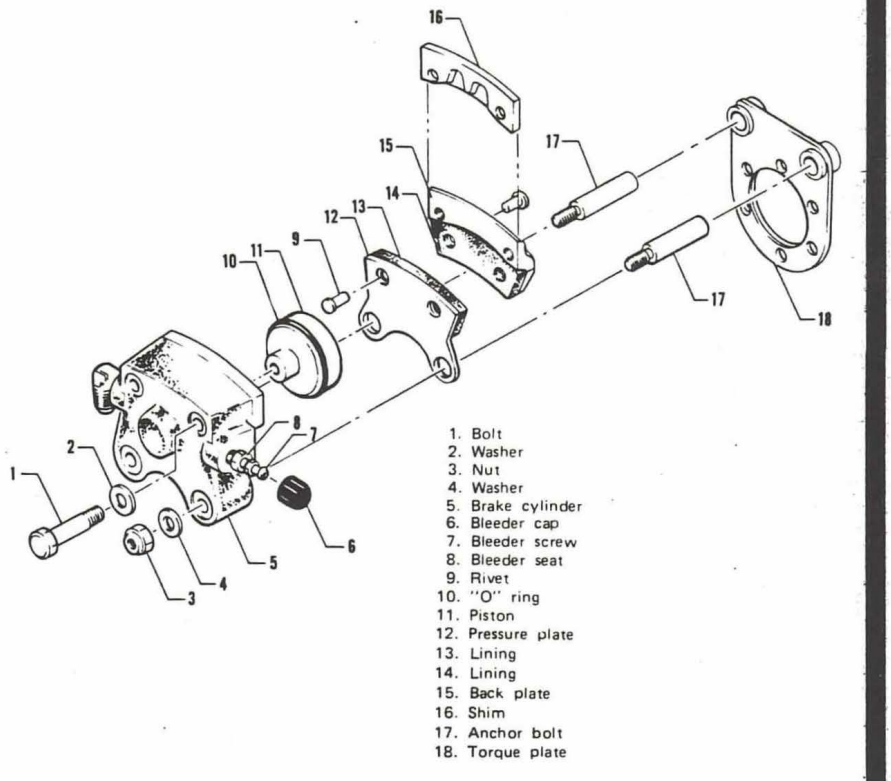
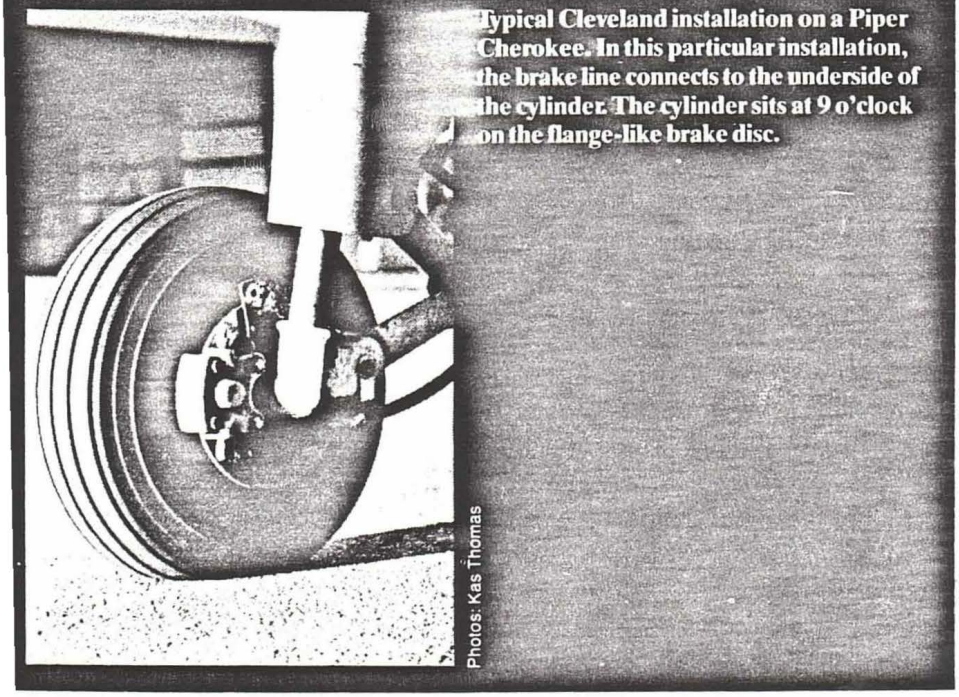
Reline Your Own Clevelands

