MotoMan

POWER NEWS Magazine

Presents:

Circular Logic

De-Mystifying Main & Rod Bearings

Engine Reliability is #1 !!

An engine failure = zero HP

Many race tuners make the mistake of sacrificing reliability for more power. The reasoning is that since race engines get rebuilt a lot, a sacrifice of some long term reliability is a fair trade off for increased horsepower. This is a natural conclusion.

My philosophy about race engines is completely different. My number one priority has always been that rock solid reliability comes first, while increased power always comes second. Another way of saying this is: anything that will cause a reliability problem or power loss at a later time, *is also a reliability problem or power loss right now.* It's only a matter of degrees.

My goal as an race engine tuner was to help my customers (who didn't have nearly the same financial re$ource$ as the factory teams) win an unusually high percentage of races and especially championships, without any rebuilds. In order to do that, the engines still had to be fast for the last race of the championship !!

When my customers won races and championships, an amazing thing happened -- they started to attract sponsors, and their financial resources greatly improved !! But, we still stuck to the original plan, and kept "reliability without rebuilds" as our first priority.

While it's true that factory race teams rebuild their engines after every race, during my career as an engine builder, many of my customers noticed that 1/2 way through the season after their engine was originally built, they could still easily pass factory riders on the straightaway. This has happened many times with many different riders and many different brands of motorcycles, and there are reasons for it ...

What I did was to study ways to improve reliability over what's considered to be normal engine wear in production vehicles. The result of this research is a great benefit to street riders and car drivers who want better than normal reliability and vehicle longevity.

In order to determine how to minimize engine wear, it's important to first study the true causes of it. In racing, this understanding can make the difference between a race win or a zero horsepower failure parked by the side of the track.

On the street, it can mean the difference between 100,000 miles / 160,000 km of high maintenance or 200,000 miles+ / 320,000 km+ of trouble free use in a car.

(Note: Motorcycle engines usually wear out much sooner, mostly due to an easily avoidable problem which will be explained on this page.)

In this article I'm going to show you something in an engine which is so fragile, that it can be easily destroyed by the friction from a wimpy piece of paper towel.

Most likely, that will now seem **unbelievable**, which is in keeping with almost everything else on Power News...

Paper Towel !!

Note: this issue contains a lot of photos and graphics. Many of the smaller photos are "clickable" so that you can view the full sized version. The problems with this is that if your browser is maxxed out on graphic memory, then all of the graphics on this page have to re-load again when you use your back button to return to it. If you know how to clear out your temporary internet files, that's one solution, otherwise, it's even easier to just do this:

Click on the photo with the right mouse button. When the gray menu box comes up, select "Open in New Window". When you want to return to this page after viewing the photo, just close the large photo's browser window. (This works with most popular browsers ... but there probably are exceptions.)

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V i e w e r   F e e d b a c k

This Website is The Most Informative Tech Site On The Web

Hi MotoMan.

It's not fair to tease us with a list of upcoming articles that look so interesting. I want to read them now. This is the most interesting and informative tech site on the web. Keep up the good work.

~Damian
(Australia)

Hi Damian !!

This issue is about one of the most widely misunderstood topics in engineering, so it was harder to write than some of the past ones -- plus it required many diagrams, animations and photos to visually illustrate the concepts.

Thanks for your support, I think you'll find that it was worth the wait !!

Sincerely,
~MotoMan

The Ratio of 719 to 1

Hi MotoMan,

Interesting (Break-In Secrets) article.

I bought a new W650 parallel twin Kawasaki three years ago. I had read of an Australian race car tuner who developed a running -in strategy similar to yours. His was to start the brand new motor, warm it enough to be safe, get it into third (or some gear where the load was high but the speed not silly) and then nail it to the red line and allow it to come down to idle before repeating ten more times, making a total of eleven. Taking my heart into my mouth, I did this with my brand new twin.

About 1000 miles later, I ran it on a dyno, and it posted 51 bhp...not too bad for a street, long stroke 670cc parallel twin. I belong to an enthusiasts group and typical horse power levels for motors run in by the manufacturers methods run from 41 to 44 bhp ...

Says it all really... I have one of the most powerful machines out of all the 720 members!

I'm glad someone else is prepared to put it on the line!

~ Jon
UK

Hi Jon !!

Yes, that's a huge difference !! The key is to warm the new engine up, then run it hard. Many people have thought that since the vehicles are ran this way at the factory, they are already broken-in. As you've found out that's not true, since each of the other 719 bikes were also run hard at the factory. That only starts the process, and as you now know, it's up to the consumer to achieve the ideal ring seal.

Before you tested the hard break-in concept, it would have been reasonable to say that 41 - 44 Hp is the standard of "full power" for the Kawasaki W650. From this limited perspective, everyone would be happy.

But, since your engine is delivering its true potential, your bike has become the actual standard of what "full power" really is. The new (big picture) perspective now becomes: 719 engines haven't developed full power. That's a big paradigm shift.

That paradigm shift is the reason so many people are now discovering Power News. Congratulations, and thanks very much for your support !!

Sincerely,
~MotoMan

P.S. To the Australian race car tuner: My "hat's off" to you !!

She's Learning Fast ...

Hi Motoman,

I am a 21 year old female who has never had any interest in motorcycles. In fact, I even hate driving cars and do so about once a year (or less). However, I decided to buy a motorcycle and to hell with my narrow-mindedness. I've been reading motorcycle-related material on the web all day, but I am totally lost. I know nothing, and I mean NOTHING about motorcycles. They all look the same, I have no idea how they work (or any engine for that matter), and it is a wonder how anyone actually manages to drive them. All the abbreviations and codes are a complete mystery to me. Also, some sites contradict each other – adding to my confusion.

I read all of your newsletters because—well--they're fun to read, and after a while I found that I understand about 35% of the technical stuff. This is very encouraging. I understand, of course, that yours is the wrong site for a beginner to learn the basics, but I was hoping you could help me.

I'm not stupid, just not-so-mechanically-inclined, and I could use all the help I can get.

Self consciously yours,
~Ilana

Hi Ilana !!

Thanks for your comments, it's very encouraging for me to read them !!

Even if you never plan on working on cars or bikes, understanding how they really work will save you a lot of money, whether you're buying a new or used vehicle. You'll also gain valuable insight into how to dramatically increase your engine's life ... without even getting out any wrenches !! That's why I think that Power News
is the best place to learn the basics about engines.

As a bonus, it will help you avoid being ripped off at the mechanic's -- something that happens to a lot of men too, although we don't like to admit it. ;)

The only thing I would add is that if you get a new bike and you want to break it in right, I'd suggest having an experienced rider do it ... running a motorcycle hard is not my recommendation for a new rider !!

Sincerely,
~MotoMan

The Challenge:

After reading this issue, I will guarantee that Ilana will have a better understanding of how engines wear than most experts, including many Factory Race Team tuners !!

Investigative Journalism of Journalism

Now we're going to examine how and why the perception of "expert" status in the media can so easily fool the general public ... as well as most engineers, and even professional tuners at the top (factory) level of competition !!

Think: Outside of the Box !!	The #1 (unwritten) rule of journalism: **Never Upset The Advertisers**

The #1 rule of science: **Always Consider Alternate Explanations** Even if it means having to rethink what we already knew.	Think: Outside of the Box !!

"They couldn't all be saying it if it wasn't correct."

We have a natural tendency to automatically trust the "official" media.

Another common perception is that when a particular bit of info is repeated in multiple sources, that fact alone proves that the info is true.

As many have noted, my conclusions about most tech topics haven't at all matched up with the information written by other magazine tech writers. The difference is, Power News goes beyond
written ideas by comparing those ideas against **actual** physical observation and testing.
This is just a basic principle of good science.

Because of the difference in conclusions, the info presented here has been heavily debated and often sharply criticized on hundreds of motorsports discussion forums !!

I encourage readers to post the Power News articles on discussion forums and let everybody
Rip 'em up & Tear 'em apart ...
... because whether this info is right or wrong, sooner or later some logic will begin to surface !!

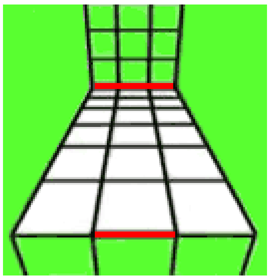
Isn't that the way things should be ??

Thinking outside of the box is usually associated with creativity, and doing things in a new and improved way. (Right side of the brain.)

But, the left (Logic) side of the brain can be seriously limited by *in the box* *thinking*. Some can't see the possibility that there might be another, even more logical explanation for things, and this limitation can be easily exploited.

Try this perceptual test:

Without measuring them,
can you see which of the 2 red lines is physically longer ... the top one or the bottom one ??



Before you look at the answer below,
double check it one more time, (but don't measure them yet !!)

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Surprise !!

These are the same 2 red lines, all I did was to remove the distracting elements that
symbolize depth of field.

Amazing isn't it ??

Without measuring them,
can you see if there is a difference in their lengths ??

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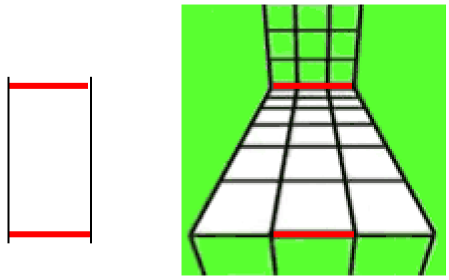
It may have seemed impossible when you first looked at the original picture, but it's true ...

the bottom line was actually longer the whole time !!



With the addition of the parallel lines, it's easy to see.

It Was Our Perception That Was Fooled, Not Our Eyes !!

These things are called optical illusions, but they should really be called Perceptual Illusions, because the problem isn't with our eyes. The symbols created by the converging lines tricks our brain into taking a mental short-cut, and we interpret the visual information incorrectly.

Observation, in the form of actually measuring the difference confirms the illusion. (Please don't take my word for it, measure the lines in the original picture for yourself ... this is important !!)

Of course, we aren't stupid for being tricked by perceptual illusions, it's a normal thing !! But, notice that once you became aware of the perceptual problem, it became easier to see that the top line is at least not as long in the original picture, as it seemed the first time you saw it.
When you become aware of a particular perceptual problem, you're less likely to be tricked by it the next time.

Ironically, We Often Learn To Take Mental Short-Cuts In School !!

In school, most of the information we read is in textbooks, which are automatically assumed to be 100% correct. This effectively trains us from an early age to read for one just thing ... the memorization of facts. Once out of school, as long as information seems prestigious, it never occurs to most people that it should be questioned or analyzed.

Thinking is much more than just memorizing and repeating facts, but unfortunately, most formal educational systems measure and reward their students only according to their ability to memorize and repeat information. **That's good, *but it's not actually thinking.***

This substitute for thinking usually becomes a lifelong habit -- a habit which invites perceptual problems !! Taking mental short-cuts severely limits our ability for rational thought.

What Does This All Have To Do With Engines ??

In this issue we're going to examine 2 articles which have been cited as intelligent and sane break-in information, especially as they pertain to main and rod bearings.

