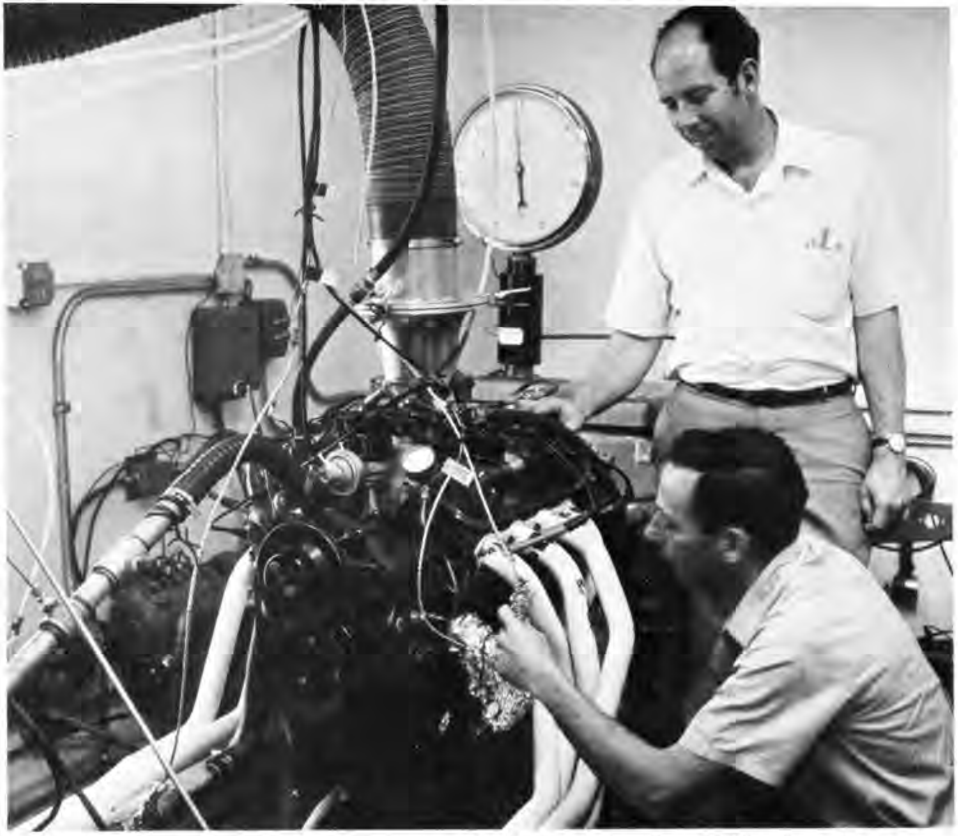
The Crane Gang takes aim on a street version of FoMoCo's little V-8 and hits the mark with 140 horsepower worth of "bolt ons"



Crane dyno duo, Don Hubbard, standing, and George Linton, preps engine for Test #3. Headers are by Tubular Automotive.

Part I

Gunning the Ford 302

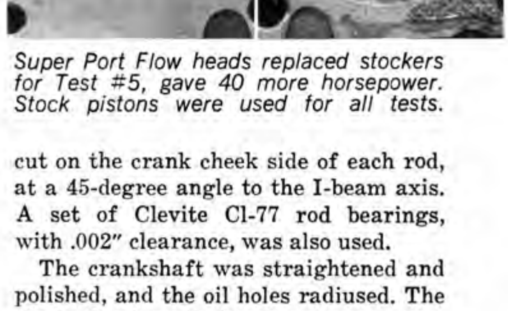
By A. B. Shuman

In uncomplicated Hallandale, Florida, just a credit card's width north of platinum-plated Miami Beach, life is pretty much easy going and pleasant, and it's difficult to think of anything but the good fishin', the good times and the good life. But tucked away in this sun-drenched community is a company whose business is quite contrary to the easy-going surroundings. Crane Engineering, headed by big, active Harvey Crane, Jr., runs two shifts a day to keep up with the orders for racing cams, valve gear and "super port flow" heads. They also have a complete engine balancing section within the plant, and an adjoining speed shop. But what brought us down to visit was their new, ultra-modern, fully-instrumented dynomometer facility, and a series of tests being run on a '69 Ford 302.

There's nothing particularly newsworthy about speed equipment manufacturers or professional engine builders having a dyno. It's accepted good practice to make use of this valuable tool for both product evaluation and research and development. Crane's dyno, however, does rate special mention. The basic unit is a highly-regarded Heenan-Froude English-built dynomometer, located in a special isolated room. The instrumentation (including direct digital readouts for torque and rpm) and controls are located in another room, allowing dyno runs to be made in much greater safety . . . and quiet. A large observation window permits visual monitoring of the engine during the tests, and besides the usual fuel and oil pressure and water temperature gauges, tabs are kept on air flow through the carb(s), carb air temperature, exhaust back pressure and fuel flow. There is even provision for mounting thermocouples at each exhaust port. Walking into the dyno room, we couldn't help but smile at the large coffee jar full of spare parts – not jets or nuts and bolts, as is usually the case, but multicolored transistors, capacitors and resistors. And we felt a little twinge as we noted one more sign of our impending obsolescence.

