

Rebuilding the  
**Chrysler  
Hemi**

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# Rebuilding the Chrysler Hemi

BY DOUG ANDERSON, CONTRIBUTING EDITOR | [danderson@enginebuildermag.com](mailto:danderson@enginebuildermag.com)

**C**hrysler made the Hemi engine famous. They didn't invent the hemispherical chamber, but they were the first to build an engine with a hemi chamber for an American car back in 1951. They originally called it the "Double Rocker Shaft V8," but it soon became "the Hemi." It made a lot more power than the rest of the car engines that were available at that time, so some people say Chrysler started the "horsepower wars" with the Hemi. What made it so good?

- It had better volumetric efficiency because it had good ports and bigger valves that opened away from the walls.

- It had a low "surface-to-volume ratio" which gave it better thermal efficiency so it made more power.

So, with the best chamber, plenty of cubes, generous ports and better airflow, it was a winner – except that it was heavy (a 392 cid Chrysler weighed 737 pounds), more complicated and more

expensive to build – so it eventually lost out to the big wedge motors like the 383, 400 and the 440 cid

Chrysler has built three different families of Hemi motors since 1951. There were 12 different engines in the first generation that ranged from a 241 cid Dodge to the 392 cid Chrysler and spanned almost ten years from 1951 through 1958.

The only engine in the second generation was the legendary 426 that was built from 1964 thru 1971. It was originally intended to be used for racing at NHRA and NASCAR tracks, but it ended up on the street because NASCAR told Chrysler that they had to sell at least 500 cars with the "street hemi" to make it legal for the Daytona 500 that year. It died in '71 because NASCAR had outlawed it on the track and the emissions police frowned on it for the street.

So, it shouldn't come as a surprise that back in the late '90s, when Chrysler real-

ized that they would need a new engine with more power and torque for their trucks, they decided to build the third generation Hemi for the 2003 Ram pickups. Since then, it's been used in their SUVs, Jeeps and RWD cars, too. There are purists who say it's not a real Hemi because it has squish areas on both sides of the chamber, but it's close enough for the rest of us. It has a hemi-shaped chamber with the valves canted toward the middle of the cylinder, four rocker shafts with good valvetrain geometry and generous ports. And, it incorporates some modern technology including aluminum heads, dual spark plugs, roller lifters and a "multi-displacement system" (MDS) that deactivates four cylinders under light loads. So, you can have 345 hp and still get 21 mpg on the road – at least that's what I got on my 4WD Hemi pickup on a 100-mile trip with the cruise set at 68 mph.

So, let's take a look at this new Hemi including both the 5.7L and the 6.1L,

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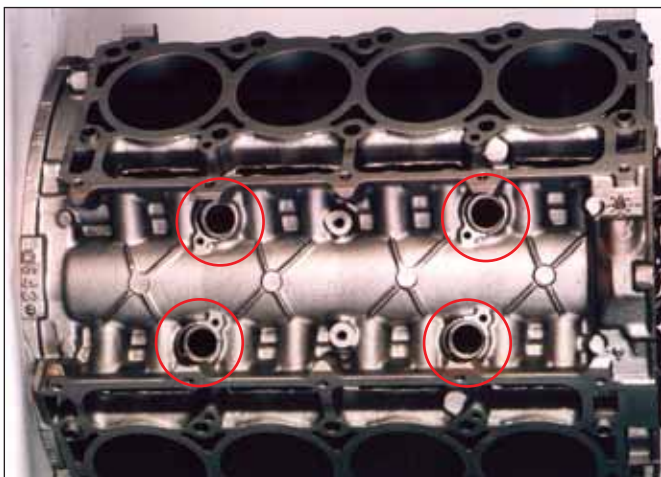
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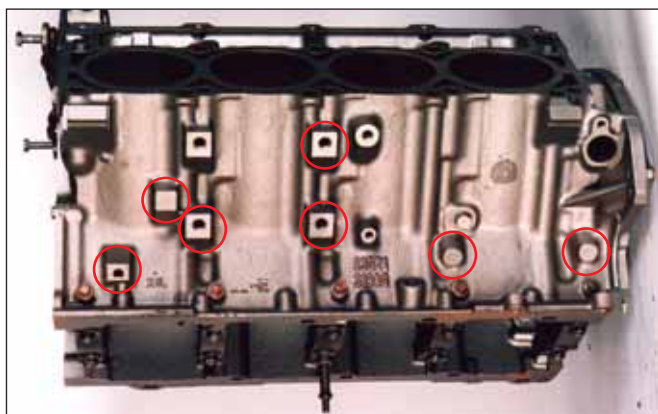


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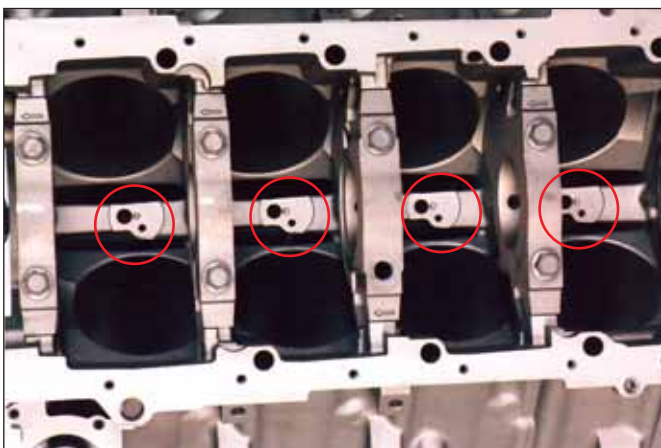
# Rebuilding the Chrysler Hemi



All of the Hemi blocks were designed for MDS so the four holes in the valley must be plugged if the engine doesn't have MDS.



