

Von Renny de Leeuw, NL

The building of a Cherry BX2 with a 100 HP bike engine

I start learning to fly and building my plane in 1990, from plans. It's a Cherry BX 2, a Swiss made design.

Its a 2 place side by side, with three cycle retractable gear and i made the choice in 1991 for a Limbach L200. That's a Volkswagen conversion 2 liter and 80 HP, direct driven.

My name is Renny de Leeuw, I live in Mijdrecht, that's a little city in the neighborhood of Amsterdam the Netherlands. I fly with this machine since the end of 1992, all over Europe and even North Africa, Marocco. The only problem with this machine was the lack of Horse power, it was good to fly, but typically under-powered. I learned myself to fly very carefully with this combination and that's has given no further problems. On highly mountainous airfields in the summer it makes me only a little nervous (and my wife) to start from there. The wish of more power was there during all those years.

After flying 1000 hours in 7 years, the engine was worn-out and it was necessary to buy another engine, but what???. 100 Hp is for my plane a good power source, but the weight is also very important. The old Limbach was 78 kg complete with exhaust and oil. Rotax makes very nice engines, but the sound is not ok, so I like. During firing up and switching off the engine makes a lot of noise. That's normal for this engine, but I don't like it. A Lycoming or a Continental with electrical starter is to heavy for my plane.

During a local fly-inn in Germany (Speyer) there was a guy from a company by the name Take-off, with a BMW engine, build on a motor mount on a little trailer behind his car. The engine was completed with a gearbox and electronic components and was running with a 3 blade propeller and a big silencer. This company makes ultralight planes and the people of the city there makes problems over the sound from the airfield. Therefore he took the 90 HP BMW engines for al those planes with thick silencers and 3 blade propellers.

A nice low sound (that's what we need in Europe) and a lot of power was the result. I was direct completely in love with this engine, direct after a few demonstration runs. The price was also very interesting to. (that's what we need in the Netherlands)

The engine was a 90 HP BMW motorbike engine, two cylinder, 4 stroke, with electronic fuel injection and electronic ignition, one spark plug pro cylinder. The cooling system is with oil and air. The guy told me, in begin of November there was coming a new type of engine on the market with 100 HP, magnesium cylinder heads and 4 kg lighter in total weight. I made the decision to wait till November.

During the waiting time, I collected everything about BMW I could get. Also over the gearbox and the clutch.

The box itself is made from smooth cast aluminium with a delay of 1:2,5. Big ball bearings makes it enable to use the gearbox for a pusher or a puller. Running the engine on his best RPM and torque during the start and take-off the prop runs 2800 - 2900 RPM.

During the firing up, the prop is disconnected and the engine has no obstruction during the firing up.

After running 1800 Rpm the flywheel clutch, in the bell house, takes the prop slowly with and by running 2500 motor RPM the connection is completed and the throttles can be opened completely, without a slippery clutch. The clutch is made fail-save, loosing the friction material and even with a broken part of the system, the engine keeps still the connection. This type of clutch is a rare view on the airport, a standing plane on the ramp with nobody in the cockpit and his propeller spinning in the wind, just like turbine engines.

The designer in Switzerland makes practical jokes with this. Walking around the plane in Grenchen airfield he takes the propeller and let it spinning by hand. He say " das ist noch immer kaputt"

The gearbox has his own oil system with very thick oil SAE 90 or more. The gearwheels are cut diagonal and the result is a very smooth and silent running box, without noise. Behind the clutch there is a Neoprene silencer mounted in the driven part of the gearbox. This silencer makes a little in-line misalignment not to a problem. The complete gearbox fit with 8, 8mm bolts to the engine

The engine is full electronic and the center of this management is a Motronic M.A. 2.4 computer, fabricated by Bosch in Germany.

This Motronic needs a lot of data from the oil temperature, intake air temperature, throttle potmeter, air pressure, the lambda sonde in the exhaust, RPM indication and crank-shaft position.

All this parameters be needed for the Motronic, enable it adjusting the engine during running on his best settings.

The engine basic adjustments are saved in a EPROM with a (kennfeld, what is that in English?) that's looking like a mountainous area view, with for every doses fuel by a special RPM and throttle position a peak or a valley. Every RPM and throttle position are preloaded and permanent saved in this EPROM. Only the different situations in temperatures and pressures etc. are fine tunings and usable for the Motronic.

