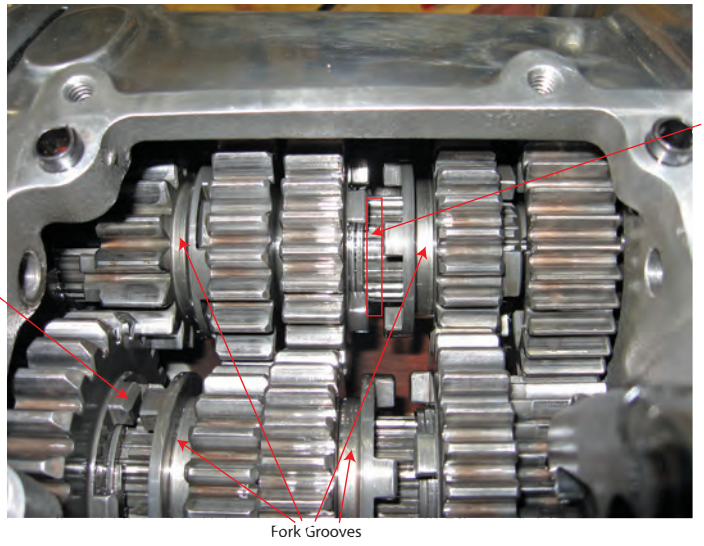
ROADMAX™ 6 SPEED VS. BAKER™ 6 SPEED

By Pete Benschoter

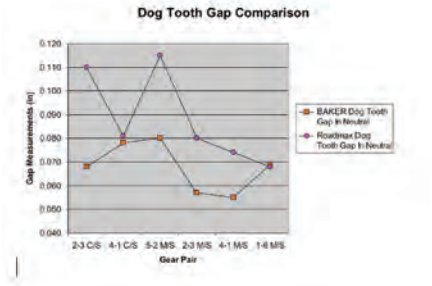
All good things must come to an end. Don't know if this transmission comparison deal had been 'good' so maybe it is just good that it is ending. So I have compared the gearsets, gear tooth design and resultant manufactured quality in the first article. Then I tackled the case machining & designed layout, quality of machining in the bearing door, as well as addressing the bearings used and the designed press values in the second installment. This month I am going to wrap it up. The shift system gets the once over. The shift forks, drum and pillow block assembly, along with the roller detent system and shifter pawl.

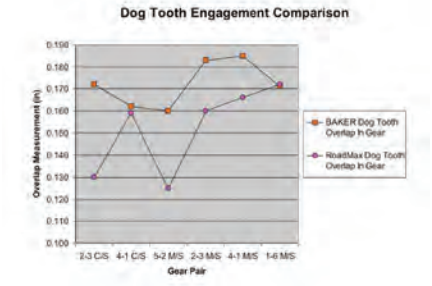
In order to tackle the shift system comparison I took measurements of the dog tooth gaps and laid out the shift drum. By laying out the shift drum I mean that I was able to decipher from the gear set layout which 'event' (think jog in the fork grooves cut in the drum) was for what gear(s). The distance of the dogs from the next gear is a relative proposition to a specific shift system and there is no 'right' answer as a blanket statement. Theoretically you want as much dog tooth engagement as possible when in gear to transfer the power and ensure the unit stays in gear while trying to counter that with as little movement required of the fork as possible for ease of shifting feel. A little bit of the robbing Peter to Paul scenario in terms of engineering compromise. The gearsets laid out the same in comparison to each other, thus making the dog tooth gap comparisons a very apples to apples task.

The dog tooth gap is a measurement that could be equated to the stack up all the tolerances of the transmission. It encompasses the bearing door, case, shafts, gears, shift drum forks, the whole nine yards. You have to ensure that dozens of parts are held to tight tolerances, with the knowledge that one part out of tolerance can and may cause a compounded problem down the line.



DOG TOOTH COMPARISON





The Roadmax had dog tooth gaps measuring a wide range, from .068" all the way up to .115", with the mathematical average being .088". The Baker unit was tighter and had gaps measuring an overall range of .055" to .080", with the mathematical average being .068". So what does all this matter? This matters because the drum only 'throws' each gear so much when you smash the shifter and throttle down the highway. In this comparison both of the shift drum's throw the gear .240" and you can see the resultant overlap measurements through out the 6 locations. That dimension of overlap is all the steel holding you in gear when you are putting the wood to it. Like I said before, the more dog tooth overlap in gear, the better. I know that I want to see more than an 1/8" of dog tooth engagement (smallest overlap amount for the Roadmax) under my ass heading down the road.