All of the bolt bosses that are circled **MUST** be drilled so the engine will work for all applications including the 4x4 Durango.



The 6.1L block has four pads that are machined and drilled for the piston cooling jets that spray oil on the bottoms of the pistons.



All the 6.1 blocks are clearly marked on the side, starting with the blocks.

## BLOCKS

There are two different blocks in this family, one for the 5.7L and one for the 6.1L. Both are a deep-skirted design with powdered metal main caps that are crossbolted for strength. The deck surfaces have large openings for easy sand shakeout after casting. That's important because Chrysler designed the block without core plugs to eliminate the possibility of any



The pistons are cooled by oil that is sprayed on them with four of these jets.



All of the Hemi blocks have provisions for MDS. If it's not used, the holes are blocked off with the plastic plug on the left. If the engine has MDS, the solenoids (right) have to be installed in all four holes.

long term coolant leaks.

### 5.7L Block

The block for the 2003-'07 5.7L is a 53021319AC/AG/CB casting. All of these blocks have provisions for MDS and they all have 10 bolt bosses on the driver's side, but some of them may or may not be drilled and tapped, depending on the original application.

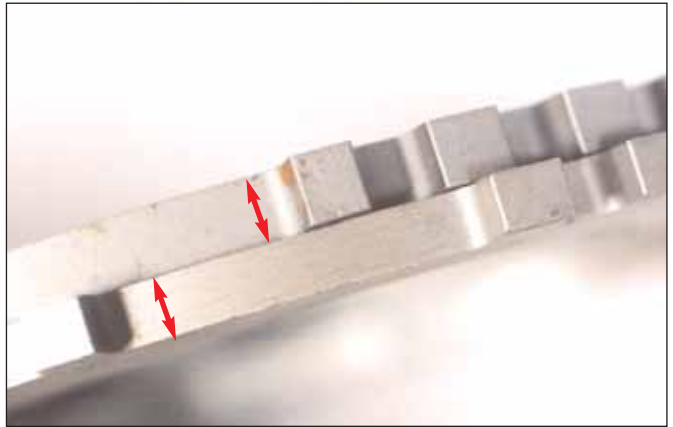
Rebuilders should drill and tap all 10 of them so that one block will fit in everything, including the 4x4 Durango that hangs the front differential off the engine.

### 6.1L Block

The block for the 6.1L is a 5037388AB casting that has "6.1L" cast on the side of the block. It's unique because it has a bigger bore and there's a large, rectangular oil gallery in the crankcase that's drilled and machined for the four "piston oil cooling jets." The 6.1L block can't be bored oversize according to Chrysler.

## CRANKS

There are two different cranks, too. They're internally balanced and they both have the same 3.58" stroke, but the one for the 6.1L is forged steel instead of cast iron like the one for the



The sensor wheel for the 6.1L (top) is noticeably thicker than the one for the 5.7L, too.



The crank sensor wheel for the 6.1L (left) has four holes instead of the three found on the crank for the 5.7L.



The crank sensor for the 5.7L (right) is considerably different than the one used on the 4.7L (left) and all the other Chrysler engines.

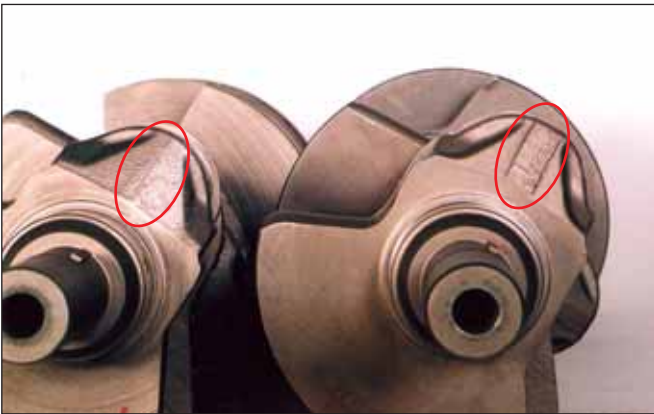
5.7L motor.

### 5.7L Crank

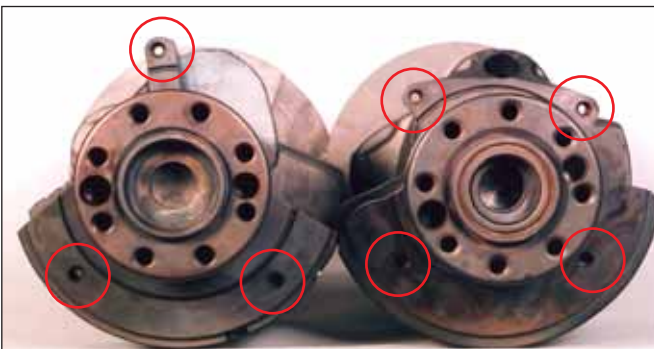
The '03-'07 crank is a 53021300AA casting. It has three bolt holes in a circular pattern for the crank sensor that's located behind the last counterweight.