Having overall charge of the Crane dyno program is Don Hubbard, a racer with extensive dynomometer experience, having served as chief engineer at the Army's giant engine testing complex at Ft. Belvoir, Va. The man doing the actual testing and setting up of the engines is George Linton, whose San Francisco engine and chassis building shop gained him a strong drag racing reputation. The whole shebang, of course, is closely supervised by Harvey Crane himself.

The engine (a 220 hp/two barrel version) was shipped to Crane directly from the factory. Before any runs were made, Linton disassembled it, checked all key dimensions and prepped it for the upcoming tests. The preparation involved several changes to the oil system to aid longevity. The oil slots to the main bearings were elongated and the passages to the cam bearings tapped for Allen plugs, which were each drilled with a .050" hole to restrict flow. (Linton also recommends that for street/strip use the oil supply to the back of the block should also be restricted – down to .045" – to maintain oil delivery to the mains and cut the excess supply to the lifters.) A Melling Tool high volume oil pump (M-68-HV), which features a large diameter pickup tube, was installed and two .010" deep by ⅛" wide oiling grooves



Super Port Flow heads replaced stockers for Test #5, gave 40 more horsepower. Stock pistons were used for all tests.

cut on the crank cheek side of each rod, at a 45-degree angle to the I-beam axis. A set of Clevite Cl-77 rod bearings, with .002" clearance, was also used.

The crankshaft was straightened and polished, and the oil holes radiused. The stock Ford main bearings were reinstalled with .002" clearance. All pistons and cylinder bores were miked and wall clearances brought as close as pos-

Linton applies Assembly Lube to Crane H232/310 CompuCam as a safeguard against wear during break-in. Lifters should also get a liberal coating. Wilder cams will be tested in Part 2.

After each dyno run, each cylinder was leakage checked with Rockair tester. System shows up problems not revealed by a simple compression check. Valve seats caused initial woes.

sible to the factory specified .003-.004" by honing. An AN 100 hone was used to get the desired finish roughness on the walls. Ring end gap, at .020-.025", was considered satisfactory. As is usually the case with Ford engines, a check of the deck height showed that one bank ran about .010" higher than the other. To remedy this simply, George ran a stock head gasket (.060" compressed thickness) on the low side and a thinner (.052" compressed) Fel-Pro on the high side. The Crane balancing department took care of getting the reciprocating parts to spin vibration-free, and Linton made his own flat windage tray for the 302. With the exception of shimming the stock (orange colored) Ford springs to 80 pounds seat pressure, the heads, manifold and Autolite model 2100 two barrel were untouched. The stock Autolite distributor was checked and installed. Though it had shortcomings it was used throughout the test series. The cam and hydraulic lifters were checked and found satisfactory. Valve lash was set at zero with the engine hot.

Following reassembly and mounting on the dyno, the 302 was taken through a very detailed and careful break-in procedure, in which speed and load were gradually increased. Though the break-in consisted of just 5 hours of running time, it took four days to complete. One of the problems encountered was high oil temperature at 5000 rpm and above. To help overcome this, Linton fabricated a cooling box, which fit over the outside of the sump and allowed cool water to flow around it. As for power, it looked good, though valve float was occurring at 5300-5500 rpm, causing a rapid drop-off in torque.

After the break-in was completed, the engine was given a compression leakage test. This shows the cylinder's ability to maintain a good seal by supplying pressure from a constant source and then measuring the drop across a calibrated orifice. It indicated that #2 cylinder was bad. The head was removed and examination showed that the valves were warped and that the valve keepers had started to pull through the stock two-piece rotater-retainers. The other head was removed and all seats and valves reground. The retainers were replaced with one-piece steel hi-per 289 parts and, after reshimming the springs to 80 pounds pressure, each chamber was given a valve leak test. For this, a small amount of solvent is placed in each combustion chamber, which is then capped with a plexiglass plate. A small hose leads from the plate to a hand pump, which is used to draw air out of the chamber. Any bubbling of the solvent shows that air is entering the chamber and, hence, the valves are not sealing completely. This is the means by which the warped valves were initially revealed, but after regrinding everything checked O.K.

