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Cleveland Brake Inspection and Relining

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by Kas Thomas

Aviation is a robber-baron's paradise, and you often hear pilots complain of the virtual monopoly enjoyed by the Big Two engine manufacturers (and to some extent the propeller makers and airframe factories); but you seldom, if ever, hear anyone carp about "the Cleveland brake monopoly"—even though Cleveland's market share (65 percent of the single-engine fleet or better) amounts to a virtual stranglehold. Pilots not only don't complain about Cleveland having a near-monopoly, they actually seem to *enjoy* Cleveland's choke-hold on the brake market. And no wonder. The product is well-designed, easy to care for, and priced as if the Pope were in charge of marketing rather than J.P. Morgan.

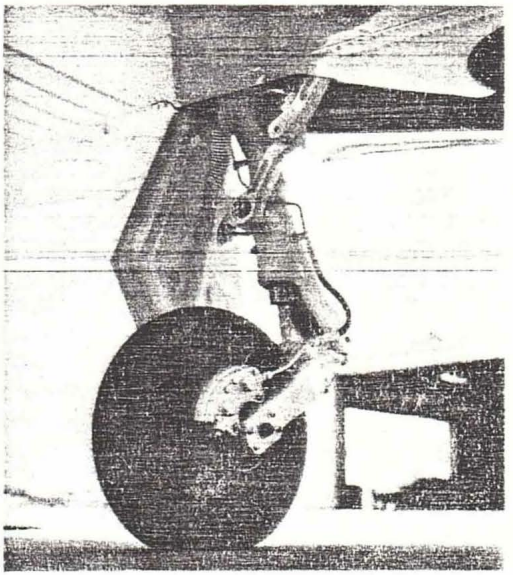
Even a product as well-behaved as a Cleveland disc brake needs *some* maintenance over the course of its useful life, however. After all, even if the discs don't pit, the brake pads are sure to wear down eventually (they're designed to). That's where a little owner know-how can begin to pay big dividends. If you know how to reline Cleveland (or the functionally identical McCauley) brakes yourself, you can pocket $30 to $50 in maintenance savings with each pad change. If you know how to *break in* new pads correctly (something most pilots don't know), you stand to get even more life out of your brakes. Understanding the fine points of Cleveland operation can make a difference in operating costs even if you never do any adjustments yourself.

How Clevelands Work

The Cleveland (McCauley) brake is of the floating-caliper, single-disc type. Various models may differ in the number of pistons and pucks (and the shape of the linings), but they all work the same. You can think of the Cleveland as a giant caliper-like clamp that grabs the spinning brake disc to slow the wheel, much the same as the front brakes on your car. Some terminology that will prove helpful later:

The *brake housing* (cylinder, casting) is where the fluid from your brake plumbing ultimately does its work. Within the housing is a *piston*, which moves outward against a *pressure plate* when you step on the toe brake in the cockpit. The pressure plate, in turn, is riveted to an asbestos *lining* which bears on the spinning brake disc. On the other side of the disc, there is an equal-but-opposite lining (or *pad*), riveted to a special holder called the *back plate*. The back plate is attached to the brake housing by two *through-bolts*. There may or may not be a *shim* between the back plate and disc, as well.

Note that (as said earlier) the Cleveland brake is a *floating caliper.* What this means is that the brake housing is *not* rigidly bolted to the torque plate at the wheel, but instead is secured loosely by a pair of *anchor pins* which are parallel to the wheel-axle axis and *on which the housing is free to slide in and out,* toward or away from the wheel (and disc). This floating action is necessary to allow the pads to wear evenly on both sides of the disc. If the single-piston housing were bolted rigidly to the landing gear, only the pressure-plate lining would wear down. You'd need a separate piston (and plumbing), with a *second* pressure plate in back of the disc, to achieve equal wear on both sides of the disc, and even then both pistons might not move the same amount



Cleveland caliper should be checked on each preflight, not just for lining thickness but for free-floating action. Badly rusted or scored disc is "no-go."

(besides which, you've created a plumbing nightmare). For compactness, ease of installation, and all-around ease of maintenance, nothing beats the single-piston floating caliper design.

