MAULE TAILWHEEL INSPECTION, REPAIR and SET-UP

By Drew Fidoe

This write-up describes how I've repaired four Maule tailwheels, one of which is mounted on my own Fly Baby. I'm sure that many of these points would work for other tailwheel types as well. As usual, this is from a homebuilder's slant. All points mentioned on replacement and parts fabrication, repair and component substitution are my opinion only, and not necessarily a recommendation for others--if in doubt, purchase aviation quality parts or have a qualified person do the work for you. If I'm off base or have forgotten anything *please* let me know so we can edit 8:^)

I have worked on the two primary Maule models, the SFSA "solid" rubber wheel model (figure 1), which weighs six lbs (as fitted on my FlyBaby, "Kerfuffle") and the slightly bulkier SFS-P8A "pneumatic" tyre model, which weighs 7 lbs. I will refer to these as the "solid" and "pneumatic" models. For reference of components, refer to the ACS&S catalogue under "Maule Tailwheels" [these corresponding part numbers will be listed throughout this write-up in brackets].

Figure 1: Maule model SFSA "solid" tailwheel. Note dissimilar safety springs and absence of anti-shimmy damper.

General description of construction & assembly:

Refer figure 2.
The Maule tailwheel consists of a main *Bracket Assembly* housing [7], which bolts directly to the leaf-type tail-spring. The *bracket assembly* supports the *wheel fork assembly* [26]. The tailwheel is steered from the cockpit via safety springs/chain to the (Fly Baby plans Figure 6-2B) tailwheel steering horn, which is mounted on the lower rudder of FlyBaby.

The *wheel fork* itself is of the "single lever" type and not actually fork shaped (like the Scott for instance). It has only one arm supporting the wheel (I'm using the terminology of the ACS&S manual--for brevity I will just call it the "*fork*").

Either a 6.50 X 2.50 solid rubber tyre or an 8" pneumatic wheel/tyre assembly rides on the (replaceable) axle of the fork. At the top of the vertical shaft of the fork rides a steering arm, with cam operated release mechanism used for either controlled steering from the cockpit, or "full swivel" feature for close-in manoeuvring. This mechanism should only release when full left rudder is applied.

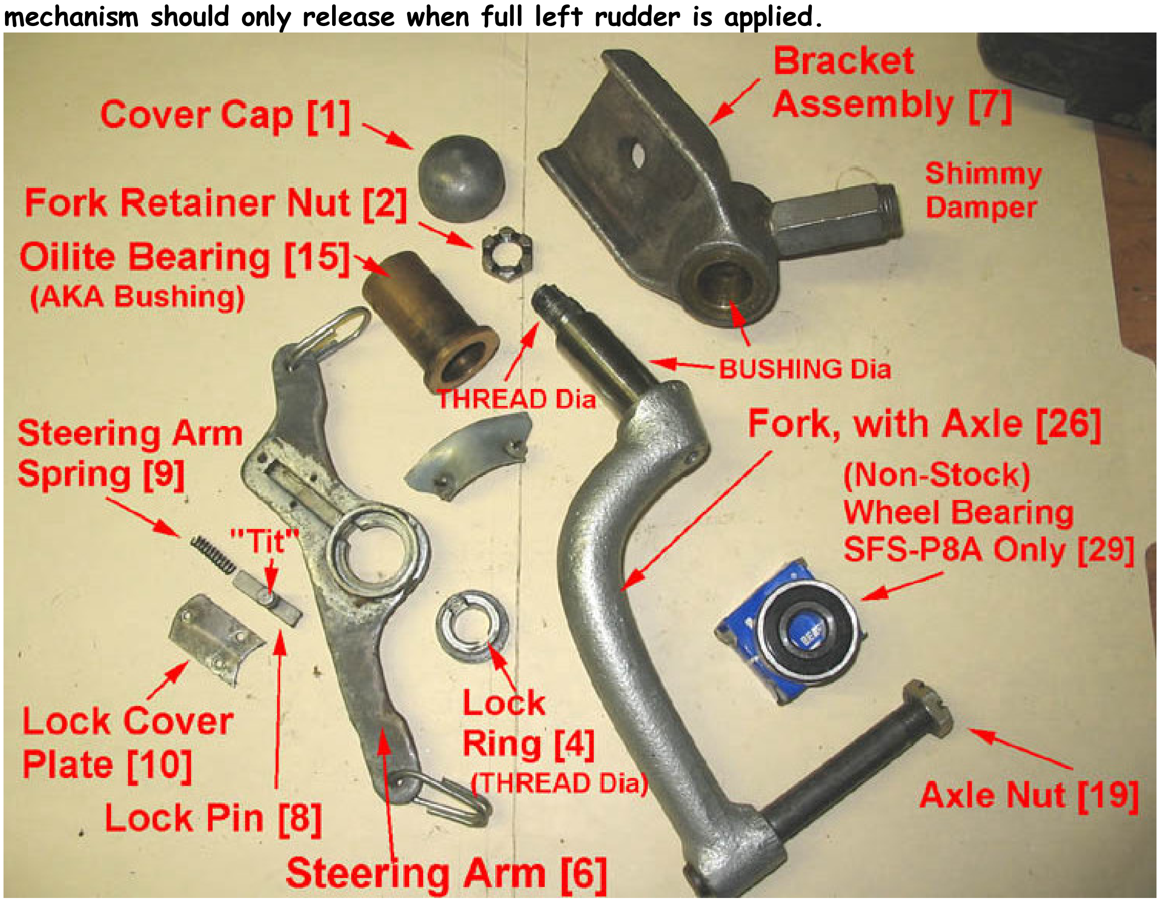

Figure 2: Components of typical Maule tailwheel assembly

Bracket Assembly:

