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HOW TO HOT ROD YOUR PORSCHE 356 ENGINE

BY CHARLES NAVARRO


William Noblitt's 356

Originally published in 2007, this feature on building an 1883cc big bore Nickies Porsche 356 or 912 engine was written only a few years after the introduction of LN Engineering's Nickies cylinders and when they were still quite new to the market. Even then there was concern for originality or that modifications were required to fit these larger cylinders. Almost twenty years since they were first introduced, Nickies are trusted and used by engine builders world wide.

I've provided some relevant updates for 2019 to "How to Hot Rod your Porsche 356" but have chosen to leave much of the content unchanged. Please enjoy this light read and as always, I am only a quick email or phone call away and always happy to discuss at great length the plans for a rebuild or restoration. First and foremost, we are Porsche enthusiasts and enjoy all things Porsche, just with a bit more focus on the engines, of course. Enjoy!

Charles Navarro
President and Co-Founder, LN Engineering LLC

THERE IS NO REPLACEMENT FOR DISPLACEMENT.

First of all, I will start off by stating that most guys aren't building a full on race engine, but rather what we call a "weekend warrior" or what most are now calling "Outlaws". Most of these rebuilt "warm" to "hot" street engines, if done right, will last an owner years or even a lifetime, since most 356s are not daily drivers. My goal is for owners to build a reliable engine that you can drive anywhere and be able to keep up with modern cars.

It is a well-known fact that putting on a big bore kit is one easy way to increase HP and torque by increasing displacement. There is no replacement for displacement! 1720cc 86mm big bore kits have been the norm for decades now, only superseded most recently by machine-in Nickies big bore kits in sizes from 90mm to 94mm. Nickies have allowed builders to make engines that run cool all the while making serious top end horsepower and massive amounts of low-end torque. The engine benefits from the added displacement, providing smooth operation from idle to redline and improving the drivability over any stock engine. And they do this all while looking original, as Porsche would have intended.

DO IT ONCE AND DO IT RIGHT.

Porsche designed the engine for the 356 very well, and later C, SC, and 912 engines are excellent candidates for big bore engines. A word from the wise – do it once, and do it right. Even Porsche stopped using cast iron cylinders on engines making more than 22 horsepower per cylinder, so why step take a step backwards? Many customers spend years accumulating parts for their dream engines and a big bore 356 can be done right, even on a budget.

The reason why an 1883 or 1925cc Porsche 356 engine is such a popular choice for the street enthusiast is that the added displacement, even over that of a 1720, allows a greater flexibility in cam selection, allowing for smooth idle, lots of low end torque, and more HP than what a 1720 delivers, and can be reliably built on late B through 912 engines, using original C, SC, or 912 parts for reduced cost. Although there are lots of details that go into building a performance engine, I'll start with the camshaft. Depending on whose numbers you use, a stock SC/912 engine makes 80% of peak torque at 2000 rpm and peak HP just below 6000 rpm.

Here is a table of popular cams to choose from when paired to a set of 1883cc 90mm Nickies:

Camshaft Grind	80% of peak torque available at RPM	Peak HP RPM
Stock SC/912	1500-2000	5500
Elgin 66509 “Maestro Grind”	2000	5500
Norris 331S	2000	5500-6000
Web 86	2000-2500	5500
Elgin 7010-17	2500	5500-6000
Elgin 7208-19	2500-3000	5500-6500
Elgin 7008-17	3000	5500-6000
Beradelli 681019	2500-3000	6000
“Wide Lobe 912”	3000-3500	6000

When I built my 1883, I used the Neutek SX-3. This is a popular cam for vintage racing, and when paired with an 83.5 bore, will create an engine capable of making power right to 8000+ rpm. Based on my estimates and recommendations of various builders, with the added displacement, I figured this was the most cam I could run for a street engine to make the most potential of the added displacement and head work I had done (more on the heads later).

With this cam’s inherently peaky disposition and expecting almost double the output of a stock SC or 912 engine, a Scat billet crankshaft and Carrillo rods were selected for the build. Assembly was difficult as the connecting rods had to be clearanced, as there was an interference issue between the rod cap, rod bolt, and camshaft lobe due to the choice of such an aggressive camshaft profile. Aside from this problem, the engine went together smoothly and performed better than expected.

