Farmer’s Notes on the WW2 Fighters and Engines
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Fruits and nuts for breakfast.

“Featuring excellent performance and high maneuverability, the Ki-84 was considered to be the best Japanese fighter to see large scale operations during World War II. It was able to match any Allied fighter, and was able intercept the high-flying B-29 Superfortresses.” - Wikipedia.

Per the Wikipedia article the Ki-84 was able to intercept the B-29 bombers and was a match for any allied fighter. Having read many of the post-war books on Japanese fighters I’d suspect the Wikipedia author could even source it to one of those books. Which, in my opinion, were written by authors not understanding the basics of WW2 aircraft or WW2 aircraft engines. A lack of study of the appropriate fields and a lack of research into the subjects, airplanes, and engines results in an assertion similar to the above.

Until April of 1945 the B-29s flew to Japan unescorted by any fighters. The total number of B-29s downed by Japanese aircraft, of all types, total for the war was 74. That’s in ballpark range of the number of B-17s lost in one raid over Germany. With the loss of Iwo Jima the Japanese were aware that American fighters would now also be putting in an appearance. In April of 1945 the Japanese officially stopped sending up any aircraft to attempt to intercept the B-29s. If, as the author of that Wikipedia article asserts, and I have little doubt that is based on books of questionable value, the Ki-84 was able to intercept the B-29s then why, with 3,514 Ki-84s built, were a total of 74 B-29s downed by not just the Ki-84s but Japanese aircraft of all types when they weren’t even escorted by fighters? Why, when the American fighters did appear, were all attempts to intercept the American aircraft halted?

“In the hands of a good pilot.” I wish I had a quarter for every time I’ve seen that expression used to wish away technical limits. I have a 1985 Ford Ranger with the 2.8L V-6. Total horsepower is listed at 115 but I suspect they’re being generous. I also have a 2017 Ford Mustang with the 2.3L I-4. Total horsepower is just over 300. In any type of competition, speed, acceleration, braking, or handling, there is no comparison. “But in the hands of a good driver.” It simply isn’t possible to wish away technical limits. I’ll provide a substitute for that “in the hands of a good pilot” phrase. “In the hands of a bad author.” To understand why it takes a bad author to wish the Ki-84 the ability to intercept B-29s or be competitive with “Allied fighters” one must understand the technology.

Life is better with boost.

Turbochargers

That 2017 Ford Mustang I mentioned as a 2.3L engine. Total horsepower, as mentioned, is 310. Torque is 320 lb-ft. Weight, according to Ford, is 584lbs. The 2017 Ford Mustang is also available with the 5.0L V-8 engine. That engine, with a 435 horsepower rating, provides 400 lb-ft of torque. Weight is 549lbs. You read that right – the V-8 is lighter than that I-4 in spite of having over twice the displacement. The 2.3L, with less than half the displacement, provides ¾ of the power of the 5.0L engine. The Department of Energy lists range for the two as 288 miles (V-8) versus 372 miles (I-4) in spite of the I-4 having a gas tank slightly smaller. City miles per gallon is 15 (V-8) versus 21 (I-4). The 2.3L is dimensionally a smaller engine.

The method that 2.3L uses to produce ¾ of the power of an engine with over twice the displacement is turbocharging. Put simply, 25% of the "energy" in gasoline is used in a typical automotive engine. 25% is wasted via heat and friction. 50% goes out the exhaust pipe without being used. That 50% wasted out the exhaust pipe is a tempting target. If one was to stick a fan in the exhaust system, turned by the exhaust, and another fan on the other end of the shaft it's mounted on, one could compress air. Basically for free. That air, compressed, could be used in the engine. Air and gasoline is mixed at anywhere from a 10:1 to 14:1 ratio (air/gas) and that needs to be maintained. Air pressure, at sea level, is about 15 pounds per square foot. If I can use that "fan" (impeller) to compress air to 30 pounds per square inch (double ambient) I can mix in twice the fuel. The 2.3L engine, at 15psi, is pushing an air/fuel mix equivalent to a 4.6L engine at 30psi. The impeller in the turbocharger is rated to spin at 220,000 rpm. Temperature on the impeller is good for up to 1,750 degrees Fahrenheit.

