Care and feeding: Shinn Brakes

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Contents:

0. LATEST AMENDMENT TO THIS DOCUMENT

Version	*Description of amendment*	*Eff. Date*
V1.5	*Second paragraph of 3.3 inserted.*	
	New Figure 15 inserted	
	New section 5.2 added.	
	Contents updated to reflect addition	*11 July 2008*

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1. SCOPE and INTRODUCTION

This document applies to the heel-operated Shinn mechanical brake mechanism as fitted to Taylorcraft and other "war-era" light aircraft designs. It is not applicable to hydraulic or toe-operated mechanisms, or to Cleveland cable brakes.

The Shinn brake mechanism is a lightweight system that with correct maintenance, care and adjustment will provide many hours of trouble-free operation. I generally use my brakes all the time (because I can), and I like to have them adjusted so to be able to hold against all 65 mighty horsepower.

The views contained herein are those of the author, and any changes to your original design should be discussed with your relevant airworthiness approval body.

Reference should be made to Operators and Service Manuals, and good practice should be exercised in handling brake material, brake dust, oils and greases.

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2. OVERVIEW of BRAKE MECHANISM

The heel-operated brake pedals pull on cables that activate a cam at each end of a horseshoe-shaped device within each wheel. These cams press steel brake shoes against a lined drum on the inside of the wheel. Return springs release the braking pressure after the pilot ceases braking.

2.1 Brake pedals & cables

Cables are attached to the pedals by passing them through and clamping off. I have seen several methods for clamping, including the "bug" (Figure 1), clamp plate (Figure 2) and cable grips (Figure 3). Note the heat-shrink tubing to secure the cut cable end.

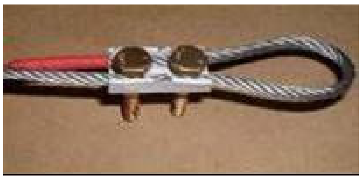

Figure 1 "Bug"

Figure 2 Clamp plate

Figure 3 Cable grips

Each cable then passes via either sleeves or metal pulleys, down the gear leg to a bellcrank, where braking action is transmitted to the brake mechanism in the wheel.

Figure 4 Two views of bellcrank spring

A spring at the bellcrank (Figure 4) maintains tension on the cable, so reducing the lost motion (backlash) of the cable.

Original cables are $^{3}/_{32}$" diameter, common practice is to use ⅛" instead, but this will induce greater curvature around the small pulleys which could increase the backlash in the cables.

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2.2 Brake mechanism

A rigid Z-link connects the bellcrank to the middle of a horseshoe-shaped actuator via a strap (Figure 5).

Figure 5 "Horseshoe" with cams at ends

Tension on the link pulls the horseshoe sideways, and because of the shape of the horseshoe ends, expands one end of each shoe onto the drum (the other end of each shoe does not move very much).

The shoes themselves are not rigidly attached, and so there is a small amount of self-centering of the shoes in the drum.

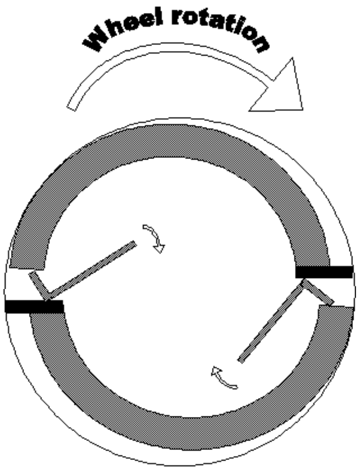

Figure 6 "Lever action" (exaggerated view)

The effect of this mechanism is to lever the leading edge of each shoe on to the drum (Figure 6).

It is important that the leading edge of each shoe is slightly chamfered to minimise the chance of sudden snatching or brake judder.

Figure 7 Return springs

Return springs (Figure 7) pull the shoes off the drum after braking.

