

# REBUILDING THE 3.8L BUICK



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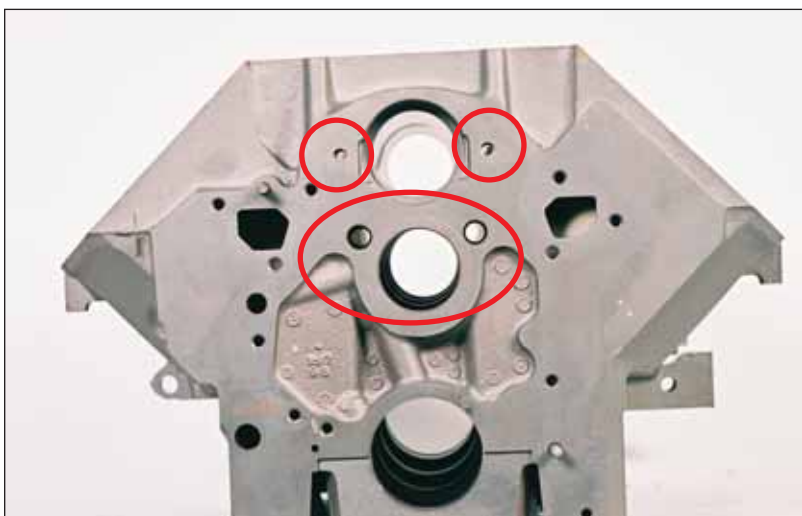
**T**he Buick 3.8L has evolved from its humble beginnings as a cheap, easy to build, economy motor in 1962 into one of the best pushrod motors in the world. It started in life as a Buick V8 that had two cylinders “missing,” because that allowed GM to machine it on the same line as their V8 with common tooling.

Unfortunately, that meant it had two cylinders missing in the firing order, too, so it was an odd-fire engine that sounded strange and ran rough. That may have been okay in the '60s, but it wasn't good enough in the '70s, so in 1977 Buick split the crank pins to make it into an even-fire motor that ran a lot smoother.

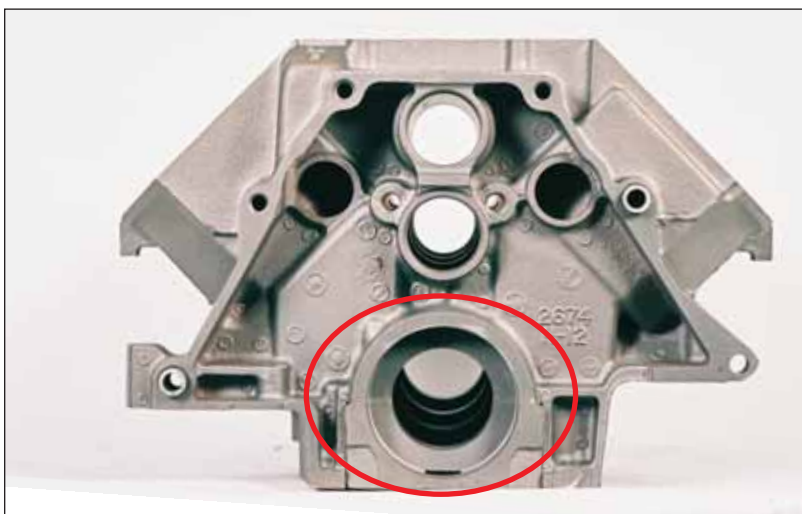
Unfortunately, it still had a nasty primary imbalance because it was a 90-degree block with a 120-degree firing order, so the 3800 would still need a balance shaft to make it suitable for the upscale FWD cars later on. The gerotor oil pump and roller lifters were added in '86, on-center bores were added in '88 along with the balance shaft, and a one-piece rear seal was introduced in '90.

The 3800 was completely updated in '95 when it became the Series II motor that was lower, lighter, smoother, and more powerful than any of the earlier versions. It's been installed in over 6 million cars since '95 and is still being used in some applications even today.

