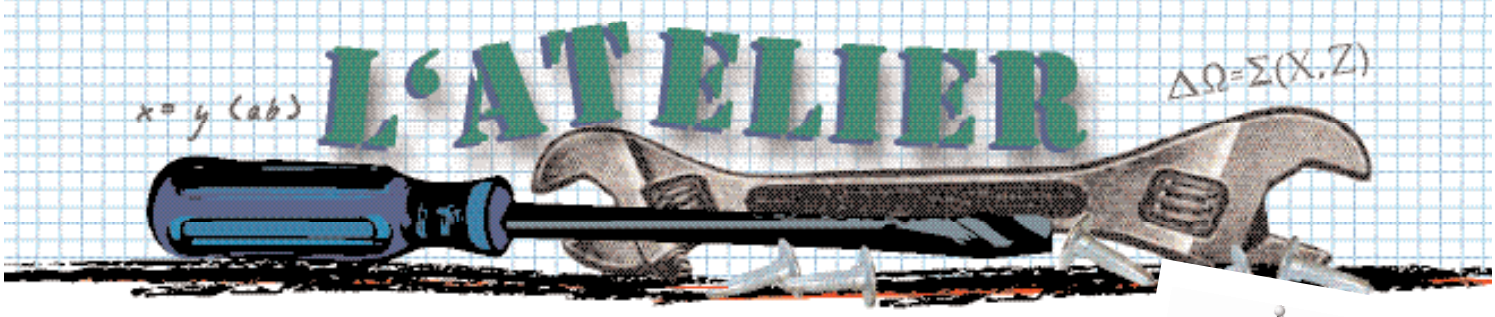


The Quest for Speed: OPERATION 324

Text and photos by Michel Garneau

The snowmobiling industry has been built on passion, the kind that motivates individuals to "think outside the box" and to aspire to goals and objectives that many, if not most, deem unreachable. As we all know, Joseph-Armand Bombardier was just such a man, determined to design a vehicle capable of traveling across the snow and accessible to all. Gilles Gagne is another such individual. Inspired by the movie The World's Fastest Indian, based on the real-life story of Burt Munro's quest to build a land speed record-breaking Indian motorcycle, Gagne has set himself no-less lofty an objective: to build a snowmobile capable of traveling over 324 km/h (200 mph) on the Bonneville Salt Flats and, in the process, qualify it for a new land speed record.

