Description: This procedure details the steps for making a better Beta clutch. This eliminates cold stick, drag and light switch engagement/disengagement. The procedure takes approximately 5 hours if done carefully and requires a set of jeweler's files or a point file, and a polishing stone or Dremel type tool with a fine polishing wheel. e.g. Dremel 425 emery Impregnated Disc.

Background: Owning Beta trials bikes from an '87 TR34 up to my current ride an '08 Rev3 I've been surprised at the difference in the behavior of Beta clutches from bike to bike even within the same year. Having access to powerful microscopes and some time on my hands I decided to see if I couldn't explain this variability as well as the persistent problems of cold stick as well as heavy clutch actuation and drag. The end result of this research is the following procedure which has been performed on Rev3 as well as EVO clutch plates. The clutch action of these bikes is progressive, showing greatly reduced or eliminated drag, and has virtually eliminated cold stick. The benefits have remained after several years of use even without frequent gearbox oil changes. Two bikes are currently running with two clutch springs removed to reduce pull and one is starting to show minor slippage in top gear under full throttle after two years of use.

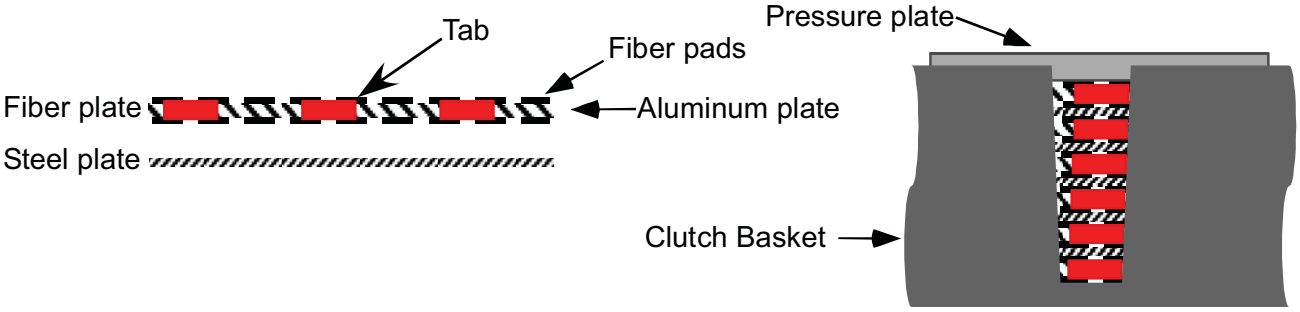
Wet multi-plate clutches are used in virtually all off-road bikes but none are so critical to the operation of the machine as the trials clutch. Many factors affect clutch performance, oil type, friction material, surface finish, spring pressure and surface area just to name a few. This procedure is for Beta clutches but should be applicable to other clutches of similar type.

Multi-plate clutches work under the seemingly simple concept that two materials moving at different speeds when pushed together will, through friction, transmit force through the area where the two surfaces interface. Sounds simple enough. The problems arise in a couple of areas.

1. Friction is not a linear function of force. In fact friction is a surprisingly complex mix of macro force effects like the flexibility of one surface allowing it to "mesh" with the surface imperfections of the mating surface and atomic scale effects like Van Der Waals forces, covalent bonds etc. The practical upshot is at some point you won't get significantly more friction no matter how big a spring you use. Or looking at the glass half full, you don't need heavy clutch springs for a slip free clutch with a trials bike. All you get is finger cramps.

2. Actuating the clutch requires a complex series of motions be performed to modify torque and displacement resulting in the approximate 2mm movement of of a pressure plate against a constant spring pressure. That's all the lever does. Move a plate a tiny bit. All the real magic happens from subtle effects of shearing force, friction and small forces generated by bearing surfaces on inclined planes. Only very weak "forces" move the clutch plates apart and the force that pushes them together is limited to the riders finger strength.

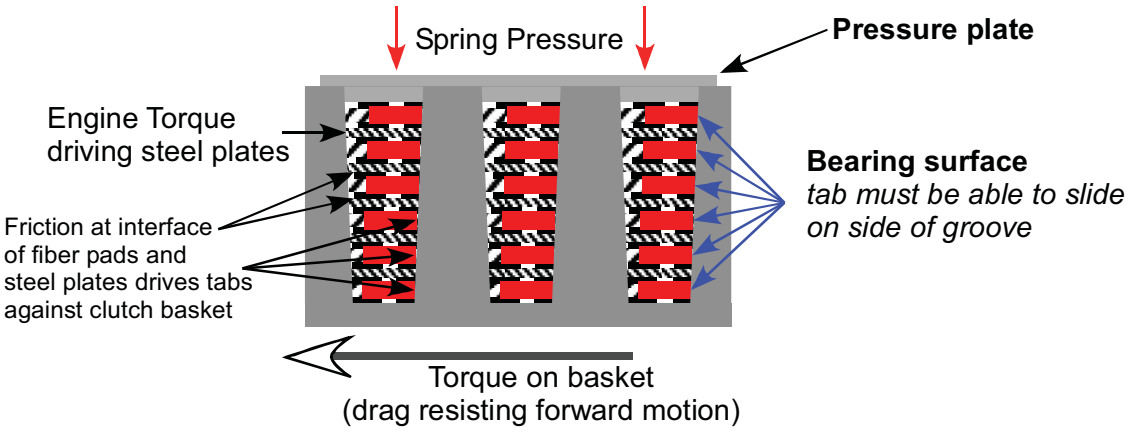
The key to this modification lies in one simple concept. The plates within the clutch pack must be able to freely move. The steel plates are splined onto the center hub and have no problem moving unless the hub itself has significant wear. The fiber plates as they are received from the factory are another matter. Poor surface finish and excess adhesive on the bearing surfaces cause significant variability in clutch operation.



