REBUILDING THE FORD FE ENGINE

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If you've been around long enough you'll recall times when the FE Fords were popular engines for both stock rebuilds and performance, and shops did good business with them. The series of performance FEs include the HP 352 engines, the huge number of HP 390s, the 406 and 410 multi-carb engines, the side-oiler 427, the legendary SOHC 427 and finally the CJ428. These engines saw duty in everything from Mustangs to Fairlanes to full-size Fords and Mercs, T-Birds and Cougars, and both the original and repop Cobras in massive quantities. In their day they made a lot of hearts hammer and adrenaline flow with brute muscle and a deep exhaust note.

This is the legendary side oiler 427. Although it was certainly a contender in its day, modern tech has far eclipsed what this engine could do. Although you may still see a few of these, mostly you'll be building from 390, 428, and aftermarket blocks. Don't let anyone tell you that it takes a side oiler to make big FE Ford power.

Over time, the FE was replaced with newer designs from Ford and the mainstream of performance shifted away from the FE. Nostalgia racers, rodders, and Cobra kit-car builders hung in there because for them the mystique and the nostalgia of these vintage engines was just as important as performance.

A few die-hards, including Shelby, continued to develop new components and update the FE on a regular basis. A fairly strong drag-race crowd has remained healthy and dedicated and pushed the limits of the original parts to a degree the original designers never foresaw.

Muscle car restorers never lost a beat or considered switching. In other words, building FE Fords declined from a mainstream, high-volume endeavor to a niche-type specialty engine up until a few years ago.

A much rarer FE is this SOHC engine, opened to see the cammer equipment. This engine was so strong that NASCAR made rules to prohibit it. You may never see one of these in your shop, but believe it or not you can build FE engines just as strong with readily-available parts.

The Background

Not too many years ago the Ford FE was widely regarded as an extinct engine. They were last produced in 1975, really good parts were becom-

ing near impossible to find or afford, and it seemed that the only folks left building them were a dedicated group of aging diehards.

It was apparent that the once mighty FE was doomed to join the nailhead Buick, the Rocket Olds, and its own Y-block and flathead siblings in the automotive equivalent of the dinosaur – engines that were regarded as once cool, but now out of the mainstream. But a funny thing happened on the way to the coroner's. The patient woke up. Loudly.

In the late '90s the Cobra clone kit-car business transitioned from a small niche group into a full-blown frenzy, with both quantity and the quality of the cars taking giant strides forward. Further fueling the fire was the growth of the muscle car movement; raising demand and prices on anything remotely cool from the '60s. And then that movie came out – the remake of "Gone in 60 Seconds" – which instantly tripled the price of every '67 and '68 fastback Mustang on the planet. All of which demanded FE power. It was this combination of automotive trends that coalesced into a new generation of performance for the engine that once powered the legendary Fords at Daytona and LeMans.

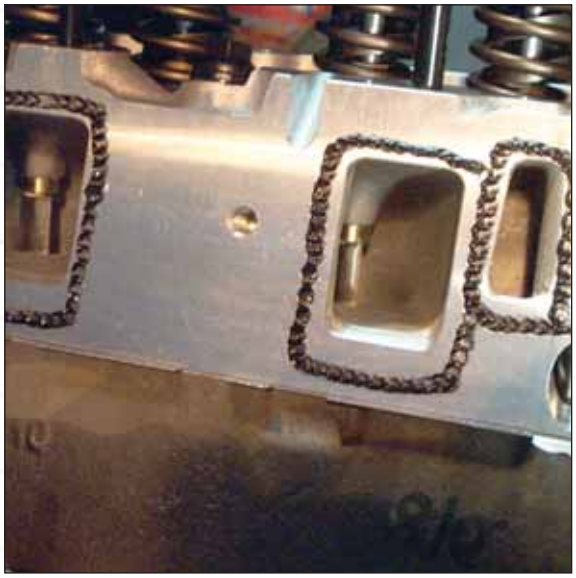
What's happened in recent times can be pinned on the Cobra kit-car business and an additional resurgence of performance and muscle-car restoration and rodding. Cobras that for years saw a lot of small block Chevys are now getting retrofitted with FE engines. The high volume of Cobra bodies sold means a lot more FE engines are being built to power them. Putting a Ford in a Ford is no longer just the refrain of a few loyal blue-oval fanatics, but a solid consideration for anyone investing in the construction or restoration of any serious Ford project.