That's quite a tribute to any pushrod motor, let alone one that started in life as a rough-running, odd-fire V6 in the '60s. With that bit



*The '88-'90 VIN C block had two bolt holes for the balance shaft, but it didn't have any bolt holes by the cam bore because the cam didn't have a thrust plate.*



*The 3800 VIN L got a one-piece rear seal in '90, so the back of the block was modified.*

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of history in mind, let's trace the evolution of the 3.8L from 1988 to 2008 and see how it has changed through the years.

## Blocks

### • 1988-'90 VIN C

Buick introduced an updated version of the 231 that they called the "3800" in '88. It was used in all of the FWD cars except the LeSabre that still came with the old VIN 3 motor without a balance shaft. The

25531617/25522646 block castings had on-center bores and a balance shaft that was located in the valley above the cam.

### •1990-'92 VIN L

The 3.8L block was updated with a one-piece rear seal in '90. The Buick Regal was the only application for this engine in '90, but the new "EV-6" motor was used for all the FWD cars and vans including the Lumina APV, Pontiac Transport and Olds Silhouette from '91

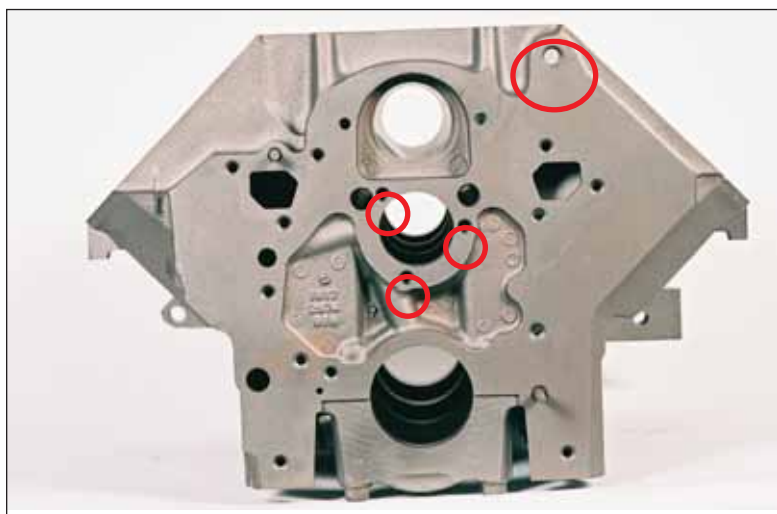
through '92. Look for a block with either a 25532674 or 25534243 casting number.

### •1993-'94 VIN L or VIN 1 (Supercharged)

The earlier "EV-6" block was revised in '93. It had an additional pad on the driver's side for the knock sensor and another bolt hole in the left front corner, just below the deck surface, for an accessory mount. It's either a 24502134 or a 24502441 casting.



The '88-'90 VIN C engines still had a two-piece rear seal.



The block that was used in '93 and '94 had an additional hole on the driver's side for an accessory mount. The '95 block looked the same, but it had two holes for the thrust plate instead of three.

### •1995 VIN L or VIN 1 (Supercharged)

The block that was used for both of these applications in '95 was unique. It had the same 24502441 casting number that was used in '94, but it was modified to share some common components with the new Series II (VIN K) motor that was introduced for most of the naturally-aspirated applications in '95. So, three of the bolt holes for the oil pan were relocated to fit the new VIN K pan gasket, the cam thrust plate was held on with two bolts instead of three, and there was an extra hole drilled in an ear that stuck out on the passenger side of the block. Mixing this block up with one of the earlier ones will cost you money, so verify the application by counting the bolt holes for the cam thrust plate. If it has two, it's a '95 block.

### •1995-'96 VIN K or VIN 1 (Supercharged)

The all new Series II 3800 was used for most of the naturally aspirated applications in '95 and for all the supercharged applications beginning in '96. It was a low-deck block that had cross-bolted mains and a sleeve bushing instead of a needle bearing for the balance shaft. The cam bores were bigger and there was a rear seal holder that covered up the oil and water passages in the back of the block, too. The end seals for the intake slipped over the rails on both ends, just like they did on the small block Chevys. The 24502287 casting was used for both the FWD and RWD applications.



