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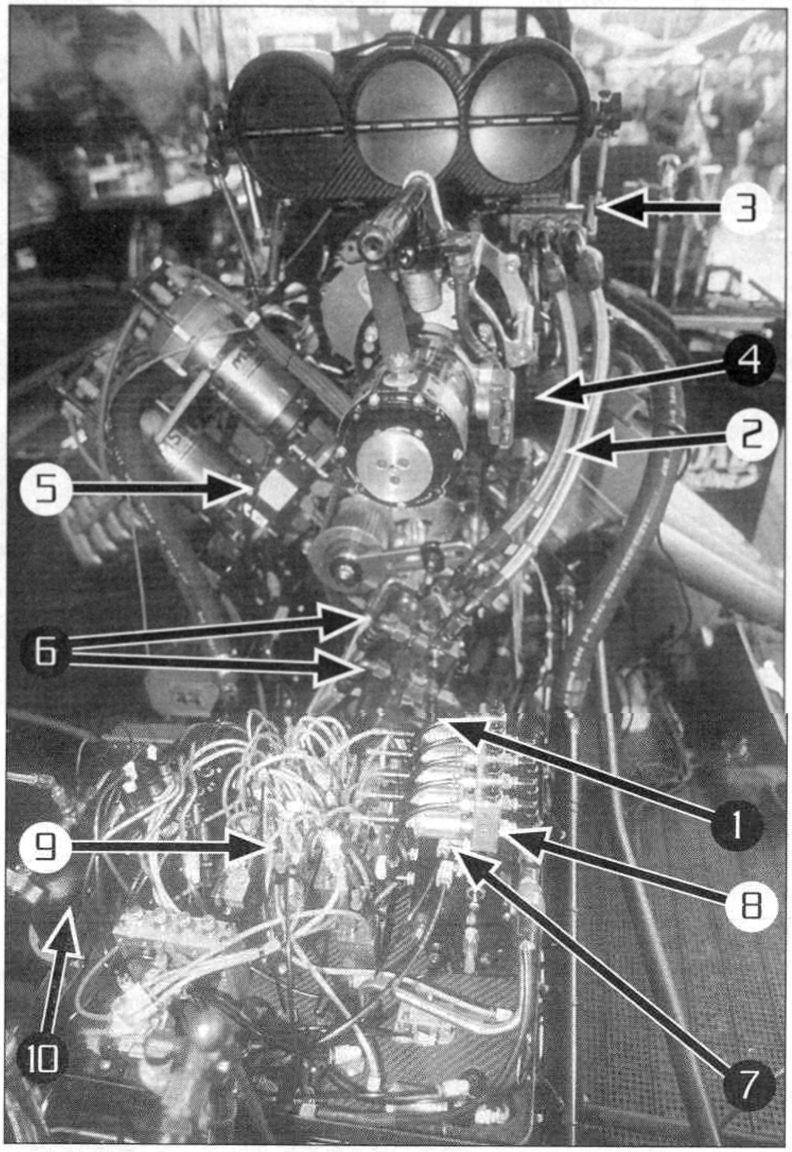
Feeding a fueler

Supplying the correct volume of fuel is a give-and-take proposition

by Bruce Dillashaw



(1) dual Waterman pumps assembled in tandem (2) pump output lines to barrel valve (3) barrel valve (4) idle bypass return line (5) pneumatic ignition advance/retard, also known as a 'wiggler' (6) return lines (closed throttle) (7) 'normally closed' clutch cylinders (8) clutch jets (9) fuel timers, hidden by CO_2 lines (10) CO_2 bottle, regulated to 200psi

Devoted followers of Top Fuel and Funny Car racing know that timer-controlled, air-over-hydraulic centrifugal clutches operate in a linear fashion during a run; i.e., the throwout bearing moves in only one direction – rearward toward the pinion gear – allowing the 18 counterweighted clutch fingers to sequentially squeeze the clutch pack for an ever-increasing application of horsepower and eyeball-flattening acceleration. Crew chiefs can only wish that fueling the engine was this straightforward.

The following is a description of fuel flow in a Top Fuel dragster under almost ideal track and atmospheric conditions, such as those present at the spring Chicago event at Route 66 Raceway on Memorial Day weekend last year. At that race, winner Kenny Bernstein qualified No. 1 with the quickest e.t. ever, 4.477 at 330.88 mph.

Pre-run

The dual fuel pumps flow a maximum of 80 gallons per minute (gpm) during the run, but to start the car and perform the burnout, they are opened halfway and flow 1.8 gpm. This occurs because the butterflies on the injector will only open a small amount against the mechanical throttle stop, which prevents over-revving during the burnout, and because that's all the horsepower that is needed to spin the tires.