The problems begin when a Cleveland caliper for one reason or another *loses* its free-floating action. How might this happen? Easy. Let a little rust develop on

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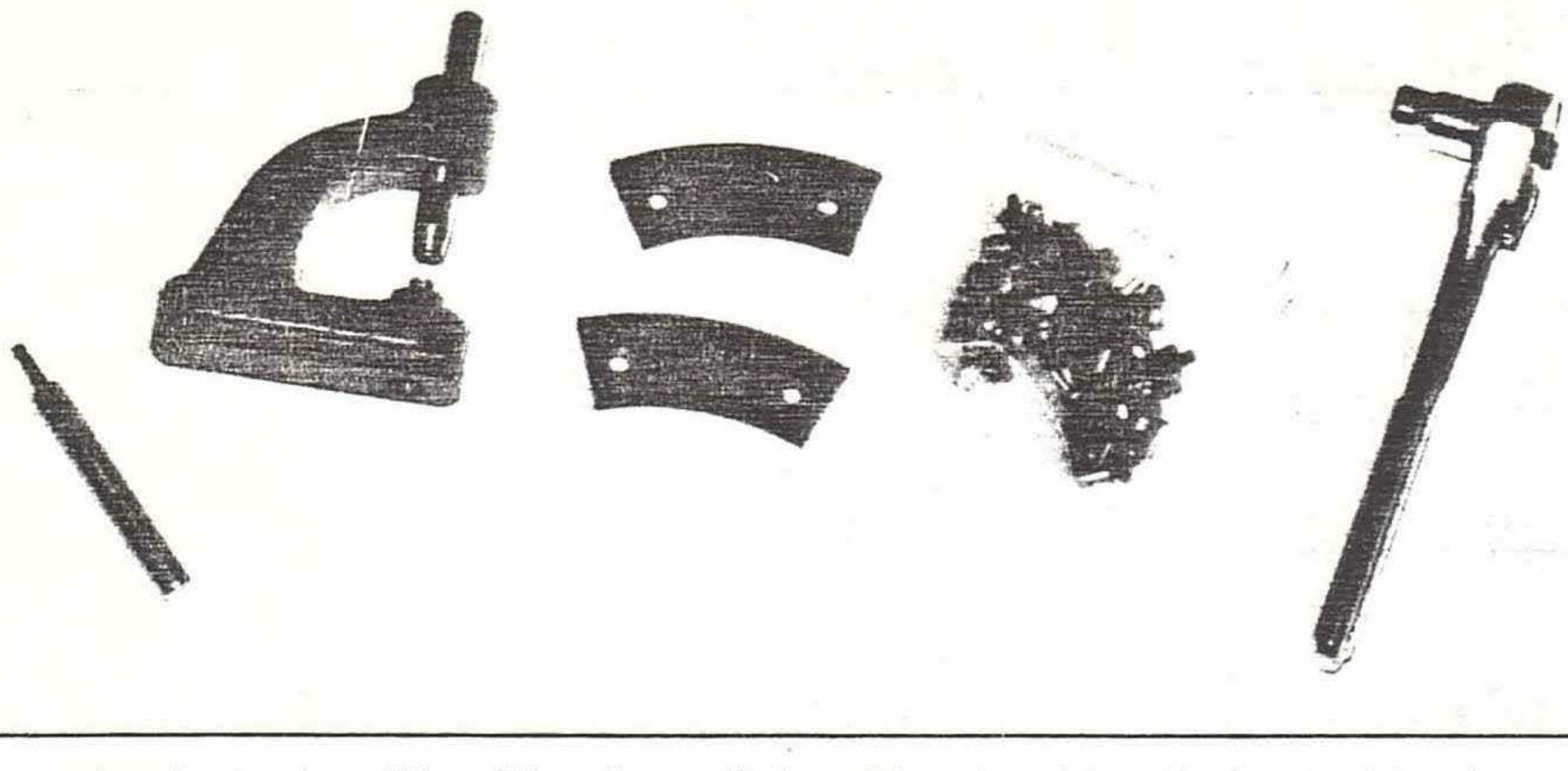

A few simple tools will suffice for relining Cleveland (or McCauley) brakes. Organic linings are $10 to $12 a pair—less if you buy in quantity—and the rivet-setting tool shown here is available from many mail-order outlets (Wag-Aero, ACI, ATS, etc.) at prices ranging from $8.95 to $12.95.