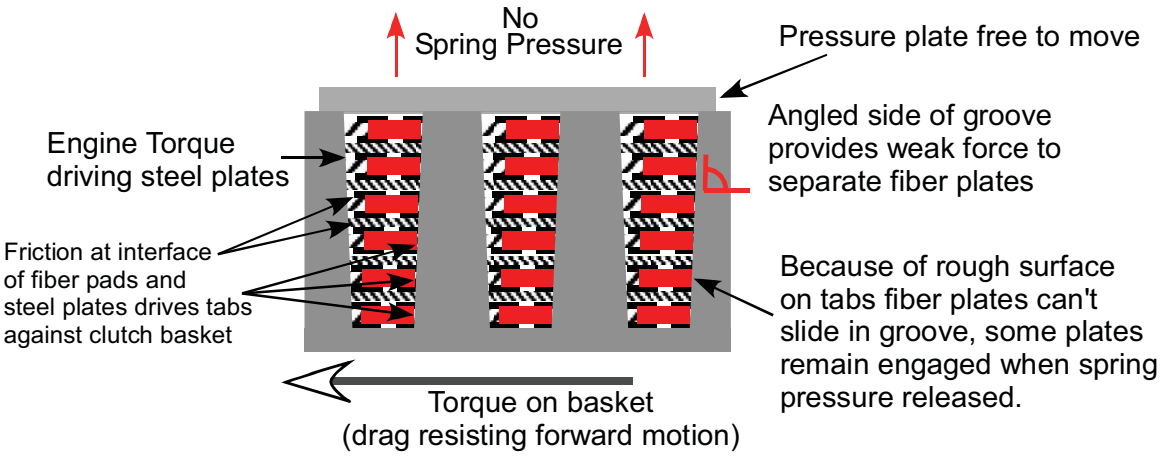
What causes clutch drag

(Assuming basket grooves not notched and plates flat)

Clutch Engaged



Clutch Disengaged



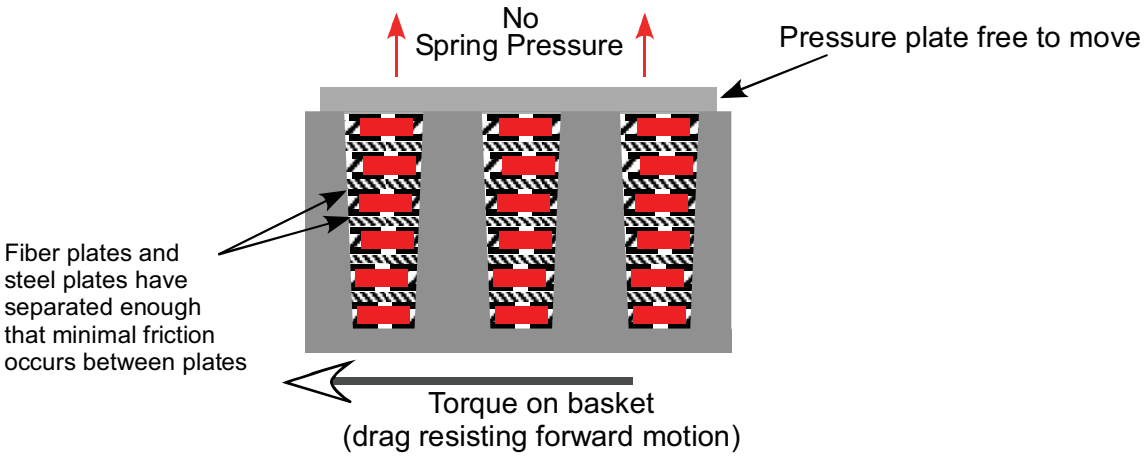
While the clutch is engaged friction between the steel and fiber plates drives the fiber plate tabs against the grooves in the clutch basket. This is what transmits power from the crankshaft to the input shaft of the transmission. As the clutch is disengaged spring pressure on the clutch pack is reduced until the force exerted by the angled side of the basket grooves, shearing force and vibration cause the fiber plates to slide apart. The rough surface and residual glue on the side of the unmodified fiber plate tabs cause the tabs to bind on the basket groove edges rather then slide smoothly apart. Since there is only a small force to separate the clutch plates some fiber plates do not fully disengage from the steel plates causing drag.

If the wheel speed exceeds the engine speed so that the tabs are allowed to come off the basket edge shearing forces within the clutch pack can separate the plates. If the speed difference is sufficient to drive the tabs against the opposite angled basket groove then the plates experience a significant shearing force that will separate them suddenly.

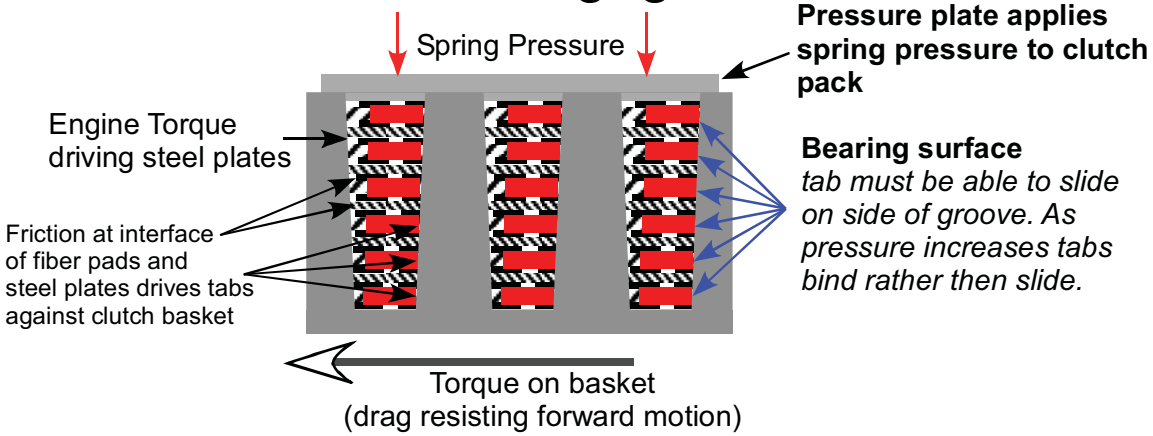
What causes clutch slip & grabby/sudden engagement

(Assuming plates not worn beyond acceptable thickness)