One was written by the most well known tech writer in the US motorcycle magazine business, and both have quoted famous factory team race tuners as their proof.
Expert status and prestige make it extremely difficult to focus on the logic.

The problem is, these articles (and others like them in the auto world) have been uncritically read and successfully memorized. The facts contained in them have been in turn passed on to millions of people. As far as I know, these facts have never been questioned in a widely read publication.

Warning:
These articles have been endorsed by many with a high level of education in science and mechanical engineering, and many highly trained professional mechanics !!
Most experts agree that these articles contain solid, scientifically sound information.

The Next Door Neighbor Critical Reading Technique

A quick read of these articles won't reveal any problems, but a careful read will reveal lots. The amazing thing is, you don't even have to know that much about engines to notice some of the problems, if you use my critical reading technique.

This technique is simple in concept, but it takes practice before it becomes easy to do consistently. The trick is to remove two of the most powerful perception distorting symbols -- expert status and prestige ! This makes it easier to consistently perceive reality using logic outside of school ... where it counts in the real world.

So, when you read these 2 articles, pretend that they weren't written by famous, well respected tech writers and published in 2 well established, widely read magazines.

Instead, pretend they were written by ...

... your next door neighbor on a piece of scrap paper !

No Disrespect !!

This technique isn't meant to disrespect the magazines, the authors or the quoted tuners. The idea of critical reading isn't to criticize people, it's to critically examine the ideas. (I suggest using the next door neighbor reading technique with my writing, as well as everything else
you read !!)

My personal opinion is that Kevin Cameron writes the most interesting tech articles, and I'm a big fan of his articles dealing with the nostalgia and the old days of racing. But, that doesn't automatically mean that all of his technical information is correct.

(Note: when you click on the links, these articles will open up in a new window.)

Here's the first article. It was featured in the 1995 Sportbike Annual and it's entitled
"It's New, It's Pristine, How Long Do You Have To Baby It ?" :
http://www.dezmo.com/breakin.html

The second article is an excerpt which was featured in the Feb. 1991 issue of Motorcyclist magazine and it's entitled "Give It A Break-In".

Important -- the longer excerpt, which is the one we'll be studying here, is the **second post** down on this page:
http://www.kawiforums.com/forum/topic.asp?TOPIC_ID=1380

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2 Important Notes:

1) I hope these articles stay on the internet for the future readers of this page, but because of possible copyright issues, the links to these articles may become unavailable. (Under fair use copyright laws, it is only legal to quote parts of an article for evaluation purposes, so I'm not going to be posting these entire articles on this site.)

This Power News article will concern the bearings only. In future issues, we will be referring back to both of these break-in articles on the topics of ring sealing and other aspects of their information. For this reason, I suggest either printing them out, or saving the text of these 2 articles as a document on your computer for future reference, in case the links disappear.

2) Some people haven't noticed any difference between my break-in method and the method described in these articles.

Although these articles recommend a slightly "harder" break-in than the owner's manuals do, I'm saying that an immediate hard break-in is required for the exceptional ring sealing benefit, and as long as the engine is warmed up first, this won't cause any damage; whereas they are recommending first running gently for a while before running moderately hard to avoid severe damage. The problem is that this completely misses the exceptional ring sealing benefit, which is the whole point of my break-in procedure.
The time frame and the damage warnings make these 2 articles the total opposite of *Break-In Secrets*.
This is why I will be referring to them as "easy break-in" articles, so there's no confusion as to the difference.

Many people have tried to "mix" the 2 break-in ideas by first doing an easy initial break-in, ("just to be safe") and then after a while switching to my method. They've been disappointed when they found that there wasn't a significant power gain, and many have decided that they might as well have followed the owner's manual. If you understand what just happened, you'll realize that what they really did, was *exactly what is described in the easy break-in articles !!*
The method described in those articles will produce nearly the same results as an owner's manual break-in.

Once the engine has some easy initial mileage on it, it may help a little bit to run it hard. It's definitely better late than never, but it's not going to make the remarkable difference that so many people are now discovering.

The reasons for this as well as my explanation for how rings seal will be illustrated in future articles with diagrams and animations.

Today's article will address the widespread misunderstanding about how bearings work, as well as the "severe damage" question as it pertains to bearings during new engine break-in.

The Problem With Non-Critical Reading ...

This comment was posted on a popular motorsports forum by a degreed mechanical engineer in regards to plain bearings and why they require a long, gentle break in:

"The new bearings are shedding their surface layers as they become intimate with the journals."
If our "next door neighbor" had written the above comment, someone would have challenged it. Because of this person's expert credentials, the debate process just stopped cold.

For another variation of the "expert phenomenon." Here are 2 different comments on 2 different forums about *Break-In Secrets* VS *How Long Do You Have To Baby It* :

#1: " I ran across an article on the subject by Kevin Cameron. I like his articles because he always seems to know what he is talking about, and because he provides meaningful technical explanations as opposed to just leaving the reader to wonder why this and why that. "

#2: " I think Cameron (one of the most respected motorcycle engineers) and Muzzy (one of the most respected motorcycle builders/tuners) take top honors out of everything posted in this entire thread. It's up to you who you want to believe but I'll continue listen to the most educated ones. "

Here's a 3rd common variation of the "expert phenomenon", posted about the *Break-In Secrets* article VS the owner's manual on yet another motorsports forum:

"Why haven't you read your owner's manual? Can't you read? Take it easy for at least 500 miles. The engineers who actually designed your bike know best, everything else should be considered snake oil.*

* Note: "Snake Oil" is a slang term usually associated with unscientific and unethical marketing.

At this point, a good question would be*... do the engineers who actually design the vehicles know things that they aren't telling us in the owner's manuals ??*

Do Ball Bearings Require Break In ??


A ball bearing assembly


The Ball Bearing Manufacturers Polish Their Balls.

Even in this low-resolution photo, you can easily see the reflection of the camera lens.

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Ball bearings are among the most closely dimensioned parts in the world of manufacturing.

Ball roundness and size as well as surface finish are held to a micro inch specification.

1 micro inch = 1/1,000,000th ...
... one-millionth of an inch !!

The races that the balls run in are finished to this level as well.

I'll admit, I can't think of any reason that they should require break-in.


A typical ball bearing assembly used on the transmission shaft.

The wheel bearings used in motorcycles are of the same basic design.

Turbochargers

This has particular significance for turbo cars.

The consequences of an easy break-in for a turbo vehicle can be even more serious than in a naturally aspirated vehicle.

One of the justifications for an easy break-in with a turbo vehicle is that the ball bearings in the turbo unit need to be gently broken in. Does anyone know a reason as to why this should

be true ?
I'd like to discuss this topic in a future issue.

How Do Plain Bearings Work ??

A main bearing (left) and rod bearing (right). They just can't wait to get to work !!

Before I took apart my first engine, I imagined that the bearing itself was some sort of anti-friction device. This incorrect idea came from the more familiar ball bearing -- in which the rolling balls themselves do function as an anti-friction device.

I had formed the wrong mental picture.

Instead, it helps to think of plain bearings as a sleeve or an insert.

How Do Plain Bearings Fit, And Stay In Place ?

Rod Bearings:

The tab on the bearing insert fits into the notch in the rod. This locates the bearing in the center of its housing.

Main Bearings:

The picture below may look intimidating if you're not familiar with engines.

It makes it a lot easier to think of the 2 crankcase halves as in the same way that the 2 halves of the rod assembly go together.

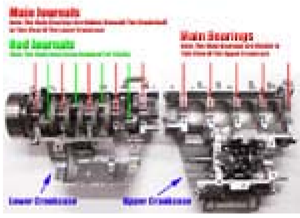
When the rod cap installed, the complete bearing is formed. In an actual engine assembly, these 2 halves are connected onto the crankshaft journal.

(The word "journal" means the crankshaft's running surface for the bearings.)

The main bearings are located in the crankcase with the same tab / notch system.

Here's how the rod connects to the crankshaft journal. The rod on the left is unassembled with the cap and nuts. The rod on the right
is bolted in place.

Notice that those pistons had an excellent ring seal.



As you look at this picture, you'll see that there are really only 4 different parts to the main bearing arrangement: the crank, the bearings,
and the 2 cases which form the main bearings' housing.

(There are many other engine parts missing here -- this is to make it easier to see only the main bearings and the crankshaft, and how they fit together.)

Just like the rod bearings, the main bearing halves go together to form a complete bearing shell which surrounds the crankshaft journals.

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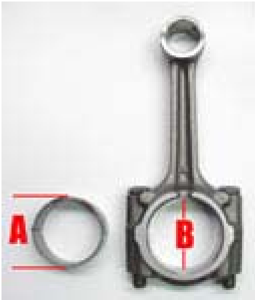
Bearing "Crush" ...

The outside diameter of the 2 bearing shells are slightly larger than the housing they fit into. This creates an interference or press fit, which is known as "bearing crush". When the assembly is bolted together, the bearings are forced outward to give a positive contact with the connecting rod, or in the case of main bearings, the crankcase block.

Note: this picture isn't visually accurate, it's more to illustrate the conceptual idea. As you can see, before the bearings are installed, the bearing shells are wider than they are high. This is because the bearings also have a spring effect, which makes them press into the bearing housing.



The point is that once the bearings are installed into their housing, the dimension "A" of the bearings is slightly larger than the dimension "B" of the big end of the connecting rod. (This is also true of the main bearings and the housing formed by the crankcase.)

This picture of the rod's lower cap illustrates the crush concept. If you look closely, you can see that the end of the bearing insert is sticking up above the rod cap slightly.

I purposely pushed it up a little more than it is in actual reality, to make it easier to see in a photo.

The bearing "sticks up" like this in both the upper and lower part of the rod, and when the parts are bolted together, the bearing shells are "pressed" in what's known as an interference fit.

In the same way, the main bearings use crush to achieve a press fit within the crankcase halves.

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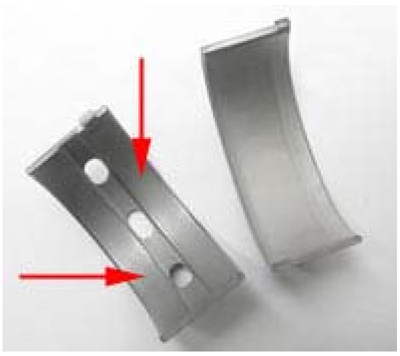
By using the tab/notch system and crush, the bearings are securely locked in place within their housings.

The Bearing Surface

The main and rod bearings work in a similar way. One exception is that the main bearings have holes in them, and an oil channel machined down the middle. This is how the oil gets into the plain bearing system which will be explained later on this page.

In some engines, some of the main bearings don't have oiling holes. The reasons for this are outside of the scope of this article, but the short answer is that there's just a slightly different oiling path. Even in those engines, the other main bearings have holes in the like the one shown here, and that is how the oil is introduced into the system.

In the majority of late model motorcycle engines,



The running surface of the rod bearing is over the entire width of its surface, while the main bearing's running surface is only on the 2 outer sections indicated by the arrows.

all of the main bearings have oiling holes, like the one pictured here.
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(The oil channel in the middle is below the running surface.)

How Does A Plain Bearing Reduce Friction ?