Refer figures 2 & 3.
The *bracket assembly* [7] is a galvanized, steel forging which is sized to accommodate either 1-1/4" or 1-1/2" wide leaf-type tail springs, with a single AN-7 mounting bolt used for attachment. The bracket assembly houses a "stove-pipe hat" shaped sintered brass *oilite bearing* [15], which is press fit into the bottom side of the bracket assembly's [7] forging.

The stepped brim of the *iolite bearing's* hat shape fits into a corresponding counterbore machined in the bottom side of the *bracket assembly*. This bushing face is for bearing pad area to support the tail weight of the aeroplane and bears against a corresponding face on the *fork* [26].

Some "old style" pneumatic tyre models have an anti shimmy device mounted in the side of the *bracket assembly* which consists of a hex shaped housing with an adjustable, spring loaded pad which applies friction to the vertical shaft of the *fork* in the oilite bearing/fork vertical shaft area. From reading the ACS&S catalogue, this feature appeared to be a pneumatic model feature at one time but doesn't appear to be available on present models.

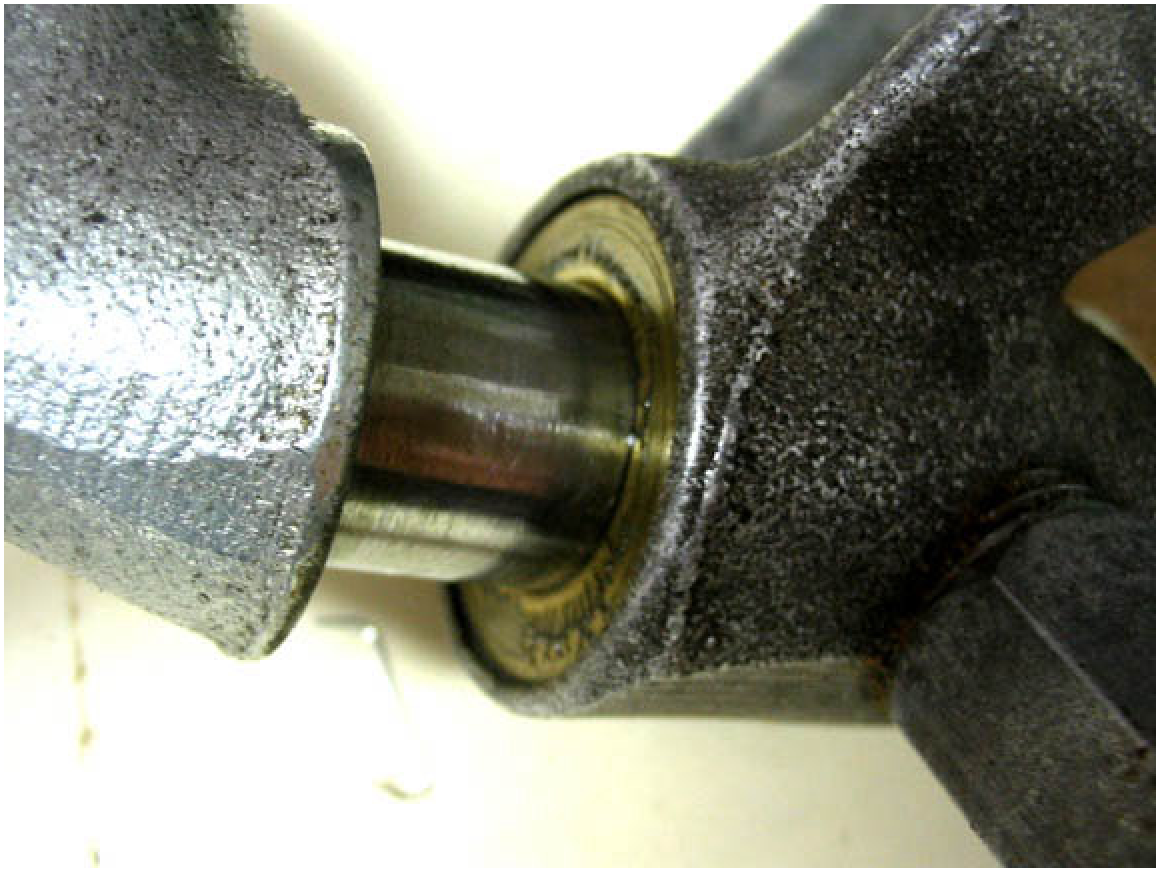

Figure 3: Fork to Oilite Bushing bearing area.
Note the potential for interference between the counterbore lip of the bracket assembly and the step of the fork vertical shaft

Fork Assembly:

Refer figure 2 & 4.