Brake Puck Replacement is Easy, Economical

by Kas Thomas



1. Bolt
2. Washer
3. Nut
4. Washer
5. Brake cylinder
6. Bleeder cap
7. Bleeder screw
8. Bleeder seat
9. Rivet
10. "O" ring
11. Piston
12. Pressure plate
13. Lining
14. Lining
15. Back plate
16. Shim
17. Anchor bolt
18. Torque plate



Typical Cleveland installation on a Piper Cherokee. In this particular installation, the brake line connects to the underside of the cylinder. The cylinder sits at 9 o'clock on the flange-like brake disc.

Photos: Kas Thomas

ANYONE WHO HAS spent any time at all working on airplane brakes will have to admit one thing: Cleveland brakes (as made by the Wheel and Brake Division of Parker Hannifin Corporation) are certainly among the world's easiest to work on. Almost everyone loves Clevelands, if only because they're so simple!

In particular, the procedure for relining Cleveland brakes is disarmingly simple. In contrast to other aircraft brakes, relining a set of Clevelands does not involve jacking the airplane (or removing a wheel). Nor do any hydraulic connections need to be broken. (You can forget about bleeding the brakes afterwards.) In fact, on straight-leg Cessnas, the wheel pants don't even have to come off before you can do the job. From start to finish, the whole procedure takes only about 20 minutes, even less if it's not your first time.

The really nice thing abut relining a set of Clevelands, though, is the cost. The total parts tab comes to only about eight dollars for single-piston-type brakes, or less, if you shop around for the best deal on linings.

Suffice it to say that if your plane has Cleveland brakes, as two-thirds of all general aviation aircraft do, and if you are not doing your own brake relining, you're missing out on a great chance to save some bucks. You're also missing out on a great opportunity to get to know your plane better, something all of us should take time to do.

How the Brake Works

Before we go any further, it might be a good idea to say a word or two about the design and operation of Cleveland brakes. A typical single-piston Cleveland installation — such as you might find on a Cherokee or a Cessna 172—is shown in the accompanying "exploded view" drawing. Most of what we'll have to say here, incidentally, also applies to the McCauley disc brakes used on late-model Cessnas. The McCauleys are very similar to Clevelands.

It's not important that you understand the accompanying diagram in every detail. You should, however, take note of the following:

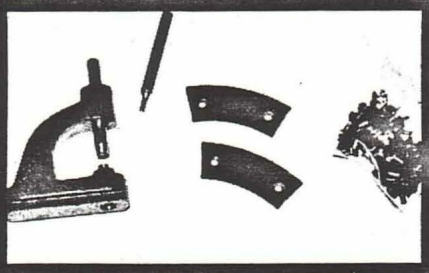
1. The torque plate (18) is rigidly attached to the main gear at the axle. It never moves.

2. The brake housing or cylinder (5) connects to the torque plate via two anchor bolts (17), or "anchor pins" as they are sometimes called. The cylinder assembly can move toward and away from the torque plate on the smooth anchor bolts, but the bolts prevent the brake housing from moving in any other way.

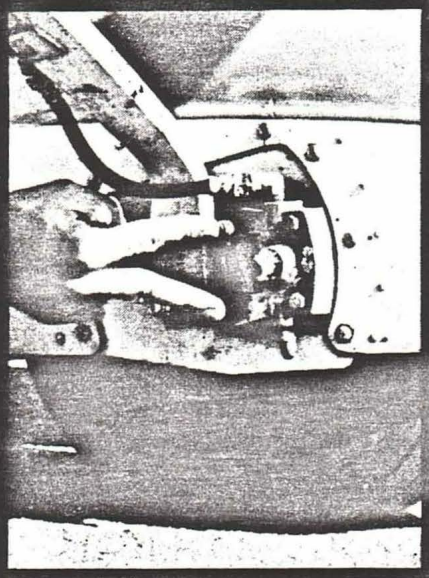
3. The brake disc (not shown in the diagram) is bolted to the inboard wheel half; its outer edge is sandwiched between the brake linings (13, 14), which, of course, grip the disc in caliper-like fashion to effect braking.

