FINE TUNING

Tips to tune a clutch for competition

Words / Photos Sam Moore

Sometime last century, engine builder Jon Kaase declared that for every 1/10th change in barometric pressure, engine output is affected by around 10 hp. The adage changed the approach to clutch adjustments, and adept crew chiefs have since followed the rule.

It's no secret that the contemporary racing clutch has morphed into a significant piece of engineering. Continual increases in engine power output, ongoing trends in tire technology, nitrous-oxide developments, and better forced-induction systems are all responsible for extensive reforms in clutch design and application.

Single-disc, street-type clutches gave way to multiple-disc units, while at the same time, clutch friction materials endured numerous upgrades and changes. Evolution ensures few customs remain constant for long.

This being the case, we thought it would be useful to shed some light on just how these clutches operate in the intense arena of drag racing — particularly the unbridled world of Pro Extreme, Pro Nitrous, and Pro Mod. To gain further insight, we contacted Ram Clutches of Columbia, South Carolina, who prepare the clutch systems for many of today's top racers.

In the 1970s, Ram Clutches designed and patented the competition paddle-style clutch, and later the urethane-encapsulated clutch spring, a creation that strengthened competition clutch springs by a factor of four.

In an interview with Pat Norcia, who co-owns Ram Clutches with his brother Mike, he revealed many of the tuning secrets used to keep the company at the pinnacle of competition clutch development. Importantly, many of these techniques can be applied to most forms of drag racing clutches.

Fundamentals of the racing clutch

"The multi-disc racing clutch systems used in Pro Mod, Pro Nitrous, and IHRA Pro Stock have two adjustments: Base pressure and centrifugal pressure," Norcia says.

Base pressure or static pressure is a fixed pressure (a constant pressure on the clutch springs) that is adjusted by an Allen-head screw on top of each spring.

"The centrifugal pressure or counterweight is applied by the weight of a series of small bolts, nuts, and one-gram washers mounted on the clutch fingers," Norcia adds. "Pro Nitrous cars, for example, leave the starting line at around 5000 rpm. As the engine speed increases to the shift point — typically around 8000 rpm — the centrifugal force increases the clutch's clamping pressure, thereby allowing the clutch to carry the load placed on it with each subsequent gear change.

"The clutch disc friction material is constructed of sintered iron. This sintered product consists of a powdered mix of several different metals. It is placed onto a steel carrier and then baked in a furnace, which bonds it to the carrier. Sintered-iron materials were first used in the 1960s in Top Fuel and Funny Car applications."

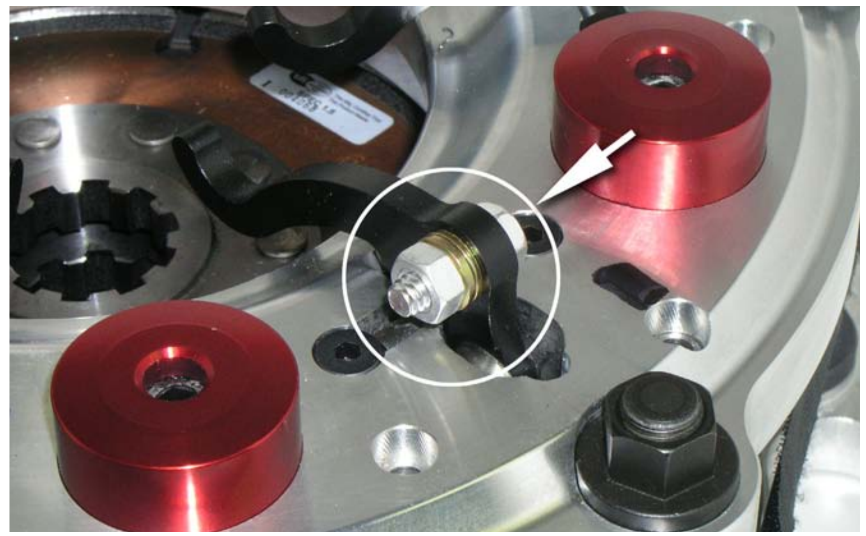
Ram Clutch's Pat Norcia has hardly missed a national event since his school days. An intelligent deep-thinking man, Norcia's technical ability has brought success to dozens of race teams.

In those formative years, Pro Stock cars were still using an organic friction material, similar to that used in street cars, though with stronger pressure plates. In due course, they progressed to metallic friction discs and thereafter to carbon fiber materials before finally graduating to sintered-iron discs in the late 1980s and early '90s.