In use, the bearing itself doesn't have any friction reducing characteristics. Rather, the system uses the unique properties of liquid (oil) as the anti-friction "device":

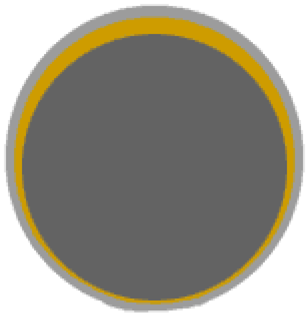
In this animation, the oil clearances have been greatly increased to give a clear view of the oil film's dynamically changing dimensions between the bearing and the crank journal.

(The average normal oil clearances for main and rod bearings are around .002 inch / .05mm.)

The bearing itself doesn't "do" anything. The crank journal surface floats above the bearing surface, on the oil film.

(This assumes proper oil pressure, bearing-to-crankshaft oil clearance and correct bearing installation.)

The crank journal is dark gray, oil is dark yellow,
and bearing is light gray.



As the engine rotates, the crank journal goes "off-center" within the surrounding oil supply. Although it can move within the dimensions of the volume of oil, the crank journal surface itself never contacts the bearing.

Both main and rod bearings work this way.

Bearings are fed pressurized oil. This pressure is critical, because although the crank can push the oil aside, it's the pressure which keeps the crank from breaking through the oil film to contact the bearing.
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At first appearance, this system seems like it shouldn't work.

It works only for one reason:
Oil, like all liquids, is non-compressible !*
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* In theory, even solids are compressible, as in Black Holes in outer space. These are forces which are far beyond the ones we're dealing with in engines. Under laboratory conditions,

liquids are slightly compressible. The pressurized fluid loses only a micro percentage of its volume
when it is squeezed with extraordinary pressures.

In real world applications, this has no measurable effect on hydraulic systems. This is why, although from a strictly theoretical scientific viewpoint, liquids are considered compressible -- in engineering applications, liquids are considered non-compressible.

The Power of Hydraulics 1

I had the opportunity to test the power of hydraulics by digging gigantic rocks at the Arctic Circle Raceway in Norway. I was amazed at how easy it was to learn to operate this huge machine, and the ease with which I could toss around mega-ton boulders, as if they were little pebbles.

Of course, the power to do this comes from an engine, but the reason it's possible to lift such a heavy load, is that the power is transmitted through the hydraulic fluid which in turn lifts the shovel.
The shovel would just collapse under the heavy load, were it not for the non-compressible qualities of liquids.

Many big name race teams just put some stickers on the race vehicle and consider that "promotion".

This is by far the most impressive sponsor promotion effort I've ever seen:

KOMATSU

Check Out These Websites To Learn More:

For Komatsu Sales In Norway
http://www.hesselberg.no

Arne Sandum
Sales Manager

For Komatsu Sales Worldwide
http://www.komatsu.com

(The 2 links above open in a new window.)

Team Komatsu-Yamaha Norway
By letting the race fans try out the equipment, 2 Time Norwegian National Roadracing Champion **Dag-Steinar Sundby** and his team have done an outstanding job of promoting their sponsor !!

MotoMan "Digs" Komatsu !!!
The thing that really impresses me about Komatsu is their commitment to long term reliability.

Check Out Their Automatic Grease Injection

If you're in the market for heavy equipment,

please consider the purchase of a Komatsu !!
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The Power of Hydraulics 2

Hydraulic Lock -- this happens when an engine's cylinder is filled with gasoline from a leaking carburetor float valve. When one attempts to start such an engine, the non-compressible fluid stops the piston. If the battery is strong enough, the connecting rod will transform from a useful engine part, into an interesting "S" shaped sculpture worthy of an abstract art gallery !!

Liquid makes an incredibly strong bearing.

The Ingenious Design Concept of Plain Bearings

Plain bearings are designed with the idea that, should failure occur, the expensive crankshaft will be unharmed, with the damage limited to the inexpensive bearing insert.

In actual practice, this is true to a point, but if the engine is allowed to continue to run much after the bearing is damaged, the crank will soon be damaged as well.

Embed-ability

The babbit layer is about as soft as lead, and it can be easily scratched by harder metal.

This is by far the softest metal in an engine.

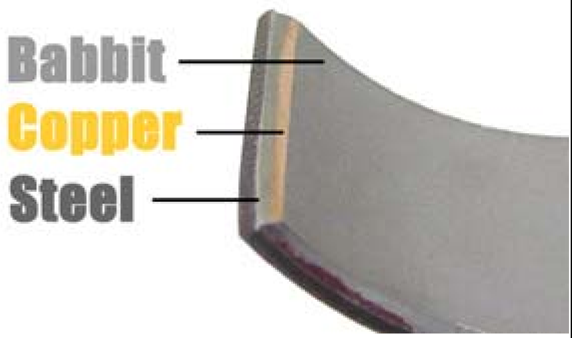
The purpose of this soft metal layer is so that any metal fragments in the oil supply will embed into the soft bearing, leaving the expensive crank unharmed.

The copper layer is harder, making it an ideal 2nd layer material. It's hard enough to support the babbit layer, while it's soft enough to allow it to "give" when a bit of metal is embedded in the babbit layer.

The steel layer gives the bearing its strength and "spring" so it can be installed with a slight interference or press fit into its housing.

Because of the embed-ability requirement, the bearings are fragile. If there is crank journal to bearing contact while the engine is running, the soft

3 Metal Layers



The copper layer looks thicker than it really is ... because I cut the bearing at an angle to make it easier to see the layers in the photo.

Also note the magenta-red paint marking on the side edge. This is to indicate the bearing's thickness. Bearings typically come in 4 or 5 sizes to accommodate slight differences in crankshaft journal diameter.

Note: The size differences for motorcycle engines are extremely small, approximately .00016 inch / .004 mm for each size increment. Some car bearings have a much larger range of sizes. This difference has caused much confusion in the motorcycle world, and this subject will be covered babbit layer is easily damaged.

in the next issue.

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It Really Works ...

This bearing surface has very effectively "absorbed" some metal bits. As you can see, there wasn't any scoring around the bearing. If the metal surface of the bearing were hard, any debris in the system would ultimately score the expensive crank.

The only drawback to this design concept is that as more and more bits are embedded, the bearing surface immediately surrounding the embedded bit raises, and tightens up.

Eventually, if there is enough loose metal or grit embedded into the bearing surface, the overall clearance can get tight enough to cause metal to metal contact with the crank journal, resulting in bearing failure.

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Embedded Metal Bits In A Main Bearing.

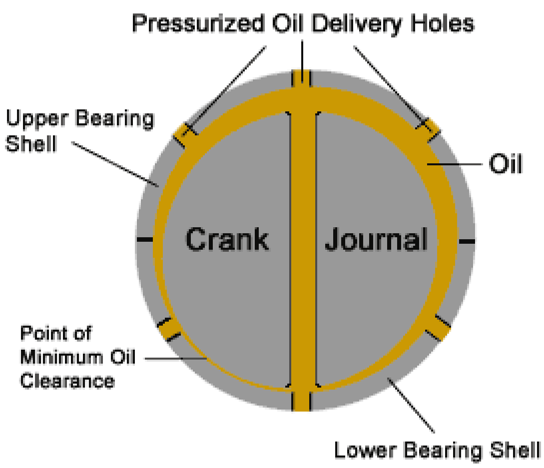
Main Bearings

The main bearings' oil comes from the crankcase, and enters into the bearing shells, through the 3 pressurized oil delivery holes in each bearing. (In the diagram, the 3 holes at the top are marked, but there are also 3 more holes in the lower bearing shell.)

Like the earlier animation, notice that as the crank rotates, the journal is "off center" within the oil clearance. The forces on the crankshaft cause the journal to displace oil within the "container" formed between the journal and the bearing, but it can't physically compress the pressurized oil.

(Again, the oil clearance dimensions have been increased for illustration purposes.)

After the oil flows between the bearings and the journal, the next route of its path is into the hole represented in the center of the crank journal. This hole leads the oil to its next destination ...



Note: As mentioned earlier, in some engines just one main bearing in the pair has oil delivery holes.

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The Oil Path Within The Crank

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The oil flows from the main journals marked "A", to the rod journals marked "B", through the passages drilled within the crank, (denoted with a red line).

The direction of oil flow is indicated by the green arrows.

This is a clever system, because it isn't practical to have the rod bearings' oil supplied from a static source the way the mains are, since the rods are moving over a large area.

Another interesting thing about this is how the passages are created. The crank can't originally be made with internal connecting holes, so they have to be drilled from the outside. The outside of these holes then have to be plugged, to form a closed system. The hole is plugged with a ball, and then the metal around it is peened over to keep the ball in place. The balls are marked "C".

(As you can see in the photo, the inspectors at the factory double check and then paint the ball areas to signify that they've been securely peened over. A loose ball would be a disaster !!)

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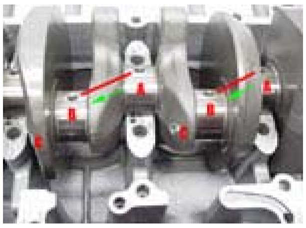
Oil Passages Within The Crankshaft:



With the connecting rods removed, it's easier to see how the oil flows.

The oil enters the crank through the main journal holes "A", then exits the crank from the rod journal holes "B".

Because of the direction of oil flow, if there is any debris inside the crankshaft oil passages, the main bearings aren't affected, but the rod bearings will be damaged.

Because they get their oil supply after the main bearings, this is one reason rod bearings are the weakest link in this system. If there's a loss of oil pressure, the end of the system is affected first, so the rod bearings are the first to suffer from oil starvation.

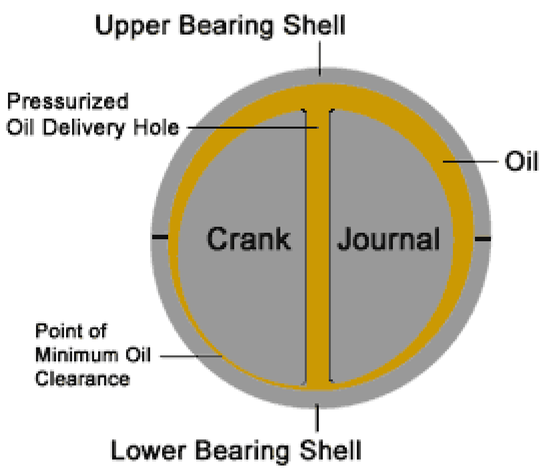
A second reason is that the force of the power stroke bears down on just 1 rod bearing, while the same force is always shared by at least 2 main bearings. In a 4 cylinder engine the load is spread over 5 or 6 main bearings (depending on whether it's a center cam chain tensioner or end cam chain tensioner design.) This stress on the rod bearing, combined with being the last to receive oil, are 2 problems that the main bearings don't have.

Rod Bearings

Whereas the oil supplying the main bearings went from the cases into the main bearing / journal interface and into the crankshaft -- the rod bearings' oil supply direction is just the opposite. It comes from inside the crank and is forced outward between the rod bearing and journal.