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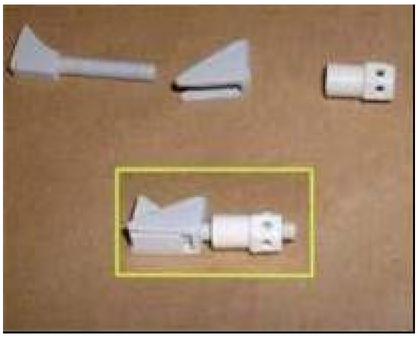

Figure 8 Adjustment wedges

The lining on the drum is riveted to the housing using copper rivets. Wear of the lining is taken up by periodic adjustment of wedges (Figure 8).

3. INSPECTION, LUBRICATION and ADJUSTMENT

3.1 Brake cables

Inside the cabin, check the cables for wear or broken strands around the pulleys. Cables should only be replaced in pairs; if one is worn the other will not be far behind. Check that the cables do not interfere with the floor pan or other structure. Check the pulleys for wear and lubricate the spindles. Because the cable travel is small, rotate the pulleys relative to the cable to even out wear around the pulley circumference.

At the bottom of the gear leg, lightly oil the bellcrank spindle.

The brake cables should be in sufficient tension to *just* not pull on the bellcrank. The cable is held in tension between the pedal stop in the cabin and the bellcrank spring in Figure 4. The clamps at the pedal end of the cable can be adjusted to take up excessive slack. I have seen some cables with turnbuckles used to adjust the tension.

Check for correct installation of cotter pins.

3.2. Brake pedals

Ensure there is some friction material on the pedal faces. I have tried a brush-on 3M product, 7888 Scotch-Clad Anti-Slip Coating, but find that it wears away too soon. Self-adhesive “wing-walk” tape works better.

Lubricate the pedal bushes. Check the parking brake link cable for security.

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3.3 Wheel mechanism

Jack the wheel off the ground and safely support the airframe to remove the wheel. Clean, inspect and repack the two wheel bearings. I use a lithium-based grease.

Check that the brake back plate is not loose on the gear leg (see also section 5.2)

Clean any dirt and dust from inside the wheels (an old toothbrush is useful) and inspect for wear or cracks in the lining. Be aware of any asbestos dust. Generally, wear is unacceptable when the lining thickness reduces to the rivet heads.

Clean the operating mechanism, check for wear on the cams and shoes, and lightly grease the cams, Z-link and horseshoe strap. Cotton buds or pipe cleaners are useful for applying grease. Be careful not to get grease on the running faces of the shoes or linings.

Check the return springs (Figure 7) to ensure they are not broken.

Figure 9 Tab washer

Lightly grease the axle OD and re-fit the bearing seal, wheel, bearings, washer and axle nut.

The washer has a locating dog on the inside which fits in the slot in the axle (Figure 9).

Tighten up the axle nut slightly over-tight to bed the bearings in and back off a castellation or two. Spin the wheel, tap the brake to centre the shoes and then check the nut again for correct tightness. There should be no "rock", slop or axial movement of the wheel, but it should also not be overtight. Renew the cotter pin.

The adjustment wedges (figures 8 and 10) are adjusted by tightening the nuts on the brake backplate (figure 11). Adjustment should be done equally on both wedges of the wheel. This moves the fixed end of each shoe closer to the drum. An approximation of the correct "tightness" of the brake is when the tyre *just* cannot be turned by hand when an assistant presses on the pedal, but they should spin freely with no brake applied. Spinning the wheel by hand and applying the brake to stop it will ensure the shoes are centred correctly within the drum.

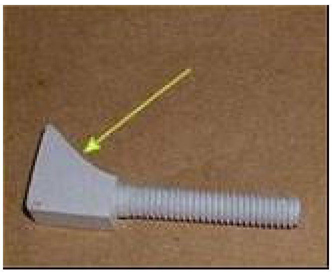

Figure 10 Wedge showing face that can be built up

If the limit of adjustment is reached, then either there is wear in the operating mechanism or the brakes require relining.