Turbochargers basically take that 50% of gasoline's energy, which would be wasted out the exhaust, and compress air for the engine. The compression is essentially free. The problems with a turbocharger are heat, heat, heat, pressure, and strength. The turbocharger itself is in the exhaust system. That gets hot. Compressing air heats it. The "back pressure" created by a turbocharger tends to heat exhaust valves excessively. That back pressure also results in more exhaust remaining in the cylinder during the next cycle. That last mentioned problem, spent exhaust remaining in the cylinder, results in engine designers spending additional time working on increasing the "volumetric efficiency" of the engine. Turbocharged engines benefit more than non-turbocharged engines from better volumetric efficiency. Lastly, a turbocharged engine is under more stress. They must be built stronger and thus the Ford 2.3L is heavier than the 5.0L engine. An engine designed for a turbocharger will typically be heavier (stronger) and have better volumetric efficiency. They'll also have exhaust valves designed to withstand more heat.

Superchargers

Putting a belt, chain, or gearing on an engine would permit the driving of a compressor for the same effect as a turbocharger. This is what a supercharger does. A supercharger, like a turbocharger, is basically an air compressor. Whereas a turbocharger compresses air, basically for free, a supercharger is powered by the engine. The air compressor I own can compress 25 gallons of air through the use of a 5hp electric motor but it takes a bit to compress to 120psi. A WW2 fighter aircraft engine with a supercharger, at maximum pressure, uses more horsepower than that Ford 2.3L engine produces just to power the supercharger; a supercharger is parasitic. Superchargers do not have to deal with exhaust heat or back pressure but, like the turbocharger, do have to deal with the "compressing air heats it" issue.

Superchargers can be used in series. If I take a supercharger that can compress air on a 2:1 ratio, and then add another supercharger after that, with a 3:1 ratio, I will get a total of 6:1 ratio. Superchargers in series are multiplied – not added. 3:1 and 3:1 gets you 9:1. Whereas a turbocharger can turn at incredible rates, that modern Ford one is rated to 220,000 rpm, superchargers are driven by the engine and cannot spin nearly as fast simply due to gearing issues.

Pre-detonation is bad, mmmkay?

If one checks a diesel engine one will not find spark plugs. Diesel engines use the "flash point" of their fuel to ignite. Gasoline engines use spark plugs to ignite the fuel/air mixture. Gasoline does, like diesel, have a flash point. If hot air is used for the fuel/air mixture, the flash point will be reached sooner on a gasoline engine. "Engine knocking" is the typical result and that is the fuel/air mixture detonating before desired. In a typical gasoline engine the explosion should happen right before the piston reaches the top of the cylinder. If it ignites too early the intake valve is normally still open, sending pressure into that, and the piston isn't far enough up where that explosion wants to drive it back down before it's up far enough. Pre-detonation is bad. Raising the "octane" rating of gas results in it having a higher flash point. That is one way of dealing with that flash point and it's normally used by gasoline engines. The 2.3L Ford engine mentioned has 310 horsepower. That is with 93 octane fuel. If 87 octane is used the engine adjusts and the horsepower rating is dropped by about 30. That is a good number to know: dropping octane rating by 6 results in a loss of 10% of the horsepower in that engine.

Another method of handling pre-detonation is to cool the air. Both turbochargers and superchargers can take use of this. A radiator is used and the air is passed through it after it's compressed – cooling it. Whereas it's a radiator when used in the turbocharger and supercharger installations it's called an "intercooler" as it cools the air between the compressor and engine. While a turbocharger, having incredible spin speeds, can compress air to pretty much any desired pressure the superchargers are "fixed" in the compression they can do and thus they may be used in series to provide that "multiplied compression" effect. In that case two intercoolers are called for:
Turbocharger → intercooler → engine.
Supercharger → intercooler → engine.
Supercharger → intercooler → supercharger → intercooler → engine.

Boost 2: Altitude

Starting at ground level, using those two Ford engines mentioned, the air pressure is, abstracted, 15psi for the V-8 and 30psi for the I-4 engine. If I was to drive both to the top of Pike's Peak the ambient air pressure is about half of what it was at ground level. Thus half the air is available for both engines just due to that altitude pressure drop. If I was to put a compressor on that V-8 and turn it on at that altitude it'd take some engine horsepower to drive it but I could then compress the air to get back to that 15psi pressure. The I-4, having a turbocharger, would be able to maintain that pressure by simply doubling boost. Effectively, at 15,000 feet, that V-8 is going to provide half the horsepower it had at ground level due to air pressure unless I supercharge it. What should not be missed is the engine doesn't need to be strengthened for this as it's getting the same stress it was getting at ground level without the supercharging. Without a supercharger the V-8 is going to be producing half the horsepower based on air pressure.

