

# Metric Mechanic M42 M44 Engine Series

One of Metric Mechanic's NEW Engine Series

## Introduction

Often the 4 Cylinder BMWs are overshadowed by their 6 Cylinder cousins of the same model. For example, the 1990 318is can get over-looked in favor of the 325i or M3. The same goes for the 318ti and 1.9 liter Z3. But at Metric Mechanic, we look at the 4 Cylinders as junior models of the M cars. The E30 318i uses lighter scaled down drive train components than the E30 M3. The E36 318ti & Z3 continue this theme through smaller more compact bodies. All the 4 cylinder car models have lightweight bodies with light-weight engines, transmissions and differentials. Weight is not only the enemy of acceleration but also handling and braking. The M42 and M44 DOHC (double overhead cam) engines used in these models have excellent power potential. Currently, our 2100 Rally Engine is good for just over 200 HP and can rip through the 1/4 miles in 14.5 sec. at 98 mph in an E30 318is. FAST for a 4 banger!

The power note (the sound the engine makes when it approaches peak cylinder filling) comes on at 4300 rpms and the engine generates very strong pull to its 7700 rpm redline. Even below 4300 the

### Anatomy of our M42 Engine

Metric Mechanic 2000 Sport Engines use our lightweight forged alusil pistons along with the stock connecting rod and 81mm stock crankshaft. Metric Mechanic Rally Engines are designed and built to be the fastest street engines that we sell. They are basically full race engines de-tuned by dropping the compression and camming slightly.

The internals are beefed up by again using light-weight but strong forged alusil pistons as well as forged 4340 Chrome Moly custom rods of "H" or "I" Beam design, and 88mm forged steel crankshafts. These components greatly extend the life of the engine and make it virtually bullet proof.



engine has a decent amount of torque which makes it a great daily driver capable of 30 mpg in highway use. Now for a closer look at the new MM "Baby M3 Killer Engine".



*2100 Rally engine on the hook ready for installation*

# 2100 Rally Acceleration Graph

1991 E30 318is with Metric Mechanic 2100 Rally M-42 Engine

*"Baby M3 Killer!" Weight is the enemy of acceleration, braking and handling. The M42 engine is already light - but we make it POWERFUL! The Metric Mechanic gang couldn't stop talking about this car! Our comments were: "More power than the factory ever intended!" "How many cars can do almost 100 mph in a 1/4 mile and 30 mpg in highway driving?" "The Lotus of BMWs, a powerful engine coupled to a lightweight body and drive train."*

## Main Run - 1991 E30 318is with Metric Mechanic 2100 Rally / M-42 Engine

5: 05/20/06 14.506-98.61

### Acceleration

### Passing

Race Date: May 20 2006 8:35:15 PM  
Vehicle Name: Sam322IS  
Vehicle Weight: 2685 lbs.  
Engine Redline: 7700 RPM  
Fixed Shiftpoint: 7600 RPM  
Rollout: 12 in, 0.39 sec

Reaction	----
60 ft.	2.170s
330 ft	6.142s
1/8 mi	9.399s @ 76.59mph
1000 ft	12.187s
1/4 mi	14.506s @ 98.61mph
0-60	6.459s

0-30	2.331s
0-40	3.922s
0-50	5.035s
0-60	6.459s
0-70	8.198s
0-80	10.490s
0-90	12.719s
0-100	15.258s
0-110	18.271s
0-120	22.210s
0-130	----

30-50	2.705s	----	----	----
40-60	2.537s	----	----	----
50-70	3.163s	----	----	----
60-80	4.031s	----	----	----

### MM 2100 Rally/M-42 Engine

205 HP @ 7250RPM  
165 Ft.Lbs @ 5000RPM  
Redline @ 7700RPM

### HP and TQ vs RPM

### HP vs time

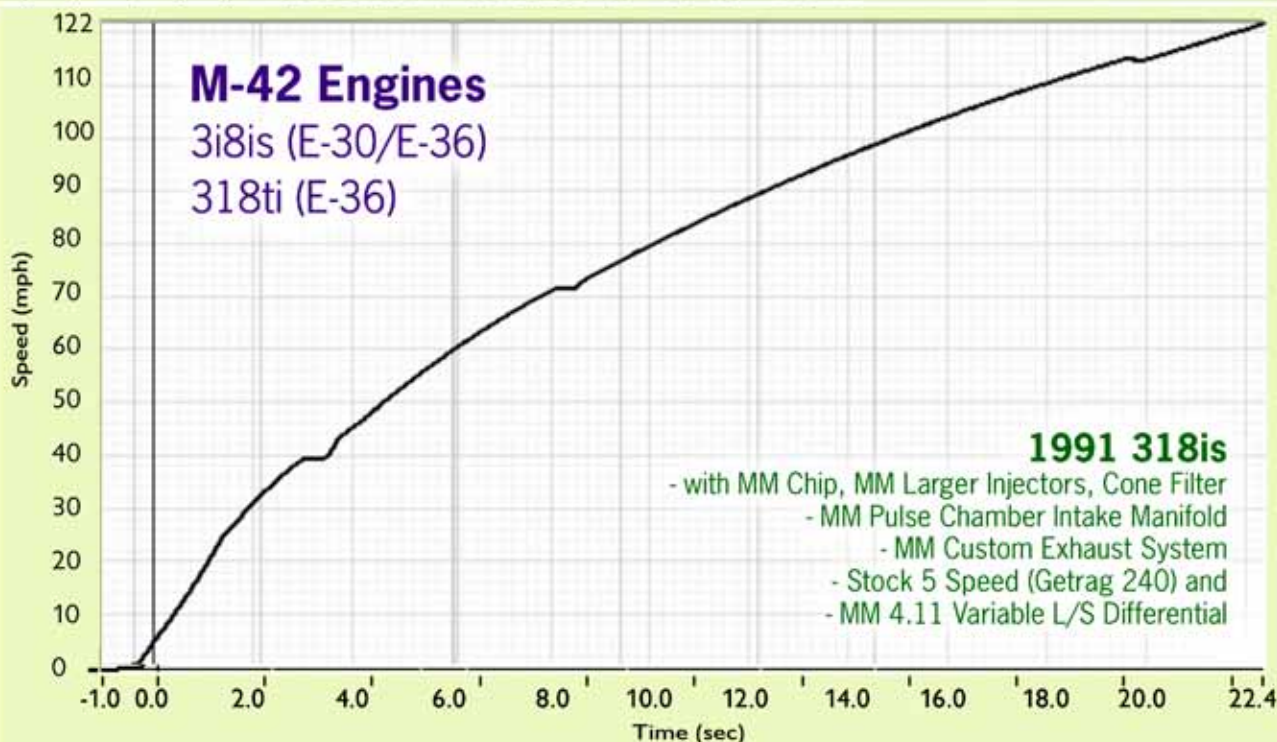
### RPMs

### Speed

### Gs

### Distance

### Braking





# Anatomy of the M42/M44 2000 Sport Engine

Lightweight yet High Quality Strong Internals



## Description

Top: the 2000 Sport bottom end components include either the M42 81mm forged steel crankshaft or the M44 83mm cast crankshaft.

Shown right: M42 rods at 610 grams, optional M44 rods at 540 grams on the right. Both are 140mm long.

Left Center: our MM slitted lightweight forged alusil pistons at 310 grams and tapered wall wrist pins at 89 grams. The ring pack uses a 1.5mm Moly compression ring, a 1.5mm iron scrapper ring and a 3mm three piece oil ring.

*MM M42/M44 2000 Sport Bottom End Components (see below for M44 crankshaft)*



*Left: M44 2000 Sport Engine crankshaft  
Right: M42 2000 Sport Engine crankshaft*



*M44 2000 Sport  
Piston Rod Assembly*

## Piston and Rod

By lightening up the reciprocating mass, an engine's longevity can be greatly increased. In a Sport Engine, this is done by reducing the piston and pin weight by 15% over stock which in turn increases rod life because it is not bearing so much weight. Also it reduces the load on the rod bearings and crankshaft. With the M44 1.9 liter rod and MM Sport piston shown to the left, the reciprocating mass is only 965 grams. But with a stock M42, 1.8 liter rod, the

## M42/M44 Cranks

The crankshaft on the left is used in the '96, 1.9 liter M44 engine, has 4 counterweights and weighs 28.5 lbs. This crank is used in OBDII engines and employs a 60 tooth timing wheel that's attached to the 4th counterweight. The crank on the right is the pre '96 M42 forged steel crankshaft, has 8 counterweights and weighs 29.5 lbs.

mass is 1015 grams - 50 grams more! Using the 1.9 liter rod is an effective option towards reducing the reciprocating mass in an M42 engine. These rods have a bearing cap that measures .275" (7mm) at the thinnest point. We check their condition closely for "out of roundness" because the thin bearing cap can cause the big end of the rod to knock out of round. Once out of round, the rod bearing cap will usually fit loosely on the rod, which leads to fatigue.