As previously mentioned, the *fork* [26] is of the "single lever" type, and fitted with either a 6.50 X 2.50 solid rubber tyre [21] or an 8" pneumatic wheel. The fork has a sliding fit into the *iolite bearing* [15] of the *bracket assembly* [7], and is free to swivel 360 degrees.

The vertical shaft of the *fork* itself is stepped in two diameters (I'll call them the "thread diameter" and "bushing diameter"), plus it has the bearing face to support the actual weight of the aeroplane's tail. The larger, "bushing diameter" of the *fork's* stepped vertical shaft is well finished for bearing support by the *iolite bearing* [15]. The smaller, "thread diameter" at the top of the *fork* is cut about 3/4 of its length with threads for a nut to retain the fork within the *bracket assembly*.

The "thread diameter" shaft has a round-bottomed keyway ground into one side to accommodate a *lock-ring pin* [3], which fits in its lower half and which is pressed into a hole drilled into the step between the "thread" and "bushing diameters".

Note: that the *fork* vertical shaft 3/8" and 7/15" diameters illustrated in the ACS&S manual do not match the dimensions of the SFS-P8A "pneumatic" tyre model shown disassembled in figure 2. This wheel has a 1/2" "thread diameter" and a 3/4" "bushing diameter".

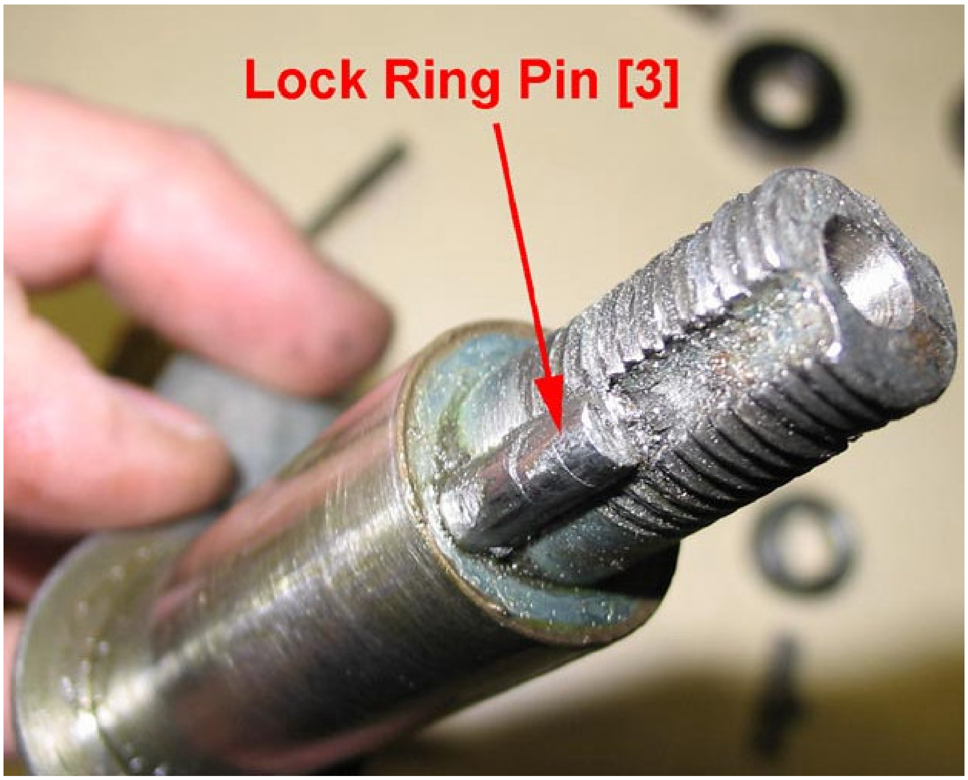

Figure 4: Lock Ring Pin--secures the Lock Ring to the Fork. Note that this pin must <u>not</u> protrude above the Lock Ring otherwise steering problems may result!

Steering Elements:

Refer to Figures 5, 6 and 7. The *steering arm assembly* [6] is fitted with a spring-loaded *lock-pin* [8] & [9], which rides in a keyway machined in the starboard arm of the assembly.

In the normal (steering) position this lock-pin is pressed by the *steering arm spring* [9] securely into the matching keyway of the *lock-ring* [4]. This *lock-ring* in turn is securely pinned to the lower half of vertical shaft "thread diameter" (figure 4). The *lock-ring* is both the pivot point and the retaining collar for the *steering arm* itself. When the *lock-pin* is engaged in the *lock-ring*, the *steering arm* is locked to the fork then both the tailwheel/fork and the *steering arm assembly* align-up in an identical position for cockpit controlled steering. These two elements, locked together, will

then act as a single unit for direct steering via the (Fly Baby plans figure 6-2B) tailwheel steering horn.