Clutch Disengaged



Clutch Engaged

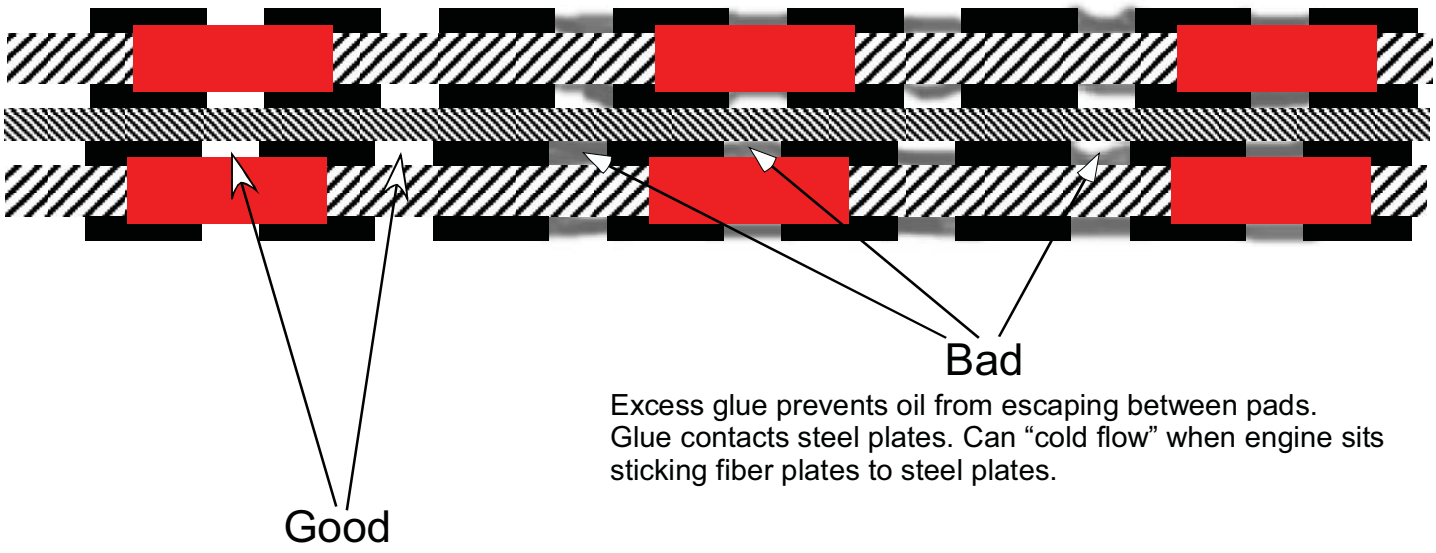


As clutch is engaged friction between the steel and fiber plates drives the fiber plate tabs against the grooves in the clutch basket with increasing force. The rough surface and residual glue on the side of the fiber plate tabs cause the tabs to bind rather then slip smoothly together. At some point spring pressure can't overcome the friction of the fiber tabs on the basket grooves so the clutch plates never come together fully and the clutch slips.

The cheap and dirty fix for this is to increase spring pressure. Unfortunately this causes the binding tabs to release with a snap when the spring pressure finally overcomes the binding causing "light switch clutch" as well as clutch pull beyond what is necessary for a properly functioning system.

What causes cold stick

(Hydraulic lock?)



Bad

Excess glue prevents oil from escaping between pads. Glue contacts steel plates. Can “cold flow” when engine sits sticking fiber plates to steel plates.

Good

Edges of pads act as scrapers during engagement reducing slip. Only pad material contacts steel plates.

OK I’ll admit this one is thin on theory and there is a fair bit of supposition as well as wild guess tempered with the belief that a clean clutch plate is a happy clutch plate. As part of the clutch mod I believe the removal of the residual glue between the pads is responsible for eliminating the cold stick phenomena.

Some people have found emery cloth or bead blasting the steel plates helps. I believe this helps the steel plates retain an oil coating which makes it more difficult for the excess glue to bond to the steel plate surface.

The amount of excess glue varies greatly from plate to plate with some having none at all while others have glue splashed all over the plate in various areas. I will, as a matter of habit, try to remove all excess glue that I can but I’m fairly certain the only critical locations are the inter-pad spaces and the sides of the tabs.

Here's all you need

to be the envy of the neighborhood. (assuming your neighbors all ride Betas of course)

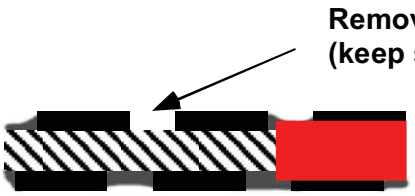
Files from Radio Shack
Dremel emery wheel from Home Depot

Random musing before we start.

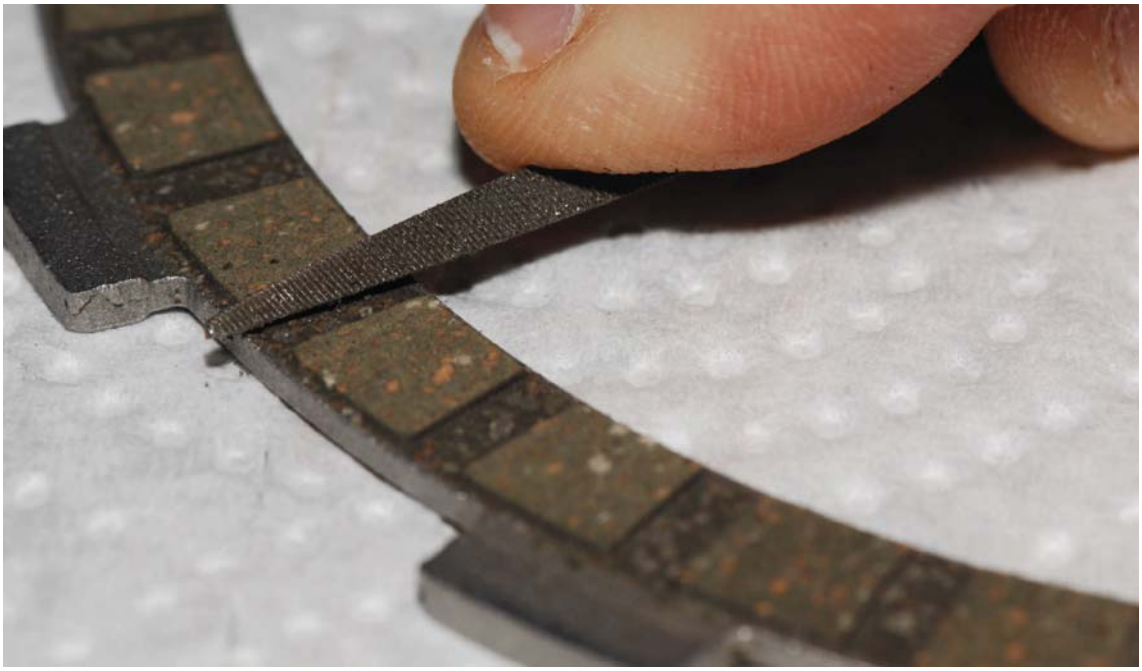
Some clutch baskets may show wear in the sides of the grooves. The temptation is to file these smooth. I'm not sure that buys you anything as the baskets may be anodized. If they are there's a coating of aluminum oxide that is very hard and once removed the metal will wear even faster. Of course it may not be anodized in that case ignore this particular diatribe. Even on 4-5 year old bikes I haven't noticed significant wear on the basket grooves. I did have a plan to have a basket electroplated with nickel infused with teflon as an uber-clutch experiment but the wallet thought better of it.