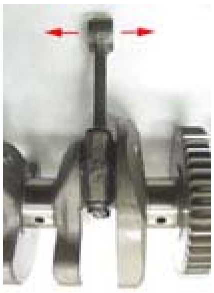
The oil delivery is in reverse, but the action of the journal "trying" to squeeze out the excess oil, and meeting an uncompressible pressurized oil film is the same as it is with the main bearings. As you can see, there are no holes in the rod bearings, since the oil is fed from within the crank.

The occasional exception to this is some engines which have a very small oil hole going through the bearing and the upper rod where the beam meets the upper bearing housing of the rod. The purpose is to spray a jet of oil up to lubricate the cylinder walls, pistons and rings.
..



Where Does The Oil Go Next ?

If you've never dug into an engine this "deep", you may be surprised to find that the connecting rod can be moved from side to side quite a lot !!



At first it seems so wrong !!
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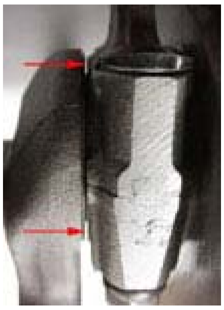
It does seem "wrong" but, this rod side clearance is required, because it's the only "escape route" for the oil on most engines.

It's also the way the piston and rings are lubricated.

The pressurized oil leaves the rod bearing - crank journal interface through this clearance, and the oil sprays up to lubricate the piston, rings and cylinders. The oil then drains down to return to the sump at the bottom of the engine,
to start the cycle over again.

Note: as mentioned above some engines use an oil hole, but these designs also have some rod side clearance.



Here, I've pushed the rod to one side so it's easy to see the clearance between the rod and crank cheek.

On most motorcycles, this clearance is .004-.006 inch / .1mm-.15mm.

Larger motorcycles and car

	engines often have a bit more rod side clearance, but the principle is the same. .

" Break-In Secrets Part 5 "

Do Plain Bearings Require Break-In ??

What is Logic ??

You've probably heard people say "that doesn't seem logical", which is a misuse of what logic actually is. Logic isn't a feeling; and a statement all by itself is neither logical or illogical (although it can be true or false). True logic is the process of drawing a conclusion from premises, and it is set up kind of like a math equation. Unless all of the premises are correct, the conclusion will be flawed.

What is Circular Logic ??

Here's a common example:
Premise 1: Most mainstream motorsports magazines warn that you shouldn't run new engines hard right away, because that will cause serious damage.

Premise 2: Power News says exactly 100% the opposite of that.

Conclusion: Therefore, Power News is snake oil.

The problem with this argument is that it contains an *assumed premise*, which is, that these magazines know the full story and contain accurate technical information.

In order for the conclusion of a logical argument to be accurate, the premises must be proven to be true first.

One premise is absolutely true, and that's #2 !!

Let's examine premise #1...

1/2 The Story

What if a newspaper reported that a man jumped from the 100th floor of an apartment building, and miraculously escaped the ordeal with only a sprained ankle ??

But, what if the newspaper reporter didn't know that the man only landed on the balcony, 3 feet below the window he jumped out of ??

.

The other 1/2 of the story drastically changes the meaning of the entire story.

Quote from the Give It A Break article:

"... it's likely that a new bike was run at the factory ..."

This statement is very misleading, because it really downplays what actually happens.

**Power News readers are learning the other 1/2 of the story ...
the part which has been kept well hidden for over 20 years:**

This is like the famous scene in the Wizard of Oz when Dorothy got to see how it all works ... except this is real:

Those Disturbing Pixels of Debunkification

The bikes aren't just "likely" to be run at the factory, in fact ...

The factory technicians give all new bikes a
Full Throttle Max RPM Blast
through the gears !!

The magazine tech writers and the factory race team bosses and mechanics quoted in these articles don't know about this aspect of the manufacturing process !!!

It might seem unfair to say this, since these break-in articles appeared back in 1991 & 1995. But a close look at the new bike in the photo above confirms that it's an early '80's model !! I'm not exactly sure when the factories started doing this, but it's safe to say that this reality predates these 2 articles by a
very long time (at least 8 to 12 years respectively.)

My estimate is that some factories were doing this as long ago as the mid 1970's ... can anyone confirm ??

When we examine the information purely from the basis of mechanical logic, while keeping in mind
the info that the writers of the numerous easy break-in articles don't know about ...

... it becomes possible to understand the real logic (reasons) behind the modern easy break-in concept.

There are many levels of logic. Once one level is seen and acknowledged,
only then is it possible to examine logic on the next level higher.
(Seeing the bigger picture.)

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5 More Reader Reports:

New Nissan Cars Fully Blasted:

A number of years ago I was in Japan working for Nissan Canada and we were invited to visit an assembly plant. You should see the final road test they submit the cars to on a dyno. The driver floors the accelerator and takes vital statistics from dials for about 3 minutes. If they pass this test they are OK. The Japanese must be laughing when they read the lines about engine break in.

All of the motor vehicle industry insiders have been laughing at this situation ... for a long time.

New Ford Cars Fully Blasted:

I once took a tour of the Ford plant. The engines are all dyno tested and screamed to top RPMs at full throttle. That's when I knew the easy break-in engine damage warnings weren't true. The funny thing is that they checked my bag for cameras or video recorders -- that's not allowed !!

Why all the concern about video & camera equipment ?? If there's nothing to hide, why is there an effort to hide it ??

New Honda Motorcycles Fully Blasted:

At Honda at Marysville Ohio the new bikes are strapped to a dyno wheel and run to red line and at over 100 mph before it is crated up and shipped.

Didn't they read those easy break-in articles ?? After all, they helped pay for them.

Diesel Blastage @ Ford:

I can only speak for 1.8 Diesel for Ford as that's what I'm assembly engineer for, but once the engine is built its conveyered into a cell and then started. After idling for 30 secs (with a lot of auto checks on oil pressure, coolant temp etc etc) it's then taken up in 500rpm increments every 10 secs until the grand finale of 10 secs at max no load speed. I still cringed this afternoon when I walked past them screaming (as much as a diesel can) away. Of course, every so often half way through this a con rod will emerge from the side of the block but this is what the test is for, to show up any manufacturing defects.

Screaming Diesels !!

New Aprilia Motorcycles Fully Blasted:

Every bike that leaves the Aprilia factory (and every other OEM factory) goes through each gear to the {rev} limiter, no bull, its part of quality control.

Bikes used to come in without the high speed indicator reset, quite often the bikes would have 175mph on the dash. I saw a Factory {model type} with 182mph on it, and I know I sure didn't do it.

{Note: the 2 bracketed comments are my additions ~MotoMan}

I wonder how the guy whose job it is to full throttle redline new Aprilias all day breaks-in his family car ?? Does he follow the owner's manual and drive real nice and easy for 600-1,000 miles, to avoid severe engine damage ??

MotoMan

"Gee Whiz ... you can't really violate the logic of the easy break-in articles any more outrageously than that."

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When you think about it ...

The first running at the factory really is the hardest running most engines will ever receive.

Except for the small percentage of cars and bikes that are used for racing, the vast majority of vehicles on the road will never get the sustained full throttle, maximum RPM use that they experience in their

very first time running.

Let that idea soak in for a little while ... it's a real brain twister !

The Denial Mechanism Known As:

CD

Some in the motorsports press, have literally "scared people out of their minds" that engine damage occurs from running a brand new vehicle hard. Seeing all of this information now may cause the readers
of those magazines to experience an extreme perceptual illusion.
No one likes to think that they've been fooled.

Like an optical illusion, even the most rational, highly educated and otherwise intelligent people
will be able to see the words and pictures, yet still have their perception distorted by CD.
CD = Cognitive Dissonance. This effect completely blocks disturbing new information from entering the consciousness.
Just as if it never existed.

Some will immediately get over it and see the easy break-in deception for what it is. But, there's no question that others will come up with a powerful rationalization in order to keep on believing the myth.

Whatever the rationale is, it would have to also ignore the concept of cause and effect,
so it won't be a scientifically sound reason.

Here's one possibility:

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At the factories, there are magical **Dweeb-a-zoids** who send a re-integrating micro-particle beam, which fully protects the engines from damage, while they get pinned to the max and blasted into the stratospheric part of their rev band !!

Alas, the Magical **Dweeb-a-zoids** vanish the moment the vehicle leaves the factory.

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Those Rarely Seen Factory Dweeb-a-zoids

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But ...

Once you take ownership of the vehicle, the "still scientifically valid reasons" contained in the easy break-in articles will instantaneously go back into retro-effect !!

You see .... that's because for the next 600 - 1,000 miles, your new engine will be haunted by ...

The Evil Hobgoblins !!

.

The Evil Hobgoblins

Newly Revised Easy Break-In Warning:
Heavy throttle and high revs in the absence of the magical Dweeb-a-zoids will cause serious engine damage.
The Evil Hobgoblins will make sure of that. ;)

To be fully convinced, people have to really believe in an idea, not just mentally, but in their heart.
The statement below is effective because it evokes the most powerful emotion of non-thinking, which is of course:
fear.

A Frozen Moment of Crystalline Clarity

Quote from the How Long Do You Have To Baby It article:

" If the break-in begins at high RPM and heavy throttle, the process may generate more heat and metal debris than the system can handle. Then the result is destruction of contact surfaces in some parts of the engine. "

(Hey wait a minute ... that precisely describes what the factories have been doing for over 20 years !!)

(Hey wait another minute ... that precisely describes what is recommended in the *Break-In Secrets* article also !!)

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It's **Crystal Clear** that the manufacturers actions show that they don't agree with the destruction statement.
Of course they agree publicly, in an "official" sort of way ... but Power News isn't about fake "official" stuff.

Many people have asked me: "Why didn't you just reveal what goes on at the manufacturers in the *Break-In Secrets* article, since it would have made it much easier to believe ??"
Because this isn't about believing things, it's about understanding things.

This page is all about a higher level of thinking ... so in a way, revealing what happens at the factories
is taking a mental short-cut. Just knowing **what** they do, doesn't give us an understanding as to **why** blasting a new engine doesn't cause any damage whatsoever.

If we fully understand how bearings work, then we will come to the same conclusions that the factory engineers did regarding bearings and break-in, without even knowing the other 1/2 of the story or having to personally visit a factory !!

In other words:

Is it possible to just "think out" the bearing part of the break-in secret without the luxury of knowing this hidden information ??

Yes !!

I figured out that the manufacturers blast the new vehicles 12 years before I heard about it from eyewitnesses or had photographic evidence of it. This is what science is all about -- thinking things out using logic and observation, without having to be told by someone who's widely perceived as an expert.
It's not about me being the perceived expert ... it's about you being a real expert !!

Quote from the How Long Do You Have To Baby It article:
" ... bearings spin without metal-to-metal contact, on full oil films "

(Note: in the article's context, this means "after the break-in process is complete.")

Oil, like all liquids, is non-compressible !

This quote brings up 3 questions:
1) Do the bearings spin with metal-to-metal contact in a running engine ??

2) Do they spin on anything less than full oil films in a running engine ???

3) *Come to think about it .... do main & rod bearings even spin* ????
Not to be confused with the term "spun bearing" which means a ruined bearing.