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those anchor pins, or let dirt, brake dust, etc. accumulate inside the pin bosses, and all of a sudden the caliper won't slide back and forth that critical fraction of an inch any more. Now the back plate will remain stationary while the pressure plate does all the work. The pad on the housing side of the disc starts wearing down faster than the back-plate lining, braking action is poor, and stresses concentrate at the base of the anchor pins as the fixed caliper tries to push away from the wheel. (This is a classic crack-forming area on a Cleveland brake casting.) If you've been wearing pressure-plate linings at twice the rate of back-plate linings, now you know: your problem is frozen anchor pins. Keep the pins clean and give them a shot of dry-slide-type lubricant (not grease or oil) periodically, and you won't have this problem.

This is something to check, in fact, on every preflight. If your brake caliper is easily reachable (many late-model wheel fairing designs make this difficult), kneel down and *grab* the brake housing, and try to shake it vigorously, on the walkaround. If you can feel a slight chatter or movement—not much; just enough to reassure you that the caliper is free—you can consider the brake airworthy (or taxiworthy). If the brake housing has no "give" at all—shows no movement whatsoever—stop and lube the pins.

Linings: What to Look For

Another item that should be on your daily walkaround is brake linings. It's amazing how many pilots fail to check for worn or cracked linings before getting into an airplane. Most pilots don't even know the go-no-go thickness limit for Cleveland linings. (It's a tenth of an inch.)

Again, crouch down next to each main wheel on the walkaround, and peek at the linings (they're not hard to find, since they're rubbing against the disc). Keep a 3/32" allen wrench in your glove compartment, and use the wrench as a go/no-go feeler. When a lining—any lining, be it front or back—wears to 3/32" thick, pronounce it dead at the scene and refuse to taxi the plane until *both* linings for the brake in question are renewed. (Never replace just one lining.) Likewise, if a lining is developing cracks—or looks questionable for any reason—ground the airplane momentarily while you change linings (see below). Riding on thin linings is extremely treacherous, because when the pad wears much below a tenth of an inch, the rivets holding it in place are exposed and can be sheared or melted off by the brake disc—leaving you suddenly without a brake pad.

How long should a set of pads last? Somewhere between 100 and 200 landings, minimum. If you're not getting this kind of longevity from your linings, take a look at your discs. (Once more, down on your knees.) Heavy scoring or rust pitting will, of course, cut your pads to shreds in no time, since the pad material is relatively soft. Light rusting is nothing to be concerned about—the rust will rub off with your first hard brake application—but heavy rusting acts like sandpaper on linings, and depending how bad it is, you may get only 10 or 20 hours of flying between pad replacements. There's nothing unsafe about this (as long as you do a good preflight inspection and are willing to put up with the cost and inconvenience of frequent pad removal). But eventually you should bite the big one and buy new discs. If you fly infrequently or are based in a high-corrosion environment, invest in a set of Cleveland Chrome discs (which at about $140 are just $30 or $40 more than standard discs). *Do not install stainless steel discs.* Stainless steel absorbs heat at less than half the rate of ordinary steel,