The four cranks that have been used since '88 are shown from left to right: '84-'88 VIN 3 (CN 267), '88-'90 VIN C (CN 502), '90-'94 VIN L/1 (CN 737) and '95-'08 VIN L/K/1/2/4 (CN 2170). Note the differences in the counterweights and the rear seal surfaces.



### •1997-2008 VIN K/2 and 1/4 (Supercharged)

There was another new block casting in '97 that had one small difference: the end seals for the intake manifold were held in place with two pegs that fit into the blind holes that were located beside the end rails. It's a 24506029 casting that was used for all FWD and RWD applications.

## Crankshafts

•**1984-'88:** There were two cranks used in '88, one in the VIN 3 and another in the VIN C. The VIN 3 motor that was carried over for the LeSabres still had the original 267 casting that had been used in all of the FWD motors since '84, but the VIN C engines came with a different crank.

•**1988-'90:** The VIN C motor had a new crank casting that was designed for the new on-center block. It was a 25530502 casting that was used with a two-piece rear seal.

•**1990-'94:** The crank was revised in '90 when the block was redesigned to use a one-piece rear seal. Look for a 25534737 casting.

•**1995-'08:** The lightweight 2170 casting that was introduced in '95 in both the VIN L and VIN K engines has been used for all the FWD and RWD Series II/III applications including the VIN 1, the VIN 2 and the VIN 4 engines since then.



There's a lot of difference between the original FWD crank (left) and the lightweight version that was used in the Series II/III motors. The counterweights tell the story.



Buick has used several rods in the 3800. From left to right, there's the '88-'95 naturally aspirated with the dot, the '93-'95 supercharged with a star, a special rod for '95? that doesn't have a weight pad on top, the '96-'03 naturally aspirated rod and the '97-'03 supercharged version that's wider and shorter than the VIN K rod. There are also two powdered metal rods that were used in the Series III motors from '04-'08 that aren't shown.



The naturally aspirated motors used three different pistons since '88. The '88-'92 is on the left, the '93-'95 is in the middle and the '95-'08 VIN K/2 is on the right.



The piston for the Series II supercharged engine (right) is quite a bit different than the one that was used in the naturally aspirated engine.

## Connecting Rods

There have been several rods used in the 3.8L over the last 20 years.

### •1988-'90 VIN C and 1990-'92 VIN L

These engines came with the 918 cast rod. It weighed about 658 grams and had a .905" pin bore.

### •1993-'95 VIN L

The 742 casting with a dot on it showed up in '93 and was used through '94 or '95. It weighs from 690 to 720 grams, based on the sets we checked, and has a .905" pin bore.

### •1993-'95 VIN 1 (Supercharged)

There's a 742 casting that has a star instead of a dot on the shank that

appears to have been used for the supercharged engines.

### •1995 VIN L

We have seen some 359 castings that look just like the 742 rods except that the top weight pad is machined off so they weigh about 680 grams. We SUSPECT that they may have been used in the '95 VIN L motors that had the lightweight 2170 crank, but that's only a guess. We use them in sets in the '95 VIN L motors.

### •1995-'03 VIN K (Naturally Aspirated)

The rods in the Series II motors were quite a bit shorter because the deck was quite a bit lower. They measure 4.130" bore-to-bore compared to 4.750" for the earlier rods and they weigh about 630 grams.

They're all bushed and they have a 669 casting number.

### •1996-'03 VIN 1 (Supercharged)

The supercharged Series II engine that came out in '96 had a shorter rod that was considerably stronger and heavier. Our sample rod weighed 692 grams. It has a bushing and it measures 4.0" from bore-to-bore. We've seen them with either a "46" or an "868" casting number on them.

### •2004-'08 VIN K/2 (Naturally Aspirated)

When GM upgraded the 3800 to a Series III in 2004, they switched to powdered-metal, forged rods. We haven't seen any of them yet.

### •2004-'07 VIN 1/4 (Supercharged)

The Series III supercharged engine should have a short version of the powdered-metal rod, too. The supercharged engine wasn't available after 2007.