Do the main bearings spin (rotate 360 degrees continuously) ??

No, the main bearings don't spin ... they don't move at all !!

.
The main bearings are in a fixed position in the crankcase, the main bearings don't rotate.

Although it's not possible to see the lower main bearing shell in these pictures, I've painted the area they are fixed to green, to make their non-moving status more apparent.

(In a running engine, the upper case would be in place, which forms the other half of the complete bearing surrounding the crankshaft.)
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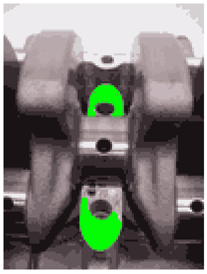
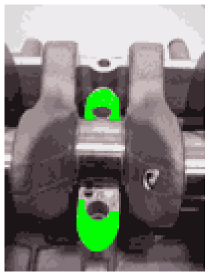

The main bearings simply support the crankshaft as it spins continuously within the bearings, but the bearings themselves don't move.

Do the rod bearings spin (rotate 360 degrees continuously) ??

No, not all all. In fact a close examination reveals that for nearly 50% of the time, rod bearings rotate ...

... backwards !!

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Backwards ??

Here the rod bearings are green -- notice that they only rotate about
15 degrees, or 1/24th of a turn, pause and then rotate about 1/24th of a turn
backwards in the opposite direction !!

The process is repeated for a total of 4 back and forth movements
per each full revolution of the crankshaft.

Remember that since the bearings are in a fixed position, they move along with the rod. If it's hard to see that the bearing rotates backwards, try concentrating only on the change
in the angle of the connecting rod as you watch the green bearings.

The crankshaft's rod journal is colored red. This makes it easier to see that the crankshaft
and its journal are all one solid part which rotates continuously in one direction within the rod bearings.

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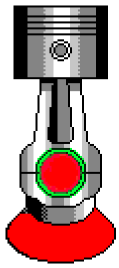


Practice making more complex visual mental images !!

The next (much more challenging) step is to visualize what an actual engine looks like as the rod rotates backwards. Make the picture in your mind complete with metal, oil, and especially the movement of the parts. Eventually you'll find that it becomes much easier to make mental pictures even to the point of simultaneously visualizing the incredibly large number of complex events happening in a running engine !!

People who are capable of doing this have an immense advantage, but it takes practice.
This is the secret to your becoming an exceptional engineer / mechanic !!

Why Is It Important To Understand The Concept Of The Rod Bearings' Backward Motion ??

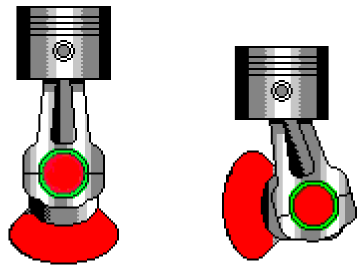
Because we can now examine one of the *least understood reasons* why the rod bearings are more failure prone than the main bearings are.

This is a more challenging concept to understand, because you've really got to study the still pictures and make a mental image of 2 moving things at once (Right side of the brain)

while at the same time you have to think about what's logically happening
(Left side of the brain):

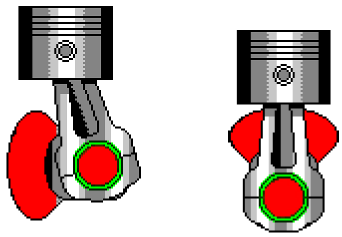
As the piston descends from the top to 1/2 its stroke, the crank is rotating clockwise while the rod bearings are rotating counterclockwise. The speed differential between the bearing and the journal is dramatically increased !!

(To see which way the rod bearing rotates, it helps to focus on the line that represents the split between the upper half of the rod and its lower half.)



Increased Surface Speed Differential

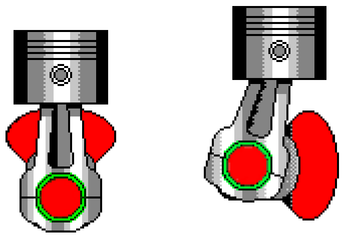
As the piston descends from 1/2 its stroke to the bottom, the crank is rotating clockwise while the rod bearings are now also rotating clockwise. The speed differential between the bearing and the journal is now dramatically decreased !!



Decreased Surface Speed Differential

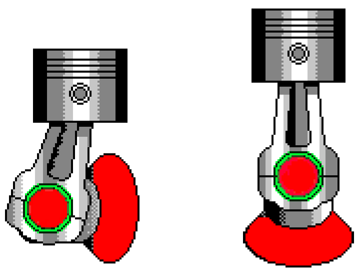
As the piston ascends from the bottom to 1/2 its stroke, the crank is rotating clockwise while the rod bearings are also rotating clockwise. The speed differential between the bearing and the journal is the same as the frame above -- decreased !!

(Note: decreased in relation to the first frame.)



Decreased Surface Speed Differential

As the piston ascends from 1/2 its stroke back to the top, the crank is rotating clockwise while the rod bearings are now rotating counterclockwise. The speed differential between the bearing and the journal is again dramatically increased !!



Increased Surface Speed Differential

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So, while the main bearing to journal speed is constant at a given RPM, the rod bearing to journal speed is actually much faster during 2 key portions of the engine cycle at the same RPM !!

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Why Do Rod Bearings Usually Fail First ??

Now we have 3 reasons why rod bearings are more stressed than main bearings. If a main bearing and a rod bearing had identical friction problems, the rod bearing will fail sooner than the main bearing would.

To summarize:

1) Rod bearing frictional problems are magnified because of the higher speed differential during the 2 "backwards acceleration" points shown above.

2) Oil delivery gets to the rod bearings last. If there's a loss of oil pressure, or an obstruction in the oil delivery path from the main to the rod bearings, the rod bearings are the first to suffer from oil starvation.

3) The force of the power stroke bears down on just 1 rod bearing, while the same amount of force is always shared by at least 2 main bearings.

This Next Concept Really Rocks !!

The 2 times that the bearing's speed in relation to the journal surface is increased, also happen
to be the 2 most stressful points in the 4 stroke cycle. These 2 points are the first half of the power down stroke, and the last half of the exhaust upstroke.
It's important to understand this, because it makes reason #1 above even more serious.

The forces involved in the power down stroke are obvious, but can you see why the last half of the exhaust upstroke is such a highly stressful point in the 4 stroke engine cycle ??

Why ??

The last part of the exhaust stroke is stressful, because there is nothing to "cushion" the G- forces of the weight of the piston and rod !!

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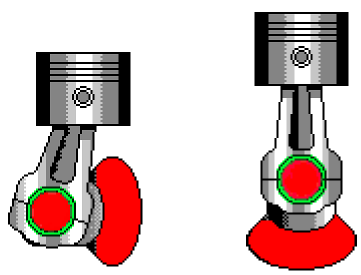
The common misconception is that the piston pushes out high pressure exhaust gasses. Remember from the *8 Phase Motor* article, that during the physical exhaust stroke the piston doesn't push out high pressure exhaust gasses !!

By the time the piston is going up, most of the exhaust pressure has already been released. In fact in a really well tuned engine, the exiting exhaust gasses create a low pressure condition in the cylinder which actually **pulls up** the piston.



The last half of the exhaust upstroke, from the picture on the

For these reasons, the connecting rod experiences extremely high inertial loads at the very top of the exhaust stroke. The weight of the piston and rod assembly is unopposed, and the G- force yanks up on the rod cap ... **Hard !!**

At high RPMs, this loading stretches the rod and pulls the big end out of round causing it to squeeze inwards across the rod's horizontal parting line. (Dimension "B" in the photo to the right.) This stretching and return to normal shape happens on every 4th stroke of the engine cycle during high RPM !!

It's incredible to think about --
At 15,000 RPMs, that's 125 times a second !!

If "wearing in" the bearings during running to make them fit properly were a realistic option, the bearing's inner diameter could just be worn in to the correct dimensions during "break-in".

When early auto racers first experimented with higher RPMs, the rod bores stretched which caused the previously untouched horizontal portions of the bearings to wear.

You can imagine the result. As soon as the babbit metal wore, it spread across the bearing, heated up and caused massive engine failures.
Many early tuners got scared of high RPMs, and with good reason.
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left to the one on the right is the number 1 stress point in the 4 stroke engine cycle !!

In this photo, the image of the rod on the right has been modified in Photoshop to illustrate the effect high RPM stretch has on the big end
bearing's bore.

When dimension "A" is increased, dimension "B" becomes smaller.

(Note: the dimensions have been greatly increased to make it easier to see this effect.)

The Solution:

Strange but true... "Oval Bearings" !!

Since metal to metal bearing contact in a running engine quickly leads to failure, bearings are designed so that even at maximum RPM, there is never any metal to metal contact.

It was found that a slightly oval bearing inner diameter is required to compensate for the high RPM stretch of the bearing housing ...

.
The bearing wall is thinner near the ends of the bearing shell than it is in the center section. This section corresponds with the horizontal split between the full circle formed by the 2 bearing shells, providing extra clearance, so that when the rod bore pinches inwards, there is no contact with the crankshaft journal during the high RPM exhaust upstroke.

A ball is required to measure the thickness of a curved surface like a plain bearing. While this won't give the absolute thickness of the bearing, it shows the comparative difference between the 2 measurements. (For the absolute thickness, just measure the ball and subtract the difference.)

When using a micrometer, it's important not to get any heat from your fingers into the micrometer, or the part being measured !! The heat will expand the part or the micrometer which will make the measurements inaccurate.

..

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Different engines have different amounts of "bearing ovality", which is matched to the engine's RPM and the weight of its piston and rod assembly.

In the case of the Yamaha R6, the difference is quite a lot -- approximately .0017 inch. Since the clearance is on both sides, this means that there is a total of .0034 extra horizontal oil clearance to allow for a rod-ovalling 15,000 + RPM !!

If you have a micrometer, please don't take my word for it. By all means, buy a rod bearing
for your favorite vehicle and measure this difference for yourself !!

Since the rod transmits the upward G- forces to the crankshaft, the main bearings also have the same "oval" design. I'm suggesting using a rod bearing for this experiment only because it's much easier to get the ball in place for the measurement, since rod bearings
have no center oil channel.

It can be really tricky to keep the ball from rolling away as you place it between the bearing and the micrometer !!

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Why is it so important to measure (test) things for yourself ??

The (symbolic) power of prestige has a very powerful effect on preventing new information from being known. (One famous tuner teaches the unquestioning next person who becomes the next famous tuner who teaches the unquestioning next person etc...)

This might not seem like a fair statement, since these easy break-in articles appeared in the 1990's, and this bearing is from a 2000 model. Believe it or not, the oval bearing solution was developed in the auto racing scene ...

... *during the 1950's !!*

In this case, the conditions of the experiment began to change way back when Elvis was the man on the radio. 50 years later, many scientifically educated engineers, mechanics and race tuners still haven't observed this change.

The most important concept of science isn't memorizing facts, it's observation of phenomena.

Throughout history, most of the really big innovations and inventions were made by people who rejected the idea that people should be trained to think a certain way.

