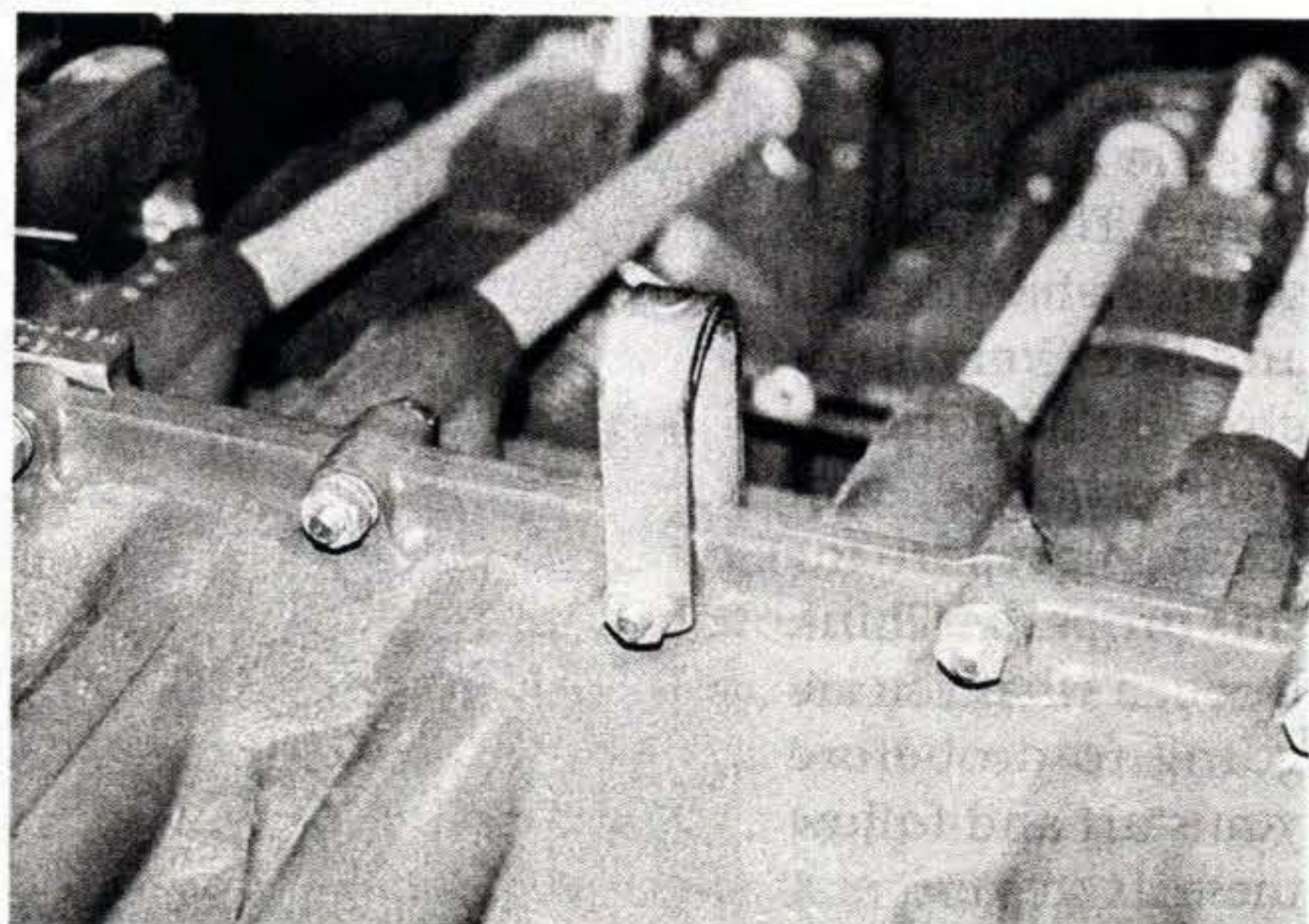


Figure 1

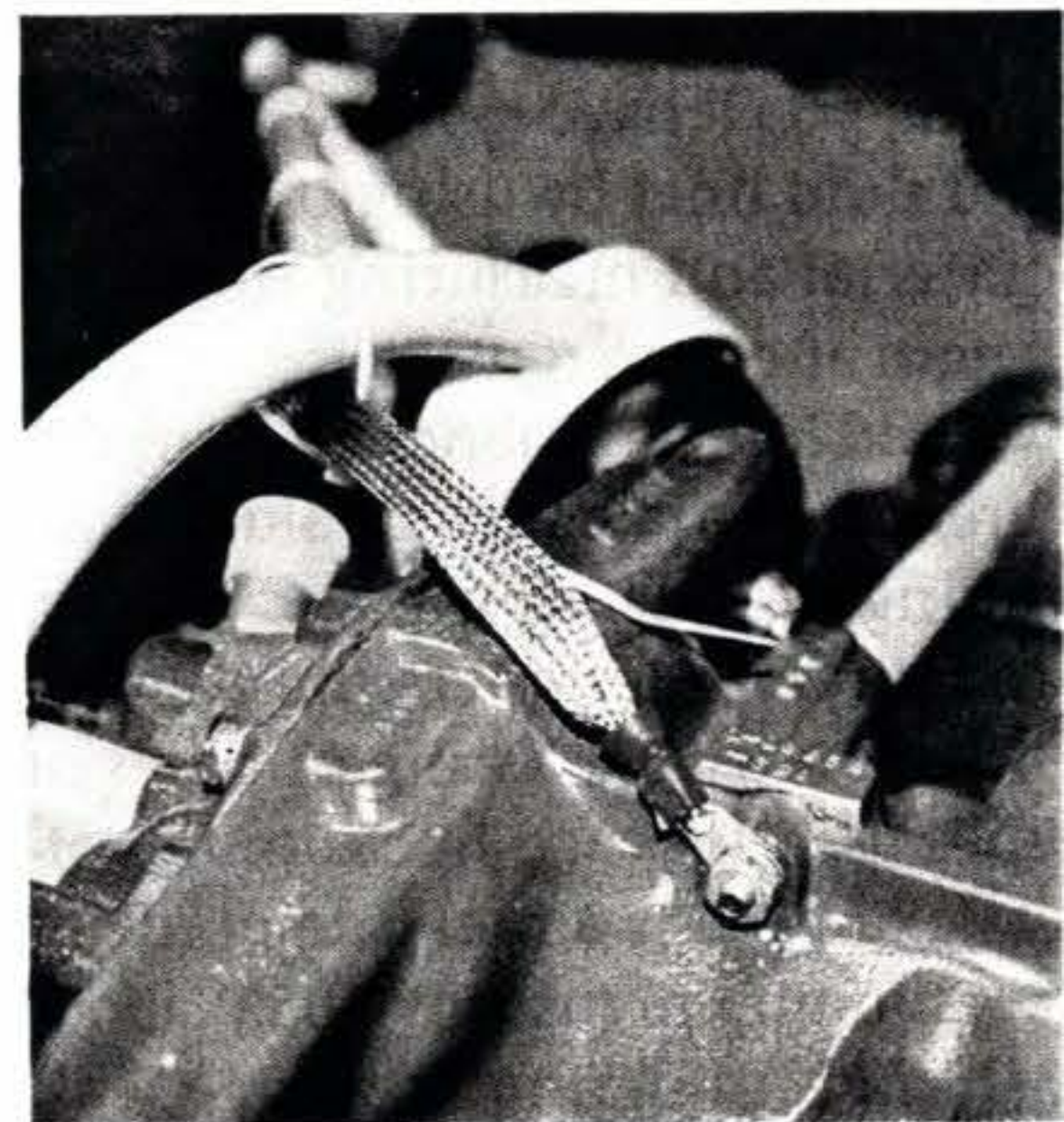
Aviation. Use the correct nuts to attach the system. Be careful not to damage the exhaust studs on the engine. Use an anti-seize compound when installing the nuts to make them easier to remove later. Thoroughly inspect all pieces of the exhaust system for any damage before you install them. Ensure that all piping is properly supported and routed. Long lengths of unsupported exhaust pipe invite problems. Use only new exhaust gaskets.