For "full swivel feature", the *lock-pin* is pulled out of engagement from the *lock-ring* at approximately 40 degrees left rudder. Here a *cam-plate* [12], which is screwed to the upper end of the *bracket assembly* [7], acts upon a protruding "tit" of the lock-pin itself, drawing the lock-pin [8] from engagement with *lock-ring* [4] for "full swivel feature". The *fork* will now pivot independently of the *steering arm* and rudder input. Confused yet? :-)

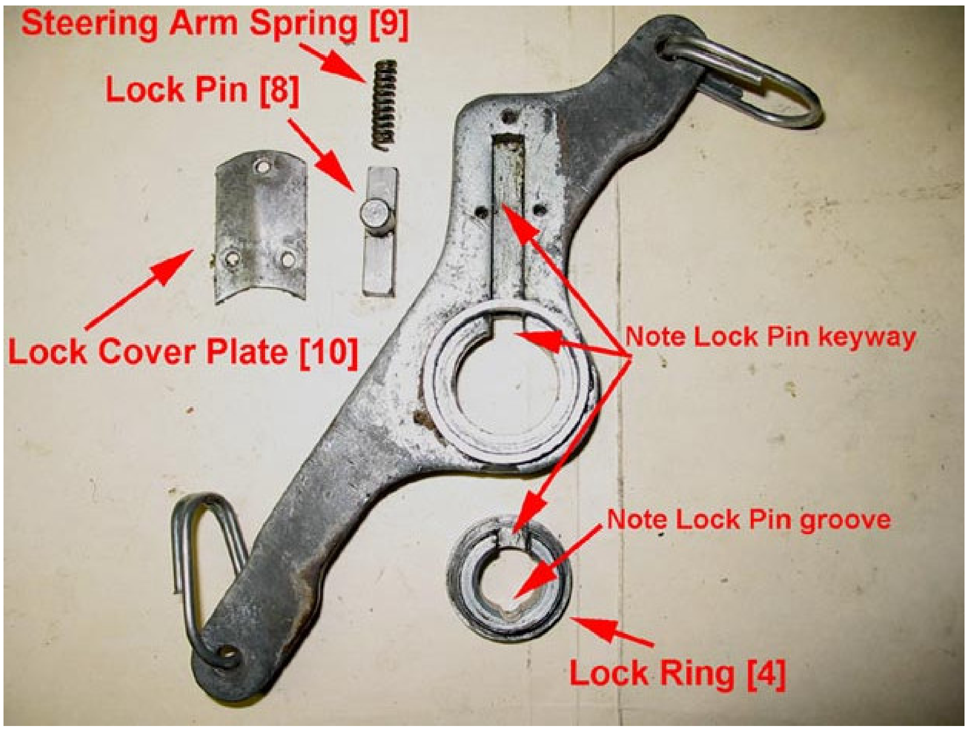

Figure 5: Steering Arm Assembly - parts breakdown.

Figure 6: Assembled Steering Arm Assembly [6], displayed bottom side up for clarity, along with the top portion of the Fork [26].
Note the Lock-Ring Pin on the Fork and corresponding detent/keyway in the Lock Ring [4] itself .

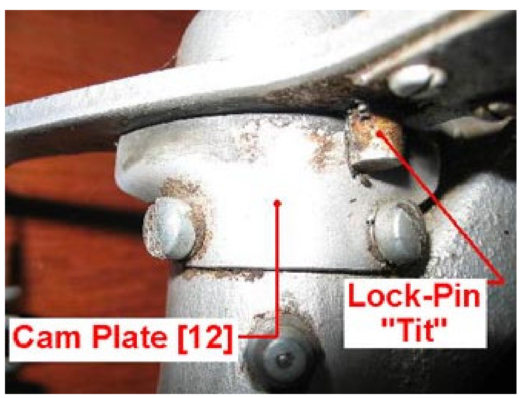

Figure 7: Lock-Pin "TIT" riding on Cam-Plate [12].
Note the position of the wheel is at right rudder. At full left rudder the Cam-Plate acts upon the "TIT", drawing the Lock-Pin [8] from engagement with Lock-Ring [4] for "full swivel feature".

Wheels:

The solid wheel has integral bearings, which I never had to replace myself but I assume are replaceable. The pneumatic wheel comes in two aluminium-casting halves bolted together. One half is fitted with two sealed bearings pressed in place.

Figure 8 (collage): SFS-P8A "pneumatic" wheel components. Note that the non-bearing wheel half has damaged hub-cup circlip-ring groove, which has been cleaned up on a lathe. A STANDARD Maule hubcap, or perhaps a cut-to-fit piece of aluminum or plastic sheet could be siliconed in place for an inexpensive repair?

Inspection:

So you purchased a used Maule tailwheel from the fly-mart and you want to give it the "once-over". These are some of the items that I inspect:

Does the *fork* swivel feely in the *bracket assembly*? Is it wobbly? Try and slide the *fork* up and down in the *bracket assembly*. Any major movement (or binding) will

require close attention. Hold the *fork* firmly and try and wiggle the *steering arm assembly*. Does it have appreciable wiggle? Does it break free of the *fork* to rotate? Unless the wheel/fork is about 40 degree to starboard steering (that's the wheel to the LEFT) from the *bracket assembly's* centre line it shouldn't disengage.