# M42, M44 Pistons

Decades of Experience & Research have led to MM's Piston Designs



*Left:  
M42/M44 2000 Sport  
Piston for use with  
the stock rod*

*Middle:  
A 2100 Turbo Piston  
used with our MM  
"H" Beam Rod*

*Right:  
The 2100 Rally piston  
used with MM Ultralite  
"I" Beam Rod*

## How MM Pistons Greatly Extend Engine Life!

A high quality properly designed forged piston, more than any other engine component, can greatly increase the life of a High Performance or Race Engine. Engine life, is curtailed by the upper compression ring hammering out the ring groove and parts fatigue caused by a heavy reciprocating mass. A forged piston is 40% stronger and can be made 15% - 20% lighter than a cast piston - when designed properly. Although a forged piston is the perfect solution, average forged pistons (not ours) do have disadvantages. Their expansion rate is 35% - 50% more than a cast piston and requires .0040" clearance or more. This much clearance creates high oil consumption (250-500 miles/quart) and causes the piston to rattle on cold start-up.

Consider this in light of the fact that high revving heats up the piston, requiring more cylinder wall clearance to accommodate the expansion. When we began development of our HiPerformance Engines in 1984, we quickly understood the benefits of switching to the Forged Alusil Piston. These early pistons were graphite coated to reduce cylinder wall scuffing. During the engine break-in period, the coating effectively wore off. Many such engines, under hard use, are still performing with over 200,000 miles on them. Despite this success, we felt certain that there must be an even better way to achieve tighter piston to cylinder wall clearance.

### Metric Mechanic Slitted Pistons

Then in the early '90s, we completed development of our "Slitted Piston" technique which involves machining a horizontal slit into the piston just under the oil ring groove. This slit keeps piston crown heat from transferring directly to the skirt by conducting it initially to the quite massive pin boss which acts like a heat sink. This interruption along with the longer traveled path, helps the heat dissipate; allowing for cooler skirts that expand less. This MM slit also reduces the expansion rate of our Forged Alusil Piston from 35% to only 5% over that of a stock piston and is the principle reason for our tight clearances. Generally, we run .0020" - .0025" clearance on our Sport Engines and .0023" -.0028" on the Rally Engines. This keeps oil consumption low and piston rattling to a minimum on cold start-ups.

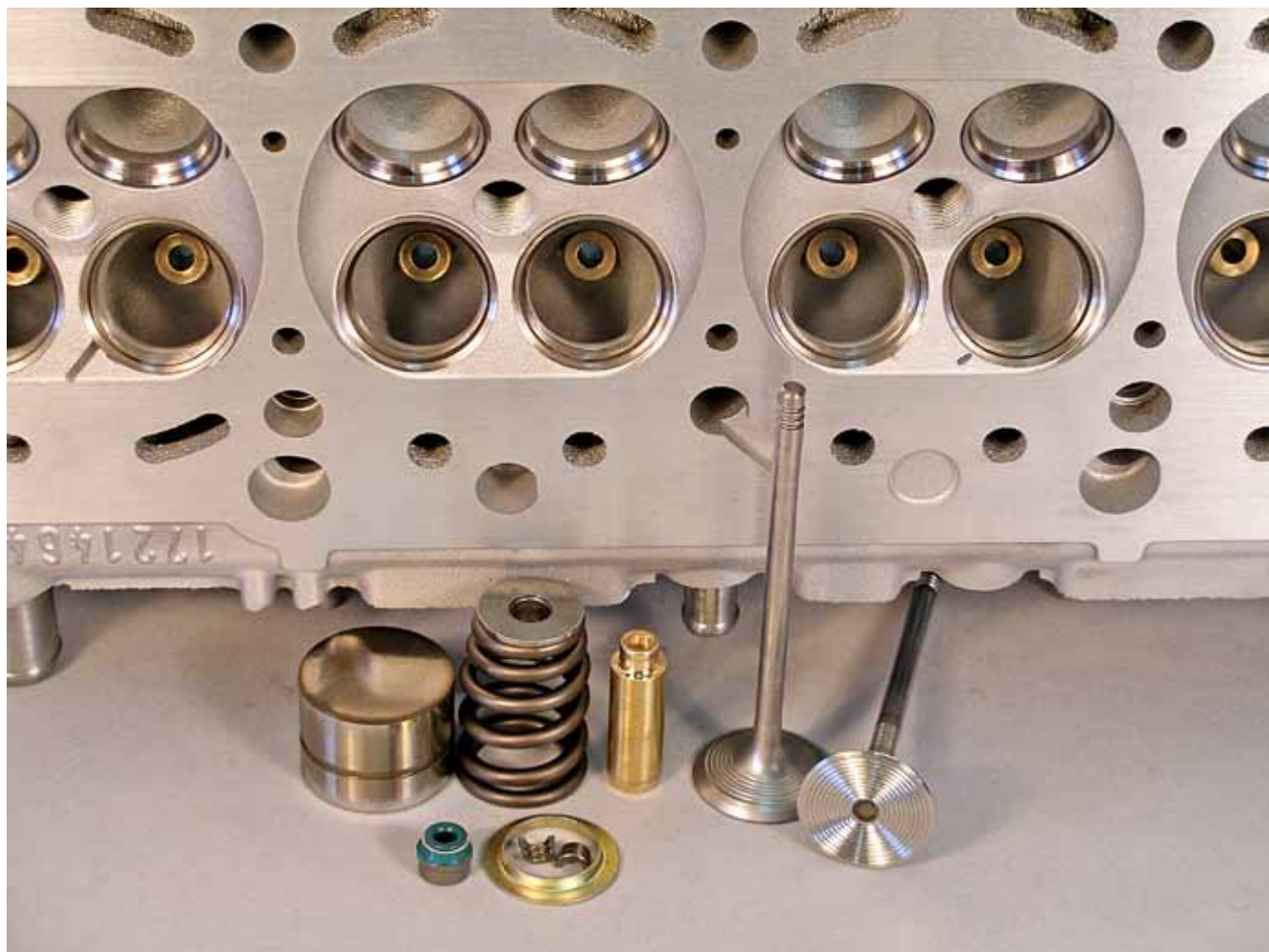
### Metric Mechanic Boosted Pistons

A primary concern with Boosted engines is piston meltdown. In order to avoid piston meltdown we increase the crown thickness by 2 mm, lower the top ring groove, and use 4mm wide high radial tension oil rings. The piston pin wall is thicker for added strength and it weighs 105 grams. The total piston and pin weight is approximately 90 grams more than a Rally piston used in a normally aspirated engine.



# M42/M44 Cylinder Head & Components

Ported Head, Surface Turbulence Parts and Assembly Components



*M42 Head with Metric Mechanic modifications, ready for final assembly. Shown left to right is an Hydraulic Lifter Bucket, "Bee Hive" Valve Spring topped with Retainer, a Viton 6mm Valve Guide Seal with 6mm Keepers and Spring Perch, Manganese Bronze Valve Guide shortened to 6mm and a pair of 6mm Surface Turbulenced Intake and Exhaust Valves*

## Tour of the MM Cylinder Head

Currently our M42/M44 heads flow 6% over the stock head. Pre '93 M42 heads are converted from 7mm to 6mm valves for added flow and lighter weight. Our shorter valve guide increases flow over the high side radius of the port. Seats are machined with three select seat angles determined during flow bench testing. A 45° angle machined into the seat matches the valve head diameter. We also modify the intake valve back-cut angle to increase flow. And we add our patented surface turbulence concentric grooves to the valve itself. For over 16 years, this treatment has proven to increase flow at low lifts. An added benefit is that they help atomize fuel by tumbling air flow over the valve surface and pulling fuel particles off the back of the valve.



## MM 100mm Head Bolts

We use a special 100mm long socket head bolt. The stock torque to yield head bolts are 90mm long. We torque our head bolts down to 64 ft. lbs. These longer bolts spread the load along the cylinder wall to reduce wall distortion and unlike the factory head bolts, these bolts are re-usable.

*Left: MM 100mm long  
Socket Head, Head Bolt  
Right: Stock 90mm long  
Torx Head, Head Bolt*

# M42 Sport Cam & Valve Train Components

Comparing Intake and Exhaust Cams used for a Broad Power Band

## M42 Sport Cams

On an MM 2000 Sport Engine, we cam up the intake side (258° Duration/11.15 Lift) quite a bit more than the exhaust. Using a hotter intake cam, increases RPMs and enhances top end performance while keeping the stock exhaust cams, maintains the mid range and bottom end torque. In the end, this cam combination makes for an engine with a broad power band. See cam chart lower left.