## Pistons

Buick has used five different pistons in the 3800 since '88. Here are the applications:

### •1988-'92 VIN C/L

These pistons had an 8.5:1 compression ratio and a 1.5 mm top ring. Our samples weighed about 530 grams.

**•1993-'95 VIN L**

There were several changes made to the pistons in '93. The compression height was increased by .060" and the dish was smaller, but deeper, so the compression ratio was increased by a half a point to 9.0:1. The top ring was 1.2 mm. Our sample weighed about 542 grams.

**•1993-'95 VIN 1 (Supercharged)**

The pistons used in the supercharged engine had a lower compression ratio and full-floating pins.

**•1995-'08 VIN K/2 (Naturally Aspirated)**

These pistons were an all new, light-weight design that had short skirts, narrow rings and full-floating pins.

**•1996-'07 VIN 1/4 (Supercharged)**

The pistons for the Series II/III supercharged motors are unique, too. The compression height is different because the supercharged rods are shorter, the lands are wider and the dish is smaller, but deeper (see pictures). There are significant differences between the various pistons, so none of them can be interchanged.



The 24502389 balance shaft on the top was used for all the FWD applications from '88-'95. The 334 that had two notches in each counterweight, (middle) was used in the regular Series II/III motors and the 336 that had four notches in each counterweight was used in the Series II/III supercharged motors. Notice the wear sleeve on the early one, too.



The cams that were used from '88 and up are noticeably different. The flanged version ('88-'90) on the left was replaced by the one with the threaded hole instead of a flange (middle) that was used from '91-'95. The Series II/III cam on the right ('95-'08) still had the threaded hole, but it had bigger journals (1.845" vs. 1.785").

## Cams

There have been three cams used in the 3800 since 1988.

**•1988-'90 VIN C**

These engines used a PN12338325 or a 12339315 that usually had "J17" cast on the barrel. It had a small flange (2.960") with three bolt holes and one dowel pin.

**•1991-'95 VIN C/L/1**

There were three part numbers used from '91 through '95 including 25536869, 24501458 and 24503401. We haven't seen a casting number on any of these cams, but they're easy to identify visually because they have a threaded hole in the snout instead of a flange and the cam journals measure 1.785". These cams were used for both the naturally aspirated and super-



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The head for the '88 VIN C had eight bolt holes plus two blind holes for the dowels that were used for the intake gasket. The upper left hole wasn't drilled when it was used on the '89-'91 VIN C.



The head used on the '90-'92 VIN L motors had seven bolt holes for the intake and a large vent hole in the intake surface.



The heads for the supercharged Series II/III engine have three holes above the intake ports for the injectors because there wasn't enough room for them in the intake manifold when the supercharger was installed.

charged engines and can be interchanged for any of these applications from '91 thru '95.

## •1995-'08 VIN K/2/1/4

The Series II/III engines all used the same cam. It's either a 24504026 or a 24505811 that looks like the earlier cam that had the threaded hole in the snout, but it has bigger (1.845") cam journals, so it's easy to tell them apart. They may have "1267" or "J278" etched on the back of the cam, but we've seen them without any identification, too.

## Cylinder Heads

There have been six different cylinder heads used on the 3800 since 1988, seven if you count the old style head on the VIN 3 carryover engine that was used in the '88 LeSabres, but some of the differences in the later heads were just minor changes to the same basic casting. Here's the chronology:

## •1988 VIN C

The heads were revised for use on the new on-center block. They looked like the ones that had been used on the FWD 3.0L engines and they came with bolt-down rockers that were located with steel guide plates. These castings had eight bolt holes plus two blind holes for dowel pins on the intake side. Look for a 25529723, a 25534250 or a 3485 casting.

## •1989-'91 VIN C

These heads were identical to the '88 castings except that the upper left bolt hole (facing the intake) wasn't drilled, but they have a different casting number; they're either 24500619 or 2136 castings. We see more of the earlier heads with the eight bolt holes, so we end up building most of these engines with the eight hole heads.