### 6.1L Crank

There isn't a "casting number" on the forged crank for the 6.1L, but we did find "2MK" stamped on the one we had, so that may be how it's identified. It's easy to pick it out anyway, because it's a forging and it has a four bolts for the crank sen-



The 6.1L crank (right) is a forging instead of the casting that was used in the 5.7L motors (left). You can see the difference between the casting line and the forging mark on the front rod pins.



The flange for the crank sensor on the 6.1L has four bolt holes instead of the three that were used on the 5.7L crank.

# Rebuilding the Chrysler Hemi



The Hemi rods are all powdered metal with cracked caps, but the ones for the 6.1L (right) are considerably stronger and they're bushed on the small end.

sor instead of the three that are found on the 5.7L crank.

## RODS

The 5.7L and 6.1L each have their own rods, too. They're both forged, powdered metal with cracked caps that are held on with cap screws. They don't have "casting numbers" on them, but they're easy to tell apart once you've seen them side by side. Chrysler says that the rod



The caps for the 6.1L (right) are reinforced so they can handle the 425 hp SRT applications.

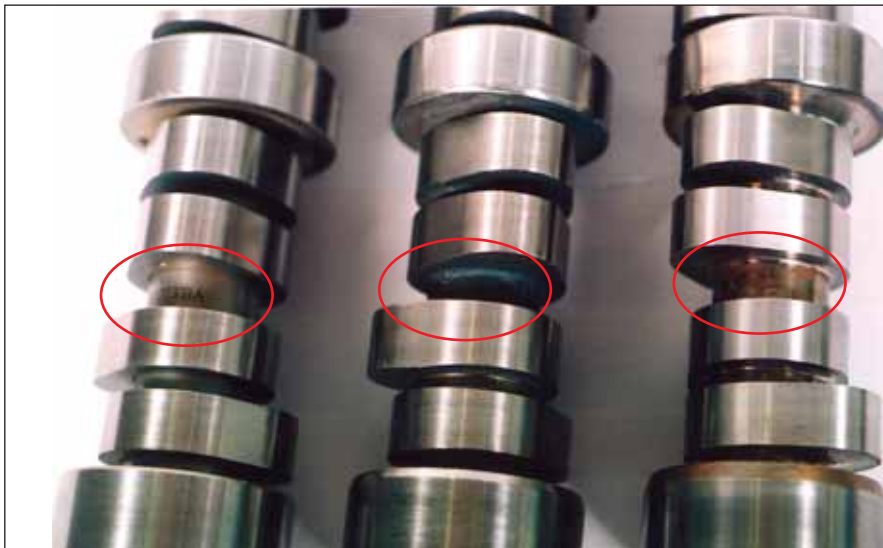
bolts aren't reusable.

## 5.7L Rod

The 5.7L rod is press fit with the hole in the small end measuring 0.945". It weighs 597 grams +/-5 grams.

## 6.1L Rod

The 6.1L is stronger in every way with thicker beams and more material on both ends. It has a full-floating pin and it measures 0.985" on the small end



The 5.7L cams may be hollow (left), cast iron (middle) or billet steel (right). All the cams for the 6.1L motors are billets. You can tell the difference by looking at the barrel on each one.

with the bushing installed. It weighs 653 grams +/-5 grams.

## PISTONS

Mahle makes the OEM piston for the 5.7L. It's a very contemporary, light-weight design (413 grams) with short skirts that are coated with Grafal® to reduce friction and noise.

The rings are narrow (1.5mm/1.5/1.5mm/3.0mm) and the ring pack is located very close to the top of the piston. Moving the top land up within 3.0mm of the crown reduced crevice volume and emissions, but the top ring groove had to be hard anodized in order to stand up to the heat and pressure that would cause microwelding and ring groove poundout otherwise.

We haven't seen the piston for the 6.1L, but we would expect it to be similar in design, except that it has a bigger bore and a full-floating pin.

Aftermarket pistons are available as well.



The lightweight, OEM Mahle piston has narrow rings, Grafal®-coated skirts and a hard anodized top ring groove.

## CAMS

All the cams for these motors are big and heavy, because the valve action is pretty aggressive and Chrysler didn't want to allow any cam deflection.

The original cams were a hollow assembled design, but we've also seen both cast iron and billet versions for the 5.7L. The cams for the 6.1L are all billets. These cams can be identified by the

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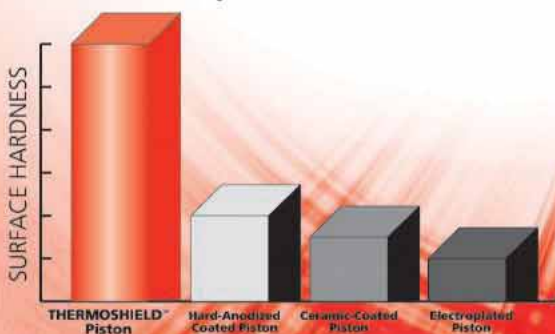


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# Rebuilding the Chrysler Hemi

full part number that's on the barrel or the last three digits of the part number that are located on the back of the cam. In mid '04, Chrysler also added an ID ring to the cam with grooves machined on the barrel in front of the #5 journal. Unfortunately, we don't know how to decipher all the codes yet, but we're working on it.