In the 1950's, thousands of professionally trained automotive engineers thought that engines couldn't be revved any higher. Guess who found the solution ?? A "non-trained engineer" who was able to think freely !! Had everyone just "Stayed In The Box", the 15,000 RPM plain bearing production engines that we now take for granted -- wouldn't be possible !!

By saying this, I don't mean to imply that formal engineering training is unimportant -- it's very important. But, it's equally important to keep an open mind, as that's the key to the development of innovative technology.

Now, 15,000 RPM might sound impressive, but for 2004, Suzuki's GSXR 600 revs to .... **16,200 RPM**.

That's a production engine, and there's no doubt that racers will push that limit even higher !! Of course, the bearing design isn't the reason that the engine makes power at such high RPMs -- that has to do with the tuning. There are also other factors that make this ultra high RPM possible, (for example, the engine uses lightweight titanium valves.)

But, the bearing design which was developed in the '50's allows that to happen without engine failure. With "round" bearings, the high revving fun would all end in an instant.

Think about it: Today's 16,200 RPM machines were made possible by a "non-trained engineer" !!

Have you ever felt like you're "only one" who thinks something ?? I know that feeling well, and I'm going to tell you this:

Don't worry, you're absolutely on the right track !!

The bearing solution was found "back in the old days", but knowledge of this hasn't fully reached the mainstream. As a result, the seriously out-dated idea still survives among many tuners and engineers that new bearings don't have the right running tolerance, and need to be gently worn in before they fit correctly.

By carefully observing an engine and asking the right questions, we can discover for ourselves that this idea doesn't at all match up with actual observation.

There has been a long unbroken chain of memorized facts.

A chain of misinformation can easily survive if no one in the chain stops to think and ask questions.

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Quote from the How Long Do You Have To Baby It article:

" ... firm part-throttle operation for a period puts a load on bearings and other parts, forcing their surfaces together so they can polish each other to a fine fit. **"**

Quote from the Give It A Break article:
" ...a constant load is not ideal for breaking in the bearing tolerances."

Bearing Clearance Break-In ?

Limited observation can "prove" that the above bearing statements are "true" !!

Why is that ??

For those who don't work on engines, it has to do with the perceived expert status of the people saying it. This "expert phenomenon" also influences many professionals, but another factor becomes involved for them. It has to do with what I feel is the most common problem in science. The distinctly *unscientific* method of not taking an open minded, objective, thorough and personal observation of the subject being studied. This has to do with fear.

There are very few scientists who can be objective when new ideas threaten their already preconceived ones. This has nothing to do with how well they memorized scientific "facts" or the amount of time spent in school. The most important skills of science aren't currently being taught in school.
It's all about honesty and the courage to have a favorite idea found to be wrong. Decide to be completely honest with yourself (objective), and you'll have the potential to be a better observer of reality than many scientists.

Bearing Comparison

The rod bearings from left to right in the photo below are as follows:

1) Brand new, just unwrapped from the package.
2) Blasted at the factory, and run hard on the street for approximately 30 miles / 48 KM.
3) Raced for 1 season, constant high RPMs for about 2,000 miles / 3220 KM.
4) Raced for 2 seasons (inc. endurance races), constant high RPMs for about 6,000 miles / 9660 KM.

Except for the brand new one, all of these bearings came from engines which were broken in according to the *Break-In Secrets* article.
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.
A casual look shows that, as the mileage increases, bearing surfaces do appear to be getting polished to a fine fit, or having their tolerances broken-in.

This would immediately confirm what the experts said.
End of story.
At this point, a careless observer might say: "That's all I needed to see."

There's no question that the dull gray metal is starting to look
bright & shiny !!

But, a simple test and observation reveals that:

4 Yamaha R6 rod bearings with progressively increased use:

#2: Even after the MotoMan's "insane" break-in method, the coating has been barely affected. (There are some small scratches on it, but that didn't

It's only a *coating* that's slowly wearing off during a certain condition !!

The areas where the coating has worn off are revealing the brighter colored babbit layer metal underneath, which exactly mimics the metal polishing process -- in appearance only !!
..

happen in the engine.)

#3: After a full season of high RPM racing, most of the coating is still there.

#4: Even after 2 full seasons of racing, the most heavily used bearing still has much of its coating !!

What's really surprising ...

... is that experts in both articles thought that new engines are assembled with bearing clearances
that are so tight, that the words "fit" or "tolerance" are applicable.

What do you think would eventually happen if bearings, (which possess the softest metal in an engine), are run with less than the correct oil clearance ??
(Ka-Boom !!)

How much did the most heavily used bearing's babbit layer actually wear ??

..
Here is the same heavily used bearing (#4) pictured above.
Its thickness is being compared to a brand new bearing (just unwrapped from the package) of the same size specification.

It turns out that even after 6,000 miles / 9660 KM of constant acceleration and deceleration from 10,000 to 15,000 RPM, the bearing's measured thickness is exactly the
same as the new one !!

(The thickness is the "fit" or "tolerance" described in the easy break-in articles.)

Although these bearings came from a newer engine, since I started building race engines in 1990, I've never seen
plain bearings with similar race mileage wear to the point of a measurable difference from new.

(There is one exception, and it affects a main bearing of engines of a certain design, as you'll see later on this page.)

Heavily Used Yamaha R6 Rod Bearing

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As long as the engine is apart, it's a good idea to replace all of the bearings, but it's really not necessary from a clearance standpoint.

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Brand New Yamaha R6 Rod Bearing

And Now ...

It's Time For The "Paper Towel" Experiment !!

For less than $10, you can learn more than many engine experts know about bearings ...

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The shiny bearing in the photo on the right looks very "worn", but it's never been in an engine ...

I just wiped it off with a wimpy piece of

Paper Towel !!

This coating isn't like most coatings. It's incredibly easy to remove. I would describe it as a powder.

Please don't take my word for it, buy yourself a main or rod bearing from your favorite vehicle and try this experiment at home.

You won't believe how easily this coating can be removed until
you experience it for yourself !!

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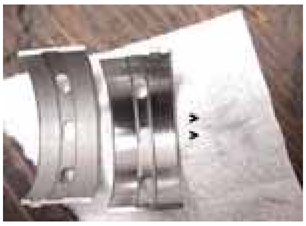

" Presto "

Like magic, in less than 5 seconds, the bearing was "polished". Here you can see that when the very top "layer" that gives the "unpolished" look is removed, the metal underneath makes the bearing look "polished."

This "layer" is now just residue on the paper towel.

.

Note: "destroying" the coating doesn't damage the bearing !!

Many race engine builders wipe off the gray coating with some paper towel before installing them, without any problems whatsoever. (The coating isn't able to protect the babbit layer.) If a wimpy piece of paper towel can wear off the coating this easily ...

**Why doesn't the coating immediately wear off, during the full throttle max RPM blast
at the factory ?? How can any of it possibly survive after all that racing use ??**

The answer to this will be revealed in a moment. This will illustrate where the easy break-in concept has been a *total misinterpretation* of the evidence. This in turn has resulted in the widespread misunderstanding of the causes of bearing wear, and engine wear in general.

How can we determine the babbit layer thickness ??

Call Yamaha ??

Call a motorcycle shop ??

Watch the Discovery Channel for a really long time ??

Ask a Factory Race Team tuner ??

Read the easy break-in articles ??

Experiment #2

Instead of asking someone who may not know the correct answer ...

Here's How To Find Out For Yourself:

. By using sandpaper, and sanding down just until a consistent copper color is seen, we can then measure the difference to determine the babbit layer thickness !! Of course, destroying the babbit layer does destroy the bearing. (These bearings are both of the same thickness specification.) .	 The bearing on the left is being sacrificed for the sake of science ... it's not going to be used in an engine !!
First, measure the bearing with the babbit layer ...	
Next, measure the bearing with the babbit layer removed ... ... then, subtract the difference. If you own a micrometer, try this experiment yourself !! Be sure to clean all the grit off the sanded bearing before measuring it. Also, be sure to let it cool completely after it's been sanded, or the heat from sanding will affect the measurement.	

Yikes !!

There's only .0006 of an inch of babbit before copper is reached !!

(On some bearings, the babbit layer thickness is even thinner -- .0005 in. / .0127 mm.)

Just How Thin Is .0006 inch / .015mm ??

For this demonstration, I chose a really thin thing that everyone can relate to -- paper.

A standard sheet of paper is .004 inch / .1mm.

That means that it takes slightly more than
6 1/2 babbit layers to equal the thickness of 1 sheet of paper !!

Words and numbers are cool, but it's way cooler to make a mental picture !!

In this diagram, I've illustrated the exact relationship between the 2 sizes as a percentage represented by digital pixels:

The softest metal in an engine, the babbit layer, is only ***15% as thick as a standard sheet of paper !!***

Oooooooo ....

.0006 inch / .015mm isn't just "thin" -- it's ***Super-Thin !!***

Ladies and Gentlemen,

The super thin / ultra soft babbit layer can't withstand any metal-to-metal contact while the engine is running.

Remember what the experts said about bearings being "broken-in" ??

Well here's the truth ...

If your "bearings are polishing to a fine fit" while you're on the road ...
or
if you're "breaking in the bearing tolerances" while you're on the road ...
or
if your "bearings are shedding layers to become intimate with the crank journal" while you're on the road ...

You'll soon be getting "intimate" with your dealership's parts department !!

Forget what the experts said.

You're becoming the real expert now :)

How Do Bearings Wear Then ??

The next series of photos are from a heavily used race engine. It was correctly assembled by another engine builder, who didn't remove the coating before the bearings were installed.

While this engine design may not be exactly like the one in your vehicle, this will demonstrate how plain bearings wear in any vehicle.

Knowing that the very top "layer" is really just an easily removable coating, and while keeping in mind all of the qualities of plain bearings, we can use the information to determine how and when bearings wear the way a good detective does.
Unemotional, deductive (logical) reasoning !!

Let's see if a pattern develops...

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Clue #1

There are 10 main bearing 1/2 shells, and 8 rod bearing 1/2 shells for a total of 18 in most modern 4 cylinder engines. The first thing that becomes immediately apparent in inspecting this engine, is that by far the most worn bearing out of all 18, is the main bearing indicated by the "X". This is the only bearing in this engine which has worn into the babbit layer.

(Note: this bearing is located on the right side of the engine. The view of the engine below is upside down from the way the engine sits in the bike.)

This is because in a side mounted cam chain tensioner design, the cam chain is exerting a force which is lifting the crankshaft upwards on just 1 end of the crank.

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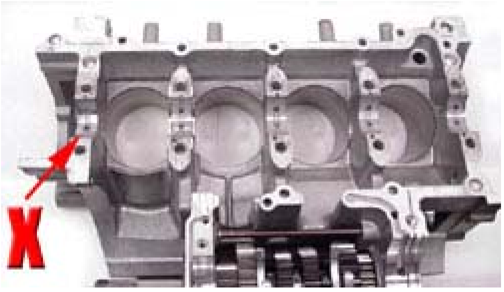

Note: this isn't a problem specific to this model, I've inspected 100's of side mounted cam chain tensioned engines from different brands and models, and this same bearing always gets worn far more than any of the others.

