EVOLUTION of the INTAKE PORT

BY DAVID C. “WOODY” WOODRUFF, CMTgE

In two previous Engine Professional articles, we have used CFD (Computational Fluid Dynamics) to take a look at a Cadillac flat head intake port and compared two configurations of a generic intake port. If you look up tortuous in the dictionary you should see a picture of a flat head port! If you look up short turn radius you should see a more conventional OHV port.

Now we will have a look at the next generation intake port that rids itself of the tortuous and short turn DNA we have had to live with. TVI – Twin Vector Induction – is that system and it is available now!

If we look at the history of the “infernal” combustion engine and in particular the cylinder head we see the evolution from the flat head to the current DOHC 4-valve configurations. The volumetric and combustion efficiencies have risen considerably during that evolutionary period.

Back in the late ’60s, a German sidecar racer, Helmut Fath, along with Dr. Peter Kuhn of Heidelberg University developed a 500cc 2-valve motorcycle engine (URS) with twin ports. At first glance, TVI may seem like the same idea but it is very different. Although the Fath URS was successful in its time, the twin ports were in-line, the two inlet air streams collided and lost quite a bit of kinetic energy.

Then many years later along came DOHC 4-valve heads and John Stowe of Sycast/Anhared Design with a unique twist to the original theme. If the twin ports are offset then the twin flow streams enter tangentially to the valve and impart a degree of swirl that is not traditionally seen in 4-valve heads. (Provides a nice spot for the spark plug, too!) The two flow streams are very straight and they merge seamlessly, so they lose virtually no kinetic energy. Two really good things happening simultaneously! The TVI system just adds icing to whatever cake you bake!

The only other concept that produces any documented, usable swirl in 4-valve heads is David Vizard’s patented Poly-Quad concept. (www.motortecmagazine.net/article.asp?AID=1&AP=1)

First iterations of TVI were installed on a series of Cosworth engines with these results:

1100 cc Cosworth BDJ went from 160 hp @ 11,000 rpm to 200 hp @ 10,400 rpm.

The 1100 cc BDJ was the first proof of concept for TVI. With these very promising results it was decided to develop a short stroke 1600 cc BDD with valve sizes corresponding to a 2 liter BDG since power output was expected to equal or surpass a 275 hp 2 liter. Port sizes were retained to examine the effects of higher port velocities. The valve sizes were comparable to 240–250 hp 1600 cc BDAs.

1600 cc Cosworth BDD went from 250 hp @ 10,000 rpm to 286 hp @ 10,400 rpm.

The 1600cc engine had such a wide power band that it was then decided to build a road-worthy 2 liter version with the same cylinder head, BDA cams and internal components. While the original 1.6 liter street engines made 75 hp/L (120 hp) the 2.0 liter version initially made an easy 120 hp/L (240 hp) on the original street cams. More aggressive cams were

Flow Test Model

Four Views

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Cadillac flat head – lots of dead air – but you knew that!

OHV - dead air in the short turn! It never goes completely away!

TVI – who needs a short turn anyway? (Icing on the cake!)

So where’s all the swirl? Just about everywhere?
installed and output went to 141 hp/L [282 hp] with absolutely no loss in drivability!

The current race version of the 2 liter makes 171 hp/L (342 hp) with only 26° of spark lead.

**2000 cc Cosworth BDG went from 290 hp @ 9200 rpm to 342 hp @ 9,900 rpm [300 hp @ 8300rpm]**

Remember these are normally aspirated numbers with race gasoline. So what did we see with CFD? Let’s start by coloring the air and look at the valve curtain flow profiles. Red is high velocity and blue is low or zero velocity. Although the velocity scales are not exactly the same we are only interested in the velocity patterns and flow lines. Is the velocity uniform and are the flow lines parallel? Twisted lines indicate flow reversals. Then we will make some section plots to see the downstream airflow patterns and some flow trajectories just to see how things are mixing! (By the way, don’t try this on your flow bench!)

Keep in mind these views show the steady state, open cylinder flows like on a flow bench. At different valve lifts with the piston in place the dynamic reactions are likely more intense as the dyno suggests! Sorry, but I’m not allowed to show you that part!

Now enter Victory Motorsports and the current 2 liter four cylinder race engine found a home in Burton Brown’s new Bonneville streamliner. This engine and the streamliner were on display at PRI 2014 and we hope you got a chance to stop by and take a look. Currently we are looking to build a bigger-bore 2 liter with room for bigger intake valves and take the current 171 hp/L to 200 hp/L or 400+ hp!

Four cylinders, sixteen valves and eight inlet stacks! Want to get in on the action? Give us a shout! Otherwise see you at the Bonneville Salt Flats in August!

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David C. “Woody” Woodruff, CMfgE, is president of Design Dreams, LLC. For more information, call (513) 403-3165, email Design_Dreams@cinci.rr.com or visit his website at www.designdreams.biz. (See also: victorymotorsports.org and www.sycastinc.com)