If I was to then drive both cars to the top of Mount Everest I'd find, at 30,000 feet, the air pressure is about ¼ of sea level or ½ of what it was at the top of Pike's Peak. On the V-8 I needed to double the air compression to get the sea level horse power whereas now I'll need to quadruple it. To operate effectively at 30,000 feet I'll need a 4:1 compression ratio. The engine won't need to be strengthened as it's using that 4:1 compression to get sea level pressure. If I start at the top of Everest, with the supercharger on at 4:1 pressure, and then race back to sea level, without changing the supercharger, I'll be getting 60psi at sea level; somewhere before sea level the engine will blow as it cannot take that stress. "Do not forget to turn off the supercharger before heading down."

Boost and boost.

An engine can be boosted to provide the same power from a smaller displacement than one gets from a larger displacement.

An engine can be boosted to maintain air pressure at altitude.

There are two different types of boost. A turbocharger provides both. Superchargers do not and must be designed for that.

Let's ignore turbochargers and just concentrate on superchargers. An engine with a "single stage, single speed" supercharger has one supercharger. At 15,000 feet the supercharger is engaged. That takes some power but provides compression. Let's take an engine with, say, 2,000hp at ground level and use 300hp as the "power needed to turn the supercharger:"

Ground level. Supercharger off. 2,000hp.
15,000 feet. Supercharger on. 1,700hp.
30,000 feet. Supercharger on. 850hp.

An engine with a single stage, single speed supercharger uses energy to provide sea level pressure at 15,000' but, at 30,000 feet, the air pressure is half again (actually 35,000 feet but I'm abstracting).

Let's add another speed. At ground level the supercharger is turned off. At 15,000' the supercharger is turned on "low." At 30,000 feet it gets turned on to "high."

An engine with a single stage, two speed supercharger would provide full power at sea level. That power would fall off to 15,000' and then the supercharger is turned on to low. Less power than was given at ground level is provided but it's better than it was at 13,000' with it off. At 30,000' it's turned to "high" and, again, a power boost is given but not as good as it was at sea level or 15,000' as it takes more power to turn it. If this engine, as detailed, is measured for horsepower it'd be peak at sea level, 2nd high would be at 15,000', and 3rd high would be at 30,000'. At 10,000' it would be lower but not as much as it would be at 25,000'.

A "variable speed" supercharger could be made and that would be one which detects altitude. Using a barometric cell, the supercharger could pick the right speed or turn off altogether. The biggest advantage of this is no pilot will blow the engine by forgetting to shift from "high" blower when he dives.

A single stage supercharger, without another supercharger, cannot provide the multiplied compression that two superchargers in series provide.

That's an important point. Again, ignoring turbochargers, superchargers in WW2 fighter engines are thus:

Single stage, single speed: low altitude performance only.
Single stage, two or "multiple" speed: low and medium altitude performance only.
Two stage, multiple speed: low, medium, and high altitude performance.

A compressor can permit an engine of less displacement to provide more power at all levels.

A compressor can permit an engine to provide power at all altitudes but for high altitude performance it requires the multiplier effect of a two stage supercharger.

Taking the R-2800 engine in the F4U Corsair, as an example, the supercharger installed was a two stage, two speed supercharger. As is typically seen, the first compressor is always “on” and the second stage has three settings: off, low, and high. “Low” and “high” in this case are multiplied by that first stage.

Taking the R-2800 engine in the F8F Bearcat, as an example, the supercharger installed was a two stage, multiple speed supercharger. As is typically seen, the first compressor is always “on” and the second stage was controlled by a barometric cell. The second stage was multiplied by the first.

Taking five aircraft:

F4U. Two stage, two speed supercharger. Good low and medium altitude performance. High altitude performance not bad given the two stage supercharger but aerodynamics limited it.

P-47. Same engine as the F4U really but used a turbocharger for compressing. Good low, medium, and high altitude performance.

P-51. Two stage, two speed supercharger. Good low, medium, and high altitude performance as aerodynamics were in its’ favor.

FW-190A. Single stage, multiple speed supercharger. Good low and medium altitude performance.

ME-109. Single stage, multiple speed supercharger. Good low and medium altitude performance.

TA-152. Two stage, multiple speed supercharger. Good low, medium, and high altitude performance.