Fluid Lines

This job will be a lot simpler if you've purchased a hose kit from the manufacturer or another source.

system, you must route wires from the alternator, voltage regulator, starter, etc. to their respective locations. You can determine the size (gauge) and type of wire each application requires in Section 5, "Electrical Wire Rating," of FAA Advisory Circular 43-13, *Acceptable Methods, Techniques, and Practices*. The charts in this section show the wire size required based upon the length of the wire and the amperage passing through the wire.

Be sure to use only aircraft wire, and keep electrical wiring at least 2 inches from any exhaust pipe. Clamp all wires properly, avoid loose wires, and use crimped ring connectors at all terminals. The larger size wire will require a special crimping tool. Use Adel clamps to hold wiring in place, and clamp wires every 2 feet. The slack in wiring should not exceed 1/2 inch, and you can use cable ties where temperatures allow.



The engine grounding strap should electrically connect the engine with the firewall. Composite aircraft usually ground the engine to the battery.

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Engine Controls

Route all engine controls—throttle, mixture, propeller, carburetor heat, cabin heat, etc.—through the firewall to the correct component, and determine the proper length and routing *before* purchasing the control cables. Again, a number of kit manufacturers supply these controls ready made. Precut lengths are also available from supply houses.

Attach the actuator end of the control to the component with the appropriate hardware. Set the controls so that forward (in) is maximum power, full rich, etc. Then label it as such.

Ensure that the control is properly rigged. Usually this means that when the control reaches its maximum forward position the control knob is about 3/16 inch away from the panel. Make sure the control achieves the component's maximum and minimum setting.

Usually the control housing must be anchored at some point near the component part, and the mixture control is an example. A clamp or some other device must hold the cable in place near the carburetor mixture arm.

On certain engines you may want to hook up a primer system, and the Lycoming O-320 engine is an example. If you will be flying in cold temperatures, a primer makes start

ing the engine easier—if not necessary. Primer lines usually run from the primer itself to one or more cylinder ports.

Engine Breather

Engine breather ports usually pass droplets of oil, and a breather line carries them away from the engine compartment. Locate the open end of the breather away from the airplane and drill a relief hole a few inches above the open end. This hole keeps the engine from blowing out its front crankcase seal if the breather line becomes clogged. You can purchase a breather separator that removes the oil before venting the gases overboard. This device is usually mounted on the firewall.

Air Ducting

You'll need flexible air ducting for carburetor heat, cabin heat, and similar connections, using hose clamps to secure them. CAT and SCAT hose are the two most common types of ducting. CAT is black and limited to 300°F. SCAT is red and will withstand 450°F. Double wall ducting, CEET and SCEET, is also available, with SCEET having the higher temperature rating. The higher temperature hose is usually preferred in an engine compartment.

Magneto Timing

Timing the magnetos is easier with the propeller installed, but a word of caution: The magnetos are hot until grounded. Wire the magnetos to the cockpit switch—and make sure the magnetos are grounded before turning the propeller!

Use a small timing light—available from aircraft supply companies—to set the magnetos properly. An aircraft timing indicator is also available. This unit attaches to the propeller spinner with degrees written on the face of the unit and a small pointer.

The engine's timing data can be found on its data plate or manual,

and the maintenance manual should give you the timing details. Remember, when moving the propeller, treat it as though the magnetos are firing and the engine may start.


