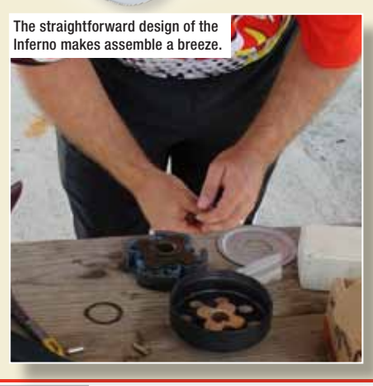
TECH ARTICLE **BY MIKE UNGER**

TRACK TESTING THE HILLIARD FLAME CLUTCH

If you haven't noticed by now Clone engines have become very popular. They are inexpensive, easy to find and if you have enough of them to race against can be a blast. The main thing driving the popularity of Clones is the low cost. Karting sanctioning bodies realize this and are doing everything possible to continue to keep costs low. Many of them have mandated that clones run simple inexpensive drum clutches. We at NKN acquired a new product in the clutch arena the " Inferno Flame" Racing Clutch.

The Inferno Flame clutch is made by Hilliard Corporation located in Elmira NY. They design, manufacture and sell a wide range of industrial motion control products ranging from starters to oil filtration equipment. Using their broad background and expertise in manufacturing along with a keen interest in karting they have developed a number of clutches for the karting industry.

The Flame racing clutch is a 4 shoe clutch with a simple drum enclosure. From the outside it looks very much like many of the other clutches on the market. Once you take the drum off you notice that the similarities end there. The Flame clutch has a unique spring and bushing design that was engineered specifically to keep heat away from the springs while keeping it all simple. The springs are actually small C shaped pieces of spring steel that attach to the base of the shoes. Not only does this keep the springs away from the heat, but it also makes the springs very easy to change. A simple set of snap ring pliers is all that is needed.



The straightforward design of the Inferno makes assemble a breeze.

The Flame clutch design keeps the springs at the center away from the heat, a straightforward way to adjust weight of each individual shoe, and a unique hub design that makes disassembly easy.

The features don't end there however. The shoes are one piece L shaped designs with cleaning grooves cut into the clutch surface. This keeps the inside of the drum clean and maintains consistent clutch engagement. Also special about the shoe is the holes near the outside diameter. These holes can be filled with multiple combinations of weights. The shoes themselves can also be run in leading or trailing orientation by simply changing the way they are mounted to the central hub. Between 4 different stiffnesses of springs, 2 sizes of weights, 2 different holes for location for those weights and orientation of the shoes, the Flame is the most adjustable karting clutch I have ever seen. Being an engineer I was anxious to test it.

Since I am not an expert on Clones nor do I have one, we turned to a seasoned racer familiar with clones to help me test it. His name is Eric Fagan and he and I have been racing karts for the better part of 15 years. When I started he was still running Juniors. He has raced everything from 4 strokes, to Shifters and recently has been having a blast racing all over the country with the Clone. I called him up and he was eager to help with the test.

We both arrived at Circleville Raceway Park the day of the test. After a brief discussion we decided how to test the clutch. Clutches are designed to allow the clutch to slip when the kart is traveling at low speeds. This allows the engine to operate at a higher rpm level and therefore higher torque level to allow maximum acceleration. We decided that Eric would start from a stop at a fixed point at the end of pit lane. He would then apply wide-open throttle and accelerate to turn 2. Right before the beginning of turn 2 we placed an AIM timing beacon. Allowing us to accurately measure the time it took to cover that distance with the various clutch setups. Eric continued the lap as fast as possible and immediately return to the pits. He turned back to the starting point and repeated the procedure 2 more times. The data was downloaded and recorded. Then using the AIM software I determined the 'laptime' from the point at which Eric hit the throttle to the timing beacon. The objective simply would be to find the configuration of the clutch with the lowest elapsed time. Nothing more nothing less, data doesn't lie.

Installing the clutch is a snap. All the parts fit securely.

So Eric took his kart out on track for about 8 warm-up laps. Eric had just come back from the Gold Cup race at Michiana Raceway Park where he won the Clone Senior Class by 7 seconds. The kart had the same setup, same settings that were on it then. After 8 warm laps Eric was ready to begin testing.

With so many variables to change with this clutch we decided to keep it simple at first so we started with the white springs, the shoes in the leading orientation and no additional weights.

Notice the cleaning grooves in the working end of the shoe as well as the holes where weights can be added.