After backing up from the burnout and the throttle stop is removed, the tuner will set the idle speed by removing or installing small orange air plugs in holes in the injector's throttle body under the butterflies. The idle speed is adjusted at this point and with the fuel pumps still only half open because it would be too late to do it after the driver pre-stages and fully opens the pumps before staging. The fuel flow with both pumps fully open at idle at the staging lights is 3.5 gpm, and fuel pressure, which is regulated by a mechanical bypass valve in the idle bypass fuel line at the barrel valve, is 110psi.

With the pumps fully open, the six to 10 timer-controlled air-activated fuel-bypass jets are set to send fuel to the engine at 53 gpm. The other 27 gallons of 90-percent-nitromethane and 10-percent-methanol fuel that the pumps are sucking from the tank are returned to the tank.

The start

The goal is to match fuel flow to engine load. The engine is fed only 53 gpm at the hit of the throttle because the clutch is at maximum slippage at that instant and because the blower is spooling up to approximately 37-percent faster than the 8,000-rpm engine speed, or 10,960 rpm. When the driver kicks open the throttle pedal, a pneumatic switch is made, which begins the fuel and clutch timers' sequence. At .2-second, the clutch throwout bearing begins to move, and a portion of the 27 gallons that has been bypassed begins returning to the engine through the sequential closure of the normally open jets. As clutch slippage decreases, engine load increases, and more fuel is continuously diverted to the engine. At .7-second, when the slicks want to rattle as a precursor to tire spin, the spark advance is retarded for .4-second to reduce power. The rate of fuel being diverted to the engine is also halted or reversed for the same .4-second. The bearing will be at the end of its travel at 1.2-second, .37-second after the front wheels have passed the 60-foot photocell, but the clutch will continue to slip for another 1.3-second.

Clutch lockup

At slightly less than 2.5 seconds into the run, just past the 330-foot mark, all bypassed fuel has been put back into the engine – the jets are in "blanked off" mode – in anticipation of maximum load on the engine when the clutch stops slipping and the driveshaft speed matches engine speed at 2.5 seconds. At clutch lockup, engine speed is pulled down by 1,500 rpm. With the engine at maximum load at this point, it is critical that the engine is receiving fuel at 80 gpm so as to make maximum power and to prevent a lean condition that would lead to detonation, damaged pistons, and a slow e.t. The outlet pressure of the fuel pumps in the two lines leading to the barrel valve is at its maximum, 550psi.

Half-track

At 3.06-second, the car has traveled 660 feet, is accelerating through 278 mph and, with the load on the engine now reduced by the momentum of the car, it is now time to take fuel away from the engine. With only 1.41-second left until the front wheels cross the finish line, the timers open and fuel is diverted to the tank at 20 gpm for the remainder of the run.

Finish line

When the driver jumps off the throttle at the finish line and the barrel valve closes, the fuel pumps momentarily continue to turn at half engine speed, which would create damaging internal fuel pressures of more than 600psi if it were not bled off. To that end, each pump has a return line that bleeds fuel back to the tank before any damage to the pumps can occur.

Sounds relatively straightforward, but when climactic or track conditions change, a change to the fuel and clutch timers are required. If fuel flow outpaces the clutch's activation, this will result in dropped cylinders, and if the supercharger's speed is increased or decreased, that, too, has to be figured into the tune-up. For this reason, fuel tuners nowadays can most often be found with a mouse in their hand instead of a wrench. ND

CH_3NO_2

Nitromethane makes an internal-combustion engine more powerful because it is 49.5 percent oxygen, which allows for a much richer air-to-fuel ratio than either gasoline or methanol. Whereas the ideal ratio (stoichiometric) for a gasoline engine is 12 parts air to one part gasoline and 5:1 for methanol, a nitro engine is run as rich as 1.3:1.

It is this rich ratio that makes a nitromethane engine more powerful than an engine burning the more volatile gasoline or methanol. As measured in Btus, gasoline delivers much more energy per pound (18,400) than methanol (9,500) or nitromethane (5,000).

As does the methanol that is added to it, nitromethane burns slow, so the ignition advance must be much greater than for a gasoline engine. That, and the large quantity of nitromethane used, is what causes loud exhaust notes and header flames. When the exhaust valve opens, some nitromethane is still burning in the cylinder, which causes the loud noises, and it gets shoved out by the upcoming piston, which causes the flames. Header flames are not created during a burnout because the engine is not under load.