SHIFT FORKS COMPARISON

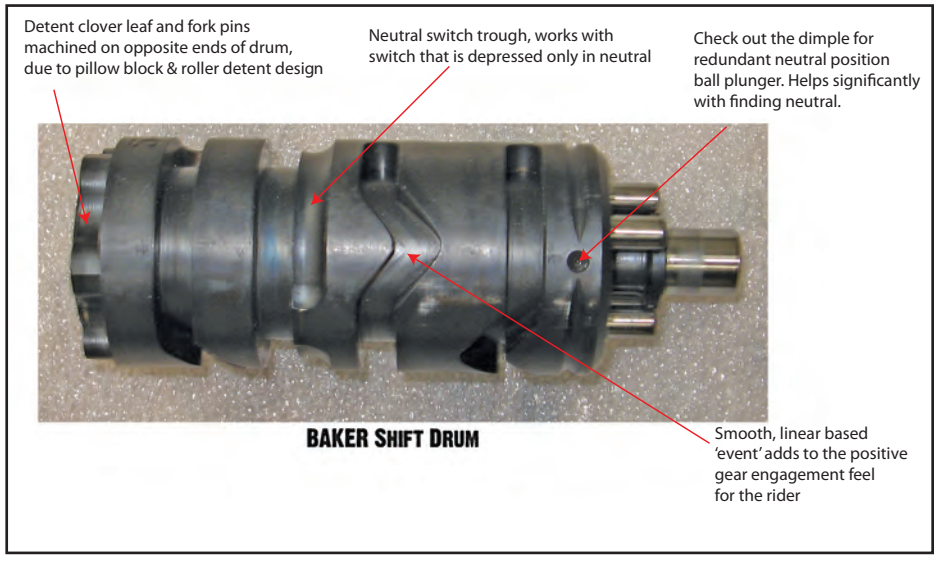
The shift forks laid out in the same general manner from one gearset to the next, save for the 3C & 2M fork pin location. The Baker approach was to have the pin coming out of the side, the Roadmax out the top. As long as there is enough meat around the fork pin hole to withstand the lateral force the drum exerts, and the pin's centerline intersects the centerline of the drum, you are fine. It is a merely a matter of choice for manufacturing ease and component packaging inside the transmission.

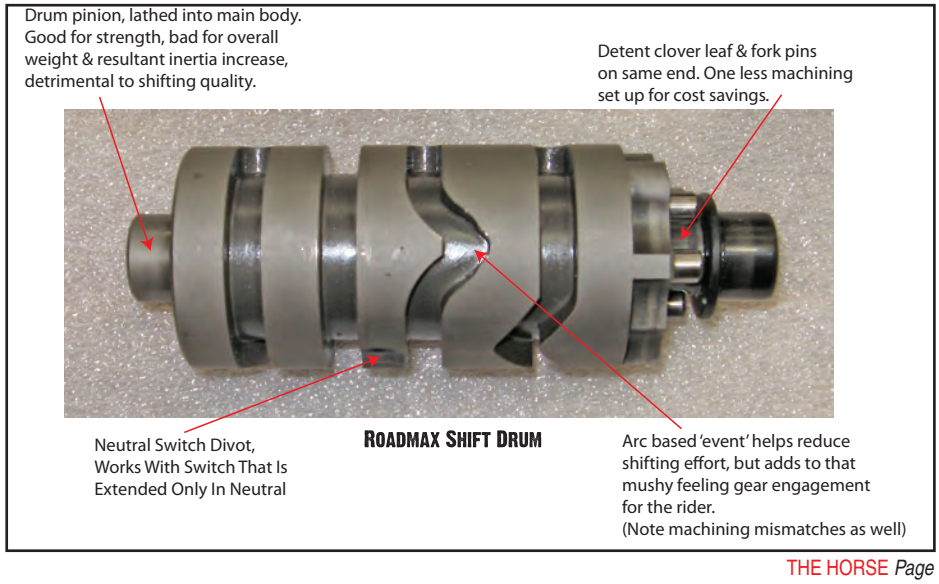
There was a distinct contrast in materials and applied coatings to accomplish the same task, smooth shifting long lasting forks. Both companies had their own solutions to getting oil in the fork grooves on the gears where the forks tips make contact. The Baker forks used a .020" deep milled-in relief, while the Roadmax used a .010" deep ball mill slot. I like the first approach due to that nature of the relief, you only have the 2 ends of the fork tines in contact with the inside walls for the fork groove, rather than the whole side of the fork. Less parasitic dragging, less heat build up and longer theoretical life span as a result. The Roadmax forks were investment cast Bronze alloy, and machined to final shape. The Baker shift forks started life as low carbon alloy steel extrusions, then machined to final shape, post machining they were hard chrome plated.