Those of you clever enough to count above one and with a knowledge of distributed forces are probably worried that the inaccuracies of handworking a large number of tabs means some of them probably will not even touch the surface of the basket grooves. At least that's what I thought when I did the first one. Then I took a good look at the wear patterns on the tabs as they were in my, then three year old, bike and realized if only half the tabs even made contact it would be a significant improvement. Optimally a fixture with an abrasive surface at the same angle as the basket groove sides that could do the initial shaping to all tabs of a plate at the same time would be ideal. I designed one but time and money again said no. Maybe someday but for now I take a spare basket and check for contact of each tab and polish off a tiny bit of high spot until they're all making contact. That is until I get bored and figure they're good enough.

OK so let's begin. Step one clean the glue.



Unworked fiber plate. Note glue between fiber pads

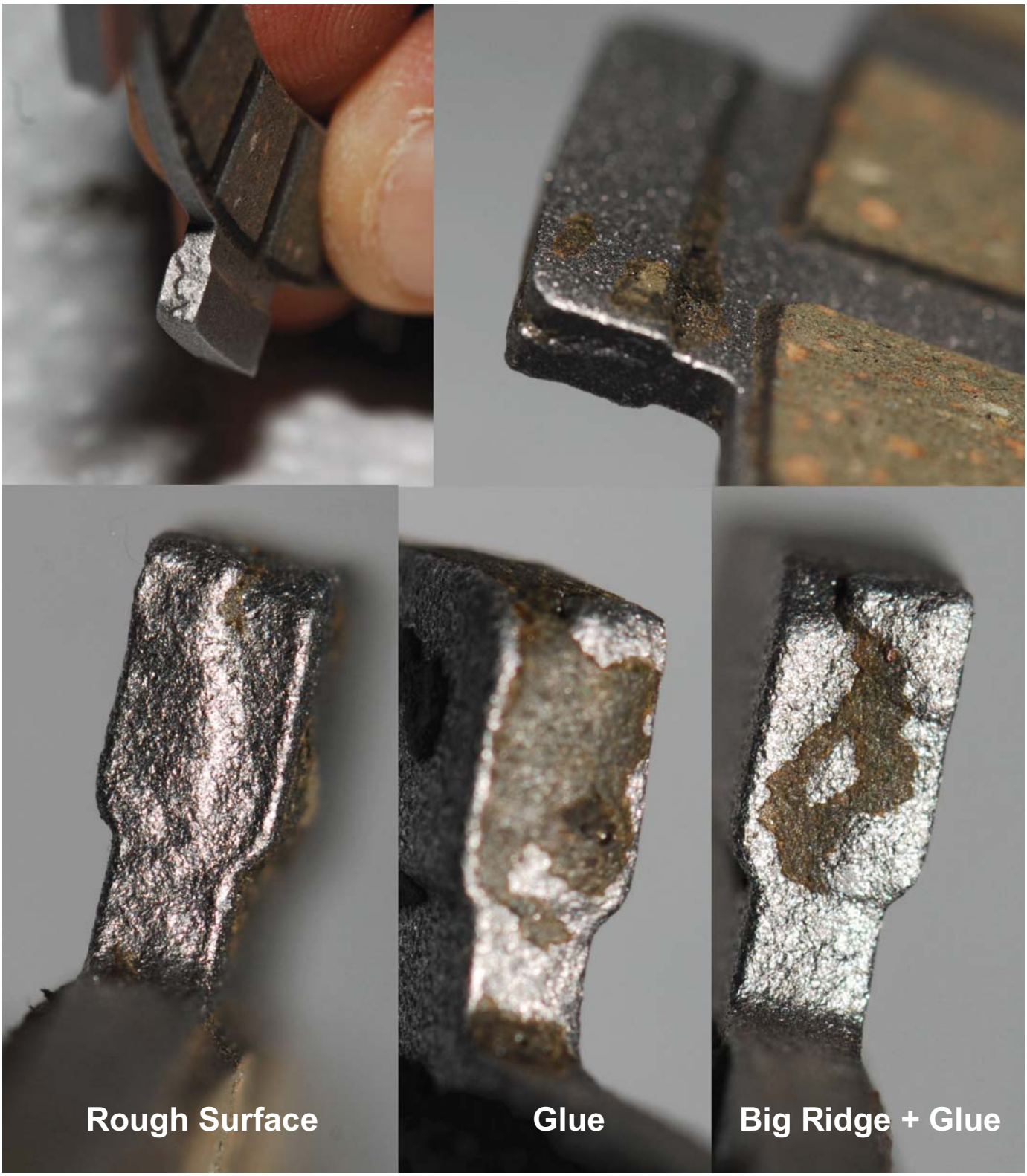


Using triangular file to edge pad and remove excess glue at base of pad

Removing bulk of excess glue with square file

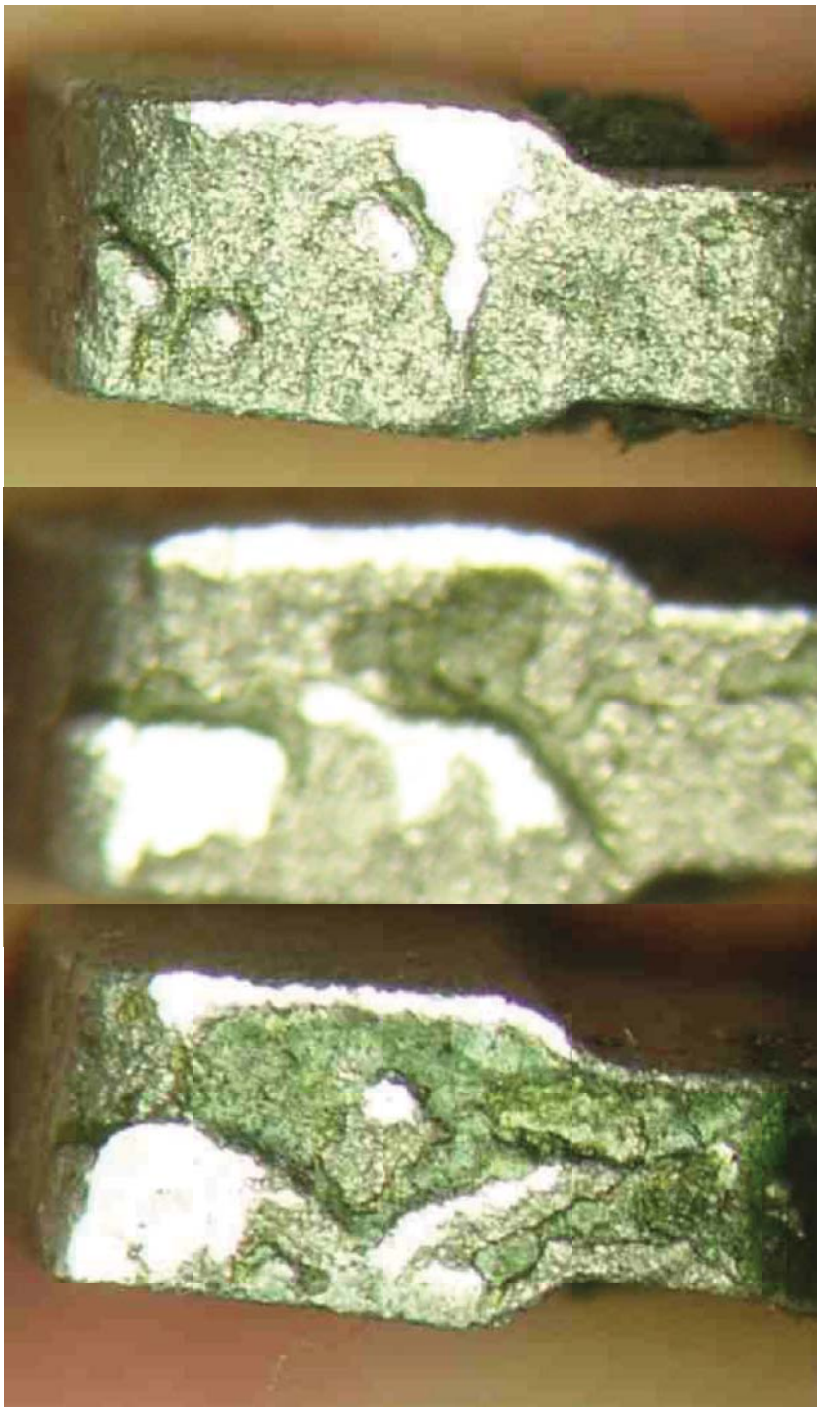
Excess glue removed from between pads. Surface need not be polished smooth. Do this until the spaces between all pads are clear of goo.

On to the tabs themselves. Step two.



