Airflow Testing

I have been heavily involved in airflow testing for over 30 years, and at the time that I designed our flow bench there were probably no more than half a dozen airflow facilities in the entire country. Most of this equipment was in Detroit, and it was used for entirely different purposes than I had in mind. As far as I know, the only other bench that was being used for racing development at that time was C.R. Axtell's facility out in California. Our bench cost over $25,000 to build —I guess it is now worth more than $80,000— and quite frankly, much of our early racing success can be attributed to the extensive development work performed on this equipment.

When we started using the bench we wanted to establish a direct correlation between airflow improvements and engine performance. In other words, we hoped to find a workable flow-testing method that would produce a comparable improvement in engine output every time we increased the gross airflow through the engine.

Initially, we assembled an entire dummy engine — carburetor, manifolds, valvetrain and the whole works— and we hooked the crankshaft of this engine to a giant electric motor so we could cycle the engine at speeds up near 2000rpm. We measured the airflow through the ports while the engine was cycling, and we did various things to alter the flow characteristics. We then went to the dyno to see how a live engine would respond to the same changes. This was a lot of work, and when it was all over, we could not find any valid correlation between the flow and power output.

It is pretty obvious that racing engines operate at speeds much higher than 2000rpm, but it is extremely difficult to motor a dummy engine at a very high crank speeds. However, we decided to take the pistons out of the dummy engine and test the airflow response without cycling the engine. Again, we cross-checked the results with live dyno engines, and after considerable testing we became convinced that the flow measurement was valid, even though we had completely eliminated all cycling dynamics.

This made the development work much easier. However, our test setups are still very elaborate. I don't believe it is essential to dry-cycle the engine, but I feel it is important to duplicate the complete flow path—as applicable—in or out of the engine. When we test the intake ports, we put valves in the head and bolt the head to a bare cylinder block. Then we put an intake manifold and a carburetor—with the throttle plates locked in a full-open position—on the head, and we use an oil pan on the bottom of the block that has been modified so we can hook the suction hose to the pan. The flow measuring equipment is hooked to the mouth of the carburetor, the intake valve is opened to max-flow point—about 0.650-inch of lift—and we begin the test.

This procedure reasonably duplicates the actual conditions in the engine. The measured air must enter the carburetor and flow through the intake manifold before it reaches the port, and it must flow past the valve and down into the cylinder as it leaves the port.

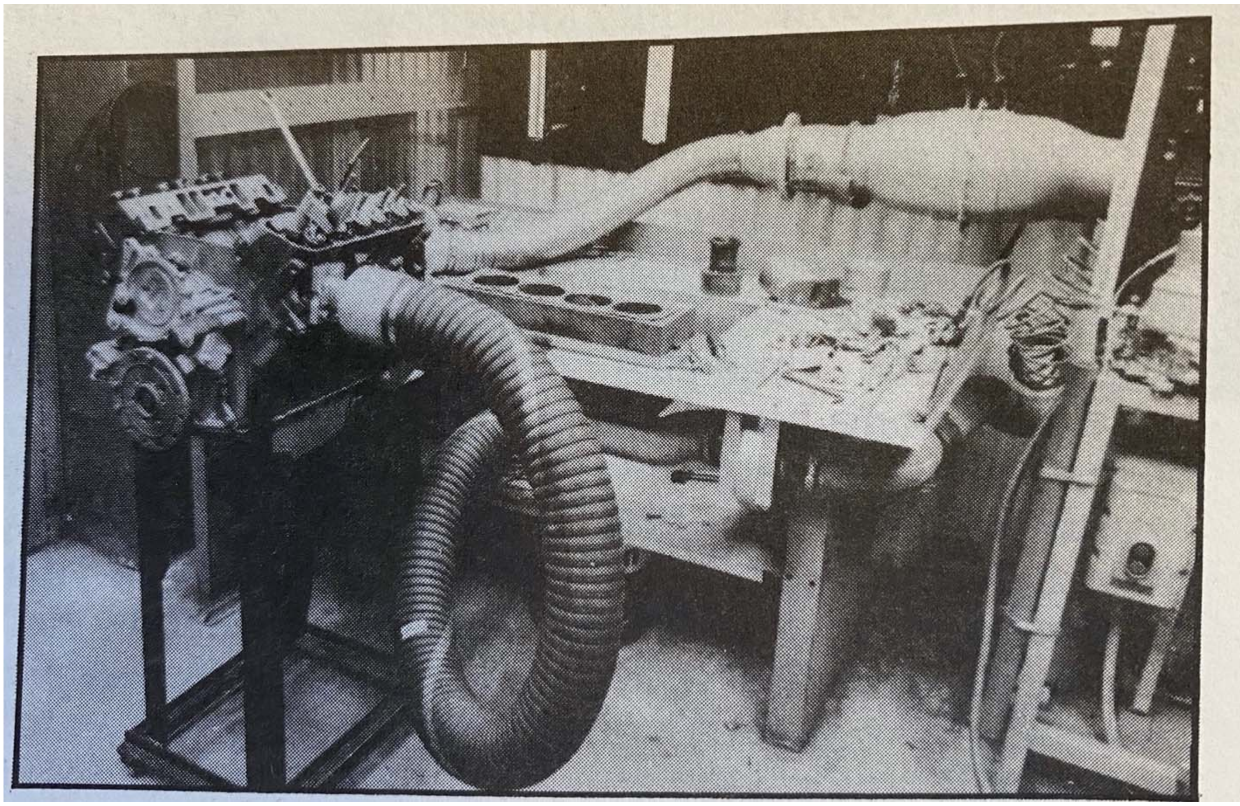
The procedures are similar if we are testing the exhaust port. In this case, exhaust headers are bolted directly to the exhaust port and the suction hose draws from the end of the header collector. The exhaust valve is opened to the max-flow point and measured airflow enters through the oil pan, is drawn up the cylinder, past the open exhaust valve, through the exhaust port, and out the header. Of course, this setup does not duplicate the complicated dynamics that occur inside the header, but 30 years of experience has shown that the results are very valid.

Once we had this worked out, the next thing we had to determine was how much pressure depression—"vacuum," if you will—to use for the pulling air through test fixture. When we first started our research, we found that most of the flow testing at other facilities was being done with depressions around 10-12 inches of water. So we initially followed along with everybody else, but before long we changed our minds about this.

Flow balance between all of the head ports is important. You want each of the intake ports to have very nearly the same operational efficiency so that each cylinder receives about the same quantity and quality of mixture. To confirm this, you must flow all of the intake ports in the head and compare them. When we were flowing the ports with a 10-inch depression we found that we could make very dramatic changes between two ports, and yet the measured airflow would not change significantly.

We then decided to undergo a series of tests to find a technique that would detect valid differences between ports. We started the tests with a depression of 10 inches of water and checked the airflow variations between ports that were obviously different. Then, the drop was increased by two inches and the same test was performed. This step-and-repeat procedure was continued all the way up to a maximum of about 34 inches of pressure drop.

When the series of tests were completed we found that at any pressure drop less than 26 inches there was little discernible variation in the port balance, but at levels above 28 inches, the percentage of change—per increase in the drop—was quite small. So we selected 28 inches as a baseline level, and we started checking the results with back-to-back dynamometer testing. We would measure the flow on the bench, make a change to improve the flow, and take the head to the dyno to see if the engine performance actually improved. After considerable testing we became convinced that the correlation was almost totally linear—virtually every improvement on the bench would show up on the dyno as a measurable increase in engine performance—and for the past 30 years all of our flow testing has been done at 28 inches of depression.


Smokey Yunick's flow bench.