Next, visually inspect the wheel/tyre. Is there any slop in the wheel bearings? Can the wheel/tyre be wiggled in the axle? The wheel/tyre should rotate with minimal resistance with no wiggle due to loose bearings, and with no tight spots from degraded bearing races. Roll the wheel/tyre and look for trueness of the tyre, there shouldn't be any wobble or eccentric movement. There should be no major chunks missing from the solid wheel, and the pneumatic tyre should have tread and hold air.

The aluminium wheel hub, which comes in two pieces on the pneumatic model, often gets damaged. The hubcaps are often missing from both models, as well as the dust cap on top of the fork assembly. Hold the tailwheel assembly at arm's length. Is the wheel/tyre in a proper vertical plane in to the *bracket assembly*? Nothing bent? No cracks? Is the *cam plate* affixed by two screws to the top of the bracket assembly immediately below the *steering arm assembly*?

Disassembly:

Remove the *hubcap circlip ring* [38] and *hubcap* [37] from the SFS-P8A "pneumatic" tyre model, or the three screws [17] and *hubcap* [18]SFSA "solid" rubber wheel model. Remove the AN-320 *axle nut* [19] and remove the wheel.

If fitted, remove the shimmy damper (this is spring loaded)

Remove the *dust cover cap* [1] from the top of the tail-wheel assembly. Remove the cotter pin and *fork retainer nut* [2] from the top of the *fork* (caution--the *fork* may slip out of the *bracket assembly* unexpectedly from this point on). The fork retainer nut is shown as a nylock-style nut in the catalogue, but I have also seen AN-320 castellated shear nuts, complete with cotter pin.

Look on the bottom side of the *steering arm* [6] and note the position of the *lock-pin's* "tit" [8] in relation to the *cam* [12]. Rotate the *fork* until the *cam* releases the *lock-pin* from the *lock-ring* [4]. This can be a pain in the butt and may require the assistance of a screwdriver but don't force anything. You may want to try removing the *lock cover plate* [10] and remove the *steering arm spring* [9] first (spring loaded components--wear eye protection...sproing!).

Once the *lock-pin* is disengaged the *lock ring* should be retaining the *steering arm*, and still held in place by the *lock ring pin* [3]. This is often an interference fit. I have used a gear-puller is to pull the *steering arm* and *lock ring* off together from the "thread diameter" shaft of the fork, I've also carefully secured the *steering arm* in a

vice and tapped the fork out. Regardless of the method use care to not damage the *steering arm* and make sure that the *lock-pin* is disengaged first.

Overhaul Points (part numbers will not be repeated from now on...)

Bracket Assembly:

Carefully check the *bracket assembly* forging for cracks or defects. I have had one of these units welded but beware that it is galvanized (or similar coated) and the welder wasn't too happy with me (poison gas) but the repair is still in service. Check the bolthole, it shouldn't be excessively worn either or it will require attention.

Inspect the *oilite bearing* for wear. These are normally worn top front and bottom rear, and the lower brim of the "hat" can wear as well (note figure 3). The *iolite bearing* is a press fit into the bracket assembly, it can be removed by an arbour press (remove the grease nipple and shimmy damper before doing this). If you order a new one, you may have to drill out a hole for the shimmy damper, so don't chuck out the old one yet.

I have had success machining up my own bushing from both iolite and regular brass. I machine the outside diameter of the bushing for a zero to 1/2 thou' interference fit. I have simply drilled and reamed the inside diameter to size but for the rather worn "bushing diameter" of my tailwheel *fork* I bored the diameter to custom size and then carefully fit the *fork* for a nice rotating fit when installed in the *bracket assembly.* Beware of the thickness of the hat brim, which as mentioned is the bearing area that supports the weight of the tail--you could almost think of it as a thrust face. Too thin a hat brim may create interference between the step of the *fork* and the bottom of the *bracket assembly* (figure 3). Too thick a hat brim may create problems on assembly as (if I recall correctly here): with the *fork* fitted in the *bracket assembly* (with *iolite bearing* pressed in place), the *lock ring* should seat the *steering arm* on the step between the "thread diameter" and "bushing diameter", with the *fork retainer nut* bolted in place, with a minimum of fork end-float (this is up and down play of the fork sliding in the *iolite bushing* of the *bracket assembly*)--too much end-float may cause shimmy, too little will cause binding!

The shimmy damper, if fitted can get worn as well. Parts are available (and probably easy enough to make) but I usually just remove them. If you do, ensure that the new *iolite bearing* that you install has no hole cut in it to accommodate the shimmy damper. The remaining hole in the *bracket assembly* side should be purely cosmetic and could be left as-is. As I wouldn't recommend the *bracket assembly* welding idea, once the unit is reassembled and tested you could try filling the hole in the *bracket assembly* wall with some JB-Weld prior to nice coat of galvanized compatible paint.

How does the *cam-plate* look? The *cam-plate* is the funny looking pressed steel thingy screwed to the top rear side of the *bracket assembly* casting. These can wear and

are cheap to replace (I always put a new one on if there is any question). The screw holes in the *cam-plate* should be clean and true, if not cam may shift causing erratic "full swivel" release.

