News for 02/13/07

Hi everyone,

Over 25 years ago John connected an oscilloscope, pressure transducers, a flow bench and a spin fixture together. The article below was in the Feb `83 issue of Super Stock & Drag Illustrated.

John was way ahead of the times even back then. Next he designed his own carburetor. What is he working on today, for the future?

GETTING AHEAD

By Bob Don

PROPER TESTING equipment is necessary for any engine builder or machinist wishing to determine either the operating condition of engine pieces or to research and develop new ones. Test equipment which can more closely simulate the actual running conditions of an engine are that much more

John Satterfield takes engine technology into the future with a dyno for cylinder heads.

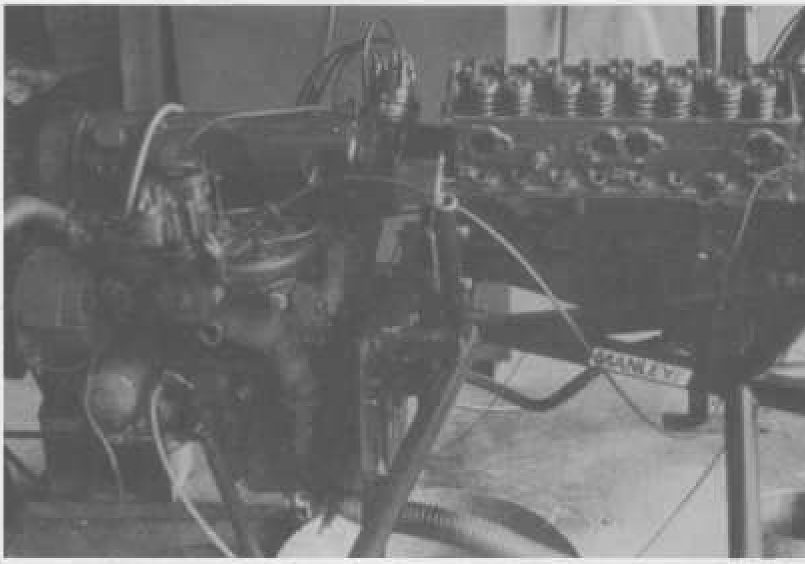
effective. Ideally, the dream of any engine builder would be to be inside a race engine as it traverses down the quarter-mile. John Satterfield, owner of Dutchess Auto Machine in Poughkeepsie, NY, has brought the dream that much closer to reality with the development of his "head dyno."

John's creation allows a close examination of an operating valvetrain. Additionallly, a flow bench has been attached to the fixture, providing a detailed analysis of the effects of opening and closing the valves on the flow of the cylinder head. All in all, quite revolutionary.

John Satterfield is a 31-year-old native of Poughkeepsie, NY. He began working in the automotive machine business at 18. By the time he reached 23, he bought the company he worked for. His technical education has come from his own experience and the experience of others. Despite his lack of post-secondary education, he is a veritable storehouse of advanced technical knowledge and engine theory.

Although John would like nothing better than to research and develop race engines all day long, he still has to pay the bills. Subsequently, Dutchess Auto Machine handles a wide variety of jobs; from rebuilding Cummings diesel engines to wringing out the trans-axle of a Formula Ford car. The shop is fully equipped with a myriad of precision machine instruments and John can perform virtually an operation, including the fabrication of pistons from raw forgings.

The Satterfield head dyno represents four years of development and refinement. Basically, the test set-up consists of a small-block Chevy (bare block) mounted on an elaborate stand. Immediately behind the block is a four-cylinder Vega engine which is connected to the V-8 block through pulleys and a rubber timing belt. When head and valvetrain pieces are installed on the Chevy small-block, the Vega engine is used to power the cam, allowing a close inspection of the working valvetrain anywhere from idle up to 16,000 rpm! John reports that some amazing things can happen to valvetrain



Photos by Bob Don

components in the upper 'twilight zone' of the rpm range.

The last two years of the fixture's development have centered around mating the machine to a flow bench. An elaborate plumbing system allows the flow bench to draw through the tested cylinder and read flow rates as the head operates!

Despite the outwardly crude appearance of the head dyno, the machine functions flawlessly, heralding a new age in valvetrain, cam and head technology. Since the fixture is in essence a Chevy block, intake manifolds and headers can be bolted to the head for even more revealing test sessions, expanding its versatility.

The head dyno is not used solely for John's own research and development work. Several major manufacturers of cams and valvetrain components, including Manley, have enlisted John's expertise in wringing out their prototype pieces prior to marketing. Interestingly, the sales literature for some of these companies may boast that their parts were tested in their own testing laboratories when, in actuality, the components were sent to Satterfield.