## •1990-'92 VIN L

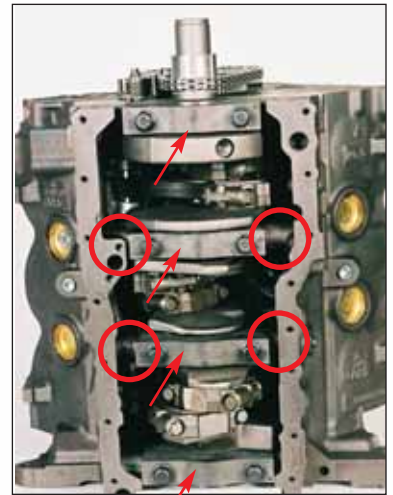
The VIN L engines came with the same 0619 or 2136 castings that had seven bolt holes for the intake, but they also had a vent hole drilled in the intake surface



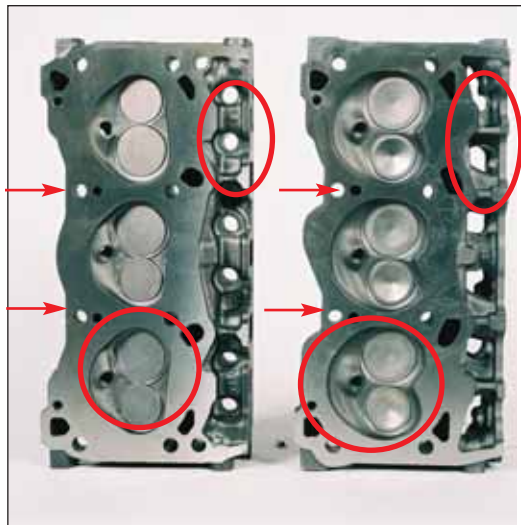
Buick added a bolt pad on the driver's side for the knock sensor in '93.



The '95 VIN L block was unique. It had powdered metal main caps and it used the '95 VIN K bolt pattern for the pan gasket, so three of the bolt holes (circled) were moved.



The rear seal holder on the Series II engine seals off the oil and water in the back of the block, too.



The Series II/III heads (right) have been "cut and trimmed" to reduce weight, and the chambers are heart-shaped.

at the left end of the head when facing the intake ports.

**•1993-'95 VIN L and VIN 1 (Supercharged)**

The 2136 castings were modified again in '93. They came with 5/16" bolt holes for the roller rockers that were located with aluminum guide plates.

**•1995-'08 VIN K/2 (Naturally Aspirated)**

The Series II engines got all new heads that had heart-shaped chambers, bigger intake ports and cast roller rockers. There were several castings including the 478/4781/8134 and 2261 that are all very similar, but the intake ports on the 2261 are slightly different, so

we always use them in pairs.

**•1996-'07 VIN 1/4 (Supercharged)**

The heads for the Series II/III supercharged motors are similar to the ones used on the regular engines, but they have three holes right above

back journal so it was compatible with the needle bearing.

**•1995-'08 VIN K/2 (Naturally Aspirated)**

These Series II/III motors had a different balance shaft. It's a 334 casting that has a total of four notches in the edges of the coun-

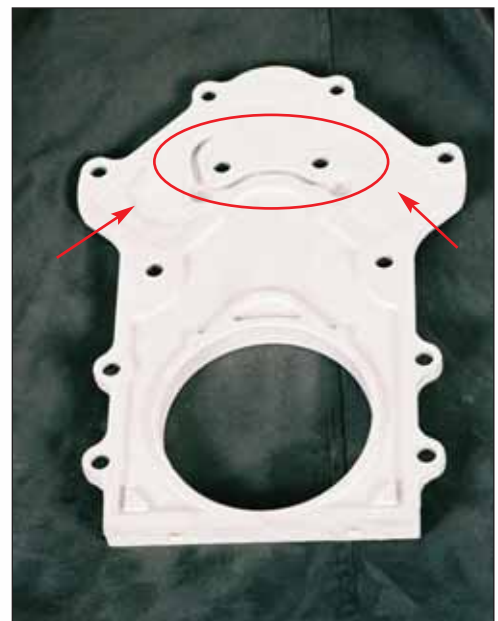
the intake ports for the injectors. Look for a 4781 casting.

## Balance Shafts

There have been three balance shafts used in the 3800. The early ones have a needle bearing in the block and the later ones use a sleeve bushing for the back journal.