## M42 256° Shrick Cams

The Shrick cam set shown lower right is basically an E36 M3 intake cam copy.

## Comparing the MM Sport Cams with Shrick Cams

On the surface, by simply comparing intake duration at .005", our cam doesn't look that much hotter with the MM at

258° and the Shrick at 256° - a mere 2° advantage. But an engine takes in most of it's air when the cam has the intake valve open to .300" lift or more. Due to faster ramp speeds, our cam has 124° duration versus the Shrick 112° duration at .300" lift. By having an additional 10% more duration at the nose of the cam, the engine will continue to make power 10% higher in RPM. Also, a larger engine will need more cam duration and lift. A 10% larger engine will need 10% more nose duration on the cam at .300" lift to hit the same peak RPM point.

In the past, most manufacturers ran the same cam on the intake and exhaust side. But, when the '95 M3 came out, BMW chose to run their intake cam with more duration and lift than the exhaust cam. They used an intake cam with 256° duration and 10.35mm lift (same as the

Shrick) but it also had 25° of VANOS added to the intake cam. And they used milder a 235° exhaust cam with 9.7mm lift along with VANOS to increase the low and midrange torque of the engine.

So by running two different lobes where the intake cam is larger by about 15% over the exhaust cam, the engine develops a much broader power band. This is also what we do.

## Metric Mechanic Sport Cam *for the* M42 Engine

	258° Intake	228° Exhaust
.005	258°	228°
.010	246°	216°
.015	242°	212°
.020	238°	206°
.050	224°	188°
.100	202°	168°
.200	166°	128°
.300	124°	76°
.400	64°	---
Lift	.439" 11.15mm	.356" 9mm

## Shrick 256 Cam *for the* M42 Engine

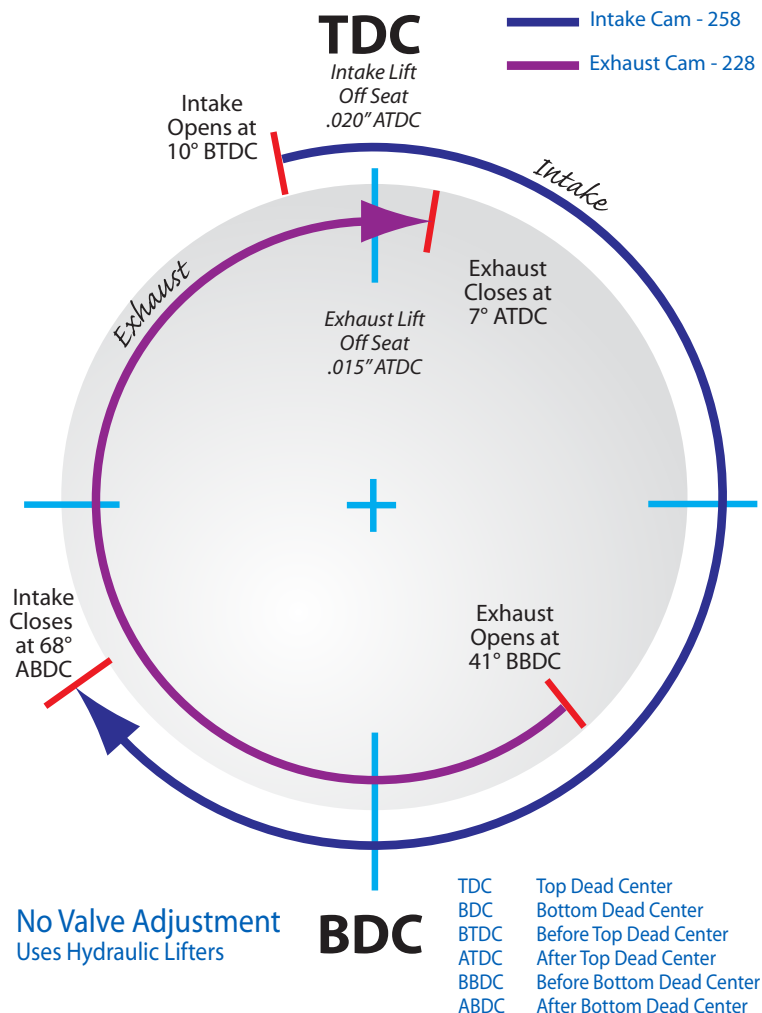
	256° Intake	256° Exhaust
.005	256°	256°
.010	242°	242°
.015	236°	236°
.020	232°	232°
.050	215°	215°
.100	194°	194°
.200	154°	154°
.300	112°	112°
.400	30°	30°
Lift	.408" 10.35mm	.408" 10.35mm

# M42 Sport Cam & Valve Train Components

## Upgraded Valve Train Components

### Metric Mechanic - M42 Sport Cam Timing Map

Intake Cam - 258° Dur./ 11.15mm Lift at .005" - Opens 10° BTDC - Close 68° ABDC  
 Exhaust Cam - 228° Dur./ 9.0mm Lift at .005" - Opens 41° BBDC - Close 7° ATDC  
 Valve Opening During Overlap at TDC .....Intake .020" (.5 mm)  
 .....Exhaust .015" (.4 mm)



MM "Bee Hive" Valve Spring with Lightweight 6mm Retainer and MM Heavy Duty 35mm Lifter Bucket

### Metric Mechanic Bee Hive Spring & Retainer

Metric Mechanic's use of the "Bee Hive" is a preference that evolved out of experience with three previous springs choices. Because spring rate is very critical in making the hydraulic lifter work at high RPMs. When using cams with higher lifts and faster ramp speeds (like our cam designs) we are continually researching for better springs.

Our "Bee Hive" springs and retainers are 25 grams lighter than the stock dual spring set-up. The 6mm retainer we use is much stronger than the BMW factory 6 mm retainer. For instance, our 6mm retainer can take up to a 310 lb. load before the keepers pull through the retainer. The factory BMW 6mm retainer fails at 185 lbs. We have taped a missed shift where the tach was just shy of 9,000 RPM with no incident of bent valves.

### MM Heavy Duty Lifter Bucket

Our 35mm Lifter Bucket has a harder nitrided crown making it more wear resistant. The lifter spring is stiffer (*see spring on left in Photo*) to reduce lifter bleed-down and help the lifter track the cam profile at higher RPMs. When an engine exceeds 150,000 miles and it's rebuild time, we suggest considering new hydraulic lifters.

#### 35mm Lifter Buckets Comparisons

	MM Lifter	Stock
Crown Treatment	Nitrided Heat Treated	Heat Treated
Rockwell Hardness (C-Scale)	54C	48C
Crown Thickness	.0957"	.0933"
Wall Thickness	.039"	.035"
Lifter Spring Wire Diameter	.038"	.031"



Shows the hydraulic lifter and spring removed from the lifter bucket.  
MM to left, stock to right.



# Anatomy of the M42 2100 Rally Engine

Rally Engine Part Descriptions



*2100 Rally Crankshaft, Pistons and Rod Bearings*

MM's 2100 Rally engine is built with an 88 stroke crank, chain sprocket, harmonic balancer hub, plus larger crank bolt & washer. Rods are light-weight forged 4230 Chrome Moly Steel, shot peened and fully CNC machined. Shown here are 525 gram "H" beam rods. MM Ultralite "I" Beam Rod weighs 475 grams - stock rod 610 grams. Pistons are 310 gram forged Alusil (13% silicon content) 310 grams. Stock pistons weigh 360 grams.



*Left: 88mm Crankshaft, Right: 89.6mm Crankshaft*

Both these cranks, originally from a 2 liter European Diesel, need modifications before they can be installed in the M42 or M44 Block. Shown left is the earlier version, an 88 stroke with 8 counter weights which is easier to adapt for the engine. The later crank on the right has an 89.6 mm stroke with 4 smaller counterweights. Because this crank runs with a counter-balance system, it is far more difficult to adapt in. The needed adaptors are shown above with the cranks.



*Adding an extra Keyway Groove to the 88mm Crankshaft*



The 88 stroke crank must have the nose turned down and a second keyway added to secure the chain sprocket and front harmonic balancer hub. Close-ups are shown of the machining process (above) and the end result to the left.

*Crankshaft Nose adapted to accept the Stock Crank Sprocket*



# M42 M44 Rods

Metric Mechanic Rod Line-Up: the usual prospects!