I’ll repeat myself. **A single stage supercharger, without another supercharger, cannot provide the multiplied compression that two superchargers in series provide. Turbochargers can.**

I’ll make it worse. I used 15,000’ and 30,000’ as they’re good round numbers. What is clear from WW2 fighters is all fighters with single stage superchargers had performance peak up to 20,000’ and it fell off rapidly above that. German performance tests of the FW-190A aircraft showed power loss started at 6,000 meters. Post-war tests of the N1K1-J, a faster airplane than the Ki-84 but using the same engine, showed 1,975 hp at sea level. At 20,000 feet it was down to 1,675 hp. This was on 92 octane fuel – not available in Japan. As a comparison, the P-47N, the edition of the P-47 with increased fuel for escort duties over Japan, produced 2,800 hp at sea level and maintained 2,800 hp up to its’ critical altitude of 38,750 feet – top speed at that altitude was 467 mph.

Let’s hit it from another angle. Turbochargers are simply efficient. At all altitudes. They’re not parasitic on the engine. The problem with turbochargers is they have to withstand intense heat and that takes exotic metals. The United States lead the world in turbocharger technology and there was an export ban on superchargers before WW2.

P-47. Radial engine with turbocharger. The turbocharger gave it good high altitude performance. This is the only WW2 fighter of any production numbers with a radial engine and good high altitude performance.

P-51 and FW-190D. Liquid cooled engines provided better aerodynamics. Two stage superchargers provided good high altitude performance.

F4U. Radial engine with two stage supercharger. Aerodynamics of the engine limited high altitude performance.

ME-109. Liquid cooled engine with single stage supercharger. Bad high altitude performance due to the supercharger.

FW-190A. Radial engine and single stage supercharger. German fighter pilots preferred the ME-109 over the FW-190A for obvious reasons as performance was better at medium altitudes.

P-38. Liquid cooled engines with turbochargers. This, by rights, should have had the best high altitude performance due to the liquid cooled engines/turbocharger combination. The P-38 suffered greatly from cooling problems and early editions had a nasty habit of eating their exhaust valves.

Aerodynamics weren't the best for an aircraft with liquid cooled engines as the "center pod" has drag – resulting in "three fuselages" invoking drag.

Pass the gas.

Getting back to gas and octane. As was seen in that Ford 2.3L a reduction in octane from 93 to 87 results in a decrease in 10% of the horsepower. After WW2 the U.S. tested German and Japanese fuels. With the Germans it was found that they measured their octane rating differently. Again, the air/fuel mixture is about 10:1 (rich) to 14:1 (lean). Octane can be measured at either with the Germans measuring it on the lean side but the U.S. measuring it on the rich side. Measurement results:

1941. Japanese. ?:92
1943. Germans. 95:130.
1943. Americans and British. 100:130.
1943. Japanese. ?:91
1945. Germans. 95:130.
1945. Americans and British. 100:150.
1945. Japanese. ?:87.

The Japanese used 92 octane pre-war. With the stopping of U.S. supplies they decreased to 91 and this was the aviation fuel octane they used for most of the war. Towards the end they dropped to 87 octane due to shortages.

The Germans had 100 octane fuel at the start of the war. Then they stepped up to 130 about the same time as the U.S.. The different was the German fuel was 95 on lean and 130 on rich. American was 100 on lean and 130 on rich. In the second half of 1944 the U.S. switched to PPF 44-1 fuel which brought the "rich" side up to 150. The Germans stayed at 130 and in fact used lesser octane fuel where they could.

The Japanese never had aviation fuel of the same class as anyone else. The German matched the allies until the summer of 1944 when the Americans/British received 150.

The Rolls-Royces,, the Allison, and the German engines.

The displacement of engines is thusly:
Allison V-1710. 1,710 cubic engines.
Rolls-Royce Merlin. 1,650 cubic engines.
DB 601: 2,070 cubic inches.
DB 603: 2,716 cubic inches.
DB 605: 2,176 cubic inches.
Junkers Jumo 213: 2,135 cubic inches.
Rolls-Royce Griffon: 2,240 cubic inches.

The Allison was 1,710 cubic inches. As can been seen, when it's compared to the other engines, it's not terribly large. It was designed to be turbocharged but, as was seen in the P-38, it suffered from cooling problems when it was. Without a two stage supercharger it would never produce the medium or high altitude performance needed. As they were building the Merlin, which had one, they didn't address that until the war was over but, by then, jets were taking over. As an engine, just an engine, it contained half the parts of the Merlin and had better volumetric efficiency – due to the turbocharger considerations. So one could honestly say it was probably a better "engine" than the Merlin. The fly in that ointment is “better” doesn’t work without a functional turbocharger and without the right supercharger. Thus, for our purposes, the Allison was really a failure with regards to WW2 fighters.