CRANE ENGINEERING FORD 302 DYNO TESTS

	TEST 1	TEST 2	TEST 3	TEST 4	TEST 4-2	TEST 4-5	TEST 5
CAM	Stock	Stock	Stock	Crane H232/310	Crane H232/310	Crane H232/310	Crane H232/310
CARB	Stock (2 bbl)	Stock (2 bbl)	Holley R-4118AAS	Holley R-4118AAS	Holley R-4118AAS	Holley R-4118AAS	Holley R-4118AAS
MANIFOLD	Stock	Stock	Edelbrock F4B	Edelbrock F4B	Edelbrock F4B	Edelbrock F4B	Edelbrock F4B
HEADERS	Stock	Tubular Automotive	Tubular Automotive	Tubular Automotive	Tubular Automotive	Tubular Automotive	Tubular Automotive
HEADS	Stock	Stock	Stock	Stock	Stock	Stock	Crane "Super Port Flow" 289 Heads
IGNITION	Stock	Stock	Stock	Stock	Reworked Stock	Reworked Stock	Reworked Stock
OTHER ADDITIONS	Melling High Volume Oil Pump		Autolite BF-32 Spark Plugs	Crane Lifters, Rockers, Springs and Retainers			Crane Valves
RPM	HORSEPOWER (UNCORRECTED)						
2500	130.5	134.2	133.8	—	—	—	—
3000	153.5	163.6	166.4	165.6	166.6	166.2	167.4
3500	164.8	173.2	192.3	190.4	—	—	—
4000	171.8	181.2	209.9	220.6	223.3	225.0	235.6
4500	174.8	184.7	217.5	244.9	249.3	251.4	267.7
5000	166.0	179.8	209.5	264.8	264.4	268.5	292.1
5500	111.0	166.7	192.3	263.7	270.6	274.3	306.6
6000					261.0	268.3	310.5
6500					250.7	258.7	314.3
7000							301.7

Crane #36751 needle bearing roller tip rocker arms for '69 small block Fords incorporate integral valve stem guide plates, allowing drop-on installation.

The heads were bolted back on and another compression leakage test run. This time, all cylinders looked good. The stock carburetor jets were bored out to .054" (.048" stock), to keep the plugs from burning. Power timing showed that 36° total advance (10° initial) to be best, so this was used for the "baseline" test series. The baseline is used as the standard for comparison with later tests to show the effect of changes to the engine. It is therefore quite important that the figures be as accurate as possible. For this reason, standard dyno procedure at Crane calls for frequent calibration checks of the instrumentation and the dyno itself. In addition, during each test series, power readings for each rpm are taken at least two different times, to see that they indeed repeat. This eliminates "flash" or unreliable readings. The figures shown here are "observed horsepower," that is, they are uncorrected for temperature, humidity and barometric pressure. Adding in these factors would raise some figures and lower others, but the "raw" data is fairly close (within about 2% accuracy).

TEST 1, the baseline, showed that even in prepared stock form (complete with cast iron exhaust manifolds) the engine falls short of the advertised 220 hp at 4600 rpm. The maximum power was 174.8 at 4500. The giant dropoff at 5500 is a result of incipient valve float and possible distributor point bounce (which was corrected later). The post-

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run cylinder leakage test showed that #2 cylinder was low again, but, as before, a valve job remedied the problem.

TEST 2 was basically a repeat of test 1, with the exception of the addition of a set of Tubular Automotive four tube headers. These featured 1¾" primaries and 15" long 3" o.d. collectors, with streamlining "goilets" where the four pipes converge. Not too much of a gain was expected with just the two barrel carb on the engine, but we got a surprise as we found an increase of about 4 to 14 horsepower through the range. Comparison of the carburetor air flow figures for the first two tests shows there really is such a thing as scavenging, as they jumped appreciably with the addition of the headers. Peak horsepower was 184.7 at 4500. When the right head showed up bad again in the cylinder leakage test, the valves were reground with wider seats, sinking them slightly. We expected a slight power loss, but increased seat life was deemed worth it.

TEST 3, Vic Edelbrock supplied one of his F4B single quad hi-riser manifolds, which was installed with heat riser block-off gaskets. The 715 CFM Holley R-4118AAS carburetor that Vic recommends for use with this manifold on small block Fords was jetted with #76's in the primaries and (stock) #78's in the secondaries. Linton also removed the choke, checked and cleaned the vacuum diaphragm and took out the ball check valve (a good trick for stick shift machines), but retained the yellow painted spring. In addition, he placed a small screw in the slot in the secondary throttle lever, so that when the primaries reach full open the secondaries are cracked slightly, improving the transition. He also feels that a better starting point for jetting on the strip would be #70-71 for the primaries and #76's for the secondaries, because of the effect of acceleration on the fuel in the carb. Spark plugs were switched from the stock Autolite BF-42's to BF-32's. The engine really responded, as power soared all the way to 217.5 at 4500 rpm and the maximum torque (290 lb. ft.) occurred at 3000, while it had been at 2500 for the other tests. The combination looked all the better for its smooth 600 rpm idle.