*From Left: M44 Stock Rod, M42 Stock Rod, MM Ultralite "I" Beam and MM "H" Beam Rods*

Far left at 140mm long is the M44 540 gram rod. Next, an 140mm long M42 Rod that weighs 610 grams. These are used in our 2000 Sport Engines. The third rod is MM's Ultralite "I" Beam rod, 138mm long and only 475 grams, used in our 2100 Rally engines. Fourth on the far right is the MM "H" Beam rod. It's also 138mm long, weighing in at 525 grams. This rods is generally used in boosted engines.



*Left: MM Ultralite "I" Beam Rod Right: MM "H" Beam Rod*

Our MM Rally rods shown to the left, are much lighter and twice as strong as the stock production rods. Forged from 4340 chrome moly steel, makes them superior in strength to billet rods. Then they are fully CNC machined to sculpture down excess weight and finally shot peened to improve surface strength. They are capped off with 3/8" ARP bolts. The small ends of each rod are coupled to the piston with a 21mm lightweight 80 gram wrist pin. By comparison, the stock piston pin weighs 105 grams.

## Benefits of Reducing the Reciprocating Mass

Reducing reciprocating mass weight (piston & rod assembly) has a far greater effect on acceleration than reducing the rotational mass. Lightening a rotational mass component such as a flywheel, comes into play only under acceleration but the reciprocating mass is constantly accelerating and decelerating. At 7000 rpm, the piston and rod assembly is going from 0 mph to 100 mph and back to 0 mph - 14,000 times in one minute since the piston changes direction twice at the top and bottom during one revolution. The jerking motion against the piston goes to 1500 G-Force. Using a lightweight reciprocating mass assembly will not only make an engine spool up quicker but it will greatly increase its reliability.



*Wrist Pins: Left 21mm, 105 gram Turbo,  
Middle 21mm 80 gram Rally,  
Right 22mm tapered wall 89 gram Sport*

# M42, M44 Oiling System

Ample Oiling - the "Life Blood" of a Healthy Performance Engine

## Oiling Problems Inherent in the stock M42 M44 Engines

### Oil Pressure Loss from Failed Pan Gasket

The oil pump is driven off the front of the crankshaft and sits in the front housing. The oil pan seals between the oil pump and the oil pump pick-up. Oil pan bolts are hidden inside the oil pan. Sometimes they'll come loose and fall down into the oil pan. When this happens, air gets drawn in between the pump and the pick-up from the loose oil pan gasket (loosened by the dislodged bolts). In the end the engine loses its oil pressure and the oil pump won't prime up.

#### MM Solution for Failed Pan Gasket

Our oil pan gasket is reinforced by a silicon sealing bead directly on this critical pick-up point. We also use Blue Loctite on the internal oil pan bolts to prevent them from working loose in the future.



*Worn out stock thrust bearing from an M42 engine.*

### Thrust Bearing Failures

Stock M42 M44 engines only have a thrust surface on the top Main Bearing. Because of this limited thrust area, the thrust surface can wear out.

#### MM Solution for Thrust Bearing Failure

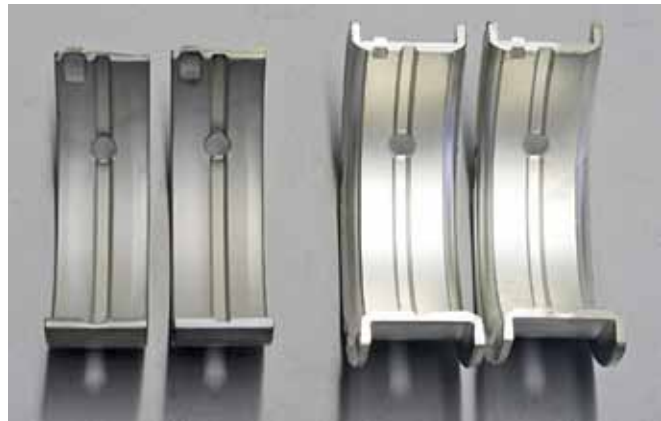
We use main bearings with a thrust surface on both the top and the bottom.

### High RPM Oil Starvation

The stock main bearings have about a 200° oiling groove and oil is shut off to the rod bearings from bottom dead center to top dead center. This causes oil starvation at high rpm.

#### MM Solution for High RPM Oil Starvation

These bearings also feature a 360° oiling groove so the rod bearing has a constant supply of oil.



*360° Main Bearing Oiling System: double thrust bearings.*



Using a milling machine and custom keyway cutter .140" wide, we machine in the new lock tang groove to accept the 360° oiling main bearings.



*360° Oiling Main Bearings Installed.*

The bottom main bearing cap has two narrow lock tang grooves. The 360° Main Bearings that we use, have a single lock tang that is 3.5mm wide. Therefore the stock bearing cap must be modified to accept the wider lock tang.



# Oiling System *continued* & the Timing Chain

Rod Bearings, Timing Chain & Windage Tray Scraper System

## Upgrading the Rod Bearings

Currently, we use one of three rod bearings in our M42/M44 engines. The stock aluminum faced bearing on the right works well in our Sport engines. Next is a heavy duty tri-metal rod bearing with a thin Babbitt facing, copper underlay and a steel backing. This bearing is used in our daily driver Rally engines. Shown right is the same bearing but with a Teflon coated face which increases bearing life by three times under race conditions. These bearings are used in our Driver's School MM Rally engines.

Remember, upon request these Teflon Coated bearings can be used in any Metric Mechanic engine!



*Left to Right: Stock Aluminum Faced Bearing, Heavy Duty Tri-Metal, Heavy Duty Tri-Metal Bearing with Teflon Coated Face*

## Single Row Timing Chain Conversion

For years we have used single row timing chains on the M10, M30 single overhead cam engines. They have proven to be extremely reliable to the point where we trust them more than the Double row chain. Yes the dual row is physically stronger but due to the centrifugal force of the spinning chain, the sheer mass of the double row chain can cause the chain links to stretch and wear out and the chain's whipping action can also cause excessive wear on the guide and tensioner rail. Converting to the single row chain reduces the rotating mass of the chain and sprocket by about 2 lbs and to-date we have never had a chain failure from this modification.

Adds \$200 to the cost of any M42 M44 engine.



*Left is the MM Single Row Sprocket and Chain  
Right is a Stock Double Row Sprocket and Chain*

## E30 2100 Rally Windage Tray/Scraper

A windage tray's function is to separate the crankshaft from the oil in the sump and the built in scraper is used to pull off oil spray from the crankshaft and deposit it back into the oil sump. The windage tray also keeps the oil level in the pan calm and insures that the pick-up remains submerged. Furthermore, by reducing oil drag on the crankshaft, the engine gains a couple more HP. Our Windage Tray/Scraper Bar System is an additional \$350 and available only to those who purchase an engine from us. We cannot sell it as a separate unit because it requires custom machining and fitting. The windage tray shown below does not apply to the E36 M42/M44 because they come stock with oil pans that have a magnesium windage tray built right in.