4. The brake linings, which may be either organic or metallic and are about a

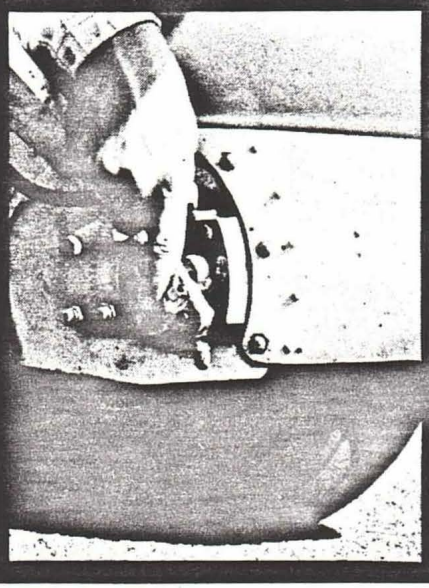
The lining material on this pressure plate has worn down so much that the rivet heads have begun to sustain abrasion damage. In time, the rivet heads would have sheared off.



To reline a Cleveland, you need a rivet-setting tool like the one shown on the left (widely available through mail-order outlets), a knock-out punch, a set of new linings, and a bag of brass 4-4 rivets.



When disassembling the brake from the wheel, do NOT loosen these nuts, which secure the anchor pins to the cylinder.



The housing through-bolts, which tie everything together, can be removed easily with a 7/16-inch socket and ratchet. Be ready to catch the back plate as you remove the last bolt.

quarter-inch thick when new, are attached to steel holders known as the back plate (15) and pressure plate (12). The back plate sits on the wheel side of the disc; the pressure plate goes on the airplane side. The only thing holding the back plate in place is a pair of through bolts (1), just one of which is shown in the diagram. Notice that these bolts terminate at the back plate; they do not touch the torque plate.

5. The pressure plate slides back and forth on the aforementioned anchor pins. In effect, the pressure plate is sandwiched between the brake disc and the brake piston (11) and cannot move unless the piston moves.

6. A hydraulic line coming from the cockpit master cylinder (not shown in the diagram) carries brake fluid to the back side of the piston. It is by means of this line that pedal movement in the cockpit is converted to piston movement at the wheel and, subsequently, braking action. Remember that this hydraulic circuit need not, and should not, be broken at any time during the relining of your brakes.

The Cleveland brake is nothing more than a big, caliper-like clamp that grabs the spinning brake disc to slow the wheel down, much the same way as the front brakes on a bicycle grab the front wheel to slow the bike down. Because the entire cylinder assembly is free to move in and out on its anchor pins, the pressure exerted by the pressure plate and the back plate is equal. Whenever the piston forces the pressure plate against the disc, the brake housing and everything connected to it (i.e., the back plate) moves in the opposite direction, in accordance with Newton's third law. This causes the back plate lining to wear evenly with the pressure plate lining.

If something happens to restrict the brake housing's movement (for example, if the anchor pins become caked with dirt and start to stick in their bushings), the back plate will stay stationary and the pressure plate will begin doing most of the work. Braking action will be impaired, and the linings on either side of the disc will no longer wear evenly. The way to avoid this is to make sure the anchor pins are kept smooth and clean at all times. You can check this by grasping the brake housing with one hand and attempting to shake it vigorously. You should be able to feel some give or play. If not, the anchor pins are frozen in their bushings. Dirty anchor pins are a common source of trouble with Cleveland brakes.

Judging Lining Wear

How can you tell whether it's time to reline your brakes? One thing is certain: you can't determine this from inside the cockpit. Your brake pedals will feel normal right up until the time the rivets shear and your linings fall off.

The only sure way to tell whether your linings have worn to the point where they need replacing is to examine them visually during preflight inspection. With Cleve-

lands, this is a simple matter of crouching down next to each wheel and eyeballing the back plate and pressure plate linings where they meet the disc. You don't even need to remove your wheel fairings to do this, unless you own a late-model fixed-gear Piper with full-length "wheel pantaloons."

Ideally, you should try to measure the thickness of your linings by comparing them with drill bits (or Allen wrenches, etc.) of known sizes. According to the Cleveland factory, linings are ready for replacement whenever they've worn to a thickness of 0.100 inches, which means that if you can insert a 3/32-inch Allen wrench between your brake disc and pressure plate, the old linings are ready to be dispatched to brake puck heaven.