The white springs are the weaker of the 2 sets we had and with no weight on the shoes should provide a medium level engagement point. Eric went out and lined up on the starting line and hit the throttle. When he crossed the timing beacon he just kept on going as if it were a qualifying session. When he came to turn 10 he showed, entering the pits, turned and lined right back up for another run. Again from a stop he did it 2 more times.

Eric came in and we immediately downloaded the data. Using the AIM software we determined the 'laptimes' and 'stall speed' of the engine during the run. The 3 runs were then averaged together. Test 1 results showed a laptime of 9.87 seconds and a stall speed of 4053 rpm. So far so good.

Next we decided to change to the lighter set of weights. These weights looked like very small dumbbells with grooves cut on the ends. In the grooves you attached very small snap rings. To put the weights in the shoe you simply slid the weight in with a snap ring only on one end. Then after the weight was in place you attached the other snap ring in place. This securely keeps the weight in place. In the clutch user's manual it was advised to only use the small snap rings one time then discard. After using them I can understand why. They are a little tricky to get on and off and applying too much force to them would damage them. After putting 4 of the smaller of the 2 sets of weights on the leading edge hole we put the clutch back on and Eric was back at it.

Top: Working on the Inferno Clutch is easy. Snap ring pliers is the only tool needed to make changes.

Above: Key to the Inferno design is the shoe and central hub design.

Right: Eric Fagan Gold Cup National Champ and happy Inferno Clutch user.

Left: The drive sprocket is removed easily with a snap ring pliers.

Below: The shield on the clutch keeps the dirt and grime out of the clutch for maximum performance and longevity.

This time the results were only slightly different. The stall speed had gone up only 50 rpm but the laptime had dropped over 0.5 seconds. Looking at the data trace adding the weight changed how quickly the motor rpms dropped after the clutch was fully engaged. It was clear that with only a small change you could dramatically affect the performance. 0.5 seconds was something that any racer would die for.

Test 3 we decided to stay with the white springs, remove the 4 smaller weights and replace them with 4 heavier weights. The instructions that came with the clutch showed this change should further lower the clutch stall speed. With a little quick work with the snap ring pliers the change was made and Eric was out for another run.

The results agreed with the Inferno instruction manual. Adding the heavier weights again lowered the stall speed to 3899 rpm and surprisingly increased the laptime to 9.403 seconds. About 0.1 seconds slower than the previous setting. From this pattern of results it is clear that how hard the shoes engage have a significant performance effect.

Next we decided to add 4 more weights filling all the holes in the clutch shoe. Based on the pattern of data so far it should further decrease the stall rpm. Again after a mere 5 minutes of working on the clutch the new configuration was set and Eric attached the clutch and went out to test again.

This time the results were as we had predicted. The stall rpm dropped again now to 3777 and the laptime slowed to 9.67 seconds. This again showed that the weights are important to tune to your specific engine and power band to hit that sweet spot where the engine likes to be.

So far we had gone through a series of changes and we had learned from tuning the weights that stall speed was not the only factor at play here. The addition of the weights changed the stall speed only slightly but changed how quickly the clutch fully engaged. As with many things in life it wasn't as simple as just doing the 'more is better' approach. Using the white springs, 8 heavy weights, and the shoes in the leading configuration yielded the best laptime of the configurations tested.

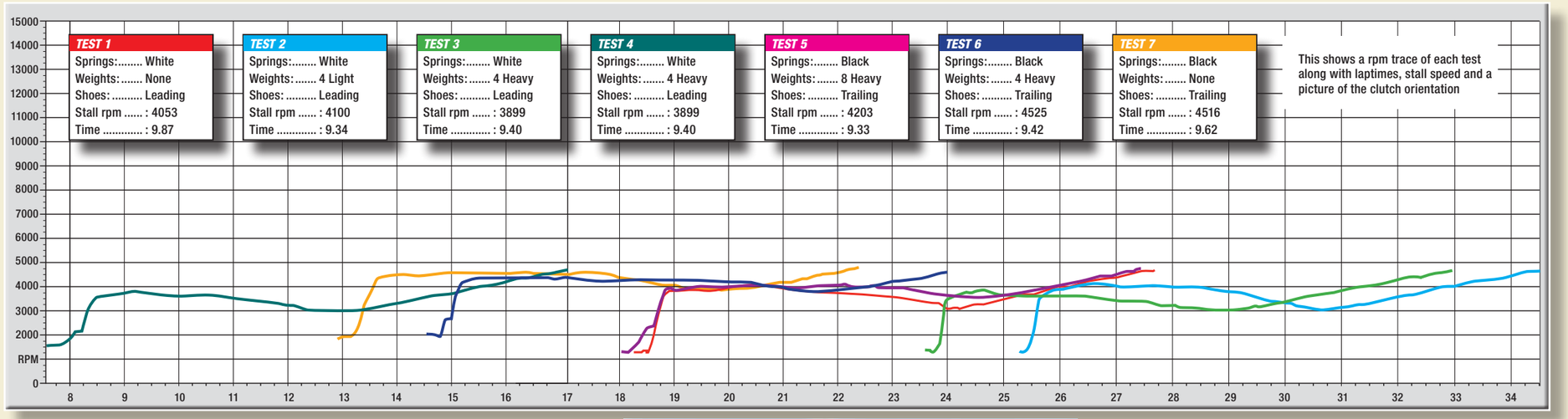
But we weren't done yet; in addition to the white springs we also had stronger black springs which should further increase the stall speed. In addition we had the ability to change the orientation of the clutch shoe from leading (the L shaped clutch shoe tip facing forward) to trailing (the L shaped shoe tip facing rearward). The instructions explained that in the leading orientation the shoe would engage more abruptly and in the trailing orientation the shoe would engage more smoothly.