Being that the transmission is fully internally coated in oil during normal operation, the gains of the self lubricating nature of bronze are negligible compared to the steel forks when you also calculate in the added stiffness that steel brings to the table, over bronze. The hard chrome plating does add a great amount of localized case hardening in the high wear areas for durability sake, which bronze can not touch. Further inspecting the forks, I next measured the blade widths of all the forks. Using the previous data I had collected from analyzing the gearsets, I was able to calculate the fork blade total gap clearance. I found the Roadmax fluctuated a lot from being a .010" clearance fit in the fork grooves, all the way up to .020". That is not good on a design or manufacturing level, especially when coupled with the already erratic dog tooth gap layout. That added amount of slop in the system, hinders the ability to hold gears in place, as well as eliminating the smooth nature of sliding gears up and down the shaft splines that you as a rider are after. The Baker fork tines had an overall fitment gap of .007" to .011" throughout the 4 forks. Tighter is better, no secret to all of us, wink, wink, and the better fitting your forks are, the faster and more firmly they will move gears into place when the transmission is shifted.

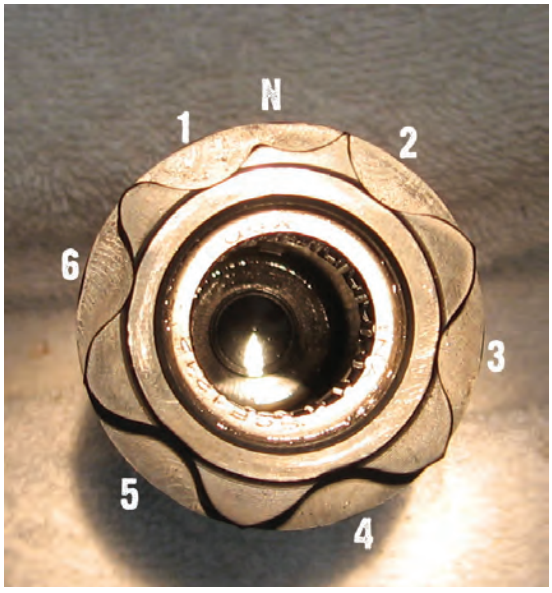
SHIFT DRUM LAYOUT AND COMPARISON

The shift drum plays the biggest single role in the shift quality of any v-twin transmission. The angle of the approach in and out of gear on the drum tracks, the shape and height of the detent clover leaf, and the quality of the pillow





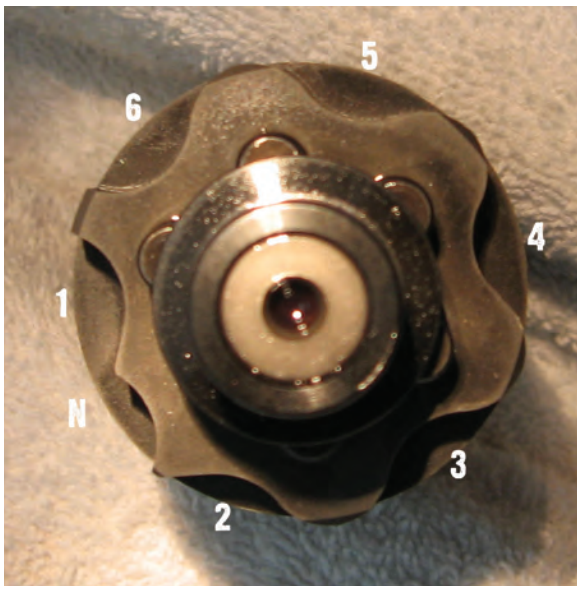
block mounting system all play a part. The drum track design in it's most basic form is dictated by the amount that you want to throw each gear, the angle of the tracks in and out of gear (the 'event' of each gear track) determine the effort required to shift, while the corner fillets dictate how smoothly the fork pin slides in and out of gear.



Baker Drum Detent Clover Leaf

The drum detent clover leaf interacts directly with the pillow block mounted roller detent and torsion spring lever arm. From an ease of shifting stand point you would to make the clover leaf very rounded over and mushy. Contrary to that school of thought is the desire for positive engagement by using steep peaks, with very sharp entry and exit ramps.