## 5.7L Cam

There have been several cams used in the 5.7L, depending on the year and whether or not the engine has MDS.

The cam for the engines without MDS went from a 53021730AB to 'AC to 'BA and has been superseded to the 53022064AA.

The MDS cam went from a 53021731AB to 'AD to 'AE before it was superseded to a 53022065AA that's now a 53022065AB. The cams with and without MDS aren't interchangeable because there are different profiles on the lobes for the cylinders with MDS according to our cam supplier. The specs call for 253 degrees of intake duration and 253.7 degrees of exhaust duration at .006" with 34 degrees of overlap. Lift at the valve is 0.472" for the intake and 0.460" for the exhaust.

## 6.1L Cam

All of the 6.1L engines came without MDS so there is only one cam used for them. It has some serious lift, about 0.050" more than the 5.7L, so the lobes are almost as tall as the journals. Chrysler says it has 283 degrees of duration on the intake and 286 degrees on the exhaust at .006" and 50 degrees overlap, so it's pretty aggressive compared to the 5.7L cam.

## LIFTERS AND YOKES

Chrysler uses two different lifters for the Hemi motors, one for the cylinders without MDS and one for the cylinders that have MDS. They're easy to tell apart because the flat sides near the top of the regular lifters are 0.040" narrower (0.7265" compared to 0.7665") than they are on the MDS lifters. And, the MDS lifters have a hole on the side of the body for the pin that disables the lifter for the MDS mode.



The MDS lifter (right) is unique. It's bigger on top (.7665" vs. .7265" across the flats) and has an extra oil hole in the body.

The lifters are held in place by four plastic yokes that have four lifters in each one. There are three different versions, one for the engines without MDS and two different ones for the engines with MDS. Each MDS engine has two of them that say "MDS Front" and two that say "MDS Rear." They both have two big holes for the MDS lifters and two smaller holes for the regular lifters so you can't install them in the wrong place when assembling an engine with MDS.

## MDS PLUGS AND SOLENOIDS

The Hemi block was originally designed for MDS, so the four holes in the valley must have either the MDS



The roller lifters are located with four plastic yokes. There are three different yokes, one for engines without MDS, one for "MDS front" and one for "MDS rear" They are easily identified by the markings found on them.

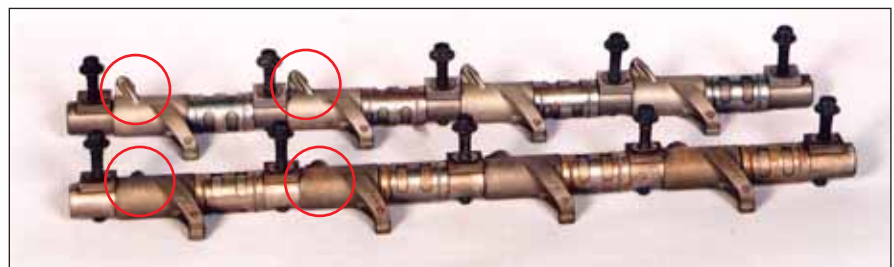
solenoids (p/n 53032152AC) or the plastic plugs (p/n 53032221AA) that block off the MDS oil passages.

## PUSHRODS

The short ones are for the intakes and the long ones are for the exhausts. Both of the pushrods for the 5.7L are approximately 4.0 mm longer than the ones for the 6.1L because of the difference in the lift at the lobe.

## ROCKER ARMS

The Hemi has four rocker arm shafts per engine, two intakes and two exhausts. The intakes have an "I" cast on the rocker arm so they're easy to identify, but you can also tell them apart by noting the location of the pushrod sock-



The intake and exhaust rocker arms are different. Note the difference in the location of the pushrod sockets.



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# Rebuilding the Chrysler Hemi

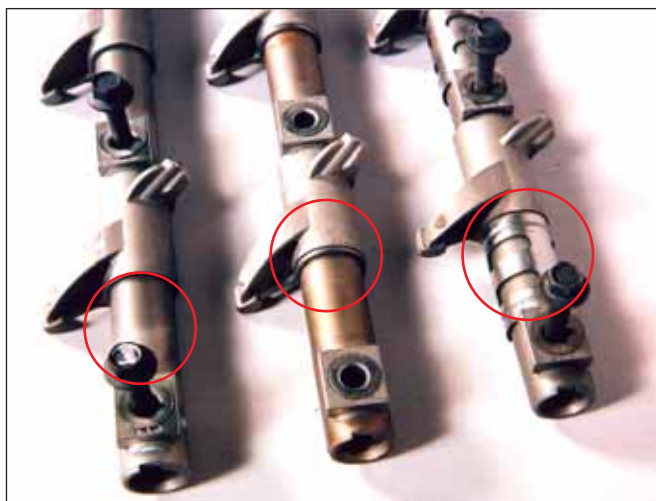
et. The shafts are fully assembled with the rockers along with the bolts and spacers. Just a word of caution: If you break off



The exhaust rockers aren't marked but the intakes have a raised "I" on them.

one of the tabs that hold the bolt and spacer in place during assembly, it could (will!) end up inside the engine.

When we started building these engines, we noticed that there were three different configurations of the rocker shaft assemblies, so we tracked down a Chrysler engineer and found out why. The original design had metal spacers between the rockers to hold them in place during assembly. In early '05,



The original rocker arms (right) had spacers between them and the later ones (middle) used "C" clips to hold them in place during assembly. The current ones don't need anything to hold them in place because Chrysler changed its build procedures.