At the end of November the seller has called me, the engine was there and I drive with my car to Dortmund in Germany. A lot of parts where delivered, I need to build up all those appendixes to a complete engine. The first problem was to mount the engine in the right place. Therefore I have made a mount of cheap construction steel for weighting the plane in case of the total balance. Just 5 centimeter longer as the experimental mount was enough for a nice balance and thereafter I made the real mount of 19 mm Chromo -molybdeen steel tube. The engine was hanging in 4 silencers of rubber. A friend of me has a company specialized in counting on special constructions. I asked him to account my engine mount and the day he told me the mount was a few times to strong I was really satisfied. It is very important to know if your mount is strong enough, because loosing your engine during flight is a big problem!!!

The oil cooler found a place in front of the engine, direct in the slipstream and the fuel pump with his fuel filter and the ignition found place in a box like area on the firewall, with air tubes under pressure from the slipstream for cooling down all this stuff. The electronic ignition is a metal box with two coils inside, one for each sparkplug. The Motronic is mounted on silent blocks, in the cockpit under the fuel tank on the top of the nose wheel bay, between my passenger and me. That's a place, free of dust, moist and cool even to.

The 3 bar pressure valve was in place under the gearbox , between the injectors and a extra fuel line for the returning surplus fuel in the tank has be made to.

A modification of my old electrical system was also necessary, because a separate circuit for the computer and fuel pump was needed in case of a electronic failure in the plane systems. From the battery, a separate wire with a big fuse of 20 Ampere goes direct to the start and ignition key and from there via the normal main switch to the battery relays. If the battery relays coming on, the feed to the busses are made. The main switch can not be activated without the use of the ignition key. The main switch could now be switched off in case of an serious failure or electrical fire, and the engine is still running on his own electrical circuit. The engine has his own cable harness, connected with a big plug under the instrument panel, securely lock wired.

The rest of the old wiring circuit is unmodified.

The propeller is a NSI 3 blade with carbon fiber blades from Warp-drive. The prop is electrical cockpit adjustable and designed for a maximum of 140 HP.

The blade angle can be adjust from 30 degrees forward to 28 degrees reverse.(beta) Taxiing backwards with the plane is possible and the mouths of a lot of people, looking to such a little plane taxiing backwards in to the hanger, falling open.

The prop can not being set reverse in flight during a propeller RPM more than 1000 . Over 1000 RPM only 10 degrees and more positive blade angle is possible. That's a safe construction. It is impossible to make the mistake to set the propeller reverse in flight The electrical connection on the engine is made of 3, long carbon brushes with 3 slip rings, mounted on the back plate of the spinner. In the cockpit is a gauge with digital information about the blade angle I have set. The buttons for adjusting the prop in flight, I have made on the flight stick top, between the buttons for the aileron/ elevator trims and the push to talk button for the radio.

The exhaust which I have made at first, was made of 40 mm inoxydable steel tube with two separated silencers . The cold intake air comes via a carbon fiber box with a big build-up air cleaner. In this box I has mounted the air temperature sensor, in front of one of the intake tubes. This temperature sensor is needed for the computer in case of adjusting his fuel management.

A carburetor heat is not necessary because there is no problem with carburetor ice by a injection engine, because there is not a venture.

The baffling I has made of a mixture of carbon and aramide fibers, with vinyl ester resin. This gives a temperature resistant and neat high-tech view.

At first i made the plates of aluminum and after being ready i used those plates like moldings and makes the surface of the resin very smooth.

At the end of December the engine was build-in complete and I fired it up the first time. After a few seconds running of the fuel pump, the engine ran direct. I was in the lucky circumstances by the use of a big industrial spraying cabin of 9 meters long in my company, because all the employers are with winter holiday. Big extinghousers in the cabin pull the fumes from the exhaust away outside the building area. No fumes and carbon monoxide, only a lot of wind.

It is also better to this job in the winter inside, because the outside air temperature was below zero. The whole test running and running a few hours I did it also in this cabin.

The only problem I meet was after running 10 minutes on high power settings the engine start stuttering and will no more accelerating. After cooling down, the engine start direct again and ran good. After a big searching I solved the problem.

