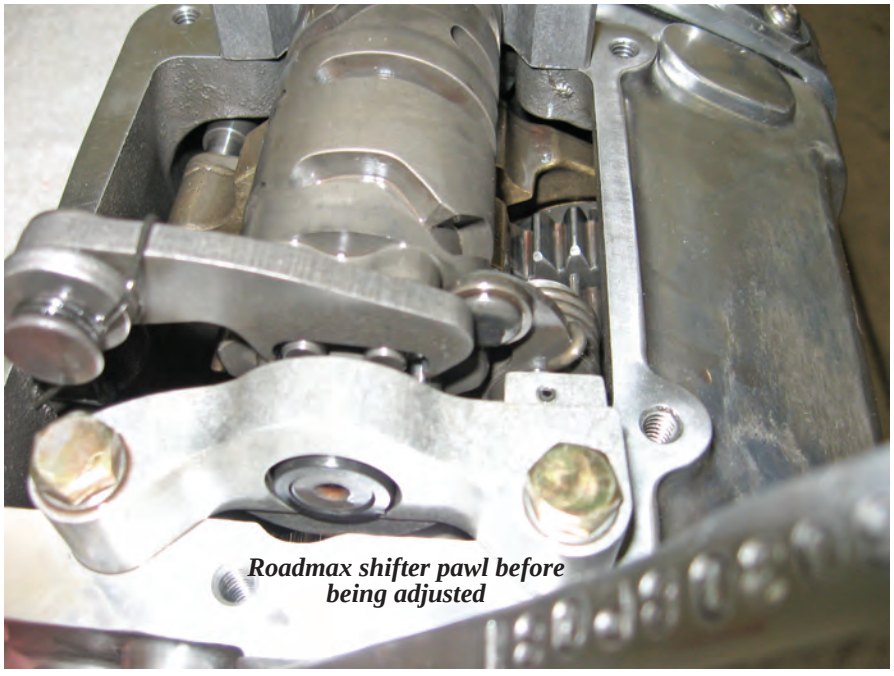
ROADMAX™ 6 SPEED VS. BAKER™ 6 SPEED

By Pete Benschoter

In last issue's installment I compared the Roadmax and BAKER 6 Speed gearsets for all aspects of overall gear design, manufacturing quality, tooth profile accuracy and metallurgy characteristics. The facts were clear and pointed to the Baker unit as the undeniable victor in those aspects. This month we are going to evaluate the initial teardown findings, the machining of the case and bearing door. As well as the bearings used and the amount of bearing press designed into the system. I am going to approach it in the same manner, evaluating the design intent and its effect on function, as well as the measured quality of the various components on a manufacturing level. I utilized some friends in the machine shop business to help me lay out the case and bearing door on a CMM. The CMM that we used, short for Coordinate Measuring Machine, can measure out to tenths of an inch, repeatedly, easily, and has up to date certified calibration.



Roadmax shifter pawl before being adjusted

Teardown Findings

When I started on this project in early fall 2008, the first thing that I did was to evaluate each units function, as I received them. The Roadmax 6 Speed was the first to be raked through the coals. I found that it shifted alright, well at least until 3rd gear. I couldn't get it to go into 3rd, because as I later found out, the bearing retainer plate on the trap door was never installed. There were no witness marks on the bearing door and the threads in the bearing door were void of any Loctite 'crust'. This allowed the countershaft bearing to walk out .101" and the mainshaft followed suit to a tune of .033".

This movement threw off the stack up spacing of the shafts to each other and made the dog teeth of the gears dead head against each other before the drum was fully rotated into gear on the detent. With the top cover off, and being able to see what was going on in the transmission, I tapped the bearings back into their intended position with a socket and some ball peen persuasion.

With the bearings knocked back in the door I could now shift into all 6 gears. Although I now noticed that it up shifted a lot better than down. Suspecting the usual culprit, I checked the shifter pawl and it was out of adjustment. It was biased to the front of the drum pins in 3rd gear. I adjusted it to be set evenly over the pins, per the Factory spec, and it shifted better still. Finding neutral was easier than a stock gear box, but not by much.

Right out the box the Baker shifted through all 6 gears, and finding neutral was easy. I found the Baker unit to be fairly leak free. Although there was some residue around the main drive gear seal. The Baker was in proper working order and shifted better than the Roadmax. Both in terms of the low effort required and the positive engagement of the shift lever in each gear.