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Here's a close up of the bearing marked "X" in the photo on the left.

If you take a close look at the large version, you'll see that it's darker in the very middle of the worn area. It's actually starting to wear into the copper layer. This bearing definitely needs to be replaced !!

..

Why hasn't this engine failed ??

Because the wear is only happening during a certain condition.

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Which force on the crank is greater: the upward lifting effect of the cam chain from the tensioner and the valve springs ...

... or the downforce of the power stroke at 15,000 RPM ??

There's no comparison, the power downforce is a much stronger force !!

Of course, during the power stroke, the force is spread across 5 lower bearings, but realistically, if bearing wear were a matter of the amount of throttle used (force) and RPM, then the bottom bearings would be wearing much more than the one being damaged by the upward pull of the cam chain.

The Cam Chain Pull

VS

The 15,000 RPM Power Downforce:

This photo shows an even better view of the cam chain tensioned main bearing's

How do springs pull up on the crank ??

I sized this photo so that the valve springs in this image are approximately "actual size":

excessive wear (Left). It's really worn !!

For comparison, one of the lower main bearings is on the right. This bearing experiences the power downforce, yet it's not damaged at all !!

When you use a wrench to turn an engine over with the spark plugs removed, most of the resistance you're feeling is coming from the valve springs. It's very easy to do on this engine.

You'll also notice that this resistance varies, (it feels "lumpy") depending on where the engine is in its cycle as it's being rotated. The cam chain gets tensioned the most at the peak of this resistance.

Now imagine what the force would be like if you were able to hold onto a wrench while this engine is running at 15,000 RPM.

That comparison puts the forces involved into perspective !!

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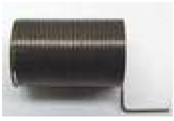
When the engine is stopped, often 1 set of valve springs are trying to push the cam forward. This force pulls up on the cam chain, which in turn pulls up on the crank.

The amount of force they pull up with, depends on the point at which the engine stops.

The cam chain tensioner also contributes a much smaller amount of upward force on the chain.

I didn't have an R6 cam chain tensioner spring, but this CBR600f3 spring is about the same size, and it exerts approximately the same force as the R6 spring does.



This image is also approximately "actual size".
As you can see by the wire diameter, this isn't a very powerful spring.

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" Hold On A Minute, MotoMan ...

I once read in a magazine article that the right side end main bearing wear is caused from the motorcycle being leaned over on its kickstand. The oil drains away from this end of the crankshaft, and the bearing is damaged on start-up. What do you have to say about that ?? "

Yes, I've heard the same thing, and most mechanics have automatically agreed with that idea.

The only problem is ... it's not a correct diagnosis of the problem.

Clue #2

Thorvald Sæby

Now, as you can see, Thorvald is a man who likes to win.

So, how did he break the new engine in ??

Did he gurgle around at part throttle like most of the other racers who were breaking-in their new race engines that day ??

No Way !!

The engine was warmed up, and moments after the picture on the right was taken, he was accelerating full throttle, shifting at 14,500 RPM through all the gears at one of the fastest tracks in the world ... Daytona !!

One of the most noticeable attributes of winners, is that since they aren't influenced by "what everyone else thinks", they don't follow the crowd.

.

The Race Stand:

Jørgen Johnsen of Oslo, Norway's ***Fast Bikes*** gets ready to remove the race stand, while Team Yamaha Motor Norway's Thorvald Sæby gets ready to break-in the 2000 Mototune R6.

Although this is a different racebike, the cam chain tensioned worn bearing shown in the
photos came from an engine which was always parked on a race stand.

With a race stand, the engine is always level when the bike is parked.

The "kickstand problem" is an an example of a mis-diagnosis of cause and effect.

Since the cam chain is on the right side of the bike, this side gets tipped up when the bike's on its kickstand which is on the left side ...

... and so the kickstand explanation "seems logical".

By using scientific thinking and eliminating that variable, one will discover that the same problem still exists.

Coincidentally, the discontinuation of centerstands coincided with the use of the end cam chain tensioner design.

Clue #3

Which force is greater, the weight of the crank, or the power downstroke at 15,000 RPM ??
There's no comparison, the power downforce is a much stronger force.

Hint 1: Main bearings have the same high RPM "oval" non-contact protection design as rod bearings. The main bearings' housings "oval" at high RPM also.

Hint 2: Gravity is pulling the crank down when the engine isn't running.

Hint 3: Sometimes there is less upward pull on the cam chain, depending on what part of the engine cycle the engine is at when it stops.

Why are the lower main bearings' coatings only worn in the center, not at the end section ??

(That's curious.)

Clue #4

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There is no coating wear happening at the "oval" high RPM pinch-in point at the ends of the rod bearings either.

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That's because all of the wear is happening...

... during a certain condition !!

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It's True:

Plain bearings, when correctly installed, and with proper oil clearance and pressure,
don't wear once the engine is running.

(While the engine is running, the bearings are floating on an **non-compressible oil film**.)

The wear all occurs at the moment of start-up, after the engine has sat, and the residual oil has drained off.
This is the "certain condition" !!

It's not a matter of the amount of force, but rather when the force is being applied:

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When the engine is at rest, the unpressurized oil is often squeezed out by the upward pull of the cam chain.

Again, this depends on the point at which the engine stops.

When that happens, the cam chain

Figure "A"

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Figure "B"

.

end bearing looks like figure "A".

When the engine is first started after it has sat for a while, there is a split second of rotation before the oil pressure returns the journal to the normal relationship with the bearing shown in figure "B".

The cam chain tensioned bearing wears due to this momentary rotation when there is a lack of oil between the 2 parts.

(Here again, the oil clearances have been greatly increased to illustrate this concept.)

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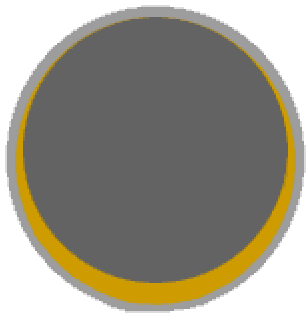

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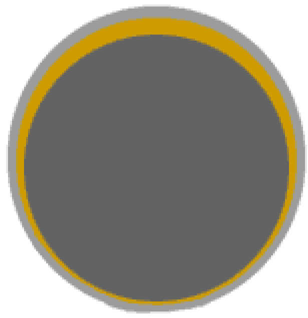
The camchain tensioned main bearing to journal relationship when the engine is turned off.



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The camchain tensioned main bearing to journal relationship when the engine is running.

Analysis

The main bearing wear occurs when either the downward weight of the crank or the upward pull of the cam chain has squeezed out the residual oil while the engine is at rest.

Except for the cam chain tensioned one, none of the other upper main bearings are wearing. This is because they don't have any "oil squeezing" conditions while the engine is stopped, and they aren't subjected to any serious force on start-up, only at high RPM.

In the case of the rod bearings, oil drain off is also responsible for the start up wear. With the rods, there is another factor worth considering. Whenever the engine is stopped, the residual oil drains off soonest from the rods that remain above the middle of the stroke, and so more wear occurs on these rod bearings. I've seen an equal amount of bearing coating wear on both sets of rods in every 4 cylinder engine I've ever inspected. I suppose it's possible that one set could always stop below the middle of the stroke every time the engine is stopped ...

... and that would be like winning the lottery and getting struck by lightning on the same day.
It's possible, but highly improbable.

Even at redline RPM, all of the bearings are protected by a full pressurized oil film. The fact that none of the 18 bearings' coatings are worn into the "oval" section is more evidence of this.

Unbelievable

The experts in these articles have confused start-up wear with "break-in wear".
If this page has caused you to start wondering about the wisdom of automatically believing experts, then you're on the "same page" as me. ;)

You can't prevent start-up wear by breaking-in your engine "easy" ...
The only way you can prevent it is to never start the engine.
That would kinda take all the fun out of things.

You've probably heard that the majority of engine wear occurs as the engine is started.

(It's true.)

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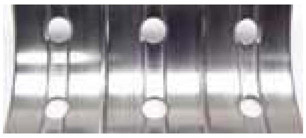
Take The Bearing Quiz !!

Removing the coating makes it difficult to see how much a bearing has been used. It's only wear to the babbit layer that's a concern, because that will cause problems.	. These 3 main bearings have had their coatings wiped off with paper towel. This is an extra large photo, so you can see the surfaces close-up.  1 was heavily used (roadraced), 1 came out of a brand new bike which was only blasted at the factory, and 1 is brand new and was never used in an engine. Can you identify the bearings ?? The answer will be revealed in the next issue. .

What happens if the bearings are tight ??
Will a hard break-in damage them ??

Absolutely ... Yes !!

But, it's important to understand that even during an easy break-in, tight or incorrectly installed bearings will be equally damaged !! A really tight bearing won't last long enough to be "broken-in", and a bearing with minor tightness will develop into a major problem eventually, regardless of how the engine is run.

Here's why:

2,000 RPM ...

Even with light throttle at a super-mellow 2,000 rpm, the tight section will cause permanent damage to the ultra soft, ultra thin babbit layer from the mere rotation of the crank journal. The re-distributed metal can't escape, so it spreads over the bearing creating new tight areas. This smearing metal process generates a lot of heat, and the heat expansion and thermal distortion tightens the bearing clearance even more -- and eventually prevents the formation of any oil film. The amount of time this takes depends on how tight the bearing is.

A tight bearing problem can only be solved by taking the engine apart to correct the clearance.

Tight bearings are an **extremely rare occurrence** with production machines. I've only seen one example of this during my entire career as an engine builder ...

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Once upon a time in Norway, a tiny plastic bit almost stopped ...

The Mighty

Budweiser Yamaha R1 !!

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Brand New 2002 R1 Engine

During assembly at the factory, a nearly invisible stray piece of plastic went unnoticed as it sat on the
main bearing saddle and the bearing was installed on top of it.

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The seemingly insignificant naughty little bit lifted the bearing enough that the crank wore through the
babbit layer and was starting to expose the copper layer.

This isn't start-up wear, so there was friction being developed while the engine was running. This causes thermal distortion (warpage) and eventually,
further damage.

But what about:

Oil, like all liquids, is non-compressible ??

The physics haven't changed, it's just that the "container" for the oil is no longer complete, because part of its space is now being taken up by
the raised section of the bearing.

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**This engine was starting to shed bearing layers to become intimate with the crank journal
while it was running !!**

Since this bike was just removed from its crate and hadn't even been ridden yet, the damage occurred at the factory during its initial run. I first got suspicious of a problem when I smelled the faint odor of burnt oil as the crankcases were opened.

Luckily, the soft metal bearing design concept worked, and the crank was unharmed. Rather than replacing a $350 crank, I only had to replace a $7 bearing !!

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I'm going to pose a question here:
What might have happened if this engine had been purchased by a street rider who carefully followed the owner's manual during break-in ??

The answer will reveal one of the best reasons not to do an easy break-in.

It also reveals one of the real reasons why the factories recommend that you should run a new vehicle gently.

I'll discuss this in the next issue.