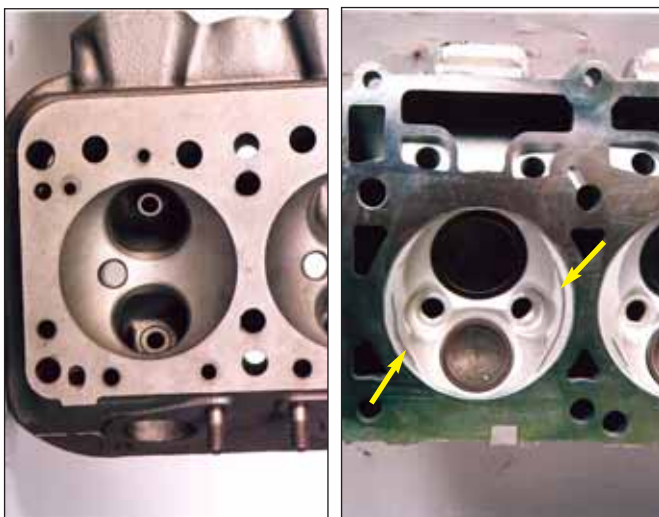
they started using "C" clips to locate the rockers for assembly. Then in February '07, they changed their assembly process so they didn't need the "C" clip anymore. Don't be surprised when you see three different versions and don't worry about which one you use when building an engine, but make sure you use them in matching sets so the installer doesn't start asking questions when he sees two or three different versions on the same engine.

## CYLINDER HEADS

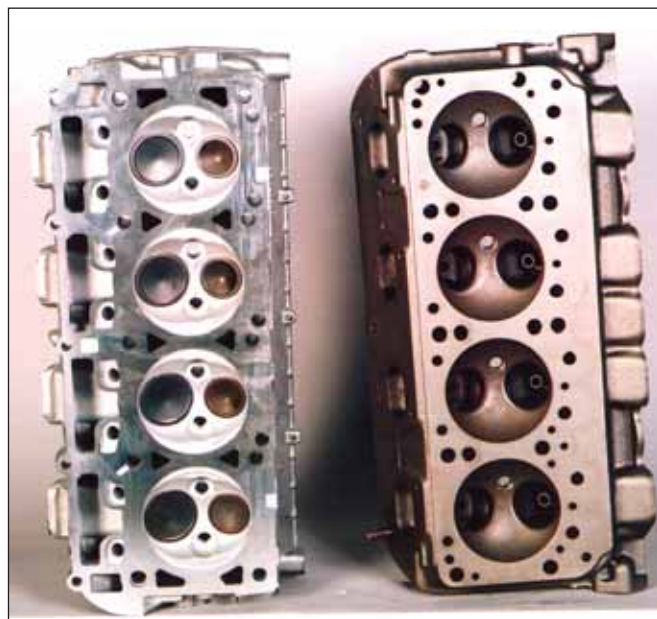
The cylinder heads can be a bit more confusing because Chrysler used the same casting on both sides, but machined it so it only fits on one side. Some heads are drilled for EGR and some aren't, and others have three holes on one end that may or may not be drilled. Here's what we know:

### 5.7L Heads

The front of the head used on the passenger side of the '03 engines (c/n 53021616AJ/BA) had a flat pad with two bolt



Purists say the new Hemi (right) isn't a REAL hemi, because it has squish areas on both sides of the chamber, unlike the chamber for the original Hemi (left).



Here's a "new 345 Hemi" head beside an "old 352 Hemi" head. The new one is lighter because it's aluminum and it's smaller, too.

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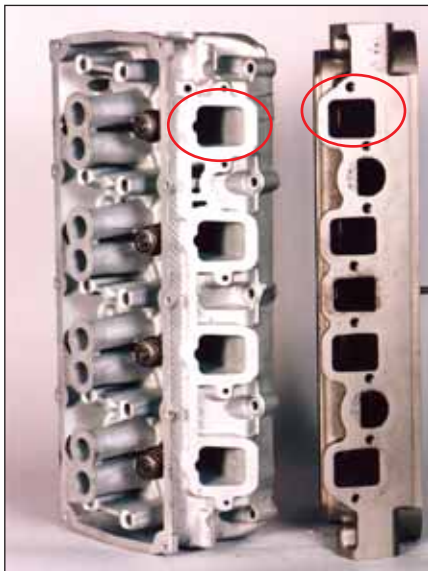


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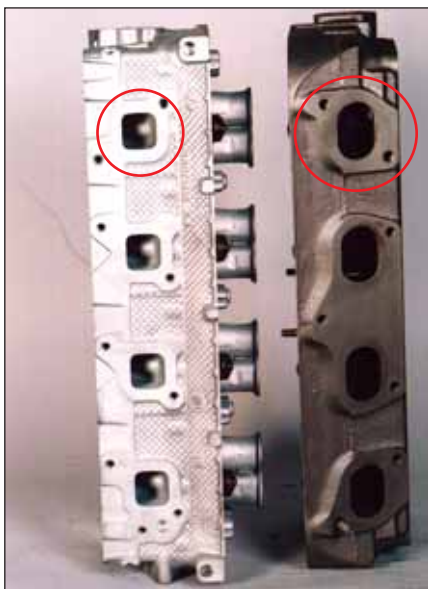
# Rebuilding the Chrysler Hemi

holes, but the EGR hole wasn't drilled. All of the '04s (and maybe a few late '03s) had the holes drilled for the EGR valve.