"Unlike earlier friction materials that distorted and became unstable due to clutch slippage, the sintered iron composition used today is designed to wear the friction material with minimal damage to the mating surfaces of the pres-

Pro Stock engines transmit their power via a pressure plate (shown on left), two 10-inch clutch plates with sintered linings, and a floater plate that resides between the clutch plates.

Base pressure is a fixed clamping load that is applied by an Allen key to the top of each clutch spring. Once the gearing is selected, the necessary base pressure and centrifugal weight on the clutch's pressure plate can be determined.



Centrifugal pressure is a variable clamping load applied by engine speed and the weight of a series of small bolts, nuts, and one-gram washers mounted on the clutch fingers.

Sintered iron is a powdered mix of different metals bonded to the steel clutch plate and then baked in a furnace.

Until the late80s, Pro stock cars used organic friction material similar to that used in today's street cars. For street-strip vehicles, note Ram's urethane encapsulated springs, providing four times increased clutch power.

Beefed-up production pressure plates served the Pro Stockers before the universal use of multi-disc racing clutches.

In the early '70s, Ram introduced and patented the paddle disc. It functioned with metallic friction pads, which were later superseded by carbon fiber materials and, finally, by the sintered iron discs of today.

sure plate and flywheel," Norcia says. "Other than superficial discoloration, today's sintered materials remain flat and stable, allowing them to be trued and resurfaced by removing only a few thousandths of an inch of material.

"Friction discs generally have a life span of approximately 20 runs in these applications. In common with other components in drag racing, the clutch assembly is serviced after every run. Servicing includes refurbishing the pressure plate, clutch discs, and floater plate(s), all of which are removed and resurfaced. The pressure plate and floater(s) are trued using either a flywheel grinder or belt sander. The clutch discs are trued with a diamond-tipped cutter which cleans up the face of the disc."

Setup and tuning

The starting point, he notes, is that crew chiefs begin by reviewing data from past runs, comparing different setups for similar weather and track conditions.

"The crew chief will normally start by correcting the run to sea level conditions, in order to evaluate the performance relative to previous passes," Norcia says. "Since running at sea level conditions is rare, a prescribed correction factor is used that gives the team a baseline from which to work.

"Knowledge of atmospheric conditions, track condition, and surface temperature allows the crew chief to make the calculations necessary for selecting the rear-end gear ratio, transmission gear ratio, and tire size. Once the gearing is selected, the necessary base pressure and centrifugal weight on the clutch's pressure plate can be determined. These adjustments control engine acceleration and provide optimum traction for the race car.

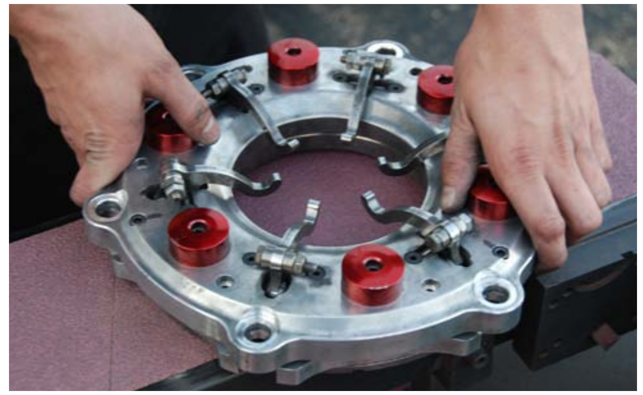
"Atmospheric conditions are determined by the temperature, humidity, and barometric pressure. These conditions are then converted into a density altitude reading (concluding the number of feet above sea level) and a correction factor. The correction factor is based on a numeric value of 1.000 for ideal sea level conditions."

But what if the correction factor deteriorates?

"Lower gearing will be required," Norcia says. "That is gearing with a higher numerical value to accelerate the car due to the engine producing less horsepower. When you increase the gearing numerically — say from a 2.30:1 first gear to a 2.40:1 first gear — less clutch pressure is required to clamp the pressure plate. Conversely, when you decrease the gear ratio, to say a 2.20:1 first gear, more clutch pressure is required. Understanding the weather and how it affects the engine horsepower is essential."