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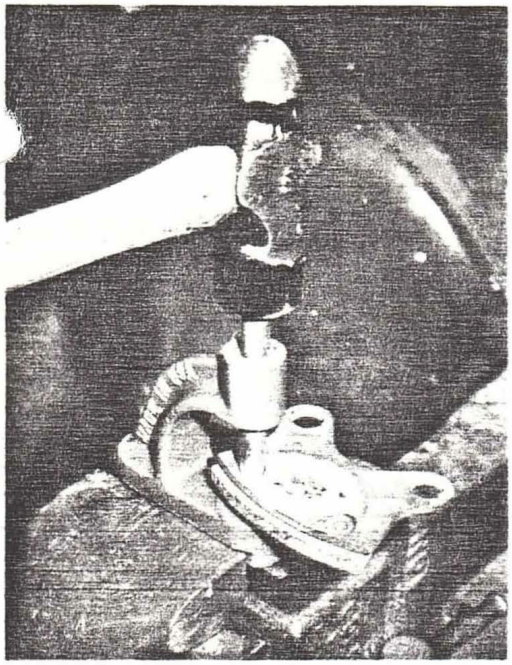
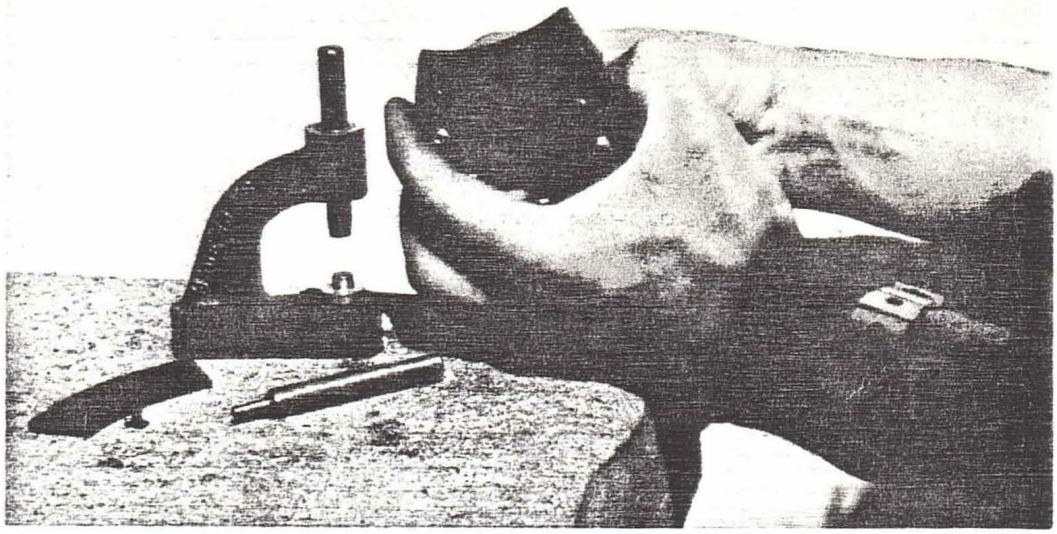


Riveting the new lining to the pressure plate calls for 10 to 20 medium blows from a 10-ounce ball-peen hammer. The assembly should be rotated from side to side while hammering, to clinch the rivet head evenly.



Check the lining/plate assembly (here, the back plate is shown) for snugness at frequent intervals while clinching rivets. When finished, the lining should have no "give."

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with the result that in a heavy braking situation, the heat of kinetic energy is reflected to your linings, which are not a big enough heat sink to take the thermal load. With one heavy brake application, you'll literally *bake* (and break) your linings with stainless discs. So buy chrome, not stainless.

Can pitted discs be turned down and reinstalled? Yes, but there are definite go/no-go thickness tolerances for each Cleveland disc P/N (check the table of tolerances in your Cleveland manual —ordering instructions below) and if you take too much metal off you'll have to retire the disc. Can a too-thin disc be chromed back to normal thickness? Yes, but to stay legal you need an STC. Several shops around the country have obtained STC approval for chroming old brake discs (among them, Engineering Plating and Processing, Inc., 641 Southwest Blvd., Kansas City, KS 66103). For a list of applicable aircraft and brake models, consult the FAA's *Summary of Supplemental Type Certificates* (your mechanic should have a copy) or contact your owner's organization.

Lining Replacement

Lining replacement is a grey area where preventive maintenance and the FAA are concerned. Obviously, you have to remove the brake caliper from the disc in order to replace a tire, and the FAA says you *can* replace a tire for preventive maintenance purposes. But when it comes to riveting new linings onto their holders, you're on your own. To play it safe, you should get an A&P's signoff. (If it's your first time through, of course, you'll want an A&P on hand anyway.)