Figure 9: Clockwise from top left: homebuilt wheel bearing press; homebuilt ring for breaking pneumatic tyre's bead from rim; homebuilt brass bushing; and old iolite bushing, note holes for grease nipple and anti-shimmy device.

Fork:

The *fork* is a major piece of the tailwheel. If this is defective it will have to be repaired, as it is not even listed in the ACS&S catalogue.

Are the threads of the "thread diameter" in good shape? If not clean them up with a die nut. If these fail, the *fork* will depart the aircraft! These can often be in poor condition from people trying to over-torque the fork retainer nut. Is the retaining nut in good condition? I've seen both nylock and castellated nuts here. I would prefer the castellated nut if the shaft is suitably drilled for a cotter pin.

Is the *lock ring pin* in its keyway, relatively true and clean? If not, the *lock ring* may not seat correctly or even shear, resulting in loss of steering control. The *lock ring pin* fits in a hole drilled into the "bushing diameter" step at the bottom of its round-bottomed keyway. The pin is pressed into this hole and should not be loose. If I recall correctly at least 1/3 of the lock ring pin should seat in this hole, but the pin

SHOULD NOT extend above the lock ring otherwise interference and binding may result.

Is the "bushing diameter" of the *fork* worn? This can be a problem. What I did to account for this on my own tailwheel was I machined a custom brass bushing to accommodate the wear, even though it was asymmetrical, then I carefully hand-fit the bushing to accommodate the shaft for minimum slop with full swivel freedom (as mentioned previously in the *Bracket Assembly* overhaul notes). If I recall correctly, I carefully polished the worn shaft on a buffing wheel as well. I have thought that perhaps a Readi-Sleeve fitted over the existing shaft may work as well, perhaps with some JB-Weld underneath to fill the voids from the irregular wear? Just a thought....

Steering Arm Assembly:

Is the *collar lock ring* in good shape? Is the keyway groove for the *lock pin* ok? How about the *lock ring* pin groove? Doe the *lock ring* seat well in the *steering arm* without any side-play?

How does the *steering arm* look? Are the steering spring attach point holes excessively worn? Any bends, cracks or other defects? The starboard bell-crank arm houses the *lock pin*--it should already have been removed. The *lock pin* should show no wear, and the tit on the underside should be in good shape and not bent. Does the *lock pin* slide smoothly in its keyway in the *steering arm*? Is there any side-to-side wiggle? Place the *lock ring* in its collar in the *steering arm* and check the *lock pin* engagement. There should not be excessive radial play. Try this with the *lock cover plate* installed as well (no steering arm spring).

The Wheel:

The pneumatic model aluminium wheel hub shouldn't be cracked. It often displays damage by the *hubcap* area. Here, the wheel halves are sold separately, the bearing portion is the expensive half. If damage isn't too excessive a clean up on a lathe may work but you may not be able to secure the *hubcap*. Perhaps a flat, home-brew replacement could be made from aluminium sheet (can't remember if there is clearance for the axle nut or not)? If the circlip groove is missing/ damaged a bit of silicone may do the job, but the wheel really spins up so be careful if trying this idea.

The tyre inspection is common sense stuff, the wheel bearings in the two-piece wheel hub are replaceable. For this I just took one down to a local industrial bearing supplier purchased new ones (for your "dishwasher"). If you can, try and get high-speed rated bearings, the dealer will probably want to consult the model number on the side of the bearing race. I have looked over industrial wheel replacements for damaged wheel hubs, these are usually pretty inexpensive, complete with tyre but the

bearings are often of poor quality or of incorrect inside diameter to fit the Maule axle. If you find a suitable wheel, the bearings are often replaceable...tell the bearing supplier the inside and outside diameters and there is usually a suitable substitution available.

If you do attempt to substitute a wheel, ensure the offset is the same so that the wheel/tyre sits in the identical position on the hub as the original...otherwise you will experience steering trouble guaranteed. The solid wheel rubber should be round/concentric, just as the pneumatic tyre should be. As mentioned, I've never had to replace the bearings in the solid wheel SFSA model, but they appear to be replaceable as well. Besides wheel bearing affecting control/shimmy, also consider wheel balance--especially on the pneumatic model. Flat spots may also affect control.

The *hubcaps* always seem to missing on used units. For the solid wheel model, I lost mine on a flight and machined up a new cap. I installed my new one with stainless steel screws held in place with Locktite.

Assembly:

Assembly is straightforward but getting the *lock-pin* and *steering arm assembly* installed on the *bracket assembly* and *fork* is a pain in the #. Any slop or wear in the areas mentioned above may affect the operation of this mechanism. Ensure that the *fork* swivels freely in the *bracket assembly* with no binding, with minimal end-float, the *fork retainer nut* in place (note above that the end-float appears to be determined by the thickness of the *iolite bearing* hat-brim, so adding washers will not help you here!). Ensure that all nuts are properly safetied.**

I have good success with most tail-wheels, but had one that just wouldn't cooperate correctly. The *cam plate* must disengage the direct steering to "full castor" at the maximum travel of left rudder. If it disengages too soon you will lose direct steering. A few technical taps to the *cam* helped but you have to ensure that all components work as a system (and that you aren't treating the "symptoms" and not the root cause).