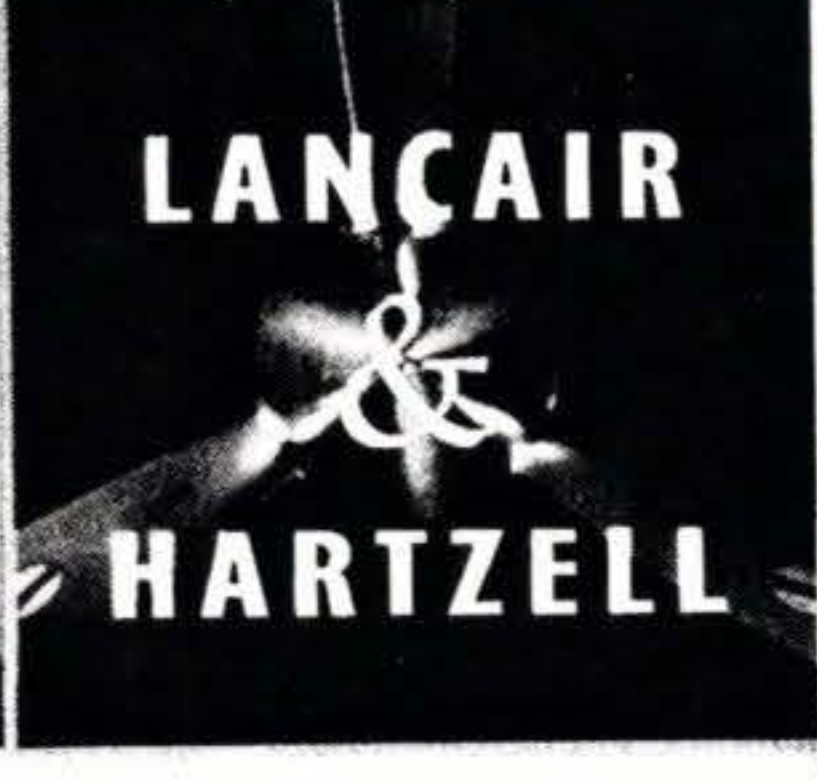
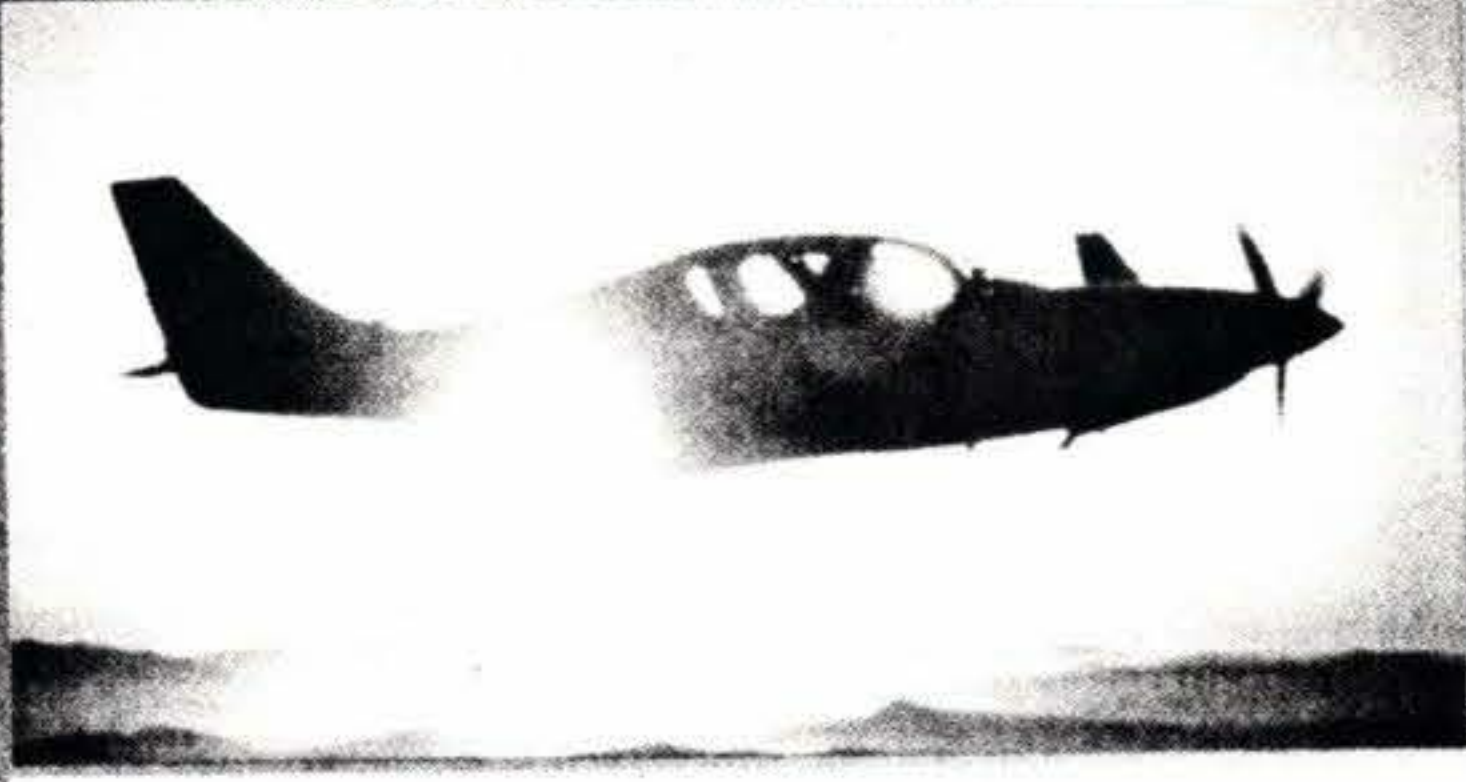
Tony Bingelis gives a good discussion on magneto timing in his book *Firewall Forward*. Briefly, you remove all spark plugs to ensure the engine will not fire and rotate the engine to find the compression stroke on cylinder number one. On a Continental engine the timing mark is usually on the propeller flange, and on a Lycoming it's on the starter ring gear. You rotate the engine into the timing mark and use the timing light to set the magnetos to the firing position. You'll need to make small adjustments on the magnetos to get it exactly right.