Only A Matter Of Time:
Had this engine been raced without fixing this problem, the extreme localized friction and the
thermal distortion that causes, could have eventually caused the babbit layer to unravel.

The Mighty Budweiser Yamaha R1
would have been reduced to zero horsepower.

A terrible situation for the racer, engine builder, tuners, fans, and sponsors !

The problem was fixed so that didn't happen, and once we got to the track in Sweden, there was a very happy ending to this story ...

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2001 Norwegian Champion André Løwen
Knee on the floor in Sweden on the Budweiser Yamaha R1

After finishing the first qualifying session in 2nd position for the
May, 2002 Superbike race at Anderstorp, Sweden --
here's what André had to say:

" MotoMan ... this is the best race bike I've ever ridden. "

High velocity intake ports, fixed main bearing problem, hard break-in ...
... plus lots more "out of the box" tuning secrets yet to be revealed !!

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Ice Cold Bud !!

More and more people are discovering that a hard break-in really does result in a lot more power.
(But, there has still been a feeling that there must be a trade-off of damage & lower long term reliability.)
Now, more and more people are discovering why a hard break-in doesn't do
any damage in a correctly set-up engine.
There is no trade-off.

What if it turns out that an easy break-in actually causes long term engine damage ...

the very thing the easy break-in article readers want to avoid ??
Stay Tuned !

It's hard to imagine that truth can be so completely reversed.
The widespread presence of the "expert/prestige box" makes truth reversal super easy to do !!

5 New Techniques For Thinking Outside of the Box:

1) Use the next door neighbor reading technique with everything you read -- you'll be surprised at what happens. Your real-world intelligence will skyrocket.

2) Don't allow experts to think for you. Observe, test and measure things for yourself.

3) Make mental still pictures to visualize reality.

4) When you've mastered #3, practice making mental moving pictures.

5) Question everything, especially the most widely assumed premises !! That's the key to forming truly logical conclusions.

You've got the Power, my friends !!!

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3 Ways to Minimize Your Engine's Wear !!

Tip #1:
What do most people do when they start an engine ??

Turn the throttle up !!

It seems logical to do this, but revving up an engine just as it starts is the worst thing
to do !! To minimize start-up wear, never start an engine with more RPM than is absolutely necessary.

Very Important Note: this is a completely different concept from warming the engine up before running it hard. The reasons why insufficient warm up causes damage will be covered in a future issue. Here I'm only referring to the first moment of rotation, and 1 or 2 seconds after the engine is started.

Tip #2:
Even if you don't turn up the throttle on start-up,
the factory does it for you ...

Did you know that most motorcycles are designed in a way which actually causes their engines to wear out faster ?? When the "engineers who design the bikes"* write the owner's manuals, besides teaching millions of people to break it in easy, they also tell people to use the choke to start the engine.

* The more you learn about engines, the more you'll realize that much of the "engine information" in the owner's manuals wasn't written by the engineers and has absolutely nothing to do with good engineering.

The "choke" on most bikes enrichens the fuel/air mixture, but it also increases the engine speed on start-up. The fast idle choke causes the cold engine to rev up to 2,500 - 3,000rpms, which greatly increases start-up wear.

Because of this, using the "choke" causes almost all of the engine wear the bike will ever
get !! Much more than during any other running condition -- even when the engine is at redline !!

If possible, don't use the choke at all. If your engine absolutely won't start without it, use the least amount of choke so that the engine idles as low as possible on start-up (ideally 1,000 - 1,250 rpm on most motorcycles).

Some might say, the manufacturers can't help this .... how are you supposed to start a bike, doesn't the mixture have to be richened up when it's cold ?? My answer is: the enrichening effect of the "choke" isn't the problem, the high idle effect is, and that's not at all necessary for cold starting.

Since most consumers and magazine tech writers are unaware of this -- as far as the manufacturers are concerned, there's no problem.
The $ bottom line is: the high idle "choke" design creates an increase in the overall sales of parts, bikes, and mechanical work for the dealerships.

I think this high idle choke effect is still used on newer cars, but I'm not 100% sure.
Can any readers confirm ??

Tip #3:

The fact that bearings don't lose all of their gray coating to become instantly shiny on start-up means that total no oil situations are rare, since there is usually some residual oil.

However, if you have an vehicle that has sat for a very long time, this is likely to cause more than the usual amount of start-up wear. I recommend turning it over with a wrench to manually pump oil to the bearings before such an engine is started.

(This is why race vehicles often suffer more extreme start-up wear than street vehicles do -- race vehicles often sit for longer periods between start-ups !!)

Babbit Layer Wear Does Eventually Take Place ... No Matter How

The Engine Is Broken In.

By using these 3 tips, it will take a much longer time before start-up wear will add up to the point of your vehicle requiring bearing replacement. Measurable wear does eventually take place on the babbit layer after thousands of start-ups. At the current level of engine technology, this continues to happen regardless of the engine's mileage.

Engineering students ... can you think of any solutions ?? I'll be sharing some of my ideas in the next issue !!

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What Does The Paper Towel Experiment Tell Us ??

Think about the other materials in an engine. If someone wanted to, they could apply paper towel friction to chrome, steel, or aluminum for a very long time. After doing this, their hands would be extremely sore, and they would discover that none of these materials can be significantly worn by it.

By isolating and studying the one thing that can easily be worn off by paper in less than 5 seconds, we can see that there is a phenomenon taking place in engines which goes beyond our normal thinking about engine wear. (Isolating is the key to setting up a good experiment.)

By fully studying the characteristics of bearing design, and eliminating the variables as a good scientist does, it's easy to see when the coating wear takes place, and that's also the way to understand how most engine wear occurs. There are other reasons for engine wear on other parts, and all of these topics will be covered in future articles.

But, in the meantime I will say this: as long as the engine is warmed up first, there is no damaging engine wear which happens as a result of running it hard when it's new.

The second bearing in the photo in this photo shows that, after a hard break-in on a new engine, the coating is barely affected.

The 2 race engine bearings shown in the photo are way past the 600-1,000 mile period that the easy break-in enthusiasts might describe as the "severe engine damage danger period", and most of their coating is still there.

You can imagine that in an engine with just 600-1,000 miles, the coating will still be in nearly brand new condition after any kind of break-in.

Paper Towel !!

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The Second Bearing From The Left Provides The Proof.

A hard break-in doesn't damage
the bearings !!

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Myths

Myths are born when trusted experts use unscientific methods of study.
Myths get perpetuated when the public gives up their thinking power to adopt a closed minded memorization of "what everyone else thinks".
Whenever there's a controversial subject, the reason for the controversy usually stems from these 2 factors.

These are the 2 biggest problems in modern science ... and as you'll be discovering, these problems affect almost all of the topics of engine tuning.
For this reason, you'll find that most of the topics in upcoming issues of Power News will be very controversial.

Plain bearings don't require break-in, but the power of the myth has caused millions of people to think they do.

Teach Others About Engines:

If you read the motorsports internet discussion forums, you've probably noticed that the subject of engine break-in often comes up, and the link to the *Break-In Secrets* article usually gets posted. The range of opinions about it are extreme. Some strongly agree, while most strongly disagree, but that percentage is starting to turn around.

You can help "break the fake" about break-in !!
Please post the link to this article on your favorite forum.

Opinions and Facts

The difference between a fact and an opinion is very clear -- an opinion is only that, until it is adequately proven. None of the characteristics of bearings are presented here as an opinion, they are all easily testable facts.

But here I will present my opinion:

In my opinion, the method described in *Break-In Secrets* could have been safely used as long ago as ...

1969

(Maybe Even Earlier)

(In no way has this been proven here yet ... it's only my opinion. But I do have a lot more evidence forthcoming.)

Plain Bearings Are Easily Damaged ...

... not from a hard break-in, but rather from incorrect installation, debris, oil dilution from fuel*, insufficient oil clearance, oil contamination from blow-by acids*, oil starvation, damaged (rough) crank journal or bearing surfaces, severely overheated oil and abnormal bearing or journal out-of-roundness which causes frictional wear on the high spots.

* Whoops -- I just dropped 2 more hints as to why an easy break-in is really bad for long term reliability.

Without any of those problems, plain bearings are very reliable !!
The key is simply to avoid all of those problems.

In the next issue, I'm going to show my techniques for bearing assembly, as well as some common, avoidable reasons that bearings fail.

I'll also reveal some more of my power secrets which helped make this situation happen:

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Thorvald Sæby (#44) and Tommy Hayden (#22) Daytona 2000.

In both '99 and '00, the Factory Yamaha R6 couldn't keep up with the acceleration and top speed of the Yamaha Motor Norway, Mototune USA built Yamaha R6.

The Yamaha Factory Team threatened us with a teardown both years, as they were 100% sure that our engine was illegal for the supersport class !!

(Especially since Thorvald is much taller, and weighed about 35 lbs. / 16 kg. more than Tommy. That's a **huge** aerodynamic and weight disadvantage on a small bike like a 600.)

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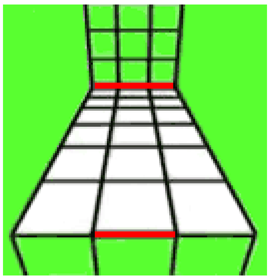
Plus:

That "bottom line" is going to get even longer ... much longer !!



For example: 2 Quotes from the How Long Do You Have To Baby It article:

Point #1 Run it too hard = rings don't seal
" If you push too hard, too soon, the parts will score and scuff each other because the heat

generated will be enough to destroy the oil film locally. A scuffed piston ring doesn't seal. "

Point #2 Run it too easy = rings don't seal
" ... break-in will fail-- usually as a result of such light-duty operation that parts are not loaded together forcefully enough to bed-in to one another. Rings glaze and fail to seal. "

(These 2 points contradict each other. Also, quote # 1 contains a cause and effect error, and if you think really deep, you'll notice that there's a contradiction within the larger contradiction.
Hint: it's contained in quote #2.)

The confusion in these statements has in turn led to a tremendous amount of confusion among the general public about the process of ring sealing.
I've noticed that there's even more confusion about ring sealing than there is about bearings.

There are many more problems with these easy break-in articles that I haven't mentioned yet. These will all be covered in future issues along with the ring sealing answers. In the meantime, use the Next Door Neighbor Reading Technique to see how many problems you can notice !!

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What kind of epoxy are you using for porting ??

I'm happy that there are so many Power News readers are from every part of the world !!
... except Antarctica.

I'd like to ask for your help:

Many people have mentioned that the type of epoxy I recommended (JB Weld), isn't available in their country.

There must be other brands of epoxies that will work for High Velocity Porting. I want to compile a list of epoxies which pass the long term reliability test. Please e-mail me with the other brands of epoxies you've used, and if possible, a report as to the long term reliability of it.


I traveled to the Netherlands to work with a Kawasaki Supersport race team with their ZX6R cylinder head development. In an upcoming issue of Power News, I'll be featuring this team, plus much more about the High Velocity intake and exhaust porting concepts, as well as new information that I've gathered since I first wrote the original porting articles.

Also, I'm compiling a list of reader success stories about the High Velocity Porting techniques featured here. If you haven't done so already, please send in the results of your efforts !!

" Have a Great Day !! "