When having a camshaft ground, it is possible to request a reduced base circle to improve the rod to camshaft clearance issue. Additionally, Carrillo has also redesigned their 356 rods to improve the clearance, so unless you are increasing the stroke or using a wild cam like I did, you shouldn’t run into the same problems I did years ago.

The engine had a smooth idle, albeit a bit rich, made prodigious torque and pulled from 4500 to redline of 6500 like a freight train, putting out a whopping 170 horsepower at redline. Now, you might ask, what was the catch? Well, the engine didn't get good fuel economy, and in bumper-to- bumper traffic, it was a bear to drive, since the engine really didn't have any torque below 2500 rpm.

SO WHAT WOULD I DO DIFFERENT THE SECOND TIME AROUND?

Since hindsight is 20/20... first, I would have chosen a milder cam, better suited to my driving style. Although a great race cam, for sure I would not use the SX-3 again for a street drive vehicle- too peaky and not enough torque.

One of the first things I ask someone who is thinking about building an 1883cc or larger engine with our Nickies is how they plan on driving it. Most people tell me they don't rev the engine past 5,000 rpm, so why build an engine to make power above that? There are some favorites – the Maestro grind, also known as an Elgin 66509 (LN Engineering Torquer #102-01) is what I call, a "stump puller" when paired with an 1883 big bore kit, with more HP and torque than a stock engine, but with similar power band, just shifted up a BIG notch. We don't expect this camshaft to make much more power above 5000 rpm, so some may want a bit more cam.

William Noblitt's 356

I learned a lot from early adopters. William Noblitt was one of my first customers, having the first 1800cc Nickies engine successfully campaigned both in vintage racing and hill climbs. Bill later built himself an 1883 to race while building engines at Air Power Racing in Utah. It was Bill who recommended to the Elgin 7010-17 (LN Engineering Performer #102-02). He ran this camshaft in his Convertible D with a 1720cc engine, which made power to 7000 rpm. This normally is considered the hottest cam you should use in a street 1720, but in an 1883 or larger engine, it gives you power to just over 6000 rpm with more torque than a stock engine. **This is my favorite camshaft for 1883 or 1925 builds.**

For race use, William Noblitt worked with Dema Elgin to develop an optimized camshaft for his own race engine that makes peak power around 7000 rpm for our 1883cc Nickies kit – the Elgin 74504-20. For best results, fully ported heads (JPS Aircooled's Sport Plus billet cylinder heads will do nicely) with larger valves and racing valve springs to ensure adequate valve control to 8000 rpm is recommended.

LN Engineering Torquer and Performer Camshafts

There are lots of good cams to choose from. I recommend either our **Torquer or Performer camshafts** depending on your driving style; I will elaborate on this reason later. Whatever you do, make sure you use OEM German, Genuine Porsche, or have your old ones reconditioned. There are lots of crappy lifters out there, and if you have a cam or lifter fail, it is a very expensive repair.

As with any rebuilt engine, it's critical to use the correct assembly lube and break-in oil to ensure the best results. I use and recommend Driven Racing Oil's products exclusively because we helped develop them for this application and we know they work. Their newest GP-1 oils using Pennsylvania base stocks are ideal for 356 engines.

CYLINDER HEADS

The estimated figures quoted for powerband and peak horsepower are figured with a free-flowing exhaust and larger than stock carbs, but most importantly, with work done to the heads- namely, on the intake. The exhaust ports on an SC or 912 head flow plenty bone stock, so you don't need to do any work there. On the heads I did for my 1883, the intakes were ported such that it corrected the exhaust to intake ratio, from the stock 1:1, to about a .7-.8:1, which is the ideal ratio. This gives you about 25% more flow out of the intake port, equating to about 13-16% more HP and 7-10% more torque than with a stock head. We were able to squeeze 170 CFM on the intake port out of a highly modified 912 head, but the amount of work required was staggering.