Rogues Gallery

As they come from the factory



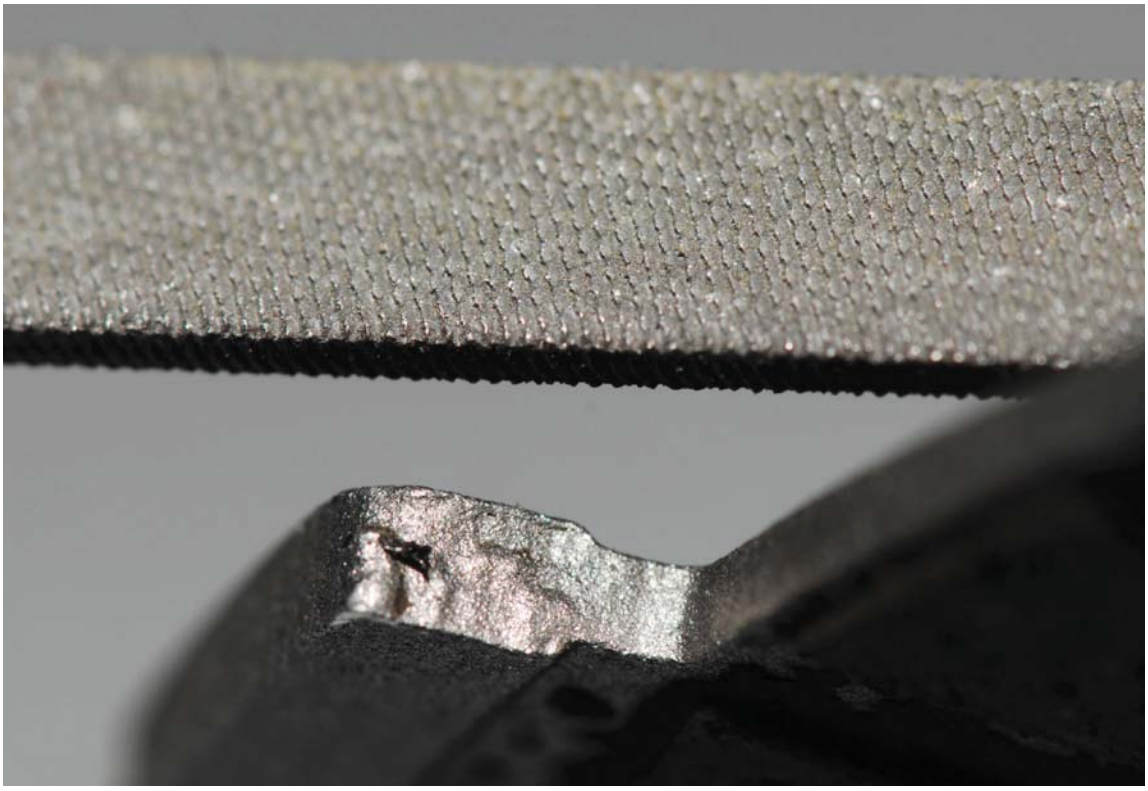
If you're thinking,

"Surely the plates will wear in after a few events"

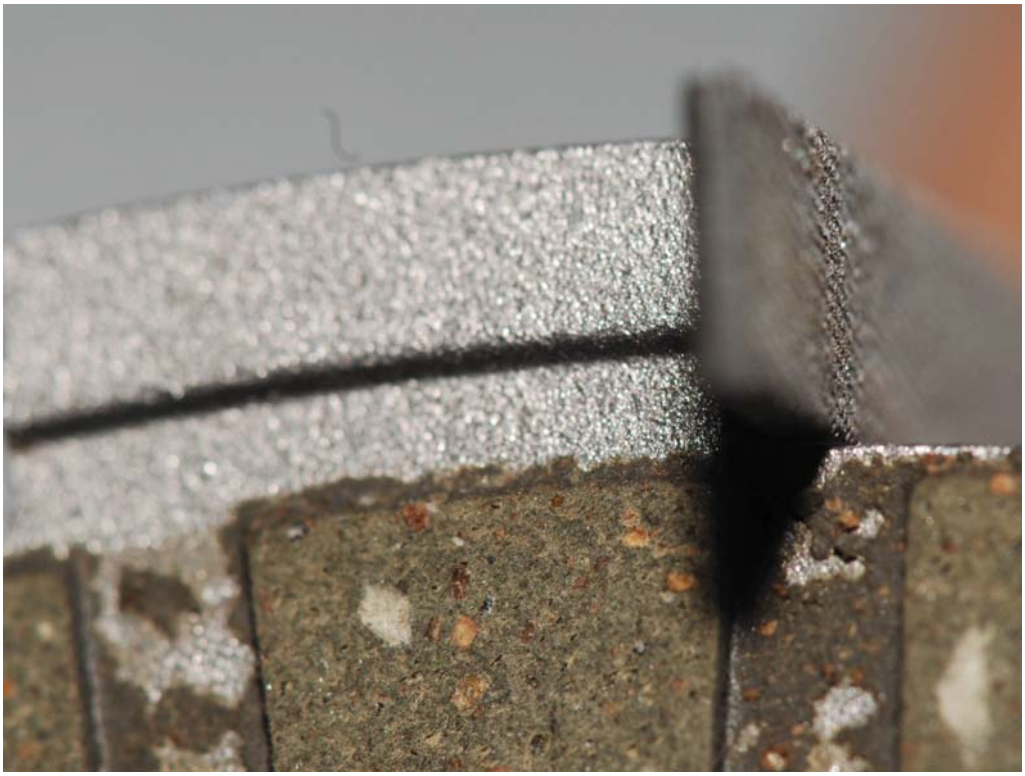