However, the new FE Fords are a lot different than you'd expect from the vintage playbook. A couple years ago I spent some time building a streetable version of an FE based on a 390 block, a Scat stroker crank, a set of aluminum aftermarket heads, and a roller hydraulic cam that put out a lot more power than the biggest baddest factory FE ever saw. I had LOTS of room to squeeze more out of the engine. I could have gone with more cubes, more compression and more cam to say the least. I figured that with over 450 horses and 500 ft.lbs. on pump gas, it would be

Stock FE heads came in several different variations. They go from mild passenger heads to performance and right out to race style (for the day) heads that are quite rare now. For restorations and mild-to-moderate performance, you can still use stock cast iron heads. Valve re-sizing and porting do a lot of good for any of them.

If you are not doing a restoration, carburetion is an issue. We did a bunch of experimenting on the dyno with carbs and the Barry Grant Demon carb was the best of those tested. We were surprised to find that this 750 cfm unit made better power than an identical 850 cfm unit on the dyno. This from an engine putting out over 450 hp and 500 ft.lbs. of torque.

MSD makes distributors and wires and with a little patience you can make the installation look this good. Just like fine food, a custom engine gets better customer appreciation if the presentation is done right. Tricks like this make the job look as good as it runs and can boost your profits.



Knowing the tricks is also a big help. John Beck at Pro Machine has found that putting this little trail of silicon dabs around the intake ports and water passages has been a big help in preventing oil and water leaks in the FE engines.

a great engine to make a Cobra stand up on its hind legs and snort.

Since then I've seen a lot of additional parts and configurations of the FE that make my project look puny. There are both cast iron and aluminum blocks, heads, cranks and much more that, while certainly not cheap, make for some serious performance from anyone's perspective. As I write this, it is now possible to build a complete FE Ford performance engine without a single Ford part. That, if nothing else, should tell you that enough people, and people who have to spend good money to back up their convictions, are interested in FE Fords that engineering, tooling and producing FE Ford parts has become profitable.

While a few small suppliers such as Dove and Blue Thunder had been churning out specialty components for the FE faithful all along, it was arguably Edelbrock who brought the FE back into the mainstream, with the release of the now familiar aluminum cylinder head. The heads reportedly blew away all expectations, selling at a pace far beyond what anyone had imagined. The success had an explosive effect on everybody in the FE market. Other large suppliers rushed in to join the boom, and the smaller ones were forced to aggressively expand and innovate in order to keep their positions. This brings us to the present day.

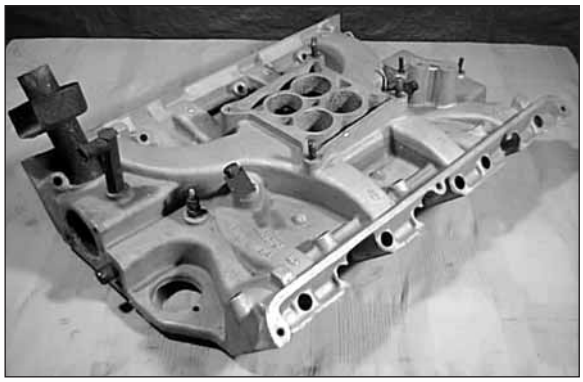
We've gone well past the stage where everyone with a $50 box of tools, a ridge-reamer, and a pile of small block Chevys could call themselves professional engine builders. Today, the massive market for stock rebuilds has declined to where many shops have given up the ghost. Today, the successful machine shops and builders recognize the market and demands have changed. You can't just chunk out a load of cookie-cutter small block Chevys and make a living, you have to become much more adaptive and flexible. That means taking the time to research and develop skills that will allow you to take on just about any engine in any configuration that comes through your door. The survivors will be those who are a lot more than assembly-line parts replacers.