Transmission Case & Bearing Door

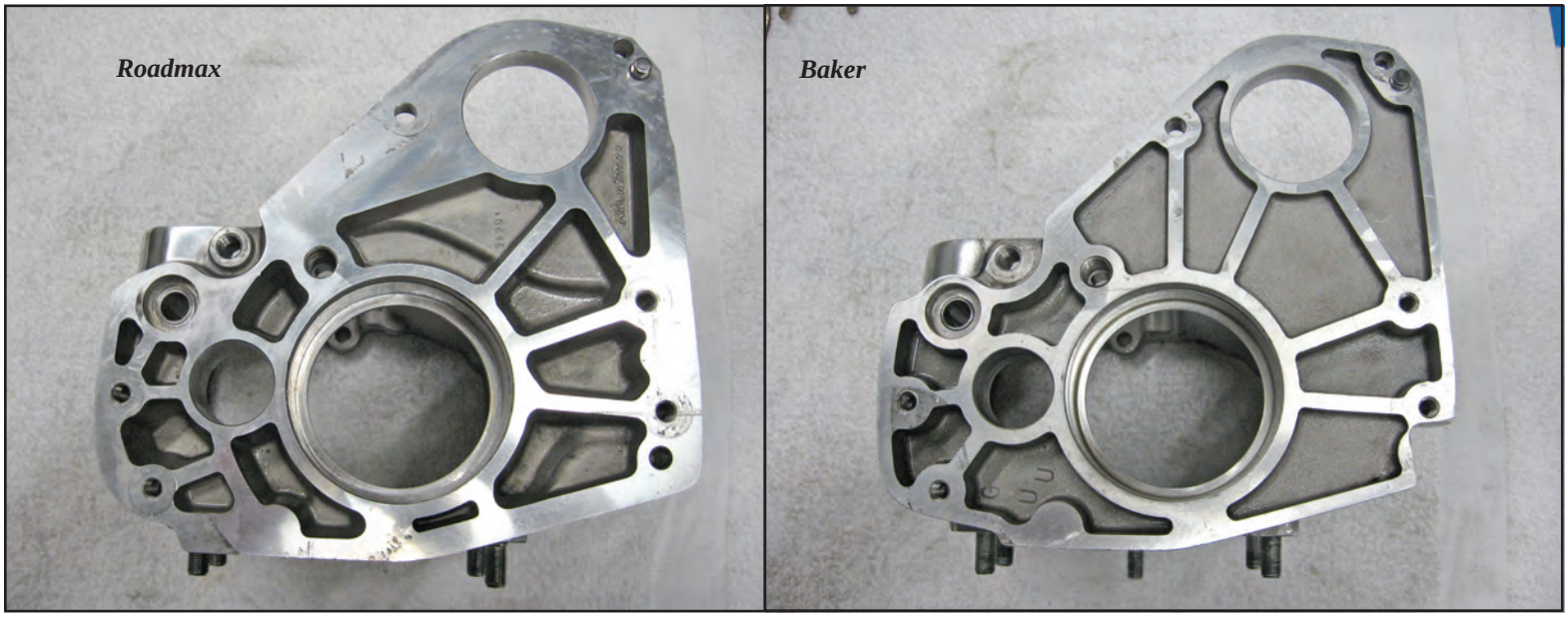
Having laid out both gearsets for last month's article, I was able to do some additional calculations to figure out the center distance of the shafts. Nominal should be 2.502" with what I feel to be a realistic minimum machining tolerance of +-.001". I used this number as a basis for comparison on the machining accuracy of the case and the bearing door for both models.

These transmissions are designed like a cube, the top and bottom, left and right surfaces are parallel and perpendicular to each other, respectively. The ability to hold these dimensions accurately directly affects the relationship of the gearset and the shift system, the gearset and the clutch and the alignment of the entire drivetrain. Both units' surfaces were within what I feel to be allowable limits, on a parallel and perpendicular nature, less than .1° total variance (about .010") throughout.

I laid out all bearing bores, dowel holes and threaded holes in relation to each other in an X,Y manner. I also captured all of the diameters of these features out to four decimal places. Due to the shear size of the resultant data, I am not going talk about each tenth of an inch difference from one feature to the next, rather focus on the discrepancies.

Both units used a 6209 main drive gear roller bearing in the case. This bearing has an outside diameter of 3.3464" and I found the Baker case was machined to 3.3443" or a resultant .002" press fit, whereas the Roadmax measured out at 3.3459", a resultant .0005" press fit. Factory bikes of the 90's ran the lighter press amount on this same bearing, and they were notorious for wearing out as it worked in and out when mated to a motor with any amount of added mustard. The 6209 bearing on the Roadmax unit was starting to show its age prematurely for the amount of miles on the gears. Was this due to the light press, maybe, but it also could have been caused by running the primary chain too tight, the drive belt too tight and/or primary misalignment. The tighter amount of press in the Baker case will add a measure of durability and strength to the clutch and transmission interface.

Roadmax case on the left, Baker on the right. Note the contrasting styles of ribs, deep stepped pockets and radial thickness around critical bores. Like the countershaft. The notch out of the lower right on the Baker case was a result of some 'custom' fab work. You can see slightly different profiles too, like around the starter ear and the front left side of the case by the inner primary mounting points.