The procedure is simple enough for any ten-year-old, in any case. You'll first need to uncouple the two halves of the caliper—i.e., the housing and the back plate—from the disc or wheel; this is a simple matter of undoing two through-bolts, for a single-piston Cleveland such as found on most light single-engine planes (four through-bolts if it's a dual-piston installation a la Bonanza). Obviously, if you own a late-model straight-leg Cessna or Piper, you will need to first spend a minute or two removing plastic wheel fairings in order to expose the brake. Owners of pre-1978 airplanes can generally keep their pants on, however, since it is possible to get the linings off *without* de-panting an older Skyhawk, Skylane, etc.

Crouching at the wheel—with the parking brake *off*—look for the two bolts connecting the brake housing with the back plate. The bolts are blind-hole types (not nutted) and may or may not have safety-wired heads, depending on the exact installation. (McCauley brakes, which are little more than a Chinese copy of Clevelands, more often than not use head-drilled through-bolts. See, for example, any Cessna Cutlass RG.) If the heads are not drilled and safety-wired, the bolts are self-locking and on removal you'll be able to see nylon inserts in the threaded end.

If you're unsure what you're looking at, bear in mind that the anchor pins are attached with nuts at the housing, and you *do not* want to undo these nuts. What you want are bolt heads, not nuts. The through-bolts on most Clevelands have 7/16" heads, so whip out your 7/16" box or socket wrench, and search the brake housing for two bolt heads that will fit it. (Clip any safety wire that is present—but not before studying it to see how, exactly, the old wire was run.)

As you undo the through-bolts, be prepared to catch the back plate (and possibly a shim) as it falls free. Then grab the brake cylinder and—without exerting undo side force on any plumbing—pull it straight away from the wheel. This may take some careful jiggling and prying, especially if metallic (rather than flexible rubber) plumbing is present. You shouldn't have to undo any hose attachments. If in doubt, call in a mechanic before proceeding further.

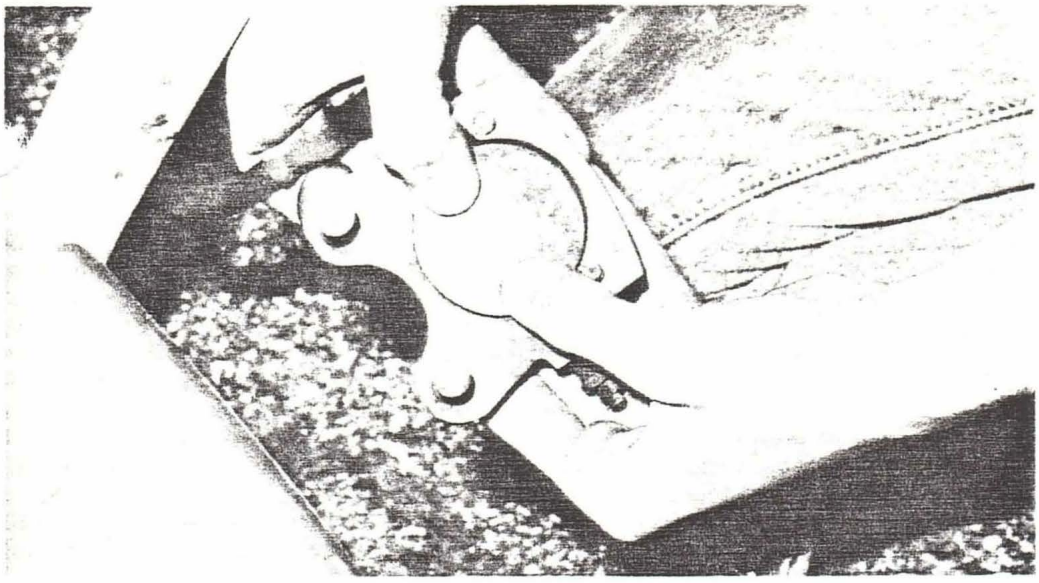
With the brake housing in one hand, reach for the pressure plate and slide it straight off the two anchor pins. Set the plate aside.