Spark Plugs


Most likely your engine will have dehydrator plugs. Remove

them and install the correct spark plugs. Inspect the plugs' overall condition and check for the proper gap. Put a new washer on the plug and apply an anti-seize compound designed for spark plugs to the threads, but do not allow it to contact the electrodes. By hand, screw the plug into the cylinder head as far as possible. If the plug will not turn easily to within a few threads of the gasket, you may have to clean the threads.

Using the proper size socket, tighten the spark plug to the torque value specified in the engine manual. This is normally around 30 feet per pound. Tighten each plug before proceeding to the next one. Insert the terminal assembly of the ignition lead into the plug and hand tighten. Then tighten using a wrench—usually about one-quarter turn. Go back and recheck each plug for security and tightness. If you drop a spark plug—replace it.




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While dehydrator plugs may have been installed in each cylinder to ward off moisture, your engine might also be filled with preservation fluid. Remove the plugs from the lower cylinders and drain the fluid *before* turning the crankshaft.

Inspecting & Safetying

As you work through the engine connections, carefully inspect the engine compartment for any loose connections, items not safetyed, components not connected, etc. Do this again when you think you've finished connecting everything. And then have another qualified person inspect your work. And then another one. Overlooking an important item is easy, and having as many qualified eyes searching for missed items increases safety. If you have questions about how to properly safety items, AC 43-13 has the answers.

Engine De-preservation

If your engine was stored using preservative oil, *do not rotate the crankshaft of a preserved engine until you remove the spark plugs!* The Lycoming Service Instruction letter on this subject warns that turning the engine before remov-

ing the plugs can result in a hydraulic lock that can damage the engine. The letter also warns that preservative oil should not contact any painted surface.