The Merlin was 1,650 cubic inches making it the smallest of the lot. With a two stage supercharger it could produce power up to, and including, high altitudes. The “magic” of the Merlin was it offset its’ displacement disadvantage via boost.

DB 601 and DB 605. Fighter engines used in the ME-109. With a displacement advantage over the Merlin they gave that up due to supercharging at higher altitudes.

DB 603. An engine considered for the FW-190. That’s too big of an engine for a fighter.

Junkers Jumo 213. The FW-190D received this engine and that gave it the altitude performance it needed *when used with the two stage supercharger*.

Rolls-Royce Griffon. Fans of British aircraft will not appreciate my view. It follows.

British Fighters.

I’m going to abstract. Using a British report, and thus favorable to them, the fighters had an operational range of:

Spitfire XIV: about 230 miles.
Spitfire XVI: just under 400 miles.
Thunderbolt: 800 miles.
Mustang III: 750 miles.
Tempest: 300 miles.

It varies based of fuel load and such but the point remains that the British fighters were designed as point defense interceptors. In their words:

“*The superiority of the American aircraft is not so remarkable as it seems in that all the other aircraft were originally designed as interceptor fighters, and it was not until the later stages of the War, when offensive action became the major work of Fighter Command, that they had to be impressed*. “

The Spitfire was designed as a short range interceptor. Later editions with the Griffon had even less range (assuming same fuel). The Typhoon and Tempest were meant to be the “next generation” but were failures in the fighter role. In the fall of 1943 and spring of 1944 the Americans were defeating the Luftwaffe. The air combat resulted in the Germans pulling their fighters back to Germany. What were all the Spitfire squadrons doing? “Defense of England.” Against what remains a mystery. After the Luftwaffe fighter strength had been seriously reduced, late fall of 1944, the British decided they could do daylight raids on Germany with their bombers. At that point they re-equipped the escort squadrons with Mustangs. “when offensive action became the major work of Fighter Command, that they had to be impressed.”

I’ll hammer it harder. By the time the Spitfire received the Griffon it was better able to handle the German fighters but those German fighters were now in Germany and thus it’d never meet them. When the British switched to daylight bombing they transitioned the squadrons to Mustangs. They received over 2,000 Mustangs. The Griffon improved performance of the Spitfire but it was never going to encounter German fighters over England anyway.

Starting in the basement, let’s work our way up. Would having transitioned the British squadrons to Mustangs earlier have helped? Unlikely. It would have permitted them to escort American bombers to Germany but America had a surplus of planes and pilots. It’s only when the British switched to daylight bombing that they had a use for long-range fighters in Europe.

The Spitfire was the right fighters for the Battle of Britain. Winning is all well and fine but not losing is more important. That it did. The Americans decided to fight the Luftwaffe by day over

Germany and thus the Americans were responsible for protecting their bombers. That the American destruction of the Luftwaffe made it safe for the British to switch to daylight bombing was a nice happenstance but the British wouldn't have survived daylight bombing until then.

So, summing that up, the Spitfire was a short range interceptor by design. Which was exactly what was needed for the Battle of Britain. After that they upgraded the Spitfires to the Griffon and that was really pointless as they weren't going to encounter German fighters over England any longer as the Americans had moved the air war. The Tempest and Typhoons were really a failure at their intended role. That they did fine in ground attack doesn't change that at all. Radial engines are better for ground attack in any event. Change over to Mustangs wouldn't have helped anything.

Going wider, from the second half of 1943 to the end of the war the British fighters didn't really do much. Looking at my tank paper they weren't anything to write home about in ground combat either. Looking at the Pacific in, say 1943 or 1944, the British fleet, like the British fighters, were at home "defending England." Against what is a mystery. So harsh. It's reality. Not that it matters anyway; the British needed to get only one thing right: don't lose. In order to accomplish that they needed to defend England against air and sea threats. The Spitfires were perfect for the air part and did the job. The British excelled at anti-submarine warfare and that was the other thing they needed to get right. So, with regards to the only two things that really mattered, they did perfectly. Which doesn't change the point that British fighters, post Battle of Britain, were basically not much to write home about. This is a direct result of overvaluing the FW-190 and heading down that Typhoon/Tempest course. Finally corrected with the Meteor but the war would have had to have gone to 1946 for that to come out.