The FE Ford is simply a good example of an engine that has good demand, an extensive array of replacement and performance parts, and can be built reliably and successfully to suit a wide variety of potential customers. If you look into the machine operations and modifications that are well documented as important and effective, you'll be better prepared to stand ahead of your competition. Knowing the quirks, the variations in parts, and the limitations of some will prevent you from making mistakes that can be costly. In short, if you consider any given series of engine as a separate and unique challenge that adds to a trophy-room of achievements and qualifications, you will be a better builder and attract more customers.

Engine Blocks

With the release of the Genesis iron aftermarket block two years ago, the FE now joins mainstream engines such as the small and big block Chevy in that you can build a complete engine without using a single original part. The Genesis block is an enhanced version of the original 427 Ford piece. It retains the original outward appearance, all original brackets and components will attach in their normal manner.

Today you can build a complete FE engine and not use a single original Ford part. It wasn't until relatively recently that aftermarket blocks were produced like this Genesis block and the Shelby blocks in both iron and aluminum.



FE intakes form the inner side of the heads so sealing between the head and intake is critical. These are very large items and the cast iron versions required the use of a cherry picker to remove from the engine compartment. There were some aluminum performance intakes from Ford.

Improvements include thicker cross-sections in critical areas, permitting bores as large as 4.400″. Other features include upgraded cross-bolted mains, and full oiling passages for both hydraulic and solid lifters. There are multiple aluminum blocks available as well, from Genesis, Pond and Shelby. Each has unique features, and each is a dramatic improvement over the old stuff.

Cylinder Heads

The entry level and restoration guys are still working on original iron, but everyone else has stepped into aftermarket aluminum heads. There are numerous options from at least four aftermarket suppliers – Edelbrock, Blue Thunder, Dove and Shelby.

The Edelbrock head is designed and marketed as an upgraded replacement for the stock components. It delivers decent performance right out of the box, and all original pieces and parts will bolt right into place. It also has good race potential in the hands of the highly skilled head porter. The Shelby head is an aluminum iteration of the original Ford medium riser head – and it has the look and recognition desired by many kit car enthusiasts. Dove's FE program includes an array of castings dedicated to the FE race community, with numerous unique port and chamber configurations – including some inspired by successful Super Stock racers.

Blue Thunder is a relative newcomer to the FE cylinder head market. They have released a series of castings that in many ways bring the FE in line with current race heads. Features include exquisite casting quality, modern heart shaped chambers, raised exhaust ports, stainless thread inserts, and integral hard washers for head bolts. The power potential of these heads is amply illustrated by my own recent dyno results: 752 horsepower on 91 octane.

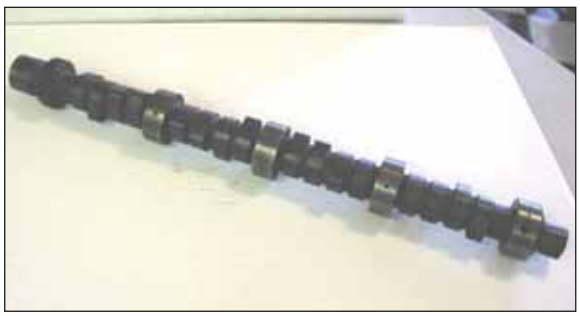
Valvetrain

The original rocker assembly for the FE may be its true "Achilles' heel." While satisfactory for street use, the combination of aluminum stands, old shafts, and a design that leaves the end rocker unsupported is fragile and prone to breakage when the wick gets turned up. Original factory race pieces are scarce and spendy – but aftermarket options abound. Upgraded roller rockers and heavy-duty shafts are available from Dove. Complete kits with shafts, roller rockers, and sturdy shaft supports can be sourced from Dove, Comp Cams, Erson, and Crane. Serious race hardware is now available from Jesel or T&D.