*Frontal View of reversed Block showing Windage Tray on underside.*

*Machined single row sprocket set for use in our M42 M44 engines.*



# MM Rally Cam & Valve Train Components

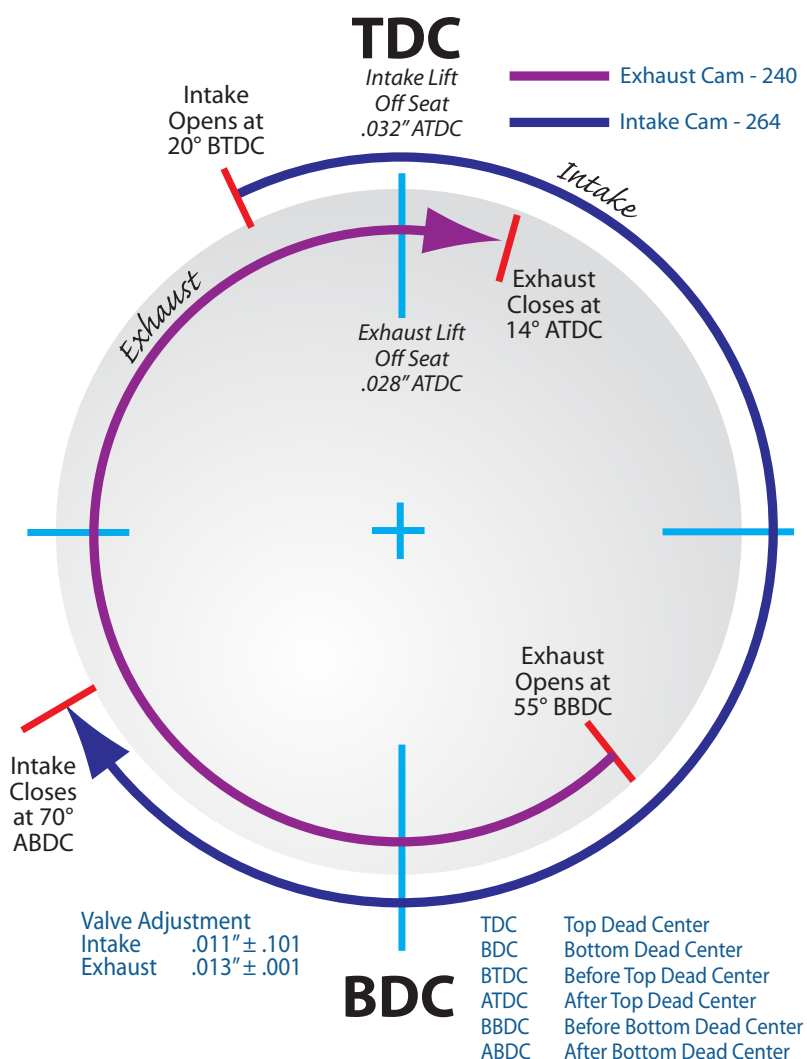
Upgraded Valve Train Components

## Metric Mechanic Rally Cams *for the M42 Engine*

	272° Intake	258° Exhaust
.005	272°	258°
.010	260°	246°
.015	254°	242°
.020	252°	238°
.050	234°	224°
.100	212°	202°
.200	174°	166°
.300	132°	124°
.400	76°	64°
Lift	.448" 11.4mm	.439" 11.15mm

## Metric Mechanic - M42 Rally Cam Timing Map

Intake Cam - 270° Dur. / 11.4mm Lift at .005" - Open 20° BTDC - Close 70° ABDC  
 Exhaust Cam - 250° Dur. / 11.15mm Lift at .005" - Open 55° BBDC - Close 14° ATDC  
 Valve Opening During Overlap ..... Intake .025" (.63 mm)  
 ..... Exhaust .020" (.51 mm)



## Rally Cam Description

Our Rally cams pull strong all the way to their 7700 redline in our 2100 Rally Engine. These cams are rather top end happy but will pull strong from 4300 rpms when combined with our pulse chamber intake manifold. These cams need to be used with our "Bee Hive" valve springs and lightweight 6mm retainers. The valve train should be lightened up with 6mm valves. MM's heavy duty hydraulic lifter buckets work well with our Rally cams for high RPM maintenance free operation. For extreme high RPM running, switch over to our MM Mechanical Lifter Bucket System. Shim pads are from an E46 S54 engine. Valve adjustment is .004" to .005" when used with a hydraulic cam.



Bee Hive Spring, Retainer & Stock Spring Perch







Left: MM Heavy Duty Hydraulic Lifter  
 Right: MM Mechanical Lifter with shim pad



# Lightening the M42 Valve Train

Reduced by Over 50 Grams per Valve Assembly!

<b>MM Valve Train Mass</b>		<b>versus</b>	<b>Stock Valve Train Mass</b>	
Lifter Bucket	35 mm ..... 64.5 grams		35 mm ..... 77.09 grams	
Keeper	6 mm ..... 1.0 grams		7 mm ..... 2.5 grams	
Retainer	6 mm ..... 10.0 grams		7 mm ..... 19.0 grams	
MM Bee Hive Spring	..... 45.0 grams		Dual Spring	.... 62.0 grams
Spring Perch				
Intake Valve	33 mm ..... 45.5 grams has a 6 mm stem and Surface Turbulence Grooves		33 mm ..... 58.5 grams has a 7 mm stem	
Exhaust Valve	30.5 mm ..... 46.0 grams has a 6 mm stem and Surface Turbulence Grooves		30.5 mm ..... 54.09 grams has a 7 mm stem	
<b>MM Total</b> .....	<b>166 grams</b> <i>with the intake or the exhaust valve</i>		<b>Stock Total</b> .....	<b>219 grams</b> <i>with the intake or the exhaust valve</i>
<p><b>The Metric Mechanic Valve Train Mass has been reduced by over 50 grams per valve assembly or over 800 grams, or 1.75 lbs. of Total Valve Train Mass.</b></p>			<p>1993 and later M42, M44 and M50tu valve trains use lighter 35mm lifter buckets and 6mm valves. They can be upgraded easily by using MM "Bee Hive" valve springs and retainers.</p>	

# M42 E30 Pulse Chamber Intake Manifold

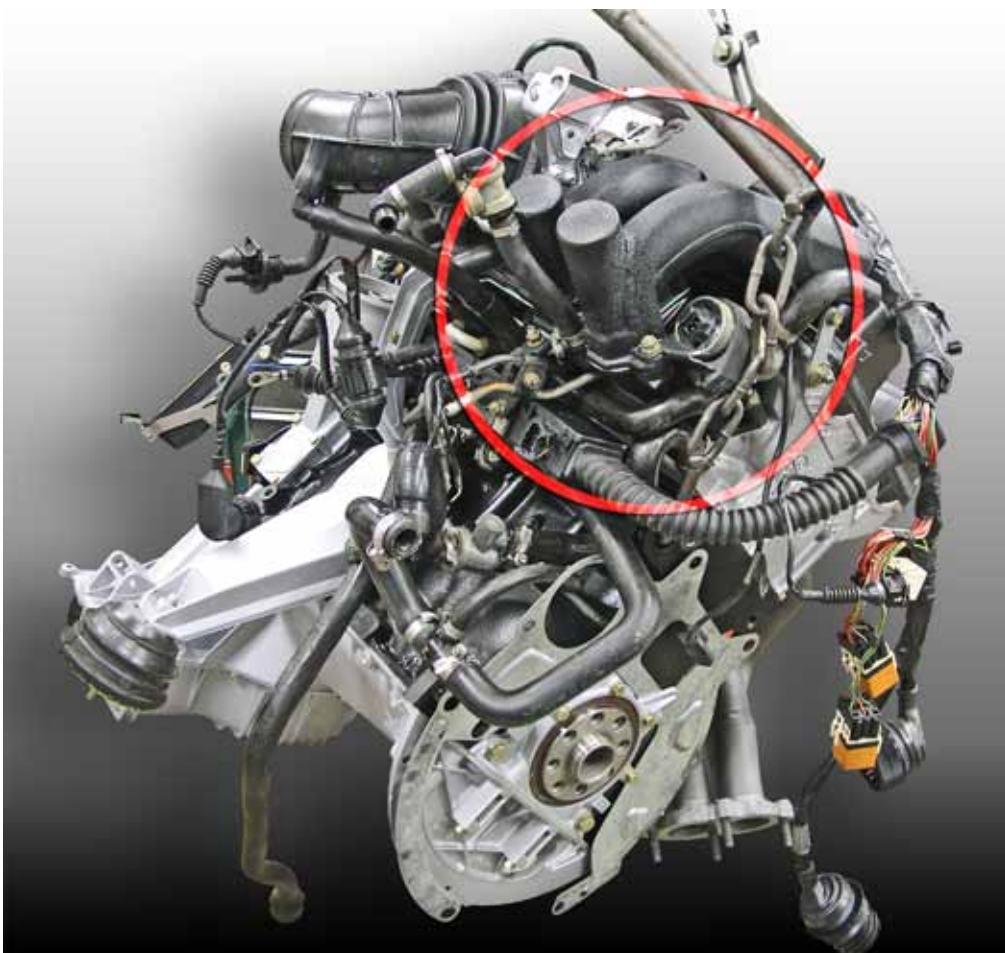
Increasing Bottom End and Mid Range Torque

## M42/E30 Pulse Chamber Intake Manifold

Our MM Pulse Chamber Intake Manifold greatly increases bottom end and mid-range torque in the M42 engine. When looking closely at the base of the “C” runners on an M42 E30, capped off tube extensions are visible. We call these pulse chambers.

### How Does the Manifold Work?

After the intake mixture (fuel and air mixture) enters a cylinder, the intake valve slams shut. In the stock manifold, the intake mixture starts to recoil off the back of the intake valve and back-flows up the intake runner to the plenum. But with a pulse chamber manifold, the intake mixture goes straight back into the pulse chamber because that is the path of least resistance. Next the mixture recoils off the back of the capped-off tube (the pulse chamber) and heads for the back of the intake valve ready to enter the engine when the intake valve opens. Since the intake mixture is ready to go into the cylinder, the cylinder filling is increased and the engine makes more power. From past Dyno testing, we can claim a 15% increase in midrange torque with this manifold.