At this point, even the newest 912 cylinder head is over fifty years old, so many have been reworked several times and most castings are just worn out. It is critical that the cylinder heads are properly prepared and this is where you will spend most of your money outside of the Nickies and labor for the engine overhaul. For most, reconditioned C or later heads opened up for 90mm or larger Nickies will provide exceptional results when paired with stock carbs and our Torquer or Performer camshaft. If going the performance route, porting the heads is a good way to make power, but there is more to it than just hogging out the intake port. The shape is where the power is, and flow is as important as port velocity. I recommend having an experience professional rebuild your heads, and if so desired, have them ported. It is important to discuss with whomever you are having do your cylinder head work the scope of the project with details like what camshaft you want to run and desired redline.

JPS Aircooled Billet
Aluminum Cylinder Heads

As already mentioned, most heads will require extensive reworking, to the point that it is more cost effective to start out with new cylinder heads. **JPS Aircooled out of Switzerland has done just that with their billet SC/912 and Sport Plus cylinder heads**. Right out of the box, the improvements are evident. Not only are these heads 100% new, they are stronger with many improvements, set up for larger 40x35 8mm stem valves. On the Sport Plus heads, even larger valve sizes are possible. With extensive flow bench research and development, over 200 CFM of flow on the intake is now possible with JPS Aircooled's Sport Plus heads, which is race car worthy and capable of supporting up to 200 HP. These are hands down the best complement to a set of Nickies cylinders. In partnership with Claus Ruppman, JPS also offers a combo with either 93 or 94mm Nickies and special 8mm head studs.

A little more on the valves. When we first used 8mm valves back in 2006, we learned the benefits right away. With 8mm valves, we were able to save a lot of weight; just the intake valve alone was 24 grams lighter than stock and the exhaust valve was 14 grams lighter too. When paired to an aluminum, lightweight chromoly, or titanium retainer, the weight savings are enormous. You might again ask, why, since this isn't a race car? Well, lower valvetrain mass allows you to reduce how much valve spring tension you have to run. In my case, with an engine that was revving only to 6500 rpm, we used less spring pressure than stock, even with a race cam. The JPS Sport Plus heads with single valve springs are good to 6250 rpm and with optional dual springs to 7500 rpm. With the weight reduction in valvetrain components, you don't need dual springs if you aren't going to be running high rpms. Dual springs needlessly increases valvetrain wear and raises your oil temperature, not to mention how much horsepower is lost opening those heavier valve springs. While on the topic of valvetrain component weight, the stock pushrods are both heavy and weak – our JPS aluminum pushrods come in under 45 grams and are proven to 8000 rpm and 440 lbs of valve spring pressure. These are ideal for all 356 engine rebuilds from stock to race.

When considering cylinder head work, twin plugging is a great upgrade, which can let you run half to a full point more compression in your engine versus a single plug configuration. However dual plugging a 356 engine will cost thousands more than keeping it single plugged and adds extra complexity. The nice thing about an 1883 with a 90mm bore is that the pistons have very shallow dome heights, even with 22 degree heads and pistons, reducing piston weight and providing good flame front propagation. Keep in mind that depending where you are in the country, your altitude, and available fuel octane rating varying from 91 to 94 (R+M)/2 can very how much compression you can safely run, which again varies from camshaft to camshaft, since cams with more duration can run more static compression (Google "dynamic compression ratio" to learn more about static versus dynamic compression ratios). When in doubt, talk to the camshaft supplier for their recommendation on compression ratio with any given camshaft. For example, Dema Elgin provides this information for many of his camshaft grinds and if you supply cylinder head flow numbers, they can often match up the optimal camshaft for the application if you are trying to do something custom.

RODS, PISTONS AND CRANKSHAFT

Now why do I recommend limiting peak HP to 6000 rpm? My reasoning for building an engine that doesn't make peak HP past 6000 or say 6500 rpm is to reduce the load caused by the reciprocating mass on the connecting rods, crankshaft, and the main and rod bearings. Furthermore, when compression is limited to 9.5:1 with mild "streetable" camshaft profiles, there is just less stress on all the engine components all the way on up to the valvetrain, allowing builders to reuse the original crankshaft and connecting rods, saving thousands on rebuild costs without sacrificing longevity and reliability.