If the little threaded cam is worn (Figure 10) it can be built up with a little bit of weld and ground back to the original profile.

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Figure 11 Locking clip

The adjustment nuts are safetied with little wire clips (Figure 11). Mine are stainless.

3.4 Wheel bearing part numbers:

	Large Bearing	Small bearing
Diameter	2.3125”	1.625”
Bearing (incl. inner race)	08125	A6075
Outer race	08231	A6162

Figure 12 Staking marks

If replacing the outer races, ensure they are staked properly. We have used Loctite “bearing fit” in the past too.

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4. BRAKE LINING REPLACEMENT

When the linings have worn approximately ⅓ of their thickness, the adjusters will have run out of adjustment. Worn or cracked linings should be replaced. New ⅛" (3mm) lining material and rivets are available from sources such as Skybound in Atlanta, Georgia, phone 770-446-6797.

Be aware that the old linings being removed may contain asbestos, so take necessary precautions against inhaling the dust.

The new linings are drilled and counterbored using the wheel itself as the drilling pattern. Use the original lining to determine the counterbore depth. The head of the rivet needs to be about one-third of the lining thickness below the surface. Care must be taken to ensure that during drilling and riveting, the lining lies perfectly flush with the inside of the drum, else the pressure of the shoes will crack the lining. Make sure the bottom of the counterbore is flat.

If a small gap exists at the end of the lining, chamfer the edges to reduce the likelihood of brake "snatch". It might be better to cut the ends at 45° to each other.

The wedge adjusters will need to be fully backed off to get the relined drum over the shoes.

4.1 Use of Adhesives.

I personally do not rivet these linings any more. I glue them using a room-temperature two-part epoxy adhesive such as Araldite. The shear strength of epoxies is excellent, and of course were not available in the design era of these wheels, or I'm sure they would have been used back then.

Another option is to use the epoxy to bed the linings in and then rivet them. In this situation, at least the epoxy backing will prevent the linings from cracking.

Figure 13 Cleaned-up lining housing

Figure 14 Clamping new lining using brake shoes.

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Figure 15 Araldite

4.2 How well do the glued linings wear?

Figures 13 and 14 above show new 3mm linings installed in September 2004.

Figure 16 Lining wear

In September 2007, after three years, some 450 hours (and countless landings), the linings have worn by 0.2 mm.

Assuming that the linings are "worn out" when they reduce by a total of ⅓ (i.e. 1mm of wear), then these linings should last for a total of 2250 hours [15 years] (or another 1800 hours [12 years] at current usage rates).

Note the lining joint is at 90°. It might be better to have this at 45°.

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5. BRAKE ATTACHMENT SCREWS

5.1 Replacement screws

The brake plate assembly is screwed to the gear leg using unusual 82° countersunk screws. It would appear that the original slotted screws are not available, but I found a source of cross-head screws in stainless from an approved source.

The part numbers for the approved, stainless structural countersunk screws is
MS51960-65 (or 10-32 UNF-2A x 1/2 PH FLT HD Machine Screw)

They are available from:
Alabama Aerospace Div,
102 Skylab Drive,
Huntsville
AL 35806
Phone (256) 851 9005 or toll-free (800) 448 1877
Fax (256) 851 1988
http://www.alaaero.com

Price in 2002 was $25.00 for 100 (minimum order quantity).

5.2. Assembly of wheel to gear leg

It is important that these screws do not come loose during service. To prevent this, ensure that the countersunk holes in the brake back plate are free of paint before installing the screws with Loctite threadlock on the threads (or locknuts on the back face).

If paint is present, this will compress or chafe away under compressive and cyclic loads, leaving a gap between the screw and the counterbore, in turn leading to rotational movement of the wheel under braking action (the same reason why truck wheels occasionally come adrift).

This can be detected by jacking the wheel and checking that the wheel assembly does not rock in a rotational sense when the brake is applied.

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