*Pulse Chamber Intake Manifold  
on a 2100 Rally Engine*



*Side View of the Pulse  
Chamber Intake Runner*



# M42/M44 Lightweight Flywheel & Clutch Assembly

Best Performance Modification for the Money



*Left to Right: Lightweight Flywheel & Bolts, 228mm Disc with Sprung Hub, 228mm Pressure Plate and Throw Out Bearing*

## Description

From the factory, M42/M44 engines use large heavy dual mass flywheels with 215mm clutch assemblies. In proportion to the engine displacement, we think this flywheel sets the record for being the heaviest BMW flywheel scaling in at a massive 28.25 lbs. We replace it with a single mass flywheel weighing 11 to 11.5 lbs. and upgrade to a 228mm clutch assembly.

### The Significance

The stock 215mm clutch can take up to about 155 ft. lbs. of torque. The 228 clutch assembly we use can handle up to about 230 ft. lbs. of torque. Going to a 228 clutch will virtually eliminate any need for a clutch replacement. This amount of “overkill” reduces the probability of ever having to replace the clutch. For the money, a lightened flywheel with 228 clutch assembly is the best performance modification you can do to an M42 or M44.

## How a Lightened Flywheel Works

While an engine revs, the flywheel creates a parasitic drag on the engine’s ability to accelerate. The faster the flywheel is accelerated, the greater the power loss to the engine.

For example, a pair of tests on a 3700, first with the stock 23 lb. and second with the flywheel lightened down to 12.5 lbs. revealed an impressive gain. When accelerated at 1500 RPMs per second, the engine picked up 17 HP with the lightened flywheel. Consider this: 1500 RPMs per second is equivalent to a 1st gear acceleration. Here’s another way to look at it: every pound removed from the flywheel, is comparable to taking 15 lbs. off the body weight.

### Summary

Installing a lightened flywheel does not generate more HP in an engine. It’s more like the reduction of a loss.

# 2000 Sport M42 Engine - Spec Sheet

For the Enthusiastic Street Driver

## MM 2000 Sport Engine

Displacement .....	1925 cc
Bore x Stroke .....	87mm x 81mm
Compression Ratio .....	11.0:1
Horsepower .....	170 @ 6500
Torque .....	145 @ 4500
Redline .....	7000 rpm

## Block Components

Crankshaft .....	Stock 81mm stroke forged steel with 8 counterweights, 29.5 lbs.
Rods .....	Stock M42/1.8 rod, 595 grams Optional: Stock M44/1.9 rod, 540 grams
Pistons	
MM 87mm .....	Lightweight Forged Alusil Piston vented skirts 11.0:1 Compression Ratio/ 310 grams
Stock Cast Piston .....	10.0:1 Compression Ratio/ 360 grams
Rings .....	1.5mm Moly Top, 1.5mm 2nd and 3.0mm 3 piece Oil Ring (low radial tension design)
Piston Pin .....	22mm tapered wall, 89 grams
Stock .....	22mm / 105 grams

## Oiling Block Modifications

Main Bearings .....	Stock main bearings with 200° oiling groove and 360° thrust bearing surface
Rod Bearings .....	Stock aluminum face bearings Option: Tri-metal heavy duty Teflon coated bearings
Windage Tray (E30 only) .....	Optional: A windage tray/scrapper assemble is installed to peel slinging oil off the crank and send it to the oil pick-up.

## Head Assembly

Head Flow .....	6% over stock
Head Bolts .....	MM socket head bolts 100mm long torqued to 64 ft. lbs. reusable Stock torque to yield torx head bolts 90mm long - non reusable
Cams .....	MM Sport Cams Intake: 262° Duration / 11.15mm Lift Exhaust: 228° Duration / 9.0 Lift
Hydraulic Lifter .....	MM heavy duty hydraulic lifter with nitrated crown
Valves .....	33.0 mm intake and 30.5mm exhaust with Surface Turbulence and 7mm stems Optional: lighter weight 33.0 mm intake and 30.5mm exhaust with Surface Turbulence and 6mm stems
Valve Spring .....	MM "Bee Hive" spring with light 7mm retainer Optional: MM "Bee Hive" spring with light 6mm retainer (25 grams lighter than the stock dual spring with 7mm retainer)
Valve Guide .....	MM 7mm manganese bronze Option: MM shortened 6mm manganese bronze



# 2000 Sport M44 OBDII/M42 Engine - Spec Sheet

For the Enthusiastic Street Driver

## MM 2000 Sport Engine

Displacement .....	1973 cc
Bore x Stroke .....	87mm x 83mm
Compression Ratio .....	11.0:1
Horsepower .....	175 @ 6500
Torque .....	150 @ 4500
Redline .....	7000 rpm

## Block Components

Crankshaft .....	Stock 83mm stroke cast with 4 counterweights, 28.5 lbs. with OBDII /60 tooth timing wheel
Rods .....	Stock M44/1.9 rod, 540 grams
Pistons	
MM 87mm .....	Lightweight Forged Alusil Piston vented skirts 11.0:1 Compression Ratio/ 310 grams
Stock Cast Piston .....	10.0:1 Compression Ratio/ 360 grams
Rings .....	1.5mm Moly Top, 1.5mm 2nd and 3.0mm 3 piece Oil Ring (low radial tension design)
Piston Pin .....	22mm tapered wall, 89 grams
Stock .....	22mm / 105 grams

## Oiling Block Modifications

Main Bearings .....	Stock main bearings with 200° oiling groove and 360° thrust bearing surface
Rod Bearings .....	Stock aluminum face bearings Option: Tri-metal heavy duty Teflon coated bearings
Windage Tray (E36 only) .....	Stock aluminum windage tray in oil pan

## Head Assembly

Head Flow .....	6% over stock
Head Bolts .....	MM socket head bolts 100mm long torqued to 64 ft. lbs. reusable Stock torque to yield torx head bolts 90mm long - non reusable
Cams .....	MM Sport Cams Intake: 262° Duration / 11.15mm Lift Exhaust: 228° Duration / 9.0 Lift
Hydraulic Lifter .....	MM heavy duty hydraulic lifter with nitrated crown
Valves .....	33.0 mm intake and 30.5mm exhaust with Surface Turbulence and 6mm stems
Valve Spring .....	MM "Bee Hive" spring with light 6mm retainer
Valve Guide .....	MM 6mm shortened manganese bronze

# 2100 Rally M42 Engine - Spec Sheet

For Hard Street and Driver School Use

## MM 2100 Rally Engine

Displacement .....	2091cc
Bore.....	87mm x stroke 88mm
Compression Ratio .....	11.5:1
Horsepower .....	205 @ 7350
Torque .....	165 @ 5150
Redline .....	7700 rpm
Acceleration.....	0 - 60 - 6.5 sec.
	1/4 mile - 14.5 sec. / 98 mph

## Block Components

Crankshaft .....	88mm stroke forged steel crank with 8 counterweights, 29.5 lbs. stock 81mm stroke forged steel
Rods.....	MM 138 Ultralite "I" Beam Rod, 480 grams or MM 138 mm "H" Beam Rod, 540 grams '95 & newer
Pistons	
MM 87mm .....	Lightweight Forged Alusil Piston vented skirts 11.5 Compression Ratio/ 310 grams
Stock Cast Piston .....	10.0 Compression Ratio/ 360 grams
Rings .....	1.5mm Moly Top, 1.5mm 2nd and 3.0mm 3 piece Oil Ring (low radial tension design)
Piston Pin .....	21mm / 80 grams
Stock .....	22mm / 105 grams

## Oiling Block Modifications

Anti Drain Back Valve.....	Valve added for hydraulic lifter buckets to keep the lifters from draining down
Main Bearings.....	360° oil groove to insure a constant flow of oil to the rod bearings. Stock main bearings have only a 200° oiling groove. this prevents oil from feeding to the rod bearings from bottom to top dead center. Also have a 360° thrust bearing - the stock thrust bearing is 180°
Rod Bearings .....	Tri-metal heavy duty Teflon coated bearings
Windage Tray .....	Optional: A windage tray/scrapper assemble is installed to peel slinging oil off the crank and send it to the oil pick-up.

## Head Assembly

Head Flow .....	6% over stock
Head Bolts.....	MM socket head bolts 100mm long torqued to 64 ft. lbs. reusable Stock torque to yield torx head bolts 90mm long - non reusable
Cams.....	MM Rally Cams Intake: 272° Duration / 11.4mm Lift Exhaust: 250° Duration / 10.9 Lift
Hydraulic Lifter .....	Lighter Late Model M50tu 35mm Lifter
Valve Spring.....	MM "Bee Hive" spring with light 6mm retainer (25 grams lighter than the stock dual spring with 7mm retainer)
Valves .....	Surface Turbulence with 6mm stems, Stock valves have 7mm stems
Valve Guide .....	Shorter 6 mm manganese bronze Stock are 7mm brass



# MM Forced Induction M42/M44 Engines

## Considerations in choosing Forced Induction

For those wanting 200 HP or more from an M42 or M44 engine, a Forced Induction Engine is the answer.