This brings me to the (Fly Baby plans figure 6-2B) tailwheel steering horn. Keep in mind that the geometry of your steering horn on your aeroplane's rudder may affect this as well--I've seen a few 'planes with new holes drilled in their rudder horns trying to correct what appears to be geometry problem affecting the steering control and "full swivel" disconnect feature.

I only use safety springs, not tension style "bed springs". As for tension style "bed springs" I had a ground loop in a friend's Chief once when the port spring departed the aeroplane on touchdown, pulling the tail-wheel into a right turn (no damage thankfully--I replaced the springs with proper safety springs the following day). I don't like tension on my tailwheels anyhow, I believe that too much spring tension leads to

excessive wear on the tailwheel assembly as well as contributing to the steering horn cracking problem on our FlyBabys, as well as rudder hinge wear.

I like to set the safety springs and their chains to be just snug when the tailwheel spring is in the relaxed position. This takes away some sensitivity from the tail-wheel but I never had a problem with this (this may also be an easy fix to eliminate a tailwheel which release to full swivel too soon?). Note that your tailspring tension may change between the leaf spring's relaxed position (in flight) and when it is on the ground in tension. Beware that some people, most likely with some justification believe that lack of spring tension contributes to tailwheel shimmy, but I believe that my tail-spring geometry eliminates this. I use the tail-spring kit from ACS&S, which includes two slightly dissimilar springs to hopefully dampen shimmy.

Set-Up:

For steering stability, I ensure that my tail spring is true to the aircraft centre-line, both horizontally and vertically (when looking from the rear), and also that the tailwheel vertical plane is true, especially in the compressed position (a tail-wheel cocked to one side may have squirrelly characteristics).

I like to have my tail-wheel set with the vertical fork shaft set for about 15 to 20 degrees in the forward to aft plane. This allows the weight of the aeroplane tail to naturally straiten the tailwheel giving a bit of stability when on the roll.

This angle may make ground handling a bit stiff however I feel the added stability is worth it. This vertical angle can be adjusting the angle of the tail spring-leaf, drawbacks are increased wear to the oilite bushing and reduced sensitivity. Be sure that your tail-spring will not easily contact your rudder when compressed in a bounced landing.