How about that brake cylinder? Are the anchor pins clean? (If not, tidy them up with fine sandpaper and/or an alcohol-soaked rag; then follow up with a shot or two of G.E. Silicone Spray or equivalent dry-slide lube. Graphited aerosols are okay; WD-40 is not.) Is the piston clean and dry around the sides? You can and should clean dust and grit away with an alcohol-soaked rag (CAUTION: Do not use unapproved solvents which could damage the piston O-ring), but if any red brake fluid is evident, the piston may be cocked and you should call in a mechanic before proceeding.

If everything is sanitary, temporarily slide the housing back into the torque plate (don't leave it dangling by the plumbing) and put those through-bolts back in their holes where they won't get lost.

Riveting

The idea at this point is to gather up the pressure plate(s) and back plate(s), knock the rivets out, throw away the old linings,



Before reassembling back plate and pressure plate to the wheel, press the brake piston back into the housing with thumb pressure (evenly applied to both sides of piston). Do not cock piston over.

Give anchor pins a shot of dry-film lube (G.E. silicone spray or equivalent) every now and then to keep the caliper "free-floating" and thus allowing brake linings to wear evenly.

and rivet new linings in place—then reinstall everything in reverse order of what went before. To do this, you'll need a few tools and supplies—about $30 worth, altogether.

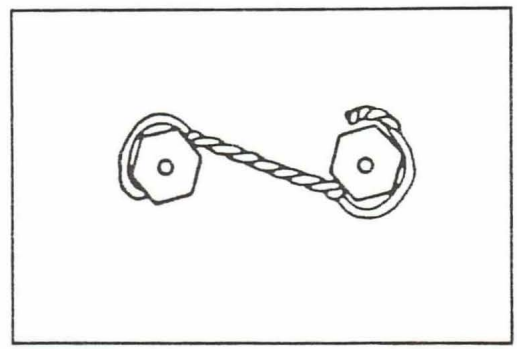
Cleveland linings come in a variety of sizes, shapes, and types (metallic, asbestos-resin or organic, and heavy-duty "high brass" organic)—virtually none of them interchangeable—and to obtain the correct replacement P/Ns you'll either need the application chart in the Cleveland catalog, or your aircraft parts catalog, *or* you can take your back plate and pressure plate (with the old linings still attached) to your FBO parts man (er, parts *person*) and ask for the proper replacement pads. The latter method will be most convenient if you haven't ordered linings before. Some mail-order houses offer Cleveland linings in pre-prepared kits (a complete set of four, or six or eight, to a kit, with rivets). For example, you can get a kit of four P/N 66-30 organic linings for a Cessna 172 or 182 for $19.95, including 4-4 brass rivets, from Central Aircraft Parts, 1105 McCameron Ave., Lockport, IL 60441 (telephone 815/838-5470). Central also sells a kit containing *heavy-duty* Cleveland linings for $23.50 (and they offer factory chrome discs at a discount). McCauley linings are inevitably a little more expensive, no matter who you buy from (in Central's case, $26.50 per kit).

Many pilots—and mechanics—aren't aware that Cleveland offers a series of heavy-duty, high-brass-content organic linings as direct replacements for its most popular regular linings. The HD-series linings cost about 20 percent more, but deliver up to 100 percent more useful life than regular linings (depending on conditions), and are especially helpful in situations involving rusty brake discs. If you can find the HD linings, we recommend that you buy them. But when switching over, don't reline just one wheel with HD pads; do both mains at the same time. Otherwise, you may notice a difference in stopping power between wheels, and the tower may ask you what you were drinking at lunch.

Note: Heavy-duty linings are required when converting from plain-steel to chromed discs.

For riveting, you'll need a ball-peen hammer and a rivet-setting kit like the one shown in the accompanying photo. Many of the tool suppliers that advertise in Trade-A-Plane sell this item, at prices ranging from $8.95 to $12.95 (plus shipping). Central Aircraft Parts (above) will ship you the rivet-setter for $10.95 postpaid.