Not all records are equal

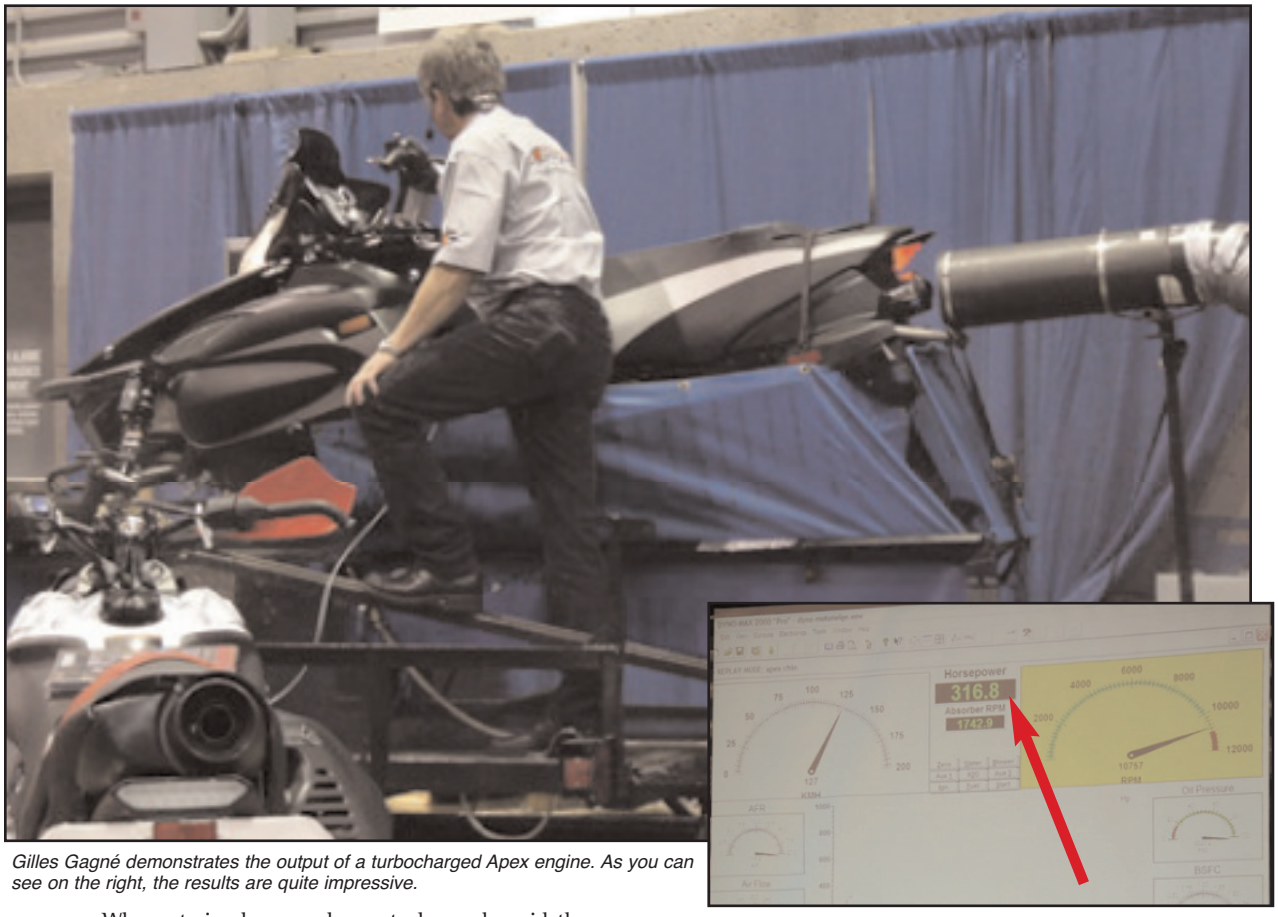
The thought of building a snowmobile capable of traveling over 200 mph sounds simple enough, especially when one considers that some individuals have hit speeds in excess of 170 mph, including one at 192.2 mph (309.3 km/h). The problem, however, is that existing "records" have all been set on relatively short runs (generally in the area of 2000 ft or 610 m) and for very brief periods of time. On the other hand, setting a record at Bonneville requires one to sustain the speed for a relatively prolonged period and distance (at least one mile). It must be then be repeated (within 2 hours in the opposite direction or next day in same direction) in order to become official. The average of the two runs is then used as the record speed.

One could be forgiven for thinking that simply upping the power of an existing record-setting sled would be a sure bet to cross the 200 mph barrier but that would be a monumental false assumption. The main challenge, Gagne tells us, is not so much making the necessary power to drive the sled for that can be done, although at some expense. Rather, the main challenge is putting together components that can withstand the extreme loads present at such speeds.

The building blocks

While there are numerous durability and other such issues that need to be addressed in the quest to build a 200 mph sled, Gagne has settled on some proven components to use as the basic building blocks of his project. In addition to taking some of the uncertainty out of the equation, it also ensures that any record set will be in line with production-class regulations. The basic chassis and running gear will be based on a Yamaha Apex model, hardly surprising given that he is owner of the Gagne Lessard Yamaha dealership in Coaticook. The (carbureted) engine used will be a Genesis Extreme from a RX-1, the predecessor to the fuel-injected unit used in the Apex. Putting out roughly 140 hp stock, the engine will be equipped with two turbochargers in order to develop the estimated 500 hp required. As if there weren't enough challenges to contend with, the Salt Flats' location at 4300 ft (1300 m) above sea level results in a 20% power loss compared to sea level so the goal is to develop 600 hp at sea level in order to have enough left over at the higher elevation. Where one turbo would net approximately 340 hp, a second sequential unit (twice the size of the first and capable of flowing air at a rate of 1000 cubic feet per minute, or CFM) will be added, in effect feeding the first one pre-pressurized air. The exhaust gases will be routed through the smaller turbo first before then heading into the second while incoming air will take the reverse path, first entering the large second unit to be pre-pressurized before being fed into the smaller primary unit.