The bombers can defend themselves.

When the American heavy bombers were first fielded it was obvious that they were something to write home about. Performance was astounding; they were faster than contemporary fighters. Those pod mounted radial engines with turbochargers gave them a capability which was well in advance of any other air force. They made two assumptions with the second being the fatal one:

1) That single engine fighters wouldn't improve.
2) That single engine fighters were the threat.

It's that second one which is often missed – even today. Taking the B-17, on one side, and either the ME-109 or FW-190, on the other, it's not too bad. Even without fighter escort. The B-17 is a plane which is hard to shoot down. Taking the B-17, on one side, and either the ME-110 or JU-88, on the other side, and it's ugly. The B-17s each had 10 .50 machine guns. The ME-110 and JU-88 are big twins and can mount cannon and rockets. Let's set it down in stone:

Unescorted bombers over Germany were most threatened by fast twins with weapons having a range well in excess of the B-17's defense armament.

"In a dogfight between the P-47s or P-51s and the ME-109 or FW-190…" That is what people look at today. That's not the point.

Escort fighters were needed to prevent the Germans from attacking the bombers with twin-engined aircraft. Being more than competitive with German single-engined fighters was simply a bonus. Put another way, if I had B-17 and was going to attack a target of yours, unescorted, which would you select to meet me: P-47 (8 .50 machine guns), P-51 (6 .50 machine guns), or B-25H (1 75mm cannon and 10 .50 machine guns) which would you choose? Myself I'd go with the 75mm cannon.

Another look at the figures above, provided by the British, show the P-47 with greater range than the P-51. Strangely the Army Air Forces figures, post war, seem to confirm the P-51 had greater range in the ETO. Stranger yet, the figures in the PTO confirm the British figures. *When reviewing range figures for the P-47 in the ETO be very careful to check which drop tanks are being used to determine range.* Gotta love the bomber mafia. The P-47, not the P-51, broke the back of the Luftwaffe. The P-

51 just did it more fuel efficiently while the P-47 was also good in the fighter-bomber role whereas the P-51 wasn't.

Let's address the Japanese.

"Featuring excellent performance and high maneuverability, the Ki-84 was considered to be the best Japanese fighter to see large scale operations during World War II. It was able to match any Allied fighter, and was able intercept the high-flying B-29 Superfortresses." - Wikipedia.

When the Germans reviewed what they were able to determine on the B-29s performance figures they started development on the TA-152. Why?

On 11 December, 1945, B-29B "Pacusan Dreamboat" flew from Burbank, California, to New York City in just under five and a half hours. Average ground speed was 450.38 MPH.

You read that right. 450MPH. The B-29 wasn't the B-17. The B-29 flew higher, much higher, faster, and was harder to knock down. Whereas the B-17 and B-24 were really "medium altitude" bombers the B-29 was a high altitude bomber. In order for a single engine fighter to fight at high altitude it must be one of the following:

1) Radial engine with turbocharger.
2) Liquid-cooled engine with two stage supercharger.

The Japanese had no fighters in either class. They single engine fighter the Japanese had with the best altitude performance was the Ki-61. Simplified, when the ME-109 "won" the German fighter competition in Germany the competitor from Heinkel was sold, numbers of them, to the Japanese. Those aircraft, having the DB 601 engine, resulted in the Japanese designing a "clone" of the DB 601 and then an aircraft like the Heinkels but more Japanese. The Ki-61 had a liquid cooled engine with a single stage supercharger. Similar to the ME-109 and FW-190 pairing, the Ki-61 was better at altitude than the Japanese fighters with radial engines and single stage superchargers *to include the Ki-84*. 89 Ki-61s were reported as expended in ramming attacks against B-29 bombers. 74 B-29 bombers, total, were lost to Japanese aircraft of all types.

The Ki-84, second prototype, hit 387mph in level flight in 1943. The XF4U prototype exceeded 400mph in 1940. In 1945 the F4U had access to 150 octane fuel instead of 100. The Japanese had moved from 91 to 87 octane. The F4U, with a two stage supercharger, wasn't competitive as a high altitude fighter; for that you need a turbocharger or inline engine with a two stage supercharger. Were the Japanese aware of this? They stopped trying to intercept the B-29s in April of 1945.