To detach the old linings from their holders, you'll need to punch or drill the rivets out of the back and pressure plates. The rivet-setting kit you buy will contain a special punch for this. Just lay the back plate face-down on a work bench or over a vise, center the punch in the rivet tail, and deal the punch several sharp blows with a 10-ounce ball-peen hammer. (Be careful not to punch so hard that you enlarge the holes in the back plate.) Do the same for the pressure plate. Put the old linings—which contain asbestos and have nothing good to offer small children—in a place where daylight never shines.



Safety wire should be run in a tightening direction only, 6 to 12 twists per inch.

Next, put a new lining on the pressure plate with the flat (not countersunk) side against the flat (not counterbored) side of the pressure plate. Hold the two up to the light to make sure the holes line up. Some Cleveland and McCauley linings are very, very close in dimensions and may fool you into thinking a substitution will work. If the holes don't line up to within a fraction of a millimeter, though, you can expect trouble. So be sure and do the hole-lineup check.

With the lining and plate back-to-back, drop new rivets tail-end-down into the countersunk hole in the lining. (The head grips the lining; the tail clinches the plate.) Now prepare to set the rivets. Put your riveter in a vise, if possible, and lay the plate-lining assembly in the jig rivet-heads down, backing up the first rivet with the bucking plug provided. (See photos.) Insert the rivet-setting mandrel in the jig and—gripping the plate and lining with one hand to steady it and hold it upright—begin tapping the mandrel with your hammer. Go slowly and rotate the plate assembly as you hammer, so as to evenly clinch the mouth of the rivet. As the rivet mouth curls over, check to see that it isn't splitting. Don't clinch the rivet fully yet; clinch it 90-percent, then set the

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other rivet 90 percent, *then* come back and fully clinch each rivet so that the lining is gripped tightly to the pressure plate (back plate).

What you want to do, of course, is clinch all rivets tightly enough so that all free movement between lining and plate is eliminated, but not so tightly that lining (or the rivet's hollow stem) cracks or splits. Thus, you'll want to attempt to move the lining by hand, and inspect it visually for cracks, especially around the rivets in the countersunk area. If cracks are present, punch the rivets out and start over.

When the pressure plate is finished, go ahead and repeat everything for the back plate. Then carry everything back to the plane.

Reassembly

Putting it all back together is *almost* (but not quite) as easy as taking it apart. There are a few things to watch out for, however.

The first thing to do is to grab the brake housing in both hands, and—with the piston facing you—press the piston down into the cylinder bore with your thumbs. The reason you want to do this is that as the pads wear, the piston moves further and further out of the housing. (In fact, if you let your pads get thin enough, it will pop out of the housing and you'll lose all ur brake fluid.) Since the piston is not elf-retracting, you'll need to push it back in place manually. If you fail to do this, you may not be able—with your new (thick) linings in place—to engage the through-bolts to the back plate; the piston/lining/disc "sandwich" will be too thick. Even if you do get everything back together, starting the next wear cycle with the piston already extended too far may result in the piston popping out, with attendant fluid loss. So push the piston back in—but do it slowly, and evenly. If you cock the piston over, fluid will escape and air may get into the brake (in which case you'll have to bleed the brake—see last month's story on p. 5). Properly done, a Cleveland relining requires no airplane jacking and no brake bleeding at the end. (This is in contrast to Goodyear brake relining, which may necessitate both.)

Dual-piston models present a special problem, incidentally, in that if you press one piston down, the other will pop out; hence, *both* pistons must be pressed into the housing at once, a job truly calling for more than two thumbs. (And you thought there was no need for an all-thumbs mechanic!) A pair of C-clamps will do the trick; or, if you have strong thumbs, you an "walk" the pistons down carefully one per thumb—using appropriate exertion and verbal encouragement.

Now place the pressure plate on the anchor pins so that it rests against the piston as before. Are your anchor pins clean? Insert them in their bushings (i.e., put the brake housing back in place on the wheel) and slide the back plate into place behind the disc. Push the through-bolts toward the back plate until contact is made, using the Braille method. (This may take awhile if wheel pants are interfering with the job, but it *can* be done without pant removal in most cases. Just be patient.) Don't forget any shims that were present.