Crankshafts

The stock FE crank has always been regarded as plenty stout, but 30 years worth of driving and racing do take their toll. Custom billet cranks have long been available for serious racers – but at a serious cost. Responding to the engine's renewed popularity, both Eagle and Scat stepped in with new crankshafts and rods. Scat has a range of ductile iron cast cranks that include a 3.984″ stroke version for use as either

The Eagle H-beam rods are also a great asset in an FE engine. Often part of a stroker kit, they allow you to alter the rod length and get better internal geometry. FE engines like long arms.



Stock and reground cams for all FE variations are still available from Egge as are custom grinds. All the major cam suppliers still offer FE cams that you can pick from.

In original blocks, one of the key modifications used to improve oiling for performance engines is to enlarge the oil pump to filter passage. Look for tech sources like WebRodder.com *to make sure you have the details of these operations so you can offer them to your customers and build better engines.*

There are several versions of FE oil pumps that range from street stock on up to high pressure side oiler units. FE engines need all the oil they can get so the high volume pumps are best, but the high pressure pumps are ONLY for the side oiler engines. High pressure does NOT translate to good flow.

a 428 replacement – or as the core for a modest stroker in other FE engines. They also have 4.125″ or 4.250″ stroke versions for those wishing to have serious big cube engines. The 4.250″ crank will turn your 390 into a 445, a 428 becomes a 462, and a 427 goes all the way to 482. When using the aforementioned Genesis block, it is possible for an FE to exceed the lofty 500 cube mark!

Connecting Rods

The original FE rod is certainly adequate for daily

There are a few places where a die grinder and small burr bit will make a big change in oil flow. Here the passage holes are aligned with the oil hole in the bearing shell. Unless you look for or get told about these modifications, you might miss them entirely. It pays to research.

driver and modest performance usage, but they are all pretty old – and all will need the full reconditioning routine. Scat's stock 6.49″ long H Beam is a very attractive option for those seeking a bit of insurance. Scat also has a similar 6.700″ long, 2.200″ Chevy journal rods for use with the 4.125″ and 4.250″ stroker cranks. These 4340 rods are all ARP fastener equipped, bronze bushed, shotpeened and magnetic particle-inspected.

Bearings

King Engine Bearings offers a fine-quality replacement bearing for the FE, and Federal-Mogul, Clevite and King all offer performance bearings as well. The F-M parts include the latest groove design used in their NASCAR and NHRA parts. A little known tidbit is that Ford Cleveland bearings will fit an FE with only a simple tang change. Really handy when you're trying to "nail" clearances, since all the useful +1 and -1 sizes are offered for the Cleveland.

If you don't know what this is or which engines it is used on, you may want to do some more FE Ford homework. It's a crank balancer spacer that has a counterweight on it. Most FEs did not have this, but if yours did it is absolutely critical to use the right one.

These are just nine of the variations of FE pistons. Depending on the head, the compression ratio, and the valve size, you could end up with any of them. Most are obsolete and in some cases result in too much compression to run today's fuels. All are obsolete designs that are not well suited for modern performance.

Even stock replacement type cast pistons like these from Egge are an improvement in terms of materials and perfection in machining. What Egge makes today as stock replacement we would have loved to have for performance stuff back in the day.

Part of making an FE suitable for a specific customer application is knowing which parts work best. If you have lots of side room, but little between frame and block, you might opt for this style oil filter housing, for example.

Modern performance pistons are much lighter, smaller, and use more efficient modern ring packs. In addition, hypereutectic and forged pistons are available from SRP, Ross and Diamond, among others.