Taking It Apart

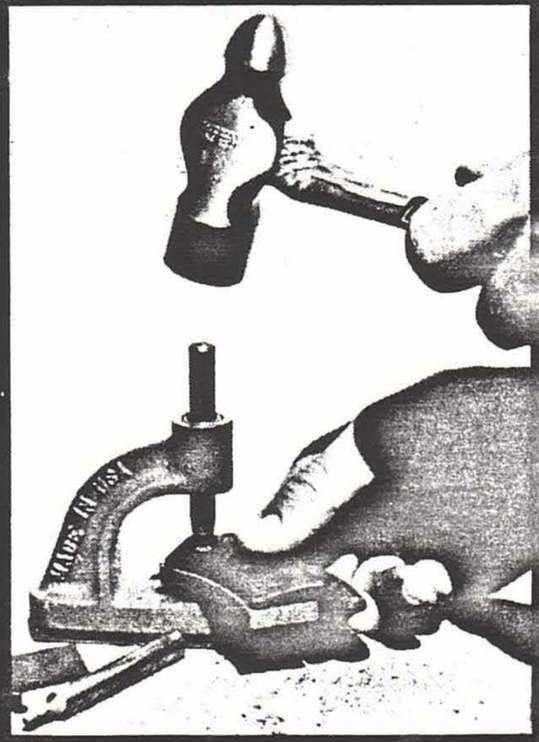
To get at your old linings, you're going to need to remove the back plate and pressure plate from the aircraft. This is very easy to do, assuming you can gain easy access to the brake assembly. Owners of certain late-model Piper and Cessna aircraft will have to spend a few minutes removing plastic fairing components (and/or whole wheel pants) before brake components will be accessible. Owners of pre-1978 Pipers can keep their pants on.

Start by unscrewing the two through-bolts that hold the back plate in place. Be sure your parking brake is off. There will be four such bolts if you are working on a dual-piston brake. For the purposes of this article, we'll assume your brakes are of the single-piston variety. Remove any safety wire that might be present in the heads of the bolts. Do not unscrew the nuts attaching the anchor bolts to the brake cylinder; leave these alone. As you unscrew the last through-bolt, be prepared to catch the back plate, and possibly also a shim, as it falls free. Set the back plate, and shim if any, aside for a moment.

Now pull the brake cylinder straight out of the torque plate, being careful not to kink the hydraulic line to which the cylinder is connected. Holding the cylinder assembly in one hand, grab the pressure plate with your other hand and slide it off the two anchor pins. Set the plate aside.

Before doing anything else, take a quick look at the brake cylinder. Are the anchor pins clean and free of corrosion? If not, wipe away dirt encrustations with an alcohol-soaked rag, and sand away any rust

Every time the brake is apart for relining, the piston should be pushed back into the cylinder (in the manner shown here) to ensure that the piston does not exceed its travel limit during the next in-service period.



When riveting a new lining to either the back plate (shown here) or pressure plate, it is a good idea to clinch the new rivets with numerous small blows of the hammer (rather than one or two sharp blows), rotating the plate assembly from side to side at the same time so that the rivet is clinched evenly. Always keep the lining side facing down, as shown.

with 400-grit sandpaper. Is the piston clean, with no evidence of fluid leakage anywhere? If leakage is evident, you may have a defective O-ring, which is reason enough to call a mechanic. Be sure to clean away any dirt that has built up on the sides of the piston. Dirt in this area will later be forced into the cylinder where it can cause rapid O-ring wear. Clean the piston and surrounding area with alcohol, if need be. Avoid using gasoline or dry-cleaning solvent, since these agents can swell and deteriorate the piston O-ring.

For the time being, slide the anchor pins back into their torque plate bushings, and leave the through-bolts in their holes in the brake housing. The main thing is, don't just walk away with the brake assembly dangling by the hydraulic line.

Lining Replacement

Lining replacement consists of nothing more than detaching the old lining pads from your back plate and pressure plate, and attaching new pads in their place. In the case of brakes employing metallic linings, this merely means snapping the old linings off and snapping new ones on (no special tools required). Most Cleveland installations, though, employ organic asbestos linings, which are invariably riveted to their holders. To deal with this sort of lining, you're going to need a riveting tool of the kind shown in the accompanying photographs. (You can order one for $10.95 postpaid from Dan-Air, P.O. Box 1626, Boynton Beach, FL 33435.) You're also going to need new brake linings, of course; the best thing to do is take your old linings to the local FBO and ask for identical replacements. Later, when you know what part number to order, you can purchase new linings in quantity from a discount supplier (such as Dan-Air) and save a buck or two per set of linings. But for now, when you need linings in a hurry, the best source is your local FBO.