### Considerations Before Making the Move to Forced Induction

A 2100 Rally engine will do the 1/4 mile in 14.5 sec at 98.5 mph. This is as fast as an E36 M3. Equipped with a Pulse Chamber Intake Manifold, it's power band is from 4300 to 7300 RPM. The engine pulls like its running on 6 cylinders and gets 30 mpg on the highway. Forced Induction is more complex with a boost apparatus and extra plumbing. The cost of a Forced Induction System, once it's all plumbed up and tuned, can be as much as the engine itself.

### Two Camps

OK! You really want to do it? Then the first decision is to determine which camp you belong with - the Supercharge crowd or the Turbo people. Both systems have their merits and drawbacks.

### Bower Bands

A boost device such as the Downing Atlantic Supercharger, will be strong at making bottom end and mid range torque but tends to fall off on the top end. In comparison, a Turbo-Charged engine feels rather flat down low but much stronger in the mid-range and top end. Now, the power band of either system can be moved up or down depending on how the system is sized to the engine.

### Comparisons

Since the Supercharger is driven off the crankshaft, it's power output is dictated by RPM whereas a Turbo is driven by the engine's exhaust output and is consequently dictated by engine load. Because the Turbo is driven by a relatively "free" power source (exhaust), it is much more efficient and since it relies on engine load, it has more power potential than a Supercharger.

So, if it is bottom-end and mid-range torque you are after, choose a Supercharger or small Turbo System, but if you are interested in a sizeable power increase, nothing beats a Turbocharger.

### MM 1900, 2000 and 2100 Forced Induction Engines

This M42/M44 Series is specifically designed and engineered to run successfully under boost. They are not merely decompressed stock engines which are limited to about 7 lbs. (.5 bars) of boost and are short lived. A boosted engine lives a hard tough life and needs to be built strong and durable so it can take the demands over time. Longevity must be a major design goal along with power.

### The Reciprocating Mass of Metric Mechanic's Forced Induction Engines



*MM Forced Induction Piston, Pin and Rod Assembly*

### Forced Induction Piston

The piston, more than any other component, receives the most abuse in a forced induction engine. Heat generated from boost and particularly detonation can be so intense it can literally melt the piston. Because of this, our forged alusil piston has a .080" (2mm) thicker crown than our normally aspirated pistons. The top of the piston is intentionally made flat with no valve pockets because valve pockets create a thin eyebrow at the edge of the piston and this thin edge is the very first place the piston starts its meltdown. Also, the upper compression ring groove is moved further down the piston to protect the top compression ring from heat. Our forced induction piston weighs 380 grams.

# MM Forced Induction M42/M44 Engines

Cooling the Forced Induction Piston

## Piston Pin

We use a thick wall 21mm wrist pin weighing 105 grams.

## Rod

The rod is an "H" beam design forged and CNC machined out of 4340 Chrome Moly Steel. At the big end, we machine 4 oiling grooves, (see close-up on page 19) through which oil squirts towards the bottom of the piston to cool the skirt. Three different rods are used in these engines; the 138 mm rod for 1900 FI engine, the 137mm rod for a 2000 FI engine and a 134.5mm rod for a 2100 FI engine.



*Oil Cooling the MM Forced Induction Piston, Pin and Rod Assembly*

## Internal Cooling of the Forced Induction Piston

The same four oiling grooves also help cool the piston internally. Oil coming off the rod bearing is collected in the rod's side chamfer and then dis-

charged out through these 4 oil squirter grooves onto the bottom side of the piston. Oil then splashes through the horizontal slits machined into the piston just under the oil ring groove. These slits not only greatly help reduce piston expansion but they also give the oil a pathway towards the upper portion of the piston skirt, lubricating it from the cylinder wall. Even with a tight fitting piston (.003"), the skirt stays well lubricated which greatly increases the skirt life and reduces the likelihood of a collapsed or seized piston skirt. The lubricating method described above does not rob oil pressure from the engine like more conventional block squirters.



*Main Bearings with 360° Oiling Groove*



*Double Thrust Main Bearing Set*

## Main Bearings

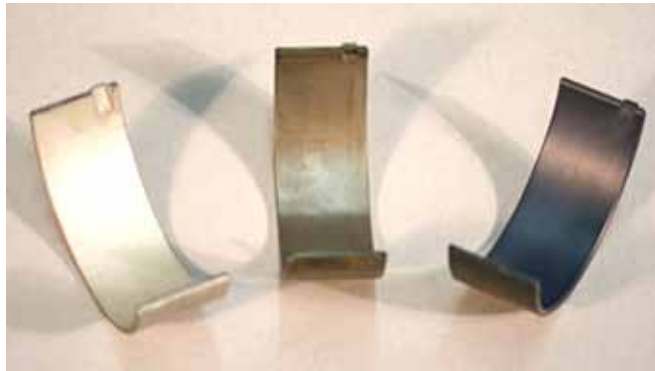
The stock main bearings have about a 200° oiling groove and oil is shut off to the rod bearing from bottom dead center to top dead center. This causes oil starvation to the rod bearings. The main bearings we use have a 360° oiling groove so the rod bearing has a constant supply of oil. We also use a double thrust surface main bearing. The stock main bearings only use a single thrust surface which tends to wear out.



# MM Forced Induction M42/M44 Engines

More Parts Specialized for the Forced Induction Engine

## Rod Bearings



*Left to Right: Stock , Tri-Metal & Teflon Coated Rod Bearings*

The stock rod journal is only 45mm in diameter. This rather small journal diameter sees a lot of load under boost. To take this higher load, we use a Teflon coated Tri-Metal rod bearing that can deliver three times the life of a stock rod bearing.

## MM Cylinder Head

Our M42/M44 heads flow 6% over stock. These heads have our patented Surface Turbulence concentric grooves machined into the backside of the intake valve and the heads of both the intake and exhaust valves. This helps to reduce detonation in a boosted engine. It also helps prevent head cracking, increases fuel mileage and helps reduce emissions.



## Cams and Valve Train

The stock cams are used on the smaller 1900 and 2000 Forced Induction Engines. The 2100 Forced Induction Engines use a 258° duration/ 11.15 mm lift cam on both the intake and exhaust cam. MM “Be Hive” valve springs and lighter retainers are used along with MM 35mm heavy duty hydraulic lifter buckets.



*Left: Forced Induction Multi-layered Head Gasket  
Right is Normally Aspirated Composite Head Gasket*

## Multi-Layered Stainless Steel Head Gasket

We use a three layered stainless steel head gasket. The top and bottom layers are embossed and coated with Viton for good sealing properties. A thicker inner stainless steel core is used for high strength. This gasket does not require retorquing and can be reused if not damaged.

## MM Head Bolts

The socket head bolts we build with are 100mm long (10mm longer than stock) for deep anchoring power in the block. This spreads the load more evenly over the cylinder wall and reduces cylinder wall distortion even under greater head torque (68 ft. lbs.) Stock head bolts hit about 59 ft. lbs. when they are angle torqued.



*Main Bearings with 360° Oiling Groove*

# 1900 M42 Forced Induction - Spec Sheet

For Boosting ... Supercharging or Turbocharging

## MM 1900 M42 FI Engine

### Introduction

This engine is designed and engineered to run under boost from the forced induction of a Turbo Charger, Supercharger or Blower. The head bolts, head gasket, pistons, wrist pins, rings, rods and rod bearings are all stronger parts specifically developed to run under boost. Because this is a larger displacement engine with better head flow than stock, the power output will be much higher than a stock engine at the same boost level.

### 1. DISPLACEMENT

1881cc (86mm bore x 81mm stroke)

### 2. CRANKSHAFT

This engine uses a stock 1.8 forged steel crankshaft with 8 counterweights and an 81 stroke.

### 3. ROD

These "H" beam rods are forged from 4340 Chrome Moly steel for strength, fully CNC machined for lightness, 138mm long and weigh only 525 grams. The "H" Beam Rods are modified with 4 oil grooves machined into the big end that allow oil squirts into the bottom side of the piston to help cool it off.

### 4. PISTON

We use an 86 mm Forged Alusil Piston designed specifically for boosted engines with 8.6 compression ratio that has a flat top and no valve pocketing. The crown thickness at .080 is 2mm thicker than our normally aspirated piston. To prevent heat damage to the top compression ring, it's moved down lower on the piston. Most boosted engines run a lot of cylinder wall clearance (usually .005" to .006") to keep the piston from sticking in the bore. We use a special 13% high silicon content piston to lower piston expansion and reduce scuffing. Our pistons also have a horizontal slit just below the oil ring to prevent the heat that's coming off the piston crown from transferring directly to the skirt of the piston. This slit helps reduce the expansion rate at the skirt 4-7% more than a cast piston. Most forged pistons expand 35 - 50% more than a stock cast piston. We run .003" piston to cylinder wall clearance.