Pistons

Custom pistons have always been an option for the FE enthusiast – but several other options are available these days. Speed-Pro has entry level forged flat tops for the 390 and 428, while Probe offers forged pieces that are a nice step up for 410s (a 390 with a 428 crank) and 428s. Diamond has really stepped up to the challenge. With the industry's broadest range of catalog FE pistons, they cover the full gamut of bore and stroke options – and can deliver virtually anything, including full custom designs, within two or three weeks. Diamond's FE line uses Chevy based oversizes (i.e., 4.155″, 4.165″, 4.250″) making piston rings easier to find and less expensive.

Rotating Assemblies

At Detroit's Survival Motorsports, Scat crankshafts and connecting rods, along with Diamond's pistons, and the required rings and bearings – are bundled into complete rotating assemblies. These kits provide the engine builder with a quick and concise way to order the pieces needed to stroke that FE – without going through all the parts chasing hassle and component compatibility issues.

Ford made another version that points the filter down and that might work better where frame width is better. If all else fails you can use an adapter and go remote. Know your parts options.

Intake options

The range of intakes for the FE equals that of nearly any engine. Race single planes in either 4150 or Dominator flange can be purchased from Edelbrock or Dove. Dove also reproduces the original "Tunnel Wedge" 2 x 4 intake.

Dual plane intakes can come from Edelbrock or from Blue Thunder (the Blue Thunder dual plane is a favorite of the Cobra crowd due to its OE appearance). Multiple carb intakes include dual quad or three two's – and are offered new by Blue Thunder, or used in the secondary market (eBay!). Those looking for a nostalgia flavor can usually find older injection, blower, and cross ram intakes with a bit of internet work.

Dress It Up

Engine dress is the finishing touch. MSD has a really nice billet distributor. Blue Thunder duplicates the

Aftermarket aluminum intakes do two important things for the FE. First, is the obvious performance improvements in flow and velocity. Second is the significant decrease in engine weight. An FE can easily be in the small block Chevy weight range with aluminum heads and intake.

My research tells me that FE engines LOVE stroke. A stroker kit can make a number of improvements all at once including better, lighter pistons with modern thin rings, better rods and rod ratios, and more cubes. Remember for ultimate performance it's either cubic inches or cubic dollars!

Key to the best of the FE hard charger engines is the Scat stroker crank. They make them in several sizes, but without question they wake up an FE engine BIG TIME. I have rarely seen an engine respond so dramatically to stroke as the FE.

OEM rockers are shaft mounted and there were three different pedestal heights used. Don't expect to just throw any set of rockers on your FE.

Original flat-tappet lifters have occasionally been hard to find lately as the manufacturers changed to later engines and rollers. Fortunately you can still get OEM replacements in good supply

For all intents and purposes, rockers came in two original versions. You mostly found non-adjustable units, but the higher performance engines had adjustables. Both worked fine, but they are not the best for high performance applications.

I found that the best performance – showing flat and high torque and horsepower curves – of any cam combination for the street came from Crane Cams' street grind roller hydraulic cams. This was another of those dramatic improvements we found for the FE. The roller cams really help them breathe better and the hydraulics make them streetable without a lot of maintenance.

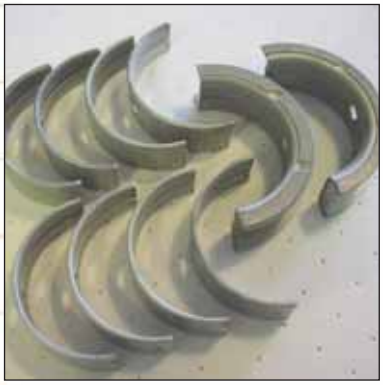
Several companies make roller rocker setups for the FE engines. These are billet aluminum units from Rocker Arm Specialists that will handle almost any performance level.

original oval air cleaners – for single four, two four, or three two barrel applications. They also have quite a range of valve covers, ranging from traditional "pentroof," to the popular fins with logo types, to modern looking versions complete with screw in breathers. Aluminum water pumps can be Edelbrock or Dove – or even electric ones from Meziere. Pulleys from March, oil pans from Moroso or Milodon or Stef's – all that's missing is the noise!