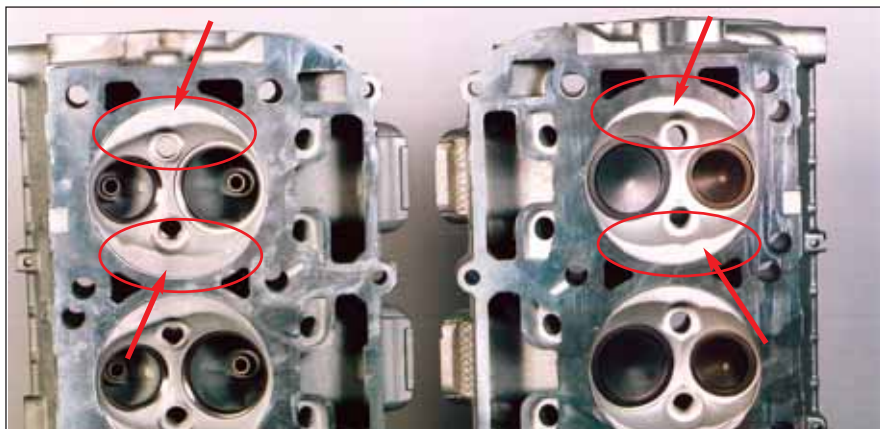
The left head (c/n 53021616AJ/BA) has a triangular pad with provisions for three bolt holes around the core plug on the front of the head. These three holes aren't always drilled, but they should be



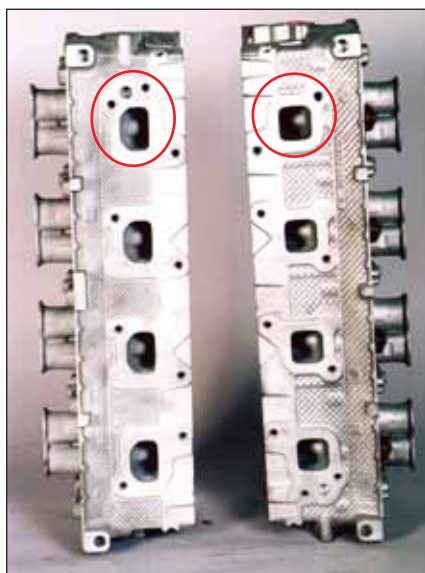
The intake ports on the "old Hemi" (right) are pretty impressive even when they're compared to the ones on the "new Hemi" (left). It's no wonder the old Hemi motors ran so well.



Check out the exhaust ports on the new (left) and the old (right) Hemi heads.



The heads for the 6.1 have bigger valves and more quench on both sides of the chamber.

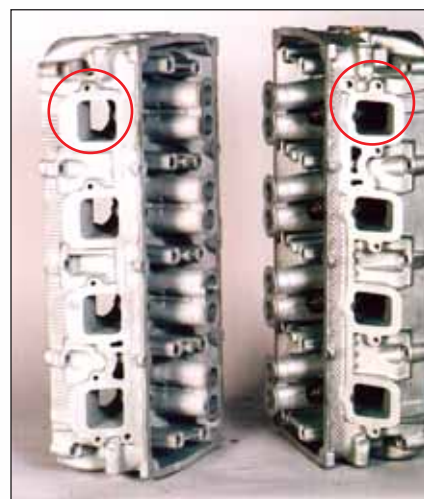


The exhaust ports for the 6.1L (left) are "D"-shaped instead of square like the ones for the 5.7L (right).

because they are needed for some applications. The bolt holes for the middle two exhaust ports are angled from the back to the front with the top bolt hole at the back of the port on the driver's side and at the front of the port on the passenger side.

## 6.1L Heads

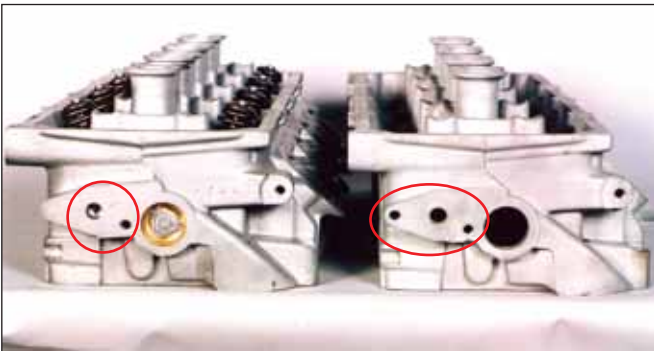
The 6.1L engine has its own unique heads that both have the same 5037369AA casting number. They have bigger intake ports without the eyebrows for the injectors, "D" shaped exhaust ports, and bigger valves



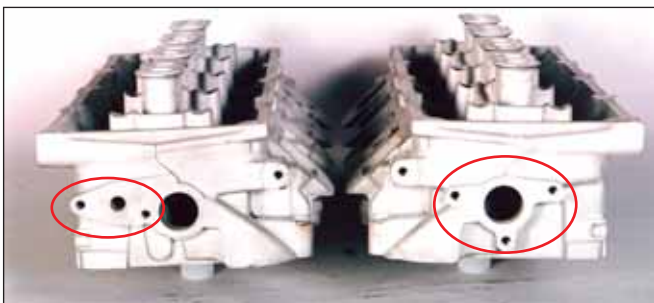
The intake ports for the 6.1L (left) are much bigger than the ones for the 5.7L and they don't have the "eyebrows" for the injectors.