TEST 4. The next phase was the installation of an off-the-shelf Crane CompuCam, an H232/310. This is one of Crane's new computer designed grinds and the name tells the story. It's designed for hydraulic lifters; has a 232 degree duration, measured from the .050" cam lift points, and has .310" lift *at the cam.* (This last figure is multiplied by theoretical rocker arm

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ratio – 1.6 for this engine – to get valve lift). Also used were the Crane high rpm hydraulic lifters (#36510), dual springs (#99836 outer, #99858 inner), aluminum retainers (#36901) and needle bearing roller tip rocker arms (#36751). These rockers, by the way, are made especially for this engine, which does not have pushrod guide plates, and use a self-contained system to maintain alignment with the valve stems. An installed spring height of 1.75" produced a seat pressure of 100 pounds. Open pressure is 290 pounds at 1.265" spring height (valve lift for this cam is .496"). The oil baffles on the inside of the stock rocker arm covers had to be removed in order to clear the new rockers. The valves were adjusted to zero lash plus an eighth turn tighter with the engine hot, and the carb was rejetted with #73's in the primaries, while the secondaries were drilled to .089".

Before looking at the results of this test, remember that the stock cam is extremely mild and the headers, four barrel and high rise manifold were more than adequate for its requirements. The engine was "ready" for a hotter cam and this was it. The power from 4000 through 5500 really jumped, with a high of 264.8 at 5000, only lowering to 263.7 at 5500. For some reason, however, the engine wouldn't pull good power at 6000 rpm. A series of checks, using the same basic engine configuration, was made to discover the cause, which at first was thought to be the ignition.

TEST 4-2. This rerun test duplicated test 4, but a set of double spring breaker points was installed in the distributor and the plug wires were swapped for a set of the silicon insulated stainless steel conductor type, with Rajah terminals. The carburetor was cleaned, regasketed and flow checked. #74 jets were installed to richen the primaries slightly, while the secondaries were left the same. The jets were modified with a 45° approach to the jet orifice and the secondary float level was raised to ⅜" from the top of the float bowl. It had been noted on the early tests that a sharp 10 psi drop in oil pressure occurred above 6000 rpm. The oil pan sump was lowered 3½" to cut windage and a baffle installed. This, even with the use of special Crane-fabricated dual pickups, failed to solve the problem, but, as it didn't appear to have an adverse effect on the engine, no further changes were made. The effort did prove worthwhile, though, from a power standpoint, as the maximum was kicked up to 270.6 at 5500 and the engine continued to pull 250 hp at 6500.

TEST 4-5. Part of the dyno room in-

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strumentation consisted of an exhaust gas analyzer, which revealed the mixture was slightly lean from 5500 rpm on up. It was also evident that the left bank was running leaner than the right. A series of runs was made to smooth out the distribution. For rerun 5, the carb was stagger jetted (#78/#74 primaries, #79/#78 secondaries) and a ½" thick spacer placed between the carburetor and the manifold. This had a simple, square opening, with no dividers. This gave another seven horsepower at 6000 and eight more at 6500. Top was 274.3 at 5500, just about 100 over the test 1 figures.

TEST 5 was basically a repeat of 4-5, with the substitution of Crane Super Port Flow heads for the stock 302's. The Crane heads were actually high performance 289 types, as time did not permit full reworking of the heads that came with the engine. They featured Crane polished valves (1.937" intakes, 1.625" exhausts) and the famous round "you can roll a golf ball through it" exhaust ports. Despite the very high power gains with these heads, it is possible that a bit more was available, as the header flanges (made for the standard exhaust port shape) had rectangular rather than round openings. A compression ratio check of the Crane heads revealed a 9.03:1 actual value, compared to 8.79:1 for the stockers. Both of these were below the 9.5.1 ratio specified for this engine.

The worth of the improved breathing became evident at 4000 rpm, with a 10 hp gain, and there was no loss of power at 3000 rpm. The power peak was boosted by 1000 rpm to 6500, and the engine picked up 40 horses, with a top of 314.3. Through the whole series, tests were run to check the effect of disconnecting the air flow measuring device. It was found that, generally, the restriction imposed did not produce more than a 1-2% drop in power. During this final test, however, the power increase caused by removing the flowmeter ducting amounted to 7.5 hp at 5000 rpm, 10 at 5500, 12 at 6000, 17 at 6500 and 5 at 7000.

The 302 test series had to be suspended at this point, as the Crane Engineering combine had a full schedule of other engines to put on their dyno, but the results achieved with just the few modifications we employed were quite good. Although the stock performance of the engine fell short of our expectations, we picked up 140 horsepower with regularly available "store bought" goodies, including a *hydraulic* cam and small four barrel. There was one bad point though, that was when we had to leave. Those Hallandale folks sure are friendly.