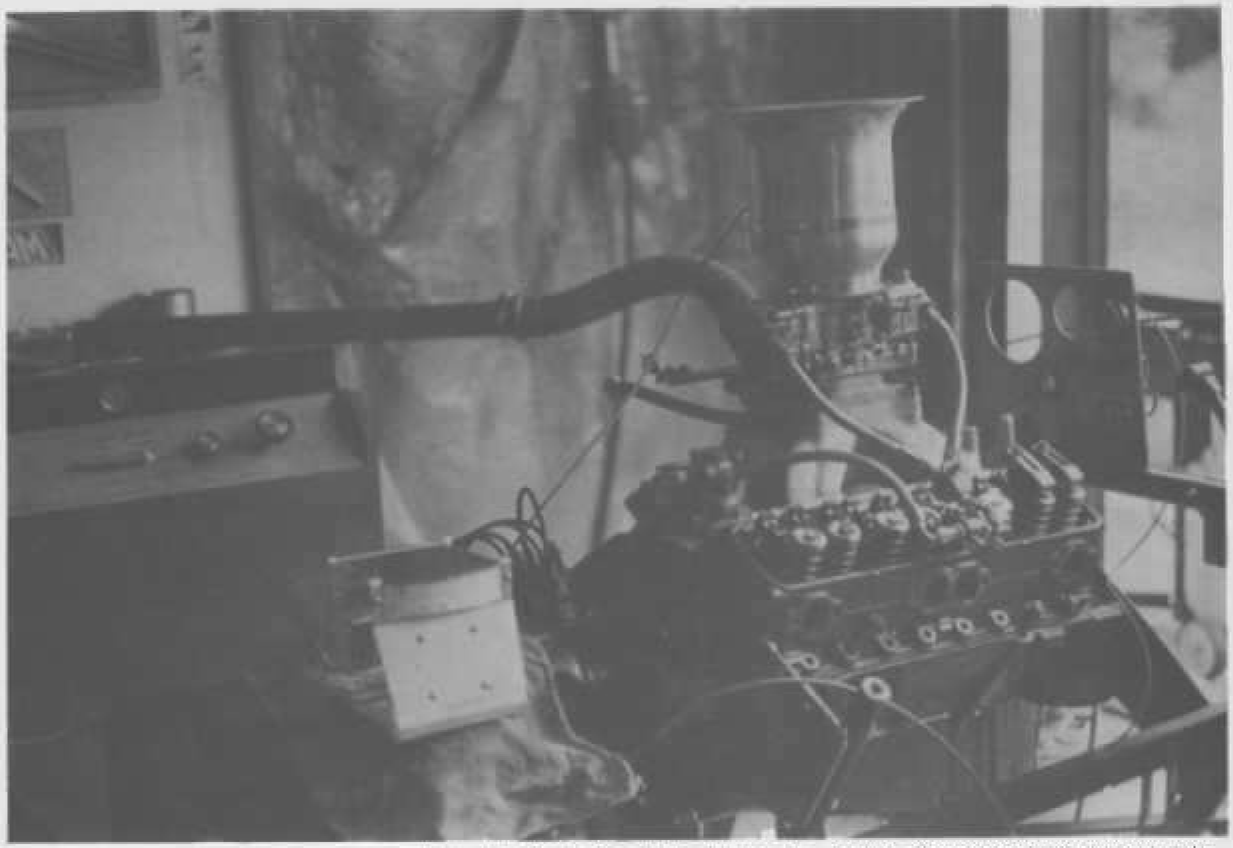
The Satterfield head dyno is a tribute to John's technical wizardry and creativity. He is quick to point out, however, that despite the revolutionary nature of the fixture, it is not the information acquired through its usage, per se, but how that information is applied which is important. Considering John's insightful and analytical nature, as well as his ability to learn and extrapolate from experience, one can have little doubt of his capabilities in applying any new-found knowledge.

Satterfield has developed other test components for various engine functions as the need has arisen. Although not widely known, one of the most accurate methods of measuring engine horsepower is by determining the amount of air consumed at the carburetor. Unfortunately, no equipment to test this aspect of engine operation could be found. Undaunted, John constructed his own by modifying a special velocity stack. A fan inside the stack is spun by the incoming air flow. The rpm of the fan is then translated electronically into an exact cfm rate. This "air flow dyno" has proven most effective in measuring even the smallest changes in power output and John has plans to market this item soon.

Besides being an engine builder, machinist, and mechanic, John Satterfield is also a drag racer. He owns an immaculate Chevy Monza which is campaigned in NHRA's Competition Eliminator as a B/Econo Altered. The car serves as a rolling test bed for John's latest development work. The car was previously campaigned as a C/Factory Experimental, and in such guise it consistently ran 1 to 2 mph above the national record, testimony to the effectiveness of John's prowess in utilizing the knowledge ascertained from his head dyno. Further chassis refinement, John believes, would have netted him the record setting ET's to correspond with his high horsepower output. Considering the performance of the car as a C/FX, the Satterfield B/EA could become a serious threat in 1983 competition if all goes according to plan.