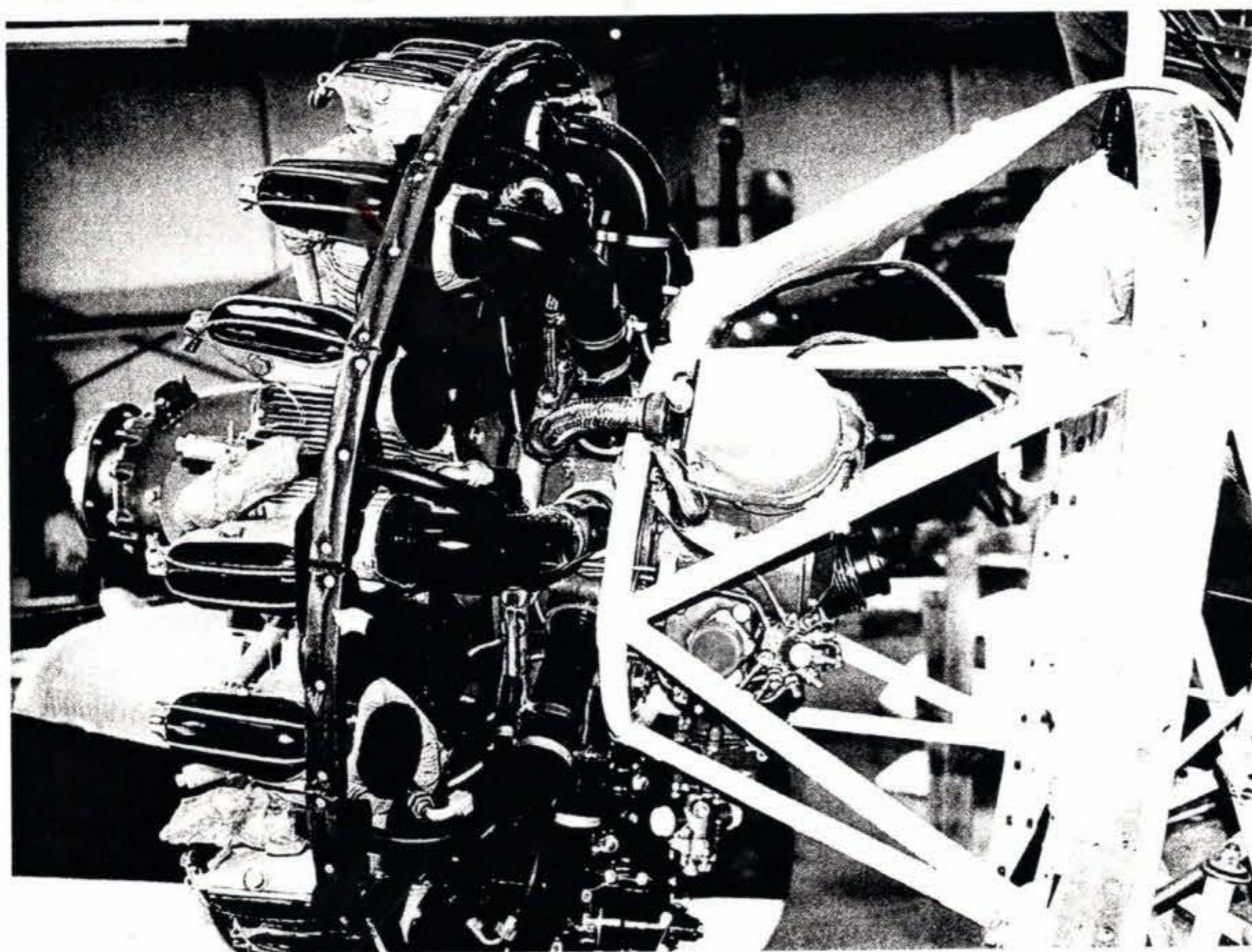
To remove preservative oil from the cylinders, remove the lower spark plugs and turn the crankshaft through three or four revolutions. The oil will drain through the spark plug holes. Next, drain the oil sump (installing a quick drain on your oil sump makes this and subsequent oil changes easier), flush the oil cooler, and remove and clean the oil screen. If your engine has one, install a new oil filter.

Preservative oil drains easier when the temperature is 70 degrees Fahrenheit or above. If needed, warm the engine with heat lamps before draining the preservative oil. After ridding the engine of all preservative oil, add the proper grade and amount of oil. Don't run the engine until you've added the oil recommended by the manufacturer. (Don't laugh, it's happened!)


Final Steps

Besides oil, before you can run the engine, you'll need to install the pro-

peller, and we'll address that, ground running the engine, and your first flight in coming months.




When mating the engine to the firewall, be sure you're ready with all the mounting hardware, then slide the engine mount into place and secure it properly.



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