### 5. RINGS

Top is 1.5mm Moly, second is 1.5mm and the 4mm oil ring is a high radial tension design with 3 pieces.

### 6. PISTON PINS

The 21mm pin we use on boosted engines weighs 105 grams while on a normally aspirated engine it weighs 80 grams.

### 7. MAIN BEARINGS

We use a 360° oil groove on the main bearings. The stock main bearing stops feeding oil to the rod bearing from bottom dead center to top dead center, so, at high rpms the rod bearings become starved for oil. This circular oil groove keeps the rod bearings well lubricated.

### 8. ROD BEARINGS

We use tri-metal rod bearing with a teflon coated babbitt facing, a copper underlay and a steel backing. In our experience, they are 3 times more reliable than stock.

### 10. HEAD

Currently our M42/M44 heads flow 6% over stock. We install our 6mm Surfaced Turbulenced valves which help reduce detonation, increase fuel economy and minimize cracking and then pair them with manganese bronze valve guides for greatly increase life. MM "Bee Hive" valve springs and lightweight retainers reduce valve train weight. Valves are capped off with MM 35mm heavy duty hydraulic lifters.

### 10. HEAD GASKET & HEAD BOLTS

Our choice is a Cometic multi layer metric head gasket with stronger 10 mm socket-head bolts that are 100mm long which is 10mm longer than stock.

### 11. CAMMING

Stock cams - 228° duration with 9mm lift.

### 12. HORSEPOWER OUTPUT

200 - 250 HP

# 2000 M44 Forced Induction - Spec Sheet

For Boosting ... Supercharging or Turbocharging

## MM 2000 M44 FI Engine

### Introduction

This engine is intended for OBDII M44/1.9 engines from 1996 on that will be run under boost from the forced induction of a Turbo Charger, Supercharger or Blower. The head bolts, head gasket, pistons, wrist pins, rings, rods and rod bearings are all stronger parts specifically developed to run under boost. Because this is a larger displacement engine with better head flow than stock, the power output will be much higher than a stock engine at the same boost level.

#### 1. DISPLACEMENT

1927cc (86mm bore x 83mm stroke)

#### 2. CRANKSHAFT

This engine uses a stock 1.9 cast iron crankshaft with 4 counterweights and an 83 stroke. The timing wheel is mounted on the 4th counterweight for OBDII timing reference.

#### 3. ROD

These "H" beam rods are forged from 4340 Chrome Moly steel for strength, fully CNC machined for lightness, 137mm long and weigh only 520 grams. The "H" Beam Rods are modified with 4 oil grooves machined into the big end that allow oil squirts into the bottom side of the piston to help cool it off.

#### 4. PISTON

We use an 86 mm Forged Alusil Piston designed specifically for boosted engines with 8.6 compression ratio that has a flat top and no valve pocketing. The crown thickness at .080 is 2 mm thicker than our normally aspirated piston. To prevent heat damage to the top compression ring, its moved down lower on the piston. Most boosted engines run a lot of cylinder wall clearance (usually .005" to .006") to keep the piston from sticking in the bore. We use a special 13% high silicon content piston to lower piston expansion and reduce scuffing. Our pistons also have a horizontal slit just below the oil ring to prevent the heat that's coming off the piston crown from transferring directly to the skirt of the piston. This slit helps reduce the expansion rate at the skirt 4-7%

more than a cast piston. Most forged pistons expand 35 - 50% more than a stock cast piston. We run .003" piston to cylinder wall clearance.

#### 5. RINGS

Top is 1.5mm Moly, second is 1.5mm and the 4mm oil ring is a high radial tension design with 3 pieces.

#### 6. PISTON PINS

The 21 mm pin we use on boosted engines weighs 105 grams while on a normally aspirated engine it weighs 80 grams.

#### 7. MAIN BEARINGS

We use a 360° oil groove on the main bearings. The stock main bearing stops feeding oil to the rod bearing from bottom dead center to top dead center, so, at high rpms the rod bearings become starved for oil. This circular oil groove keeps the rod bearings well lubricated.

#### 8. ROD BEARINGS

We use tri-metal rod bearing with a teflon coated babbit facing, a copper underlay and a steel backing. In our experience, they are 3 times more reliable than stock.

#### 9. HEAD

Currently our M42/M44 heads flow 6% over stock. We use 6mm Surfaced Turbulenced valves which help reduce detonation, increase fuel economy and minimize cracking and then pair them with manganese bronze valve guides for greatly increase life. MM "Bee Hive" valve springs and lightweight retainers reduce valve train weight. Valves are capped of with MM 35mm heavy duty hydraulic lifters.

#### 10. HEAD GASKET & HEAD BOLTS

Our choice is a Cometic multi layer metric head gasket with stronger 10 mm socket-head bolts that are 100mm long which is 10mm longer than stock.

#### 11. CAMMING

Stock cams - 228° duration with 9mm lift.

#### 12. HORSEPOWER OUTPUT

200 - 250 HP



# 2100 M42 Forced Induction - Spec Sheet

For Boosting ... Supercharging or Turbocharging

## MM 2100 M42 Turbo Engine

### Introduction

For “boost junkies” seeking a 300 HP thrill, this forced induction engine is the answer since its designed and engineered to run under boost from a Turbo Charger, Supercharger or Blower. The head bolts, head gasket, pistons, wrist pins, rings, rods and rod bearings are all stronger parts specifically developed to run under boost. Because this is our largest displacement engine with better head flow and hotter cams (differentiating it from our other boosted engines) the power output will be much higher than our other boosted engines.

### 1. DISPLACEMENT

2044cc (86mm bore x 88mm stroke)

### 2. CRANKSHAFT

We use a modified diesel crank with an 88mm stroke. The bolt that retains the harmonic balancer adaptor is 2 mm larger and we would need the supercharge drive pull to adapt it to the engine.

### 3. ROD

For the boosted engine we use a 134.5 mm long “H” Beam Rod weighing 500 grams. The “H” Beam Rods are modified with 4 oil grooves machined into the big end. These allow oil to squirt into the bottom side of the piston to help cool it off.

### 4. PISTON

We use an 86 mm Forged Alusil Piston designed specifically for boosted engines with 8.6 compression ratio that has a flat top and no valve pocketing. The crown thickness at .080 is 2 mm thicker than our normally aspirated piston. To prevent heat damage to the top compression ring, its moved down lower on the piston. Most boosted engines run a lot of cylinder wall clearance (usually .005” to .006”) to keep the piston from sticking in the bore. We use a special 13% high silicon content piston to lower piston expansion and reduce scuffing. Our pistons also have a horizontal slit just below the oil ring to prevent the heat that’s coming off the piston crown from transferring directly to the skirt of the piston. This slit helps reduce the expansion rate at the skirt 4-7%

more than a cast piston. Most forged pistons expand 35 - 50% more than a stock cast piston. We run .003” piston to cylinder wall clearance.

### 5. RINGS

Top is 1.5mm Moly, second is 1.5mm and the 4mm oil ring is a high radial tension design with 3 pieces.

### 6. PISTON PINS

The 21 mm pin we use on boosted engines weighs 105 grams.

### 7. MAIN BEARINGS

We use a 360° oil groove on the main bearings. The stock main bearing stops feeding oil to the rod bearing from bottom dead center to top dead center, so, at high rpms the rod bearings become starved for oil. This circular oil groove keeps the rod bearings well lubricated.

### 8. ROD BEARINGS

We use tri-metal rod bearing with a teflon coated babbitt facing, a copper underlay and a steel backing. In our experience, they are 3 times more reliable than stock.

### 9. HEAD

Currently our M42/M44 heads flow 6% over stock. We use 6mm Surfaced Turbulenced valves which help reduce detonation, increase fuel economy and minimize cracking and then pair them with manganese bronze valve guides for greatly increase life. MM “Bee Hive” valve springs and lightweight retainers reduce valve train weight. Valves are capped of with MM 35mm heavy duty hydraulic lifters.

### 10. HEAD GASKET & HEAD BOLTS

We use a Cometic multi layer Metric Head Gasket and stronger 10 mm Socket-head Bolts that are 100 mm long which is 10 mm longer than stock.

### 11. CAMMING

We use a 258° duration /11.15mm lift cam on both intake and exhaust.

### 12. HORSEPOWER OUTPUT

250 - 350 HP