In looking at the pics below, you can see the different approaches to detent clover leaf design. The Roadmax has fairly round shaped shifting events, with more arc based peak profiles. The neutral valley is wisely biased towards 1st gear, aiding in finding neutral coming up from 1st gear, but not heading down from 2nd gear. This detent clover layout would lean towards the easy shifting effort, but lack of positive engagement school of thought. The Baker on the other hand has a more linear peak type layout, with arcs forming the valleys and the leads in to the peaks. The peaks help to snap the drum over into the next gear by using the aid of inertia. Same type approach of using a neutral valley biased towards first gear. See the difference in the peaks after the neutral event, the Baker style sticks out less and would be less likely to hang the drum up in neutral when you do a lazy footed 1-2 shift. The mixed design detent profile approach that Baker used would be to nail down both schools of thought, snappy shifting, that is still smooth and low effort.



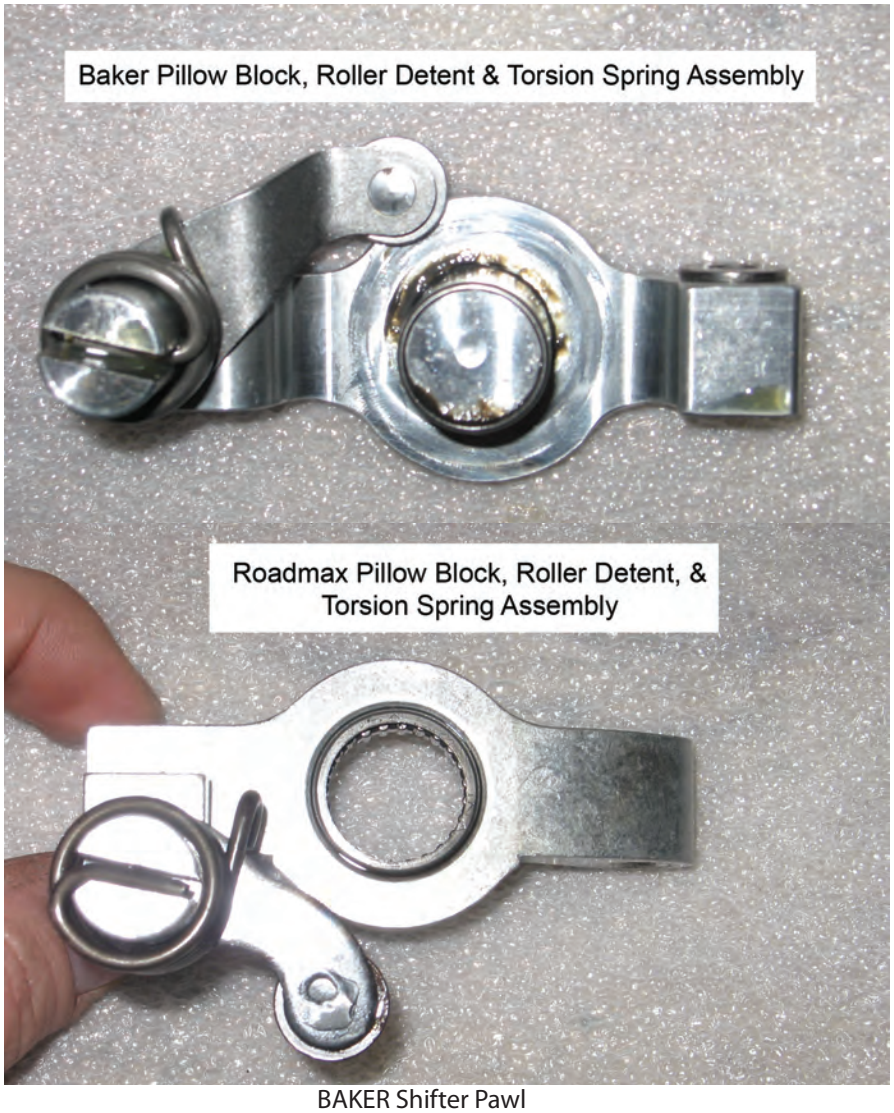
Roadmax Detent Clover Leaf

Like every other part in these transmissions, I ran over the drums with a fine toothed comb. I used the same Starrett® Hardness tester that I used on the gearset, to check the case hardness values of the two shift drums. Remember the liquid chocolate dipped soft serve ice cream cone analogy from the first article, same case here? The Baker Drums tested out to a range of 46-48 Rockwell C over the whole part. To put that in perspective, it is about the same hardness as that metal file in your toolbox that will go through anything. The Roadmax in stark contrast, was in the 16-19 Rockwell C range over the whole part. Way softer, more of the mild steel grade of metal that you clean up with your file on a regular basis during fabrication. This lack of case hardness is a recipe for premature part wear and failure down the road. The shifting will start going as the detent clover leaf events are getting worn out, the hardened fork pins with still start to wear their own paths into the drum, causing worse shifting and possible fork failure as they start to wear unevenly, etc.