With all of this in mind, the custom pistons we supply from JE, CP, and Mahle Motorsports have been engineered to remove dead weight from the reciprocating components. As far as the crank and rods are concerned, by making the piston and wrist pin lighter, we've reduced the stresses exerted by the rotating mass at the end of the rod. In some cases, the weight of the new components is significantly less than most aftermarket 86mm pistons and lighter than even a stock 82.5mm piston. Now how can you safely remove material you might ask? Well, there are different forging alloys available. The 4032 high silicon forging material, popular for use in cast iron cylinders for quiet operation because it doesn't expand as much, is weaker. We use a 2618 forging that has no silicon, so it expands more, but matches the expansion rates of our Nickies cylinders, allowing for quiet operation without piston slap. The stronger 2618 alloy allows us to make the piston lighter without reducing its strength too. Lastly, all pistons we supply come with anti-friction coated skirts, which reduce break-in wear and extend piston life. These modern pistons feature slipper skirts, thin low-tension piston rings that confirm better to the cylinder walls allowing for better ring seal, and features like accumulator grooves to further improve ring seal. Optional thermal barrier coatings increase thermal efficiency and gapless rings virtually eliminate blow-by. There is no reason why any engine should not use modern pistons.

For the rods and crankshaft, I recommend using SC or 912 rods. For the crankshaft, an un-counterweighted C crankshaft, SC, or 912 crankshaft will do nicely. We recommend having these components properly reconditioned including magnafluxing. If the crankshaft journals need more than just polishing and have been turned more than once (and a replacement crankshaft is not available), verify journal hardness and re-nitride if required to restore the proper hardness. Optionally, all engine components can be cryogenically treated which helps improve component life including fatigue life and lessen the chance of cracking.

CYLINDERS

Other than the normal cost of reconditioning the stock engine components, you have the choice of leaving your heads un-ported which is a further cost savings or having them ported. We don't recommend skimping in the area of cylinders. Many say these engines are oil cooled, but no, they are indeed air cooled. For cylinders, we don't recommend building an engine with a bore larger than say 83.5mm unless you use an aluminum Nikasil plated cylinder. There are cast iron and biral cylinders out there in 86mm, but I wouldn't trust them in any size over 83.5mm, as they don't have the longevity or cooling of an aluminum nikasil cylinder. Furthermore, the use of aluminum cylinders, as Porsche discovered years ago, helps to increase the thermal capacity of your engine, helping to reduce the heat soak on cylinder heads and other vital engine components, further helping to keep your big bore 356 engine as or more reliable than a stock engine!

Aluminum cylinders help reduce oil as well as cylinder head temperatures, which most people do not monitor. Cylinder head temperatures over 400F will cause damage to the engine, and without aluminum cylinders for added cooling, even a stock engine can reach these temperatures on a hot day, going up a steep grade, or at high speeds. In our own testing years ago, we found Nickies would reduce cylinder head temperatures by up to 150F while helping to maintain safe oil temperatures.
Another problem experienced by many with cast iron 1720cc or larger piston and cylinder kits are the fact that higher tension rings are used to help make these piston and cylinder sets seal up. Even then, it's noted that many of these engines smoke and burn oil if driven hard or in hot climates. Increased ring tensions also increase oil temperatures, so by using lower tension rings when paired with aluminum Nikasil cylinders, like Porsche uses, we reduce friction, which means less heat goes into the oil. With the added cooling Nickies provide, the stock oil cooler works just fine – unless your oil cooler is bad (leaky or contaminated with debris from a previous failure), there is no need to get a fancy billet oil cooler, unless you really want one. Just have your original oil cooler cleaned and pressure tested, and again, you've saved a few hundred dollars.

For years, we offered a "budget" aluminum 86mm 1720cc cylinder where we stripped out the chrome or feral coatings from the original alloy cylinder, bored, and re-plate them, fitted with new pistons and Nikasil compatible low tension piston rings. However, unless you have a set of original alloy cylinders from which to start, our supply of good cores dried up many years ago, so we no longer can offer this option. Good news for those who don't want to machine their engine case or heads to accept our 90 to 91.5mm Nickies, we do offer slip-fit 86mm Nickies that can be fitted with no modifications, even during a top end rebuild.

Ideally, when going larger than 1720cc, the only solution is one of our 1883cc or 1925cc big bore kits, including the newest sets from Mahle Motorsports that feature our Nickies cylinders. Although pricey, with the thoughtful improvements we've applied to the pistons and careful selection of a camshaft, your can build a big bore 356 engine on a budget, saving thousands on the cost of Carrillo rods and a Scat crank, which can be spent on the pistons, cylinders, and requisite machining for the case and heads.