2008 Yamaha Apex GT 40TH Anniversary.



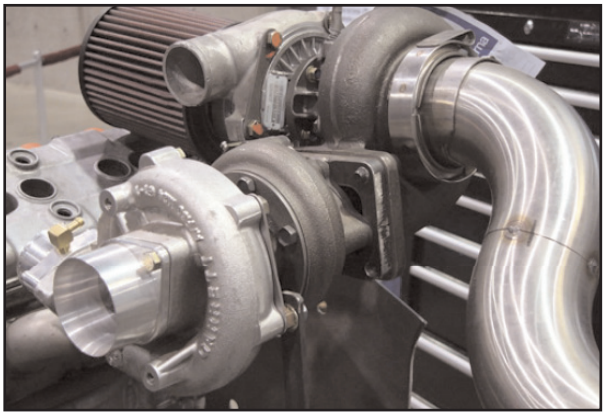
Gilles Gagné demonstrates the output of a turbocharged Apex engine. As you can see on the right, the results are quite impressive.

Why not simply use a larger turbo and avoid the complexity of using two? Quite simply, any single turbo large enough to generate the pressure required (4 atmospheres) would be too large for the engine and would result in unpredictable power delivery and excessive lag. More specifically, such a scenario could easily result in track spin which would in turn reduce boost (turbos need a load to work), a situation that could perhaps not be recoverable in the time and distance allowed.

Early on in the development process Gagne realized that the stock engine block was unable to withstand outputs in excess of 400 hp as it tended to become distorted and unreliable. Through the help of the key project sponsor, LamTrac, engineering students from the University of New Brunswick undertook Finite Element Analysis (similar to that used by Ski-Doo engineers in designing the new REV-XP platform) of the engine in an attempt to reinforce it for the task ahead. The result of the work has been a series of key reinforcements for the engine, each designed to make it more rigid and better able to stand up to the extreme forces generated in such a heightened state of tune. First among these is the incorporation of an aluminum insert in the upper cylinder area. The insert, which essentially creates a closed deck configuration, dramatically reduces cylinder distortion in addition to increasing rigidity of the block four-fold. Equipped in this manner, the engine can handle up to 40 lbs of boost! In fact, there is so little distortion now that additional piston clearance has had to be added.

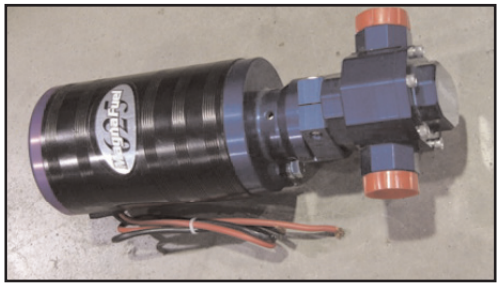
New cylinder studs were also added. While similar in size, they are twice as strong as the stock ones. A new head gasket design was next, one able to withstand the heightened pressure. Positioned between the upper cylinder and head, the new gasket ensures that the seal between the two surfaces remains intact. The heads were also reinforced between the cylinders to reduce distortion and prevent compression leaks. Finally, a special bearing support was added to the crankshaft's PTO (or clutch) side bearing in order to prevent it from being expelled under load. Suffice to say that extreme horsepower can have some rather nefarious effects!

Horsepower builds heat and keeping the engine cool (especially in light of the elevated temperatures and lack of snow to assist) is a critical factor. For this reason, alcohol will be used as the fuel source. Alcohol, which has significantly less energy per unit than gasoline, is pumped into the engine at a much higher rate and, in the process, helps to cool the piston and surrounding hardware, helping to

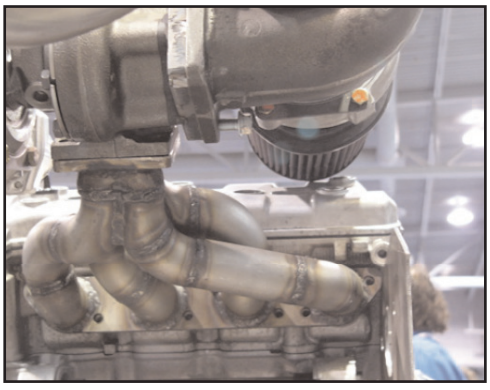


The two turbochargers (set sequentially) that will be used to provide the necessary boost.