The fuel pump have a big capacity and the surplus fuel flies back to the tank. All those fuel must passing true the fuel filter and that was not big enough. The fuel before the filter was vacuumed and start bubbling there, assisted by higher fuel temperatures after running a few minutes. Vapor-lock was the problem. After mounting a bigger filter and isolating the fuel lines well, the problem was solved permanently.

The oil was really hot after 1 hour running, but that's not so mad, because the cooling system is designed for using the slipstream during flight and not only the wind of the propeller.

After 5 hours running the engine was ready for power-up with full throttle, but it took better outside place than in the cabin, because I was affright to blow-up the cabin or my cabin paintstop filters.

With the plane on a thick rope, grounded on the construction of my building the throttles could be opened then.

The propeller with a blade angle of a pitch of 28 degrees, the engine runs 5000 RPM. Not so much for my feeling, but at first I has to do the test flight. I transported therefore the plane to Lelystad, that's my home base and after a few taxi test runs on the runway I made take-off.

Climbing with 1000 feet /minute and later with a top speed of 120 knots is not so bad, but also not so good as I hoped before .

Simultaneous climbs with a same type of aircraft with a Rotax 912 80 HP, the performances where the same as with my plane with the BMW, also I was sure there was not enough power. Much better as the old Limbach , but at long not enough.

A complete new exhaust wit a balance tube between the two cylinders and a two in one system silencer, just like the BMW motorcycle and with the Lambda sonde mounted in the Y fork I has made. During static runs with this modifications, the engine (with again 28 degrees blade angle) runs now 5300 RPM, much better like before, but still not enough at all. The intakes are straight cut PVC tubes, mounted on the throttle body's and ended straight in the box. Turbulence at the end of this tubes can be there, and later I made conical tubes with rounded ends, like a trumpet, very smooth inside, without obstructions to the throttle body's that's like a system as used on older racing engines. I made this parts of carbon fiber with vinyl ester resin on a mold.

Calculated with the airspeed in the air cleaner, the air stream was 90 KMH, but it be better to calm down the airspeed in the box to avoid turbulence there. During another static test, the engine runs now 5500 RPM, looked still better again.

In sequence I made a new carbon fiber box, also with vinyl ester resin, bigger in volume and very smooth inside and a bigger folded paper air cleaner with a maximum streaming speed of 20 KMH calculated by 7500 RPM. The airflow comes via a duct on top of the cowling and in flight the air will lightly pressurized into the intake trajet.

After this job, the engine runs static 5800 RPM at the maximum, again better, but still not enough. what to do now???

Experimenting with a lot of exhausting systems and sizes, even with tubes of 45 mm in stade of 40 mm and a lot of types silencers, still the engine runs not more than 6000 rpm. It looks good, but still not the 6500 RPM I hoped and calculated for 100 HP before.

The Computer is a self learning system with a adaptive program. Is it the computer that protecting the engine for detonating ??? All the old mistakes en missettings in exhaust and mixtures are saved for the last 3 hours. I look how i could reset this computer but the factory Bosch would and could not help me. I asked by the BMW factory in Munchen but the could not help me also. I had made myself a few experiments and I discovered and figured out that if the motronic is connected on the power line (contact on)and than disconnecting only the memory wire of the computer, the computer resets itself. The engine runs 200 RPM more static directly. After re-connecting the memory wire, again another 200 RPM extra on the RPM indicator. Now the engine was running 6400 RPM and after a few hours of flying, the program learned by itself another 100 RPM extra.

All this building, rebuilding, discovering and experimenting cost me over a year work in my spare time, that's only for the engine!!! At the other side, it is not realistic to think you can take a bike engine, put it in your plane and having an new aircraft engine without problems. I was the first flying with this 100 HP engine and a pioneer for the seller

On the moment the plane climbs quickly with 1500 feet /minute on his maximum weight and with a top speed of 140 knots I am completely satisfied. The Rotax planes are behind me during the climb and top speed. Maybe there is more in it, but there is a time to be satisfied. I have flew now 130 hours with this engine and I am really happy with this engine. I start planning big trips over Europe again and take my flight planning's out of the refrigerator, the are there for a year.

Renny de Leeuw