The Nakajima Ki-87 was an experimental Japanese fighter. That aircraft was equipped with a radial engine and a turbocharger. The question is, if they'd managed to make any production copies, which they didn't, what would performance have been on 87 octane fuel?

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No Japanese fighter could intercept the B-29 bombers successfully. 74 total were lost to Japanese fighters of all types. That includes 89 Ki-61s expended in ramming attacks. Is it possible to shoot down a B-29 with a Japanese aircraft? Certainly. Once 20,000 feet is exceed their speed fell off greatly. As did most other performance figures. That said if one managed to climb ahead of time, directly in the location the stream would pass, one would get exactly one pass. So it could be managed but it was more luck than anything. The ME-163 had a similar problem in so many ways – if the bomber stream didn’t go exactly where expected no intercept was possible. The Japanese were in that same position. Advance notice was needed to give the fighters time to climb and they needed to be in the perfect position for an attack. No second pass was possible. When the Japanese had fighters on Iwo Jima the airfields are directly in a line from the bomber bases in the Mariana islands to Japan. After Iwo Jima was lost it was less probable.

“But in the hands of a good pilot!” If you think about it, if I was in an A6M Zero it’s possible I could bounce an F-16 jet fighter and shoot it down. That’s called luck. Japanese aircraft, of all types, weren’t technically designed in such a fashion that they could intercept the B-29s. Lack of turbochargers, two stage superchargers, and fuel with high octane rating prevented it. No amount of pilot skill can off-set that.

The F6F, the F4U, and the Japanese fighters.

Over Okinawa an A6M tangled with 97 F6Fs and shot down 19 of them. Says who? Me. I’ve seen claims in books with stuff like that. “The pilot of the A6M must have been great!” No, the author is really bad. The claims are either unsourced, read made-up, or from a Japanese pilot and unverified. Check claims and post-war efforts at verification and see the results. “Overclaims were epidemic.” Everybody knows that. An author needs to ignore that well known fact to include such a claim in a work. Suspend reality in hopes of a better story. In other words? “Fiction.”

Let’s separate it out. Fighters can operate at high, medium, or low altitude. No Japanese fighter was able to operate at high altitude. The grand total of 74 B-29s show down while they were unescorted is clear on that. Lack of turbochargers or two stage superchargers is the cause and low octane fuel just adds.

At medium altitude they’re going to be more competitive. What the FW-190A and ME-109 showed us is at medium altitude the liquid cooled engine had the edge when single stage, multi-speed superchargers were used. That’s logical. The F6F and F4U had radial engines with two stage superchargers whereas the Japanese radial engine fighters, to include the Ki-84 and N1K, had single stage superchargers. The Ki-61 was probably more competitive at medium altitude than the Ki-84 or N1K.

At low altitude the supercharging and turbocharging isn’t as important. The P-40 was competitive at low altitude with the Japanese fighters and that makes sense as it had a single-stage single-speed supercharger along with the “inline aerodynamics” advantage. So, with respect to the F4U and F6F versus the Ki-84 and N1K, all things being equal, are they on the same level? “130 and then 150 octane versus 91 then 87 octane.” Clearly “no.” The 2.3L in my Mustang losses 10% of its’ power with an octane drop from 93 to 87. That it’s a modern engine likely increases that problem but it’s there for all to see. All things being equal, the Japanese had inadequate fuel to be competitive. The Germans had better fuel but were still trailing.

The Japanese fighter were not competitive with the American. Just on fuel alone. As altitude increased the disadvantage increased. Better fuel not only provides better speed it provides better acceleration. Taking the Ki-84 and the N1K fighters, they were the most competitive at lower altitudes but they were still inferior. At medium altitude the Ki-61 was the most competitive but, again, it simply wasn’t competitive. At high altitude it was hopeless. What was needed was a twin with high altitude performance for the B-29s. The Japanese didn’t have one. 270 F6F fighters were lost, total, in aerial combat. First used in September of 1943, they were in combat until the war ended in September of 1945. Let’s call it 24 months. 270 F6F fighters lost in two years. 3,514 Ki-84 fighters were built. F6Fs claimed a total of 5,223 enemy aircraft destroyed. If we use 10% of that, which is massively low based on what’s known, it’s 522. Which is still about double the number of F6Fs lost. The Japanese fighters, all models, were simply not competitive. As altitude increased they became less competitive.