As mentioned earlier, Jon Kaase's venerable formula for barometric pressure and its effect on horsepower still applies. For example, if the barometric reading falls from 30.0 to 29.0, the engine will lose around 100 hp. And because the chassis and gearing are so sensitive, and thus receptive to tuning, it is critical that adjustments are made to correct even small changes — as minimal as 10 or 15 hp.

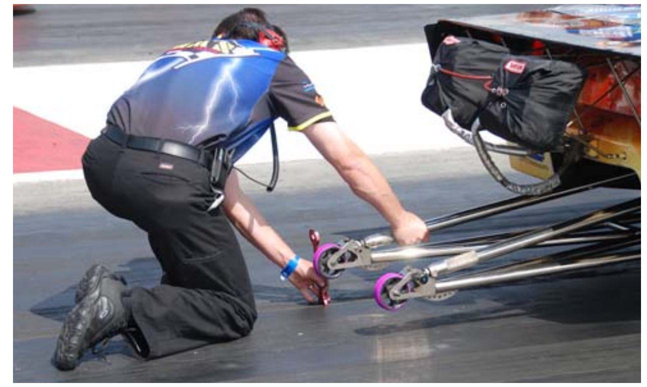
"Track temperature is the other variable that must be considered when determining how much clutch pressure — base and centrifugal — will be required," says Norcia says. "As the track temperature increases, the coefficient of friction between the tire and the track surface deteriorates, which means less clutch pressure will be needed.



Racing clutch assemblies are serviced after every run. The pressure plate and floater plate(s) are removed and resurfaced, using either a flywheel grinder or belt sander.

The discs are resurfaced and trued with a diamond-tipped cutter.

An inspection window at the upper right side of the bellhousing allows crew members access to make final changes to the base pressure and to the centrifugal pressure on the clutch.



If set correctly, the wheelie bars will break initial traction, helping to promote greater tire speed (wheel spin) at launch. If conditions deteriorate, they may be raised slightly to compensate for reduced traction.

"Track temperature is also the final variable that a crew chief will evaluate, in order to select the starting line launch rpm. As the temperature of the track surface increases, it becomes necessary to decrease the launch rpm, as hotter asphalt promotes wheel spin.

"To gain a last moment advantage, three final adjustments can be made: First, to the clutch base pressure, second, to the clutch centrifugal pressure (counterweights), and third, to the wheelie bar settings. As the driver buckles himself into the race car, an inspection window on the upper right side of the bellhousing allows crew members access to make final changes to the base pressure and to the counterweight on the clutch."

What if the sun fades or disappears behind a cloud?

"You will often find crew chiefs diving into the passenger side of these high-powered drag race cars to make final adjustments," says Norcia says. "These last-moment adjustments can make or break a final qualifying attempt or elimination round. Crew chiefs spend a great deal of time analyzing computer data, trying to optimize the initial tire spin off the starting line, and after the burnout, you will often observe them making an adjustment to the launch rpm.

"The third and final adjustment relates to the wheelie bars and would be applied just before the driver stages the car. The function of the wheelie bars is to break the initial traction of the spinning tires as the car leaves the starting line. If conditions become warmer, which denotes deteriorating traction, the wheelie bars may be raised slightly to compensate. All three of these final adjustments are based on last-minute track readings, as well as the performance of the cars that ran before them.

"Once a run is complete, crew chiefs scrutinize the data from the team's on-board computer," Norcia adds. "The crew chief will normally start by correcting the run to sea level conditions, in order to evaluate the performance, relative to previous passes giving the team a baseline from which to work. The run will then be reviewed to evaluate the gearing, clutch pressures (base and centrifugal), chassis setup, and engine tune-up, along with the driver's performance. Bringing all these elements together is what produces a winning performance.

"Having several different parameters to evaluate, g-meter readings also weigh heavily when reviewing the overall performance of the car's setup. The greater the g-forces carried, the faster the car is moving, and thus the greater the distance the car has travelled. If the g-meter falls off too quickly on the launch, or during gear changes, the crew chief may have selected the wrong gearing for the conditions. As the run is further analyzed, the crew chief will search for areas where the car has under-performed, keeping in mind any changing conditions that could occur during the next run down the track."

Most fans in the grandstands rarely have the opportunity to see or understand the effect of these finite changes, which can have the most profound effect on a car's performance. Yet, many of them are aware that there are 50 ways to lose a drag race and only two ways to win one: luck and intelligent preparation. **DRS**

Source: Ram Clutches, ramclutches.com