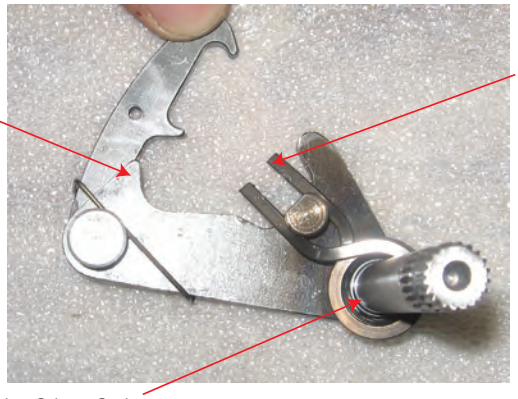
I also weighed both the drums, sans pillow blocks. Baker 1.464lbs, Roadmax 2.130lbs. This does matter and here is why; weight correlates directly to inertia. The lower the inertia, the easier something is to spin. The 45% difference in weight between the two drums will definitely be felt in the ease of shifting category. That lower inertia enables the same roller detent assembly to work better, it turns the drum faster and requires less effort as well to stop the drum in the desired position.

PILLOW BLOCKS DESIGN

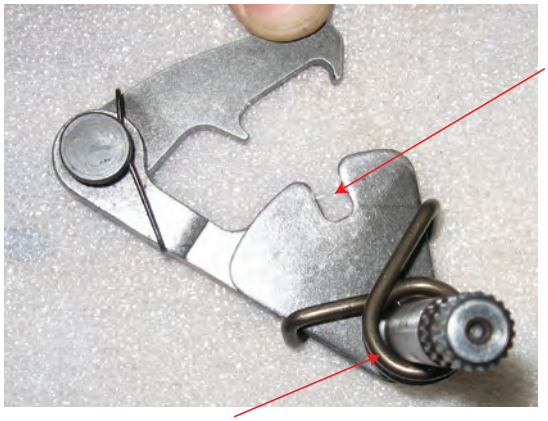
The pillow blocks used different approaches for the same objective. Both sets are machined out of billet aluminum extrusions. I can't tell the exact grade of aluminum, but neither appears to have any cross sectional thickness issues that would cause concern of failure. The Roadmax unit has the roller detent arm on the underside of the drum for easier packaging and machining. On top it would have interfered with the shift pawl since it is on the left side of drum. By having the detent clover leaf and pawl pins on the same end, you can skip a machining set up, saving money. The Baker unit places the detent clover leaf on the opposite end of the drum from the pawl pins. This adds another machining step, but enables you to have the detent lever on top of the drum. As you can see



BAKER Shifter Pawl



Roadmax Shifter Pawl



from the picture, the Baker detent lever is longer. This goes back to basic geometry from 10th grade, the longer the lever, the less force required to move it. The trick to ensure strong shifting feel to the end user is to add a stiffer, thicker gage steel torsion spring. So it's easier to move, but still strong at staying in gear.

Lastly is the different approaches to the shifter pawl. The first thing you will notice is the springs used. The Roadmax uses an EVO™ era set up, with the Baker using a more modern scissor spring design. Another design evolution found in this picture is the anti-overshift stop found on the Baker pawl. When up-shifted very hard, like racing light to light, the pawl will deadhead against the pawl pins of the drum and prevent the WFO shift at 5000 rpm's from pulling the drum over into the next gear. Another part of the puzzle, that makes a big difference.

THE RESULTS

There are many objective ways to compare many products out there in the big crusty world of ours. Which beer taste better, or is it better because it is less filling? Cheese on top of your hot dog at home, or injected in the middle at the slaughterhouse? Chili with beans, or without? These types of extremely important daily questions aren't something that you can apply to a transmission on your motorcycle. I approached this deal from a scientific mindset based on my full adult working life spent in gear & drive train design of one form or another.

Numbers don't lie and they didn't in this case either. Every discernable & measurable category saw Baker in the lead. It is true case of getting what you pay for. Overseas designs based on other people's work, using cheap materials and cheaper manufacturing methods, or American Made designs made with premium grade materials on state of the art machinery. This is not an objective choice that should be hard to make, to which would you trust your life?