Yeah they'll wear in.

Sort of.

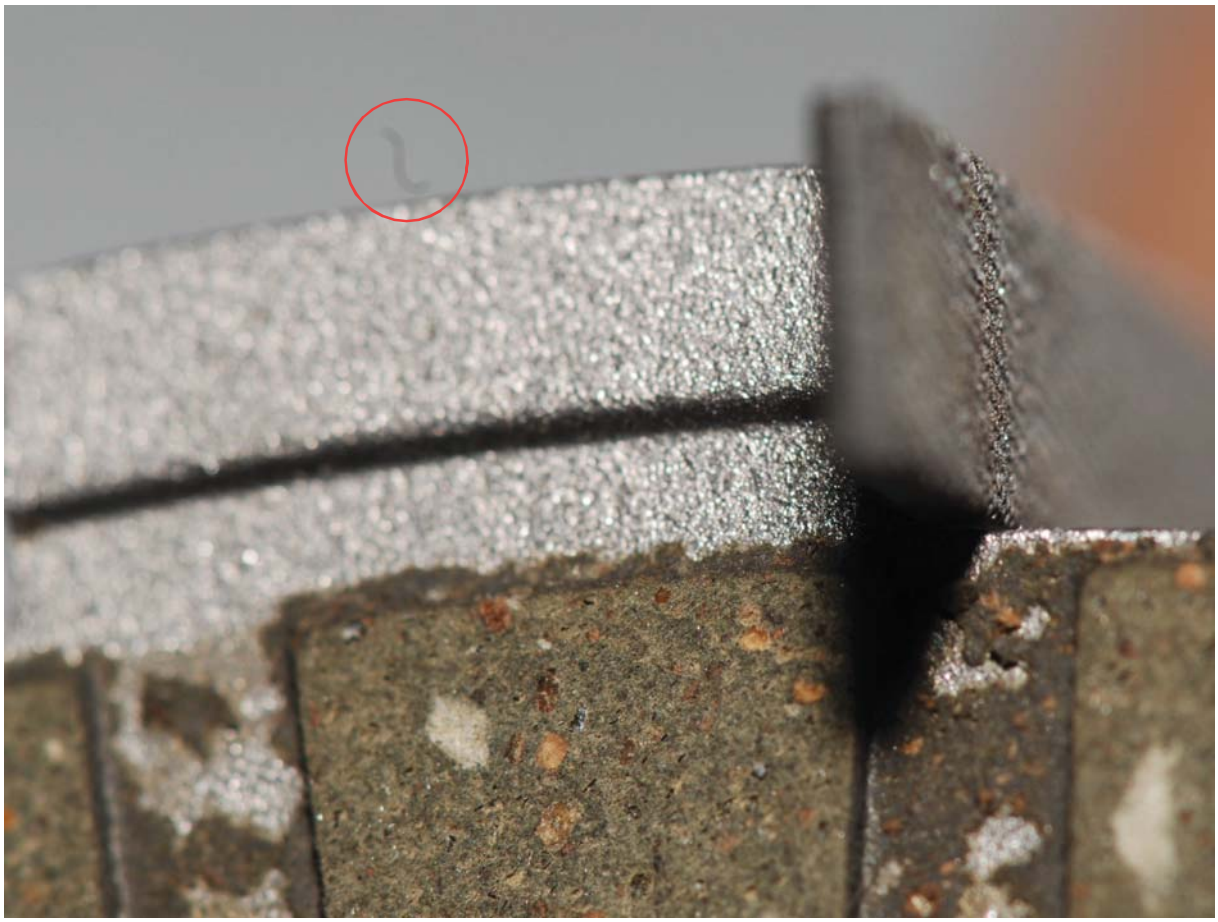
3 years wear on untreated fiber plates.
Remember these are essentially sliding bearings