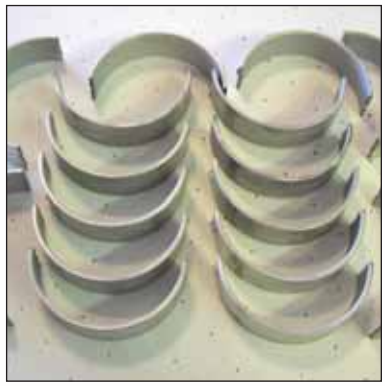
The Noise!

At the recent Engine Master's Challenge the noise was delivered. A very straightforward assembly of some very good parts produced a 505 cid FE entry that nailed down a brutal 752 horsepower on 91 octane. Look out world – the dinosaurs have returned!

I have spent some time with my engine work at *WebRodder.com* building some FE examples that I feel do a good job for street use. I detailed a stock 300 horse reproduction 390 engine, a hot rodded 390 that gave a more edgy sound and a boost in performance, and wrapped up with that stroked 390 that made over 450 hoses and 500 ft.lbs. on pump fuel and under 10:1 compression. It was made with a Scat crank, a set of Eagle rods, Ross pistons, and a small Crane roller hydraulic cam. Heads



Some vintage engines suffer from a lack of available or affordable main bearings. I've found that this has changed much in the last 5 years or so and a great many of those formerly unavailable sets are now back on the shelves. Egge has always been great for finding rare NOS bearings.



Rod bearings are available in all standard oversizes and in various material and construction styles. Egge offers them for all FE engines back to the first 1958 332.

were the Edelbrock aluminum parts straight off the shelf and the Blue Thunder intake was topped by a single 750 cfm Demon carb. It ran as good as it looked, could easily be used as a daily driver, and made a LOT more power than the original 427 side oiler.

The point is not to look at FE engines as a cookie cutter deal. Pay attention to the needs of your customer, be prepared to advise him to use a combination that is suited for his car and performance level, and know both the advantages and disadvantages of jumping to the next performance level. Also, make sure you can explain why running a 12:1 engine with a flying toilet and huge cam may not be in his best interests when installed in his '68 Mustang restoration.

Both original style quality timing sets like these from Egge and more expensive performance versions are available in the aftermarket. Here too, you will need to get clear what your customer needs and what he wants to spend so you can give the best results.

Ford FE Product Supplier Sources

Companies listed in alphabetical order. Additional resources are available at the Engine Builder Buyers Guide, online at **www.engine-builder.com**