(2.08"/1.60" vs 2.0"/1.55") that are lighter, too. Both the intake and exhaust valves are hollow, and the exhaust valves are sodium-filled for better heat transfer. The valve springs for the intake and exhaust are not interchangeable because the intakes have a higher installed height and they're both matched to the specific weights of the intake and exhaust valves. These springs are unique to the 6.1L, so they can't be used on the 5.7L motors. The revised chamber has wider quench area so it's slightly smaller, too.

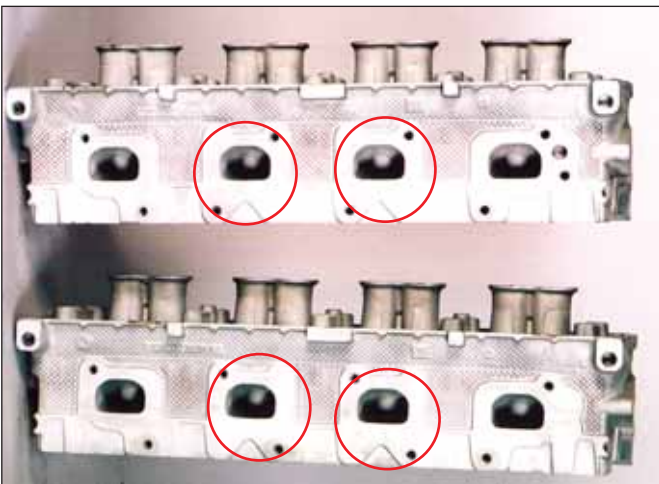
The head on the passenger side is always drilled for EGR and the one on the left should always be drilled for the accessory mount.



All of the '04 Hemi motors (and possibly even a few of the '03s) had two bolt holes and an open passage on the front of the right head for EGR (right).



Some applications use the three holes on the driver's side head (right) for an accessory mount so it's best to drill them on every head. Some rebuilders drill all the heads on the passenger side for EGR (left) and send a block-off plate with the engine for the '03 pickups.



The bolt holes for the exhaust manifold are reversed on the middle two cylinders, depending on which side the head is on. The head on the top is for the passenger side and the one on the bottom fits on the drivers' side.

So, that's the story on the major components, but there are a few other things you should know about these engines:

## OIL PUMPS AND OILING

The 6.1L has a different oil pump that provides the extra oil needed for the piston cooling jets. It's a p/n 5037687AA instead of the p/n 53021622AF that's used on the 5.7L engine.

The lifters are oiled through the pushrods. Oil goes from the pump to the cam bearings and then up through the heads to the rocker shafts before it goes through the rockers and down the pushrods to the lifters. This accomplishes two things: 1) the oil passages in the valley can be used to deactivate the MDS lifters, and 2) the pushrods provide a reservoir of oil to help prevent "morning sickness" (i.e., noisy lifters at start up).

Chrysler calls for a minimum oil pressure of 4 psi at idle. That's not much, but the service manager at a local Chrysler dealer told me that they have had Hemi motors turn on the check engine light when the customer used anything other than the 5W20 oil that's specified for these engines.

## PISTON OIL COOLER JETS

The 6.1L has four of the piston oil cooling jets. They're available under p/n 5037524AB. They should be replaced if they're plugged or damaged in any way.

## CRANK SENSORS

The 5.7L and 6.1L engines have their own unique crank sensors. The one for the 6.1L is thicker (.295" vs. .250") and is held on with four bolts instead of the three found on the 5.7L. The bad news is that none of the crank sensors are available separately; you have to buy a crank to get a sensor because Chrysler balances the crank with the sensor on it and they believe that the balance will be adversely affected if the crank sensor is changed.

## HEAD GASKETS

The head gaskets for the 5.7L can be physically installed either side, but they will leak if they're on the wrong side, so they're marked with a "R" or "L."

The head gaskets for the 6.1L are interchangeable, but they must be installed with "UP" facing up in order to avoid coolant problems.

## EGR BLOCK-OFF PLATE

Most rebuilders are drilling all the heads for EGR and sending a block-off plate (p/n 6034826) with the engine for the '03 trucks that didn't have EGR.

## MULTI-DISPLACEMENT SYSTEM (MDS)

MDS deactivates four cylinders simultaneously when the vehicle is cruising down the road under light load. The Hemi has

## 345 HEMI – MDS & EGR Applications

Year	Trucks	VIN code	w/o MDS	with MDS	w/o EGR	with EGR
03	Ram 1500/2500/3500	D	X		X	
04	Ram 1500/2500/3500	D	X			X
05	Ram 1500/2500/3500	D	X			X
06	Ram 1500 (EX HD)	2		X		X
06	Ram 1500 HD/2500/3500	D	X			X
07	Ram 1500 HD/2500/3500	D	X			X
07	Ram 1500 (EX HD)	2		X		X
04	Durango	D	X			X
05	Durango	D	X			X
06	Durango	2		X		X
07	Durango	2		X		X
05	Jeep Grand Cherokee	2		X		X
06	Jeep Grand Cherokee	2		X		X
07	Jeep Grand Cherokee	2		X		X
06	Jeep Commander	2		X		X
07	Jeep Commander	2		X		X
07	Chrysler Aspen	2		X		X
Year	Cars	VIN code	w/o MDS	with MDS	w/o EGR	with EGR
05	Chrysler 300/Charger/Magnum	H/2		X		X
06	Chrysler 300/Charger/Magnum	H/2		X		X
07	Chrysler 300/Charger/Magnum	H/2		X		X