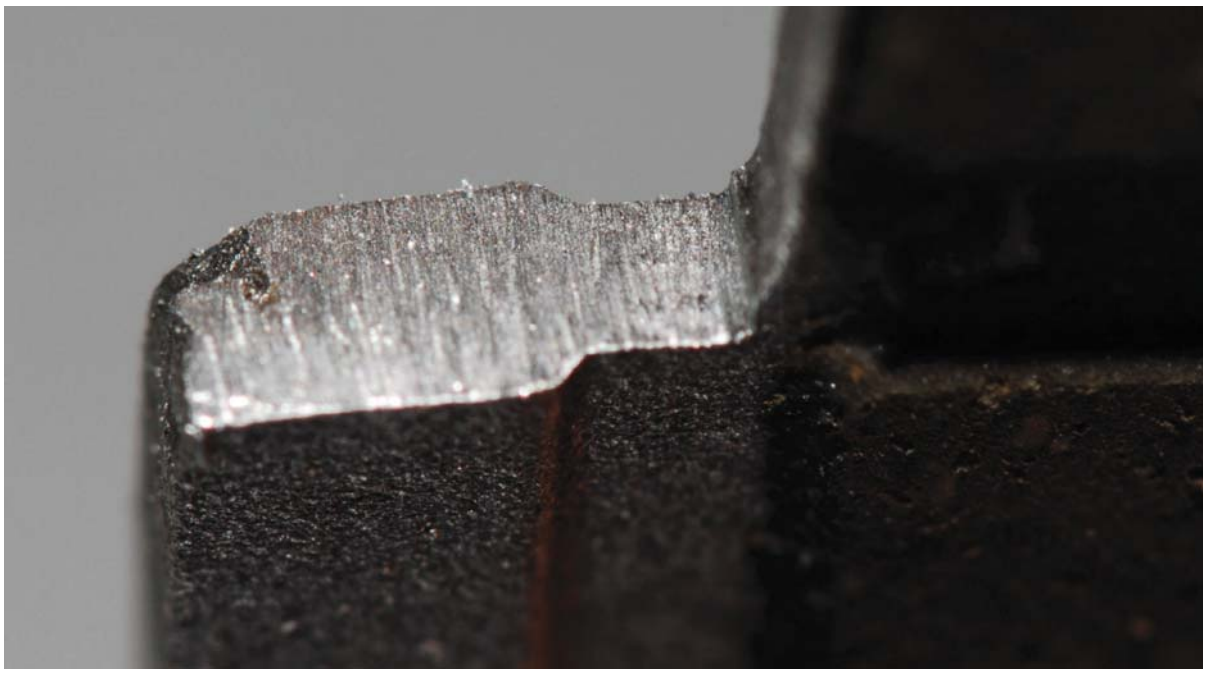
Unsuspecting tab with no idea what's about to hit it.



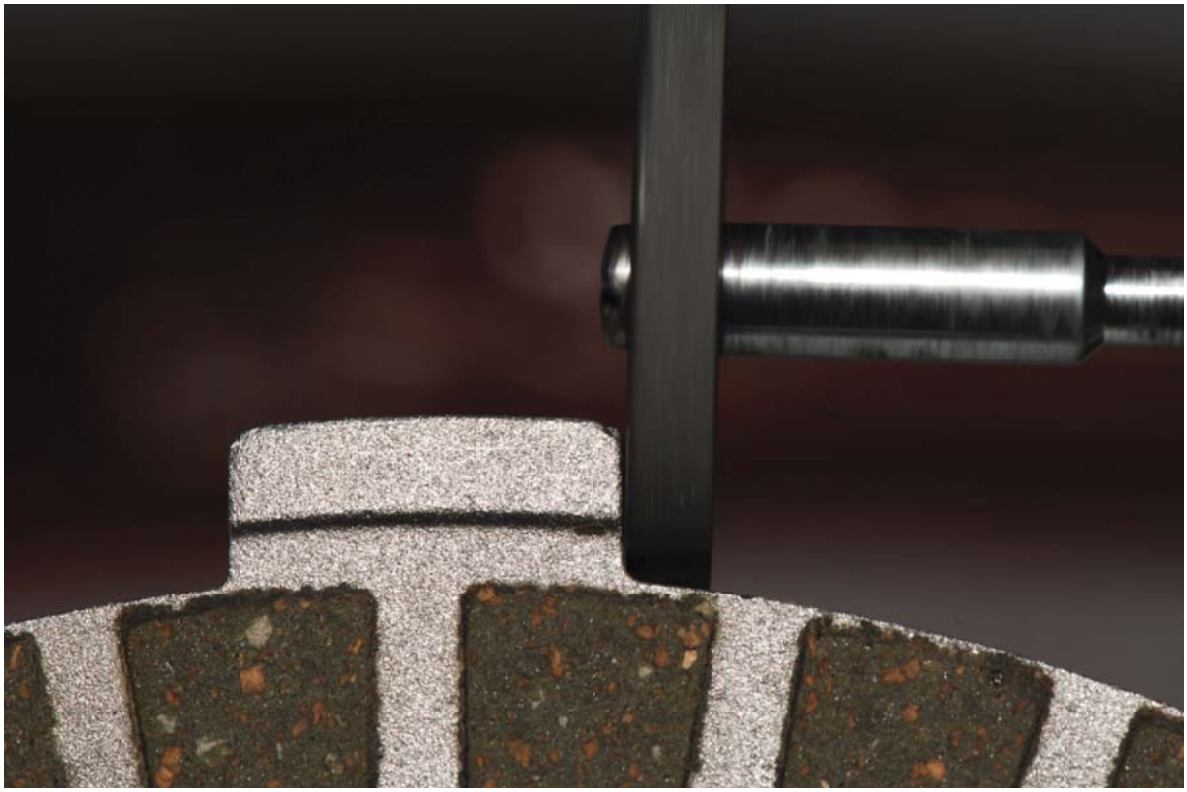
File flat on edge of tab to knock down high spots