Satterfield is constantly in motion. Even when his body stops, his mind is still going at around 200 mph. He is constantly analyzing, correlating and applying even the tiniest shreds of information that may surface through the course of his test sessions. Only the best engine builders have a thorough grasp of the internal dynamics of a racing engine. Still fewer have the ability to properly interpret test information and effect meaningful change. John Satterfield is one of those people.

Have you ever gotten a headache from trying to ingest too much information at one sitting?



That's what happened to me when I paid a visit to John Satterfield in Poughkeepsie. Satterfield's head dyno produced an incredible plethora of technical revelations that are of such a startling nature that it is difficult to describe. While revolutionizing the development of valvetrain components and port design, the head dyno also has the potential to render obsolete such test equipment as static flow benches and spring pressure testers—equipment whose results were heretofore taken as gospel.

John's creation allows close examination of an operating valvetrain from idle all the way to 16,000 rpm! There's even a flow bench attached that provides a detailed analysis of valve action on the flow of the cylinder head.

Valvetrain science, and in particular, valve spring development, is beginning to reach a plateau. The amazing discoveries through Satterfield's fixture may, however, turn things around and open up a whole new field of development. The object of any spring is, of course, to keep the valve closed until the point where the cam opens it. When the spring no longer does its job, the valve has been said to "float." This is a misnomer. The valve does not float. In actuality, the spring floats. The spring reaches a point where it no longer functions and just sits there, slamming back and forth between the head and the retainer.

Two factors cause spring float. The first, and more common, is spring wear or metal fatigue. The spring steel wears over a period of time so that it no longer rebounds as it was designed to. This, though, can sometimes be difficult to determine. John demonstrated a worn spring which floated at a relatively low rpm (around 8000). This same spring, however, read the same as a new one on a static spring pressure tester.

Another factor contributing to spring failure is metal frequency. Every metal, including the spring steel used to make valve springs, has its own frequency—like a tuning fork. Since each cam has a different ramp design, different cams accelerate the spring at different frequencies. At a certain point in the rpm range, the frequencies of the cam ramp and the valve spring coincide. When this occurs, the spring freezes and fails. Amazingly, however, if the rpm's are driven higher, the spring comes out of this frequency and begins working again!

Subsequently, the ideal spring for your cam may not be the strongest or the 'trickest,' but the one who's metal frequency best matches the frequency of the cam. Be careful, however, that spring frequencies can vary from maker to maker, model to model, and even batch to batch! We ran a test of two new high-tech springs which were taken from the same lot, magnafluxed, and statically pressure tested to be identical. The first spring failed at 8800 rpm. The second spring, supposedly identical, ran up to 13,000 rpm without failure! Evidently, the two springs were made from different batches of steel with the first one being totally unsuitable for the cam used in testing.

Spring selection can thus become a matter of trial and error; an expensive proposition. But it is far less costly to have springs fail in the shop than on the race track.

A new area of head and manifold development that is just beginning to surface is the dynamics of reversion, whereby the gases (either intake or exhaust) travel contrary to the intended flow. This factor can be graphically demonstrated on the Satterfield head dyno. With the flow bench operating and the valvetrain functioning, you can stick your hand into the plenum of the intake manifold and feel the reversion pulses. By using a piece of string attached to a pointer and a strobe light, you can see the string curl around at certain areas of the manifold runners.

As the valves move up and down, they act like small pumps, pushing the gases in the opposite direction and creating pulses of reversion. Dealing with this phenomenon, however,

Although it may not look like much, John Satterfield's cylinder head dyno has taken valvetrain science a giant step into the future. By being able to observe the valvetrain in operation, Satterfield (left) can detect any irregularities and then tighten up the weak link.

is far more involved and borders on redesigning the internal combustion engine entirely. John, though, has been able to work around the reversion as reflected in his port designs and has come up with noticeable increases in horsepower.

Designing head ports using air flow as it would occur in an operating engine can be most advantageous. John has taken a fully prepared head from a major company and flowed it statically. On the static flow bench, it flows better than his own design. On his head dyno, however, the situation is reversed and the Satterfield head becomes the better performer. The race track bears out his findings as his own port design can run circles around the commercially prepared head — the one that flowed better on a static flow bench!

These informational gems are only the tip of the iceberg. Satterfield has reams of notes and test results that he has amassed through the course of his four years of working with the head dyno. It is safe to say that he will continue to discover additional and equally relevant facts concerning air flow and valvetrain science. And that will put him that much further ahead of the competition. —Bob Don

NOTE: Special thanks to Bob Schmalz of Manley Performance Products for his assistance in conducting the tests. And thanks for lunch, Bob —the pizza was good!

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