When the first thread has gone in, start tightening each through-bolt alternately until resistance is encountered. (Did you clean the through-bolts? If they're dirty, torque will be affected, so wipe them down thoroughly before beginning.) Continue tightening alternately until 100 inch-pounds is reached (or whatever torque your mechanic recommends). When you're done, the brake linings will touch the disc, but the brake shouldn't drag. The brake pedal should feel comfortably stiff (not mushy) in the cockpit, and there should be no fluid leakage anywhere.

If your through-bolts are of the head-drilled kind, you'll want to safety-wire them with the thickest MS20995 stainless wire that will fit through the holes, with the run oriented so that the wire can only pull in a tightening direction. (Have your A&P show you accepted safety-wiring methods—or simply refer to your other brake.) A good run of wire will have 6 to 12 twists per inch, with no slack, and a half-inch pigtail (wrapped around the side of the bolt head) at the distal end. Buy or borrow a locking-type wire-twisting pliers (the kind that sells for $69 in Trade-A-Plane) if you want this job to go fast.

For More Information

Cleveland has just issued a new, expanded catalog (twice the size of the previous, 1980 version) replete with service information, application charts, and bulletins, and this year—for the first time—the factory is supporting the catalog with a revision service. The price? Just three bucks for the catalog, and five more if you want periodic updates. To order, write: Customer Service, Aircraft Wheel & Brake Division, Parker Hannifin Corp., 1160 Center Rd., Avon, OH 44011. (Or dial 1-800-BRAKING.)

Originally known as Cleveland Aircraft Products Co., the Cleveland brake firm (which *was* located in Cleveland, Ohio until it was absorbed into the Parker Hannifin conglomerate in the 1970s) was founded by Elmer Van Sickle, a senior captain for American Airlines. The first Cleveland brake was for the Aeronca in 1936. The first big production run of factory Clevelands didn't come, however, until 1956 with the Piper Apache. (The Apache used Goodrich brakes from 1954 to 1955.) The rest is, well, either history or monopoly, depending on how you call it.

How to Get More Lining Life

Is there a trick to getting more life out of brake linings? It turns out there is. You can switch to heavy-duty Cleveland linings and enjoy an immediate 20 percent (minimum) increase in puck life; and you can *break in* your new linings properly, to pick up even more hours (miles) of lining use.

Cleveland linings come in two basic types—metallic and organic—and (unbeknownst to most pilots) there is a proper break-in procedure for each. When linings are not broken in before being put in service, it's possible for a single hard brake application to carburize the lining material, preventing the design braking coefficient from being reached from that point on (and decreasing the pad's durability). A proper break-in, by contrast, cures the resins in the organic lining before carburization has a chance to occur. The end result: linings that work better, longer.

To cure a set of new organic linings, first call ground control and tell them you'll be making extended taxi runs. When you get the okay, start a 25- to 40-mph straight-line taxi; brake to a smooth stop using *light pedal effort*; and allow the brakes to cool for a minute. Repeat the taxi, brake, cool-down cycle a minimum of five times. When you're done, the linings will have cured in such a way as to provide optimum service life.

If you fly an Aerostar or other plane with *metallic* linings, a different break-in procedure is called for. With metallic linings, you *want* heat-glazing to occur. (Factory dynamometer tests have shown that at low braking energies, "unglazed linings experience greater wear and the brake discs can become severely scored.") To condition new linings, perform three hard brakings from a taxi speed of 45 to 50 mph. Do *not* allow the brakes to cool between stops. (Exercise extreme caution in a tail-wheel aircraft, so as not to lift the tail.)

As mentioned above, long-lasting "heavy-duty" Cleveland linings are available as direct replacements for the most popular organic linings used on General Aviation aircraft. Some of the available HD P/Ns include P/N 66-56 (replaces 66-2), 66-57 (for 66-3), 66-58 (for 66-4), 66-55 (for 66-30), and 66-59 (for 66-35). Contact your dealer, or Cleveland directly (at 1-800-BRAKING) for more information.