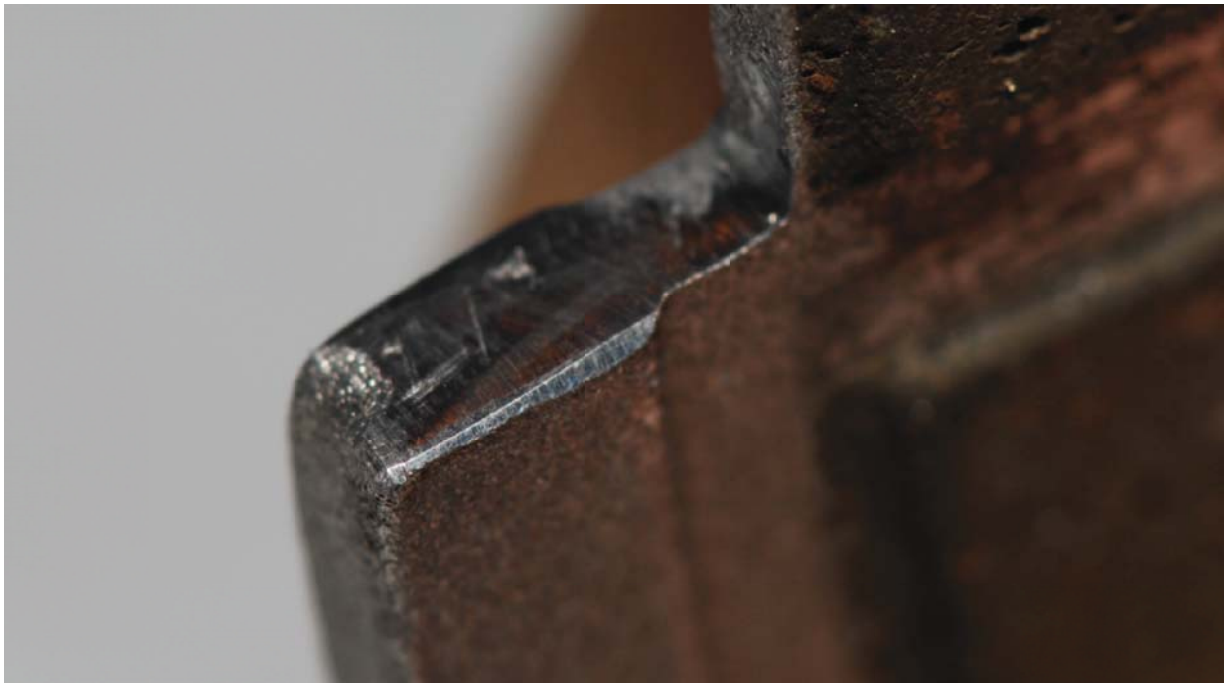
Another shot of the file knocking down the high spots. 4-5 swipes of the file are usually enough. Keen eyes will note the glue between the pads still there. I wasn't going to risk my camera around nasty gritty plates so yeah it's shot out of sequence. I can already see a big hair on the sensor!



Not as smooth as a baby's bottom but the high spots and glue are gone



Using Dremel and polishing wheel for final finish. Hold as straight as possible to not angle tab. There will be rounding of the tab edge but it's OK. Finish the tab by angling the tool to break the sharp corners.



Finished tab. Note chamfer on edge from polishing wheel

Polishing with the Dremel emery wheel complete.

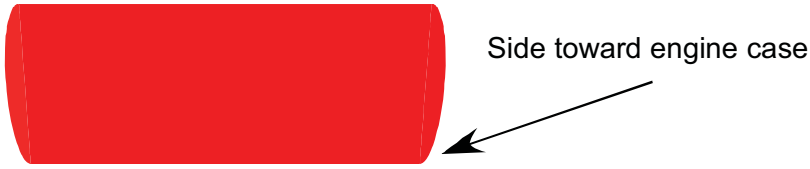
It's not necessary to make the surface absolutely flat. Some rounding is OK and will help the plate set into the basket groove. Note the corners are hit with the polishing wheel just to break the edges.

Tab shape from factory

This is what we all start with.

Tab shape after file & polish

This is what you end up with.



Optimum shape after file, polish & match to basket

If you're really into it this is optimum.

Matching to the basket requires endless time and a real case of OCD (look it up). It also means the plates can only be installed one way. I have a spare basket and microscopes if you don't then you might be happiest with just level/clean/polish.

The final step

Wash the fiber plates in soapy water. You want all the glue and metal bits to be gone. Rinse the plates thoroughly. I SAID THOROUGH! Soap in a transmission is a bad thing. Dry carefully. Reassemble clutch pack. You will first notice it's a little noisier then it used to be. Good, it means the plates are actually moving around rather then sticking to things. You will notice an immediate improvement in feel but it gets better. After a few weeks of riding the tabs will have worn into the basket and be sliding like they were designed to. If you want lighter pull you can remove a couple of springs and be amazed how you can hold the clutch in all day without fatigue. You can also change clutch engagement characteristics with different fluids rather then resorting to prayer. Little quicker clutch, ATF, little smoother, full synthetic. It's all good.