To remove the old linings from your back and pressure plates, just place a plate on a work table with the lining side down flat, then center a 9/64-inch punch in one of the rivets, and give the punch several firm blows with a ball-peen hammer. Punch the remaining rivets out of both plates in this manner, and you will have liberated the old linings from the plates.

Next, take a new lining and position it on the pressure plate so that the countersunk side of the lining faces away from the plate, and so that the countersunk side of the plate's rivet holes faces away from the lining. In other words, align the new lining on the pressure plate in *exactly the position occupied by the old lining.* Now place fresh rivets (your FBO or mechanic can sell you the proper kind) in the holes. Remember that the head of each rivet sits in the lining; the tail of each rivet sticks through the plate.

Incidentally, if you find at this point that the holes in the new lining do not line up with the holes in the pressure plate, it means you've probably been sold the wrong type of lining. McCauley linings look just like Cleveland linings, in many cases, but have sightly different rivet spacing. Also, Cleveland makes several apparently interchangeable types of linings that, on closer examination, are not interchangeable. Be sure you have the correct replacement linings for your brake. If you have, or merely suspect you have, the wrong kind of linings, take them back and ask for replacements.

In order to rivet your new lining to the pressure plate, you'll need to place your rivet-setting tool in a vise, lay the plate/lining/rivet assembly in the jig with the rivet head facing down, insert the rivet-setting punch in the jig, and bring the tip of the punch down to the mouth of the rivet. Then, while holding the pressure plate firmly against the lining, begin tapping the punch firmly with a hammer. Give the punch several taps, while moving the lining/plate assembly back and forth so that the rivet is clinched evenly around its edges.

Repeat the foregoing procedure for the remaining hole(s) in the lining/plate assembly. Afterwards, check the lining carefully to see that it is tightly mated to the plate. Try to move the lining back and forth with your fingers. You should feel no give whatsoever. The trick in putting new linings

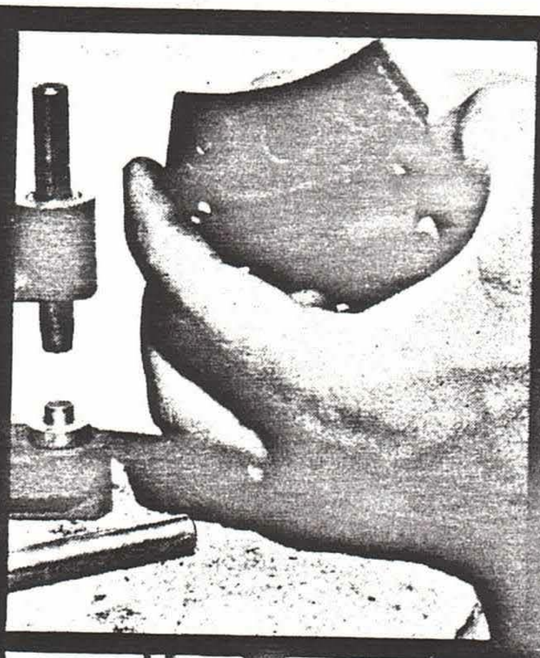
on is to clinch the rivets tightly enough so that all free movement between the lining and plate is eliminated, but not so tightly that the rivets or the lining begin to break. Have an experienced person walk you through this the first time if you're not sure what to look for.

Now that you've relined your pressure plate, go back and repeat the above steps for your back plate. Then stop and congratulate yourself: you've just relined your brakes.

Reassembly

Putting everything back together is almost as easy as taking it apart. The first thing to do (back at the wheel) is grab your brake housing and, applying pressure with your thumbs, press the piston back into the cylinder until it is nearly flush with the surface. Take care not to cock the piston over, creating a leak and possibly letting air sneak into the housing. If you are working with a dual-piston brake, plant one thumb squarely in the middle of each piston and press it in slowly, remembering that as you push one piston down, the other will want to pop up. The reason you are doing this is that during normal service the piston tends to extend further and further as the brake linings wear down, until, by the time the linings are worn out, the piston is nearly at the limit of its outward travel. If you fail to push the piston back in before reassembling your brake, you probably won't be able to reassemble it at all, since the extended piston and the larger clearances created by the new, fatter linings will very likely prevent the through-bolts from reaching the back plate. (Try it and you'll see.) But assuming you did succeed in reassembling everything without first pushing the piston back in, it's quite likely that after your new linings began to wear down your piston would exceed its limit of travel, at which point all the fluid would begin gushing out of the cylinder and braking action would be lost. So it's important to push that piston back in.