Figure 10: partially assembled tailwheel

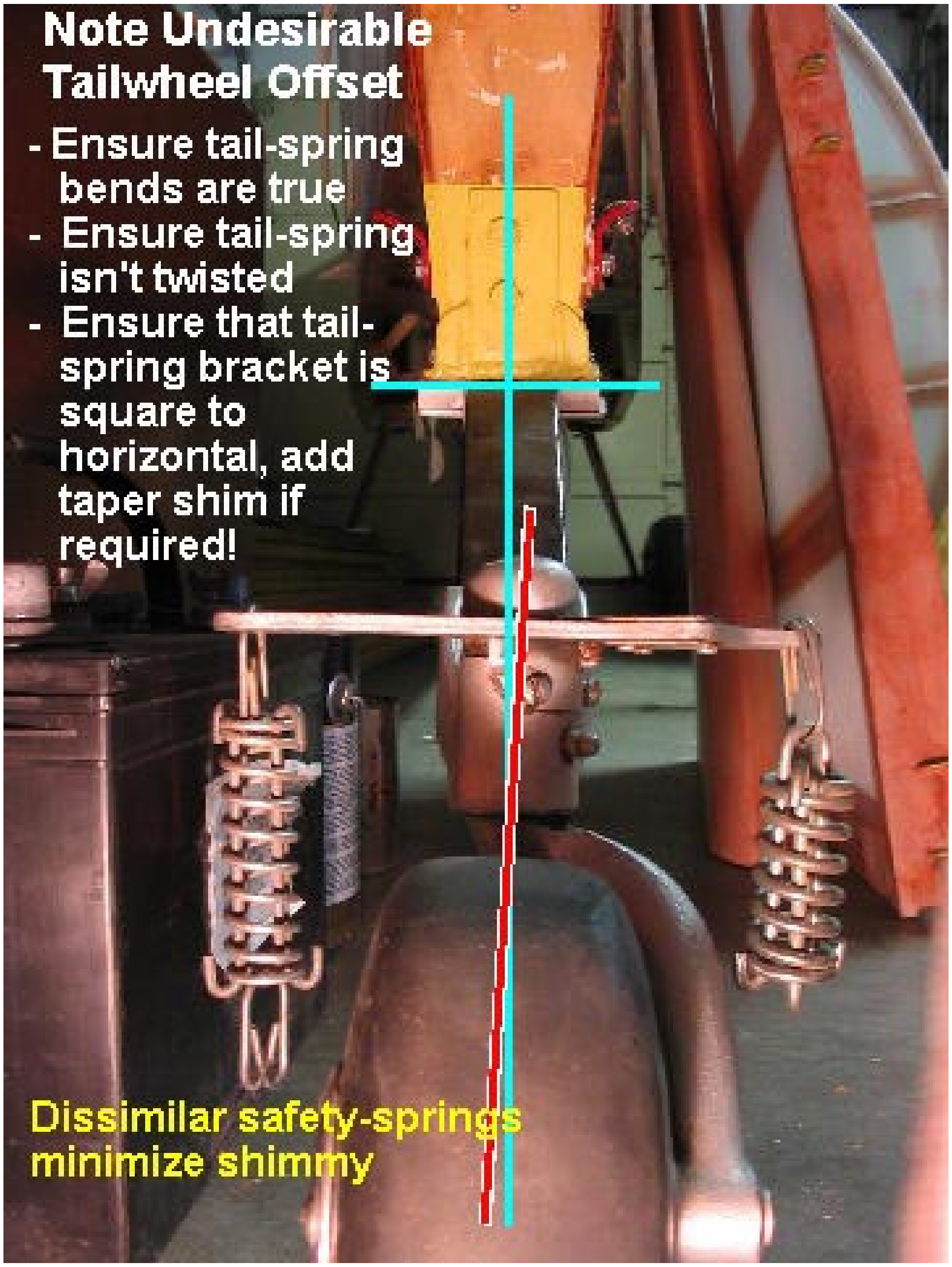

Figure 11: Unacceptable vertical offset

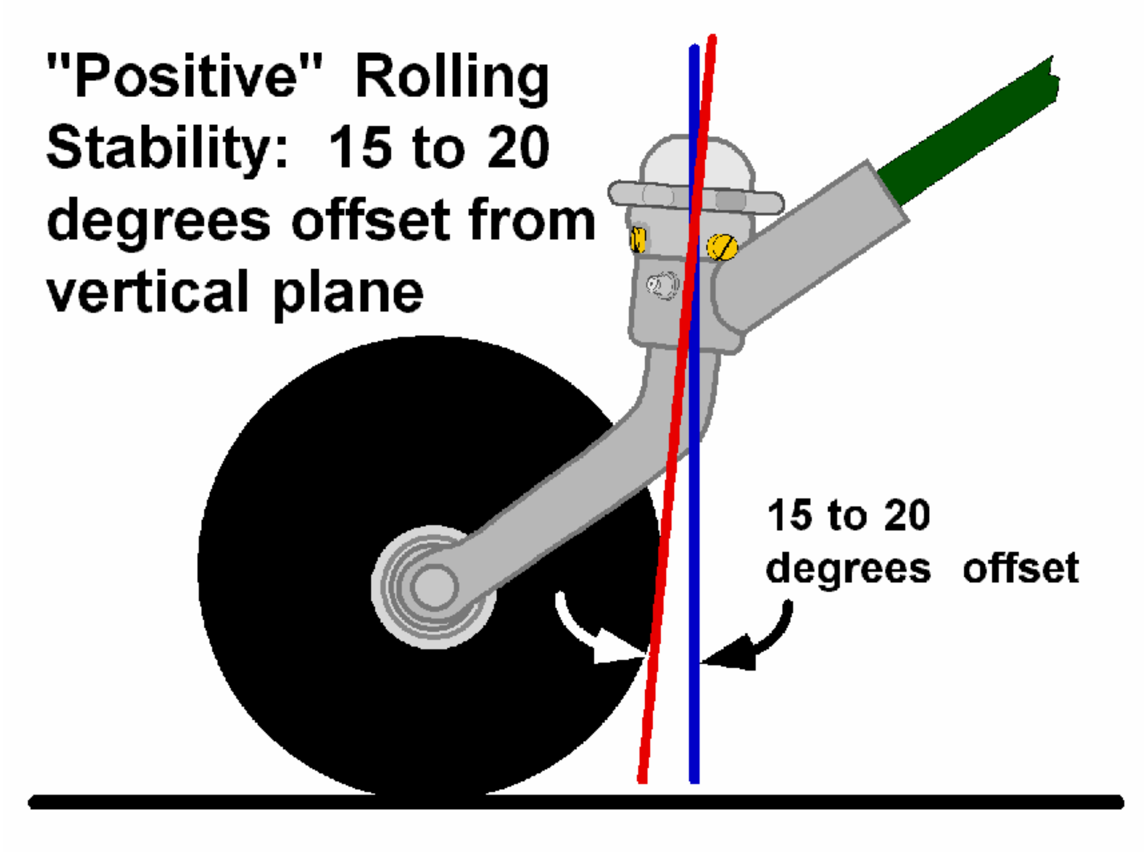

Figure 12: Forward offset for positive "on the roll" stability

Conclusion:

Well, that's all that I can think of regarding these tailwheels. To review, slop in any component is bad, as well as any binding. This can lead to shimmy, or unplanned disconnect to "full swivel". The geometry of your tailwheel mounted to the tailspring leaf is very important for stability and steering manners. When trouble-shooting or repairing your tailwheel, look at it as a system--all components relate to each other and can affect each other's function. Worn components or misalignment can affect steering control, steering stability and potential shimmy.

As a final thought, for first-flights, if you are happy with the tail-wheel but concerned with accidentally unlocking to free swivel during overly energetic use of your rudder, you can always remove the cam-plate to disable this feature.

Happy home building!

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