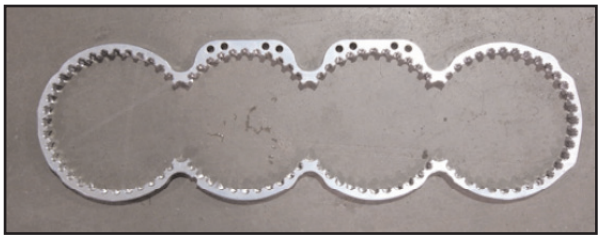
increase dependability and durability, as well as allowing higher boost pressures to be used. In order to supply the massive quantities of alcohol needed to feed the engine, a special fuel pump with a flow rate of 8 L per minute (three times the capacity of a stock automobile pump) is used. The pump works by delivering a constant delivery rate, the unused fuel being re-routed into the reservoir via a return line. This, however, creates issues of its own as the returned fuel gets heated in the process, thereby reducing its contribution to engine cooling.



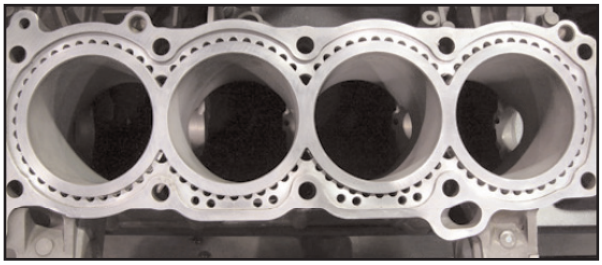
As alcohol alone is not sufficient to keep the engine cool, regular engine coolant will be used as well. Aerodynamic concerns make it preferable to smooth out the airflow as much as possible so routing air through radiators is not a viable option. In the absence of cooling air, a reservoir of coolant sufficient to do the job must be stored on the vehicle. Calculations indicate that 24 L of liquid should be sufficient for a 60-second run.



The plumbing responsible for channelling the exhaust gases to the blowers.



The aluminum reinforcement (above) that will be used to strengthen the engine block, in position (below).

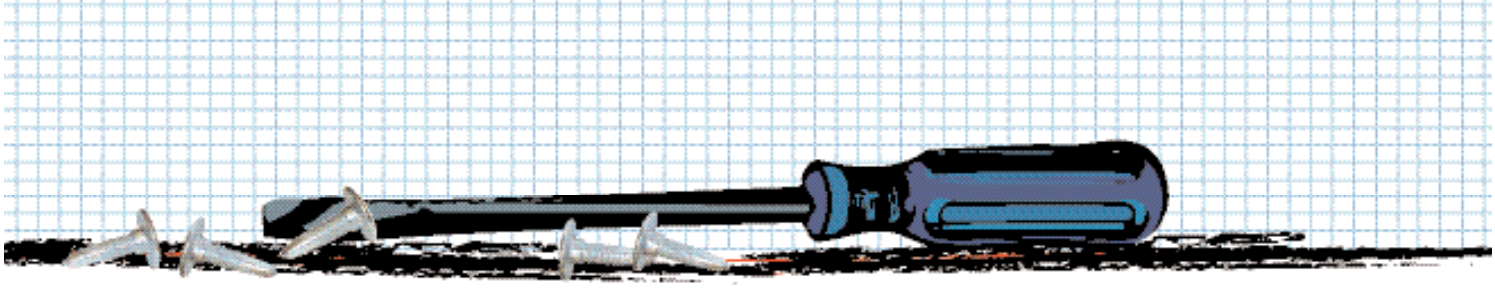


And now for the difficult stuff....

One thing should be becoming quite clear at this point: building a 200 mph snowmobile is anything but simple for every possible angle must be studied and considered. As you will see, however, the real challenges have yet to be discussed. First and foremost is the issue of the drivetrain. Put succinctly, snowmobile drivetrains are not designed to handle 500 hp. Take the CVT clutch, for example. Efficiently transferring the monumental torque of such an engine would require tremendous lateral forces, resulting in the belt being squeezed so hard that its longevity would be practically nil. Reducing the forces to preserve the belt would result in slippage which would, in turn, produce incredible heat and again thrash the belt. What to do? That part is being studied and no obvious answer jumps to mind although some form of multi-stage, or mixed, system is being considered.