BEST GASKET
Whittier, CA
888-333-2378
www.bestgasket.com

BHJ PRODUCTS
Newark, CA
510-797-6780
www.bhjinc.com

BLUE THUNDER AUTO
Palm Springs, CA
760-328-9259
www.bluethunderauto.com

CARROLL SHELBY ENTERPRISES
Gardena, CA
310-538-2914
www.carrollshelbyent.com

CLEVITE/DANA
Ann Arbor, MI
800-338-8786
www.engineparts.com

COMPETITION CAMS
Memphis, TN
800-238-0341
www.compcams.com

CRANE CAMS, INC.
Daytona Beach, FL
386-252-1151
www.cranecams.com

DEMON CARBURETION
Dahlonega, GA
706-864-8544
www.barrygrant.com

DIAMOND RACING PRODUCTS
Clinton TWP, MI
877-552-2112
www.diamondracing.com

DOVE PERFORMANCE
Columbia Station, OH
440-236-5139
www.doveengine.com

EAGLE SPECIALTY PRODUCTS
Southaven, MS
662-796-7373
www.eaglerod.com

EDELBROCK
Torrance, CA
800-739-3737
www.edelbrock.com

EGGE MACHINE CO.
Santa Fe Springs, CA
866-528-3443
www.egge.com

ERSON CAMS
Carson City, NV
775-882-1622
www.erson-cams.com

FEDERAL-MOGUL
Southfield, MI
248-354-7700
www.federal-mogul.com

GENESIS PERFORMANCE CASTINGS
Indianapolis, IN
317-357-8767
www.genesis427.com

JESEL INC.
Lakewood, NJ
732-901-1800
www.jesel.com

KING ENGINE BEARINGS
Cedar Grove, NJ
800-772-3670
www.kingbearings.com

MELLING ENGINE PARTS
Jackson, MI
517-787-8172
www.melling.com

MEZIERE ENTERPRISES
Escondido, CA
800-208-1755
www.meziere.com

MILODON INC.
Chatsworth, CA
818-407-1211
www.milodon.com

MOROSO PRODUCTS
Guilford, CT
203-453-6571
www.moroso.com

MSD
El Paso, TX
915-857-5200
www.msdignition.com

ROCKER ARM SPECIALIST
Anderson, CA
800-747-2767
www.rockerarms.com

ROSS RACING PISTONS
El Segundo, CA
310-536-0100
www.rosspistons.com

SCAT ENTERPRISES, INC.
Redondo Beach, CA
310-370-5501
www.scatcrankshafts.com

STEF'S FABRICATION
Lakewood, NJ
(732-367- 8700
www.stefs.com

T&D MACHINE PRODUCTS
Carson City, NV
775-884-2292
www.tdmach.com

TOTAL SEAL PISTON RINGS
Phoenix, AZ
800-874-2753
www.totalseal.com

TOTALLY STAINLESS
Gettysburg, PA
800-767-4781
www.totallystainless.com

A lot of people have unrealistic expectations and wildly inappropriate concepts about engine building that often need to be dispelled so both you and your customer get satisfaction in the real world. You will never go wrong – even if you miss connecting with a potential customer – if you take charge of the design and make clear that not everything the enthusiast magazines claim or buddies insist is true or within the realm of reason.

Niche engines are by nature something that are not cheap and quick, but take a bit more handling, a better understanding of engine building overall, and a commitment to fitting the customer to the right engine.

You'll build fewer engines but have the potential to make more profit using your experience and knowledge instead of wearing out your back competing for jobs with belly button engine builders where low parts markups and heavily-discounted labor costs mean fighting with everybody else over pennies. **EB**

An item often missed by both resto guys and performance guys is what you are going to bolt it all together with. Rusty, crusty hardware can make a good job fail or at least look unprofessional. Totally Stainless makes complete engine kits in stainless steel including high strength head bolts.

I recall a time when any obsolete or vintage gaskets were made somewhere in South America and in some cases you could still read the newsprint they were made from. Companies like Best Gasket have really stepped up to the plate and hit a homer with high quality reproduction and upgraded gaskets that you can use with real confidence.

Not everyone will opt for trick aftermarket pistons, so it's good to know that original ring sets are still available for all common oversizes from Egge. Make sure your customer knows that restoration engines are not the same as a race engine and different parts are used with success.

Aftermarket balancers like the BHJ unit in front here are a good choice for non-restoration engines. Here again, knowing the right unit is essential if you want to get your engine balanced. The two OEM units may look the same, but one will make your engine shudder.

About the Authors

Doc Frohmader got his first car at the age of nine and has been an engine builder and performance enthusiast ever since. He is currently editor of the online rodding resource Webrodder.com *and a frequent contributor to* Engine Builder *magazine.*

Barry Rabotnick has a strong and documented technical background in all facets of designing and building automotive performance engines and components and now operates Survival Motorsports.

More information is available at www.survivalmotorsports.com or barry@engine-builder.com.