Assuming your anchor pins are relatively sanitary, place the pressure plate on the pins in the position it occupied before, plate facing the piston, lining facing the disc. Then put the pressure-plate/housing assembly back in its proper position on the wheel. (Tip: Spray the anchor pins with a



It's important to check the lining/plate assembly for proper rivet-hole alignment and absence of lining sideplay after the rivets have been clinched before assuming everything is okay. When you're done, all parts should fit tightly together with no evidence of damage.

Before reassembling everything for the last time, clean your anchor pins and give them a shot of silicone spray to keep them free in their torque-plate bushings. Clean anchor pins are essential for proper brake performance. Do not, however, lubricate these pins with oil, which will only attract dirt.

dry film lubricant before inserting them in the torque plate, to keep them free in their bushings. Do *not* lubricate the pins with oil, however. Oil attracts dirt, sand, and all the other junk that causes anchor pins to stick.)

All that remains is to assemble the back plate to the through-bolts. Just insert the bolts in the brake housing, place the back plate, and shim if originally present, in its proper position behind the brake disc and thread the bolts into the back plate. The latter step can be tricky if there's a wheel fairing in the way. Even if you have a wheel-panted Cessna, though, you will be able to install the back plate entirely by feel with a little practice. Tighten the through-bolts alternately until you reach 100 inch-pounds, or whatever torque your mechanic recommends. When you're done, both brake linings should ride against the disc, but the brakes shouldn't drag. Test this by pushing the plane forward a few feet. There should be no rolling resistance.

Naturally, if your through-bolts are of the drilled kind, you'll want to safety-wire them with MS20995 stainless wire when you're done. Have your mechanic show you the proper way of doing this, if you're not sure. Many Cleveland installations do not make use of head-drilled bolts but instead use a self-locking type through-bolt having a fiber insert in the tip. The latter is a special type of bolt that must not be replaced with a standard, non-drilled, non-self-locking AN counterpart.

Lining Break-in

At this point, you'll want to climb into the cockpit and feel your brake pedals to make sure everything is working properly. If it is, you'll then want to break in your new linings according to Cleveland recommendations.

Many pilots, as well as most mechanics, are completely unaware that Cleveland has established a break-in procedure for its linings. And yet,the fact is that if new organic linings are not conditioned before being put into service, a single hard brake application can carbonize the lining material and *prevent attainment of the required braking coefficient for the life of the linings*, which won't be long, since carbonized linings seldom live to a ripe old age.

Call ground control and tell them you'll need to make some extended taxi runs. After you get the okay, begin a 25 to 40-mph straight-line taxi, then brake to a stop using light pedal effort. Allow the brakes to cool for a moment. Start another 25 to 40-mph taxi, and once again, using light pedal pressure, brake to a stop. Let the brakes cool briefly.

Run through the brake/cool/taxi cycle a minimum of six times. This procedure generates sufficient heat in the linings to cure the resins in them, but will not cause enough heat buildup to cause carbonization.

The foregoing procedure is good only for organic, asbestos-resin type Cleveland linings. It is not for the metallic linings. To break in a set of metallic linings, it's necessary to perform three consecutive hard brakings from a taxi speed of 45 mph (approximately), allowing no significant cooling between stops. This has the effect of glazing the surface of each lining, preventing uneven wear and, possibly, brake-disc scoring.

The important point is this: Don't overlook these break-in procedures, regardless of whether you reline your own brakes or have a mechanic do the job for you.

For More Information

If you need additional information on relining Cleveland brakes, go straight to the source: write the Aircraft Wheel and Brake Division, Parker Hannifin Corporation, P.O. Box 158, Avon, OH 44011 (or call 216/934-5221). While you're at it, enclose $2.00 and ask for the Cleveland catalog, which contains many fine illustrations and an excellent section on brake maintenance. If the information you need isn't in the catalog, or in the various technical bulletins published by Parker Hannifin, there's a good chance it just doesn't exist!

(Editor's note: Kas Thomas is author of the forthcoming McGraw-Hill book Personal Aircraft Maintenance: A Do-It-Yourself Guide for Owners and Pilots, *from which this article is adapted.)*