So we were anxious to see if we could further push the laptime lower. We installed the stronger black springs and flipped the shoes from leading to trailing. The expectation was that this should increase

the stall speed and make the clutch lock up more smoothly. With some simple work of the snap ring pliers the clutch was reconfigured and Eric was out testing.

The results from this change were good. As the manual suggested, the stall speed increased to 4203, the addition of the heavier springs, and the change in shoe orientation made the clutch engage more smoothly. This clearly is shown in the rpm vs. time trace comparing Test 4 to Test 5. The cool thing about the result was it had yielded the lowest average laptime so far of 9.33 seconds. Now a little more than 0.5 seconds better than the starting point of 9.87 seconds.

Now the clutch with the strongest springs, 4 of the heaviest weights and the shoes in the leading orientation the only way to go from here was to remove the weights. So for test 6 we removed 4 of the weights from the forward most holes in the shoes. From our previous series of tests this change should increase the stall speed and make the clutch engage smoother yet. After Eric made his runs that is exactly what we got, the stall speed increased to 4525 but the laptime slowed to 9.42 seconds. The clutch engaged more smoothly but apparently we had missed the sweet spot on the engine's power band.



To prove that theory we removed all the weights and ran it again. If the trend held true the clutch stall would again increase, the clutch would be smoother and the laptime would get slower. Test 7 results proved the theory correct. Test 7 stall speed 4516 & laptime 9.62 seconds. Looking at the data trace it appeared that the clutch engaged more smoothly but as we thought we must be further away from that sweet spot in the engine's power band.

So what did we learn? We learned that stall speed while an important parameter does not tell the full story. How hard the clutch fully engages also plays a very strong part in achieving maximum performance. In our tests the best 'laptime' was with the strongest springs and all 8 of the heaviest weights, and the shoes in the trailing orientation. In the leading orientation the second best laptime was with white springs and 4 of the lighter weights. Considering the major differences between the configurations it is clear to Eric and me that without data acquisition fine tuning the clutch to this level could not be done. Eric himself struggled to predict the results based on his seat of the pants feel.

In the end we were both quite impressed with the Inferno Flame clutch. It was super easy to change configurations, a simple straightforward yet unique design, and it performed as the manual suggested. Considering we took the clutch off the engine, downloaded and analyzed the data, made the changes and put it all back together 7 times in less than 2 hours speaks for how easy the clutch is to work on. After doing the test, not only is stall speed important but how quickly the clutch fully engages seems to be just as important. The Inferno Flame clutch allows you to fine tune that lockup to your specific needs. Also after 21 launches from a stop the clutch shoes and drum looked very good and ready for more.

But as you would expect the true test of this clutch would be a comparison to the clutch Eric had run so far this season. After all, Eric was leading the points in the Gold Cup and his machine had performed flawlessly to date. Getting Eric to change clutches halfway through the season would require data. So we bolted Eric's original clutch on as he had raced it the week before and tested it like we had tested the Inferno Flame. Same series of runs, same beacon, same driver. The results: After after checking in with NKN's corporate office and a conversation with Brent from Hilliard, Eric had decided to use the Flame clutch for the remainder of the year. In the following weeks Eric won the Commercial point Street Race, the Gold Cup Race at Pittsburg and secured the National Championship in the process. As it turns out data and results don't lie.

Eric Fagan, WKA Gold Cup winner.