The cases as a whole had all of the dowels and threaded holes in the same relative location to each other, so I searched the data for noticeable differences. I found three.

1. The dowel that locates the inner primary and starter to each other.
2. The location of the shifter pawl case bushing.
3. The alignment of the bearing door to the case dowels.

The Roadmax starter dowel hole

Roadmax Bearing Door
Note the mismatch of machining in the 2 center oiling ports. The dowel hole for the left most side cover hole would cause a lack of full thread engagement and possible stripping in the future. Though this door did not show signs of thread stripping or side cover movement. Check out the hardware store drain plug with pipe dope.

Baker Bearing Door
Note the 2 offset drilled oiling holes to clear the 6th gear on the mainshaft. The lack of a left side dowel should be overcome by having 6 fasteners with full thread engagement. No sign of side cover movement on this door. Check out the aftermarket drain plug with built in o-ring.

was .0064" lower towards the centerline of the bores than the Baker case, but the two mounting thru holes, and starter flange hole measured within .003" of each other when directly compared. You can't move a dowel hole for design improvement sake, when you don't control the design of the mating components. It would be called a manufacturing error instead. This error can result in starter gear binding due to the starter being cocked when trying to line the dowel and starter bolts up during assembly. You will probably see inner primary line up issues as well.

The weirdest of all the dimensions that I have taken thus far is the location of the shifter pawl hole. The Roadmax and Baker were within .003" of each other measured left to right from the output gear bore center, but the Roadmax was .0348" lower. I double-checked it four times, had the Quality Manager of the shop I was at do the same, re-calibrated the CMM to be safe, and then did it again. No change. I checked the layout of the shifter pawls to each other and found them to be within .011" of each other from the pawl shaft center to the theoretical center of the pawl pin hook. Only having one sample of each case and pawl to measure I can not say that the dimension difference is a definitive design or manufacturing error, but it was the only locating dimension difference of more than .0064" between the two cases, so I would guess the latter.

The last area of dimensional mismatch that I want to talk about is the line up relationship of the bearing door, to the case. The alignment of the bearings bores in the door to the

Trap Door Bearings
Both the 6204 on the left and the 6304 used riveted together steel cages for strength. You can see from the picture the difference in the size of ball bearings that can fit within the races of the larger 6304.

case is dictated by the machined in bore to bore center distance of each, as measured front to back on the bike, and the location of the dowels pressed in the case to the slip fit dowel holes in the back of the doors. On these cases, and all Factory cases from 1990 to 2006 the shaft centerlines and dowel holes are supposed to on one plane, parallel with the top cover surface. You will get variances due to allowable machining tolerances and those will translate directly to the interface of the multiple gear pairs in the case. Neither was perfect, but the variance line of the Baker spec'd out to .0026" with the Roadmax coming in at .0047". Almost twice the difference, with farther away from zero incurring a higher chance of gear binding and premature wear throughout the gearbox due to shaft misalignment.

Another contrast in design that I observed was the choice of bearings and the resultant press fit in the door. The Baker 6 Speed used 6304 single roller bearings, whereas the Roadmax 6 Speed used 6204 single roller bearings. What does one number and 5 mm bigger diameter matter? More than you would think. The 6204 bearings were used in the bearing door for all stock 80" EVO transmissions, whereas the 6304 bearings were used in the bearing door of all TC88 transmissions. This is due solely to the 20% higher dynamic load ratings for the 6304 bearings. The bigger the outer diameter of a roller bearing, the bigger diameter the ball bearings you can stuff in them, thus increasing the load carrying capacity. If the Factory didn't think that the 6204 bearings would hold up to an 88" emissions motor, then one can't possibly think that a hot rodded 96" will fair much better.

As I talked about earlier, the amount of bearing press used plays a role in helping to control and limit side to side movement of the shafts. A stock 5 speed uses retaining rings in the door. These aftermarkets 6 speeds are limited by side cover packaging of being able to include snap rings. This is not a bad thing, retaining rings, can and often do fail. Roadmax took the approach of replicating the light stock press, about .0004". Baker upped that amount 4 fold to .002" of press, and when coupled with the steel retaining plates should offer a much greater resistance to bearings walking out of the door.

So I was criticized after last months article by my wife, a retired English teacher, for highlighting the faults of the Roadmax, and the good points of the Baker. That I was not impartial. Well my propensity for American made products aside; the main point that I want to make in presenting the facts in this manner is that there is a principal of function behind every mechanism. The Baker transmission is not black magic or designed in a completely revolutionary manner in comparison to the Big Twin transmissions that have come before it over the past 70 years. It is 2 shafts aligned horizontally, some shift forks, a bearing door and a drum plopped on top. You either make good transmissions or you don't. There really isn't a much a grey area. The devil is in the details, and the details are tighter tolerances held here or there, and slightly changed this or that, adding up to a large difference of quality as a complete unit.

Stay tuned for the shift system comparison next issue…