One last point with respect to Japanese fighters and that "in the hands of a bad author" thing. When Guadalcanal was obviously going to fall the Japanese pulled men out via the Tokyo Express. That was the last time they had that ability. The Marines took island after island after that with the Japanese being completely wiped out – outside of a few prisoners. Whereas the Marines gained experience in each invasion the Japanese lost all their troops and each subsequent invasion was against either green or Japanese troops having experience in China only. The Japanese pilots, in many regards, faced the same issue. The U.S. Navy used their fast carrier task forces to strike target after target. The Navy pilots gained experience with each strike. The Japanese generally didn't. When the American fighters appeared in Europe they met German pilots with experience against modern aircraft (British and French). The American pilots did just fine against them. When the Japanese struck Pearl Harbor the only experience the Japanese pilots had was against obsolete fighters in China. Where exactly did these "good pilots" the Japanese had in 1944 and 1945 come from? By 1944 the U.S. Navy pilots had a lot more, not less, experience than the Japanese pilots. The only "experienced" Japanese pilots remaining would have been those injured earlier in the war and now able to return to service. Which means they missed the middle of the war. They would have less, not more, experience against any type of modern aircraft than the U.S. Navy pilots. In the Pacific, prior to Pearl Harbor, the Japanese didn't have experience against modern fighters. During the war the U.S. Navy pilots gained more experience than the Japanese. The only way the Japanese aircraft were competitive is in the hands of a bad author. The Germans were competitive, the Japanese not so much. The Germans had more experienced pilots and better aircraft. Yet they were bested by Americans. The math is clear.

It's interested to review it from the other side. Hans-Werner Lerche was a Luftwaffe test pilot. Head of the section which tested foreign aircraft, he flew a P-51B and a P-47D. He also flew the ME-109, FW-190, and DO-335. In his words, "it was bitter of course that the enemy fighters were superior in performance *at exactly those altitudes in which their massed bombers formations were usually flying* their raids under an overwhelming escort protection." (Page 129). "Only the exhaust-driven turbo-superchargers gave the B-17 its good performance at higher altitudes." (page 37). "But for the production of these devices one required not only the know-how but also large quantities of heat-resisting materials which were lacking in Germany." Germany's fighters weren't completely competitive at the altitudes the B-17s could operate at.

B-29s flew higher and faster as they had pressurized cabins. At the altitudes they flew at turbochargers are required. Only the P-47 had that in a single engine fighter. The best fighter for altitude, with superchargers, was clearly the P-51. At the altitudes the B-29 operated at the P-47 is faster. Turbochargers. The Germans had the fuel needed. What they lacked was turbochargers. Japan had neither. The Ki-84 was unable to break 400 mph at any altitude. The N1K topped out at 408 mph at 6,000 feet on better fuel than the Japanese had. The F4U-1 was tested at Patuxent in 1945 and hit 422 mph at 18,000 feet. The difference between radial engines with two stage superchargers (F4U) and a turbocharger (P-47) is seen in that "critical altitude" (altitude where maximum speed is hit). For the F4U it's 18,000 feet. For the P-47N it's 32,000 feet. In other words, the F4U is faster at 18,000 feet but the P-47 is faster above 25,000 feet with the margin increasing as the F4U loses power but the P-47 doesn't. Up to B-29 altitudes. Put another way, the N1K was faster than the Ki-84 at high altitude. A fully loaded B-29 was as faster at 35,000 feet, than the N1K. The F4U is 15 mph faster than the B-29 at 33,000 feet with the P-47N being 100 mph faster than the F4U at that altitude.

Let's put it one last way. The N1K, at 32,000 feet, is 355 mph using Methanol boost. P-51D is 410 mph (Test TSCEP5E-1908). The top speed of the P-47N at that altitude is 467 mph (Report ES-302-A). The top speed of the ME-262 at that altitude is 506 mph. "On 11 December, 1945, B-29B "Pacusan Dreamboat" flew from Burbank, California, to New York City (empty) in just under five and a half hours. Average ground speed was 450.38 MPH.

11 pages with no graphics, headings, cites, or anything else. Written pretty quickly so if there are nits with something feel free to send them. If you're more interested in an argument don't bother. Reasoned debate is good but emotional argument is pretty pointless.

This isn't an "academic paper" or a book for sale so I'll not bother with the footnotes and such. It was written rather quickly and is simply a paper to illuminate some of the aspects of WW2 fighter and engine design and the usual arguments.