**•1988-'95 VIN C/L/1**

The CN24502389 balance shaft was used for all of these applications from '88 through '95. It had a wear sleeve pressed on the

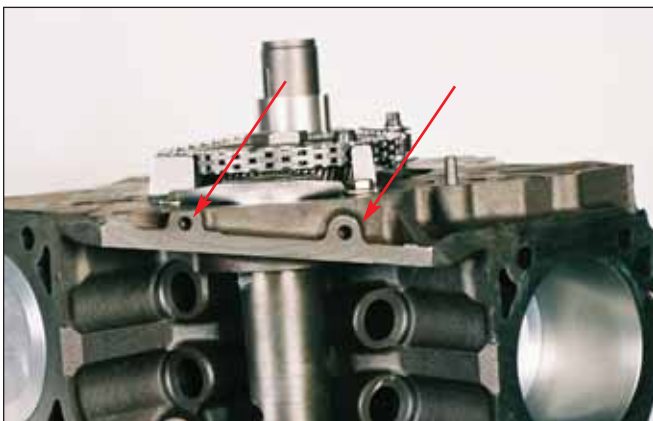


All the caps on the Series II/III blocks were powdered metal and the two middle ones were cross-bolted.

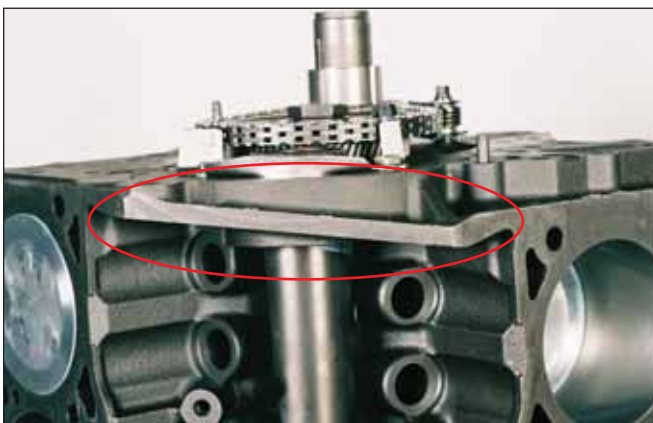




The only difference between the early and late Series II/III engines is the way the end seals for the intake are held in place. The early ones (left) slip over the rails while the late ones (right) are held in place with two pegs that fit into the blind holes on the outside of both end rails.



The end seals for the later engines are held in place with two pegs that fit into the blind holes on the outside of both end rails as shown above.



The end seals for the early series engines slip over the rails as shown above.

terweights. It weighs about 2190 grams with the bearing still on it. These balance shafts have a hole that goes all the way through the rear journal that bleeds off the excess oil pressure that can build up behind the back journal. This wasn't a problem with the needle bearings, but it was a problem when the sleeve bushing was used on these engines.

#### •1996-'07

#### VIN 1/(Supercharged)

The late supercharged motors have a special, heavy balance shaft that weighs about 2480 grams with the bearing included. It's a 336 casting that has a total of eight notches in the edges of the counterweights.

## Conclusion

So, that's the story of the "little engine that could." The 3.8L Buick may have come from humble roots, but it's considered to be one of the "most significant V6 pushrod engines ever designed." It's been selected as one of the "ten best engines in the world" by *Wards* three times and is the benchmark for others in the industry. GM has built over 25 million 3.8L Buicks and six million of them have been built since '95. That means there are a whole bunch of Series II and III motors that are in cars that will be worth fixing when the time comes, so we should all see our share of these engines in the years to come. **EBTG**



Doug Anderson is Manager of Technical Services for Grooms Engines, located in Nashville, TN. He has authored numerous technical articles on engine rebuilding for *Engine Builder* magazine for more

than 19 years. Anderson has also made many technical presentations on engine building at AERA and PERA conventions and seminars. To find Doug's other articles for *Engine Builder* magazine, visit our Web site at [www.enginebuildermag.com](http://www.enginebuildermag.com). You'll be able to search our archives by engine make and model.