The beauty of our 90 and 91mm Nickies big bore kits is that to get a these larger bore sizes, we open up the head register to 98mm and the case register to 94.5mm, giving us increased wall thicknesses greater than an 86mm cylinder, for better rigidity and strength. The added machining won't affect the strength of the heads or case and costs little more than what it costs to have your case and heads resurfaced.

Nickies and Mahle Motorsport Big Bore C+P Sets

HEAD STUDS, FASTENERS AND OTHER CONSIDERATIONS

Like with everything else on the engine, the head studs are over 50 years old at this point and should be replaced when upgrading to Nickies. We have custom ARP head studs that are perfect for replacing your old, thermally-cycled head studs, which are specifically designed to handle the increased expansion of an aluminum cylinder. Fasteners get torqued to 24-28 ft/lbs using the factory prescribed pattern. Instead of using the rubber seals under the original head nuts, a non-hardening sealant like Curil T can be used in their place.

Lastly, you should to vent each valve cover and use steel reinforced valve cover gaskets. This will save you the hours of grief we encountered with my 1883 on the dyno, sucking in valve cover gaskets. Some builders recommend re-torquing the heads after the engine has been broken in, and we did so while the engine was on the dyno, after we were thoroughly convinced the engine was broken in.

Besides re-torquing the heads after break-in, it is good practice to verify your valve adjustment after break in and at every oil change. On my 1883, valve adjustments settled in after the first 1000 mi, and after that point, I just did monthly inspections to verify that I had some valve lash, between .004” and .006”, and I never did have to adjust the valves, even after 5000 mi. Optimal valve lash will vary depending on what type of pushrod is used – aluminum will require adjustment to stock lash specifications where some have reported running tighter lash with chromoly pushrods.

INTAKE, EXHAUST AND ANCILLIARIES

Now that we’ve discussed internals, we need to take time to consider intake, exhaust, and ancillaries. Believe it or not, too large of carburetors or not enough backpressure from the exhaust can really hurt the low end of these engines, say below 3500 rpm. For a street 1883, a set of Weber 44 IDFs with 34 or 36mm venturies provides plenty of breathing. I found that the engine had better idle and low end drivability with a smaller set of venturies, so similarly, a set of Weber 40 IDFs or 40 Solexes with will be plenty sufficient and won’t really hurt HP until 6000+ rpm. Zeniths will limit top end horsepower, but engines with these carbs will make up for this with ample toque at all engine speeds.

Velocity stacks help improve airflow (and power) by straightening the intake charge and also increasing air velocity. There are lots of options out there - taller stacks help improve low end torque where shorter ones help top end. Regardless of whether or not you run stacks, you must run filtration, and that consists of a K&N that has been oiled (or quality equivalent), preferably with a pre-filter, also available from K&N, that although not pretty, do help filter more than the K&N alone. Oil bath air cleaners do an exceptional job of filtering dirt from the intake charge, so that’s always an option as well.

For the exhaust, I originally used one of Vic Skirmants stepped racing headers make by Bursch, with a muffler more or less retrofitted onto the system to make it streetable. For a race engine, this header might be ideal, but for a street driven car, a Bursch quiet power 1.5” header is more than sufficient. However I recommend replacing the cheap muffler that is provided with a high quality muffler. Your local muffler shop can weld a new one in place of the Bursch supplied muffler.

You will want a free-flowing muffler that flows at least 350 CFM but can provide some backpressure – running an open header may increase peak horsepower, but torque will suffer greatly as will your ear drums. As most systems are made out of mild steel and come painted, I would recommend having the whole system ceramic coated to keep it from rusting. There are many other options out there for exhaust systems. Ultimately, it boils down to aesthetics for most owners and for a mild 1883 using mostly stock components, the stock exhaust should be plenty. If not, it's an item that can be easily upgraded at a later date with a minimum of fuss.