- (1) There may be a few late '03 Ram pickups with EGR, so ask the customer before shipping the motor.  
 (2) We believe that all the '07 applications carry over to '08, too, but we haven't researched it completely at this time.

a separate oil gallery in the valley with four solenoids that apply pressure to the pins in the sides of the eight MDS lifters on cylinders 1, 4, 6 and 7 to disable them.

When they are disabled, the lifter body continues to go up and down, but the plunger inside the lifter remains stationary, so the valves stay closed. The exhaust gases that are trapped in each cylinder are compressed on the compression and exhaust strokes so they help push the pistons back down on the intake and power strokes. The injectors are shut off so there's no problem with fuel wash down. The computer can activate and deactivate the solenoids in 40 milliseconds so the transition is seamless.

Chrysler says MDS reduces emissions and improves fuel economy by 6 percent overall, depending on driving habits, but it definitely makes a big difference in mileage between 40 and 70 mph under light load. It's worth noting that MDS isn't available with a manual transmission because they need the torque converter to "cushion" the transition and make it "seamless." It's interesting technology – and it works well on the Hemi.

### 6.1L SRT

The 6.1L engine is used in all of Chrysler's "SRT8" vehicles including the Chrysler 300, Dodge Charger, Dodge Magnum, Dodge Challenger and Jeep Grand Cherokee. It's a serious engine with 425 hp and 420 ft.lbs. of torque. It has a bigger bore (4.055"), a higher compression ratio (10.3:1), a cam with more lift (+@ .050") and more duration (+30 degrees), bigger ports, bigger valves, a forged crank, stronger rods, a high volume oil pump, piston cooling jets, and a different timing set along with several other subtle upgrades and changes.

### CRATE MOTORS

The 5.7L/345 cid and 6.4L/392 cid Hemis are both available as crate motors with either the factory fuel injection or a carburetor. And, there are several companies in the aftermarket that are supporting these engines with additional performance parts and electronics, so more and more of them are showing up in street rods and older cars.



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## Chrysler HEMI Casting Numbers

	<b>5.7L 03-07</b>	<b>6.1L 06-07</b>
<b>Blocks</b>	53021319AC/AG/CB	5037388AB
<b>Cranks</b>	53021300AA Cast	2MK/1709458AA? Forged
<b>Rods</b>	Press fit (597 grams)	Bushed (653 grams)
<b>Heads</b>		
<i>Drivers' side<sup>(1)</sup></i>	53021616AJ/BA	5037369AA
<i>Passenger side<sup>(2)</sup></i>	53021616AJ/BA (w/EGR in '04)	5037369AA (w/EGR)

(1) The bolt holes on the two center exhaust ports angle from the back to the front when looking at the upper hole.

(2) The bolt holes on the two center exhaust ports angle from the front to the back when looking at the upper hole.

### BORE AND STROKE

The bore and stroke varies, depending on which engine you have:

- 5.7L: 3.92" bore x 3.58" stroke
- 6.1L: 4.055" bore x 3.58" stroke
- 6.7L: 4.055" bore x 3.795" stroke

### THE 2008 AND 2009 HEMI

We haven't researched the '08 Hemi thoroughly, but we believe it's the same as the '07, especially since there were extensive changes made to it in '09. The '09 Hemi has an active dual-stage intake man-

ifold and variable cam timing, so it's got 390 hp and 407 ft.lbs. of torque now. That's not bad for a pickup truck motor that's rated at 20 mpg on the highway, thanks to MDS.

### The 345 vs The 354

It's interesting to make some comparisons between the new 5.7L and the original 354 cid Hemi motor.

- The new 5.7L weighs 533 pounds, 164 pounds less than the old 354 cid that tipped the scales at 697 pounds. Most of the difference is found in the two aluminum heads that weigh 100 pounds less, but Chrysler took some weight out of the

block and the rest of the engine, too. By the way, at 533 pounds, it weighs about the same as a small block Chevy!

- The intake and exhaust ports on the 354 cid are impressive. Take a look at the pictures and captions. It's no wonder it ran so good.

- The valves on the 354" were 1.94"/1.75" compared to 2.0"/1.53" on the 5.7L.

- The 1955 Chrysler 300 was named that because the 331 cid Hemi was the first domestic car engine to make 300 horsepower. Now, the 5.7L makes 390 hp in a pickup truck – and that's with the current SAE ratings that are considerably less favorable than they were in 1955, and it's dealing with some stiff emission standards. How the times have changed.

So that's the story of the "new HEMI." It's a well-designed, durable package that makes some serious horsepower and torque, and does it with reasonable fuel economy while meeting current emissions standards. It doesn't have any weak points, but there are over 2 million of them out there already, and they're starting to filter in the door, so we can all expect to do more and more of them as the population grows and the engines get some miles on them. **EB**

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