The track is another area ripe with challenges. To date, research conducted by Camoplast (the world's foremost snowmobile track builder and a partner in the project) has uncovered a ceiling of sorts at about 280 km/h, after which point heat begins to cause disintegration and eventual failure. Compounding the problem is the fact that temperatures at the Flats during Speed Week typically hover around 40-45 degrees Celsius. Again, research is on-going to find a solution.

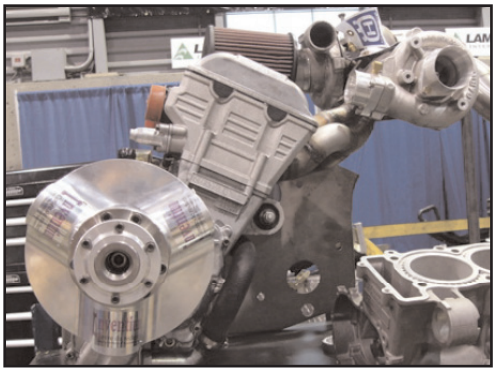
The aerodynamic dimension is also riddled with unknowns. While wind resistance for most snowmobile applications is not cause for too many



sleepless nights, at elevated speeds, it becomes excessive, quite simply due to the fact that wind resistance increases at the square of the rate of speed. In other words, wind resistance at 320 km/h is 16 times higher than at 80 km/h (320/80 = 4, 42 = 16)! As fans of Formula 1 know, finding the optimal balance between downforce and reduced drag is critical in ensuring not only high speeds, but also vehicle stability. Somewhat related to this is the suspension design, for traction must be maintained even when wind resistance becomes high. While comfort is not a consideration, spring rates and suspension geometry must be such that the downforce can be handled. Also, track tension must be constant, for there are 500 hp being driven through so ratcheting and/or friction are not exactly desirable.

September 2008

As you can tell, there is no shortage of challenges and problems waiting to be addressed in the quest to build a 200 mph sled. Fortunately, Gagne has been fortunate to enlist the help of several notable experts, including Moto R.L. Lapierre and Star Suspensions. Partners such as Choko, Patrice Beaudry, and CCNB have also contributed generously to the project.



The Hydradjust (by Inventium) clutch is one of the components being tested. Managing 500 HP is a tall order, however.

No one knows with any degree of certainty how everything will play itself out but Gagne assures us he will be in Bonneville in September, eager and ready to boldly go where no one has gone before. You can count on seeing the lights on quite late at Gagne Lessard in the meantime and rest assured that if anyone can pull this off, Gilles is the man to do it!

The inimitable Gilles Gagné in action during the Salon des Sports Récréatifs Motorisés.

More about the Bonneville Salt Flats

The Bonneville Salt Flats (and the Great Salt Lake) are located in the state of Utah in the USA. Stretching over 30,000 acres (12,140 hectares), the Flats are remnants of an ancient lake that covered the area during the last Ice Age. At that time, Lake Bonneville was the size of present day Lake Michigan. Each winter, a shallow layer of standing water floods the surface of the salt flats. During spring and summer, the water slowly evaporates while winds smooth the surface into a vast, nearly perfect flat plain. The salt surface contains potassium, magnesium, lithium and sodium chloride (common table salt). The Bonneville Salt Flats are administered by the Bureau of Land Management, an agency of the US government.

The vast expanse of land makes the area a natural place for the setting of land speed records, the first (unofficial) one having been set in 1914. In 1970, the site was used by Gary Gabolich when he drove his rocket car, "Blue Flame", to a top speed of 622.4 mph (1001.7 km/h).

Speed Week is an annual event held in late summer/early fall and features participants from around the world in a multitude of classes, each striving to reach new heights of speed in specific classes. The 2008 edition will be held Sept. 17 - 20, 2008. To learn more about the Salt Flats, please visit www.saltflats.com