ENGINE COOLING

As far as engine cooling, Nickies add the much needed cooling, since you'll be making as much horsepower as a 4-cam Carrera engine, which had aluminum chrome or Nikasil plated cylinders as well. For starters, use a 28 blade fan for a street engine, and keep clear of power pulleys. If you're revving less than 6500 rpm, there is no need to run the 16 blade fan or a power pulley to reduce the rpms of the cooling fan. Like said previously, the stock oil cooler is more than adequate for most street applications. If you plan on tracking the car or operating in extreme environments, you may consider doing a full flow conversion and running an external oil cooler and filter. For those wanting full-flow filtration (the stock filter is a bypass filter), the Precision Matters full flow spin-on filter pump cover, that eliminates the hassle and expense of running external oil lines and remote mounting of the oil filter. A sump extension like the one offered by JPS is a good upgrade for all engines and the addition of an Accusump oil accumulator both can help prevent oil starvation for engines that will be tracked

IGNITION

As far as the ignition system is concerned, assuming the car is still six volt, opting for a points replacement like a Pertronix unit is a good idea, however always carry a spare set of points and condenser, just in case. On a 12 volt system, adding a capacitive discharge ignition (CDI) or multiple spark discharge ignition like an MSD will provide longer plug life with reduced fouling, easier starting, more power improved throttle response, and increased fuel economy. What more can you ask for? These systems can go a long way to improve idle on engines with big cams or that run rich at idle, as I discovered on my 1883, and extends service intervals on spark plug replacement, further reducing maintenance. I have found over the years that a quality copper core spark plug, like an NGK, works best with an MSD box. I've never had good luck with precious metal or multiple electrode plugs for this application. Be sure to set the spark plug gaps accordingly as well.

Have your distributor checked to make sure the advance is still working and set your max advance at 32-35 degrees at 3500 RPM. A twin plug engine would need roughly 20 to 24 degrees max advance at 3500 RPM. Do not use a 009 or 050 distributor; the advance curves of these distributors are far from ideal for a 356. If you want a new distributor, 123 Ignition offers 100% new distributors, some even that are Bluetooth programmable, allowing for custom ignition timing curves. Don't worry about setting your static timing or idle timing, since your full advance is what matters most – the idle timing will fall right into place if the max timing is step up right. I found that my engine worked best with about 5 degrees idle advance at 850-950 rpm and 35 degrees max advance at 3500 rpm, but you will have to find what works best for your engine, which will vary depending on many variables including camshaft selection, compression ratio, and fuel used, just to name a few things

FINAL CONSIDERATIONS

When it is time to get your engine running, it is important to verify tuning. We've found that it's better to be a bit lean during break-in rather than rich, and with Nickies, we found that an air/fuel mix of 12.8 to 13.2:1 was optimal. Using a wide-band o2 meter to carefully monitor air-fuel ratio will ensure that you are not running too rich during break in, as this will wash down the cylinder walls, causing increased wear and possible engine damage. I know with carbs it can be difficult to find a happy balance between idle, progressive circuit, and wide open throttle tuning, but try your best. We've also noticed over the years that engines running ethanol enriched fuels tend to need a bit larger idle jets than those engines running ethanol free fuels (like Rec 90), so be mindful of this when making tuning adjustments and choosing fuels. If you have access to ethanol-free fuels like Rec 90, use them. If all you can get is E10 (10% ethanol), be sure to use a fuel additive like Driven Carb Defender to protect against ethanol corrosion and always install modern, ethanol rated fuel injection hose to prevent fuel line failures and fires that follow.

Other final considerations when increasing your engine output is to be sure the rest of the car is up to the task. Besides the gearbox, the braking system needs to be in tip top shape. You need to be able to stop as much as go!

Learning to live with a Nickies equipped 1883cc or larger 356 engine is pretty easy, as these are powerful, cool running engines, that once tuned, should last a long time, with a minimum of fuss. For those fortunate enough to live somewhere you can drive year round, regular oil changes every 3,000 miles or 3 months is a safe interval to protect your investment. Those in areas where your car might sit in storage half the year, change the oil prior to putting the car away for the season and fight the urge to start and idle the engine. Unless you plan on driving the car for an extended period and can get the oil temperature above 215F, don't run the engine! Equally important is to be sure to put some sort of fuel stabilizer that also provides protection against corrosion caused by ethanol-enriched fuels, like Driven Storage Defender.

If you have made it this far, I invite you to email us your questions and comments. I hope you have enjoyed my revised How to Hot Rod Your Porsche 356.

Cheers and keep the faith!

Charles Navarro
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