
D-EPCF

# TAKING IT BREEZY

## BUILDING MY RLU-1

STORY AND PHOTOGRAPHY
BY CARL-FRIEDERICH SCHMIDT

**WHEN I DID MY** flight training in the mid-1980s, I only wanted to fly ultralights. They fascinated me with their simplicity and the original spirit of flying. Over the years, I learned to fly increasingly complex aircraft. Only after many years as a flight instructor and freelancer in commercial aviation did I finally go back to the roots. I stumbled upon an old photo of the first Breezy on the internet and immediately wanted one. So, I got the drawings, and in 2005 I flew to EAA AirVenture Oshkosh where I saw and flew a Breezy for the first time. It was even better than I imagined. Flying a Breezy is like swimming naked!


**Above:** *The original Breezy, which is now on display at the EAA Aviation Museum.*

**Right:** *Carl-Friederich (left) and original Breezy designer Carl Unger at AirVenture.*

## THE FUSELAGE

I started by building the fuselage and looking for Piper wings. Four years of sawing, grinding, and welding. The plans call for the use of SAE 4130 steel tubing. After consulting with my engineer Ingo Luz, I decided on the German equivalent DIN 1.7734.4, which is about 15 percent more tensile and three times as expensive as 4130. The material does not harden during welding, which means there is no need for heat treatment. I chose the next larger dimensions for diameter and wall thickness — the weight gain was negligible, but the reinforcement was enormous. The whole fuselage weighs about 70 kilograms (154 pounds) but turned out to be so long that I had to chop a hole in the back wall of the garage.

I built jigs, ground the tubes for optimal fit, and tacked the parts with a TIG welder. Then I brought everything to Roman Weller in Schwäbisch Hall, who finished the welds in three long sessions. I blasted and immediately primed everything with zinc chromate. The top coat is polyurethane car paint.

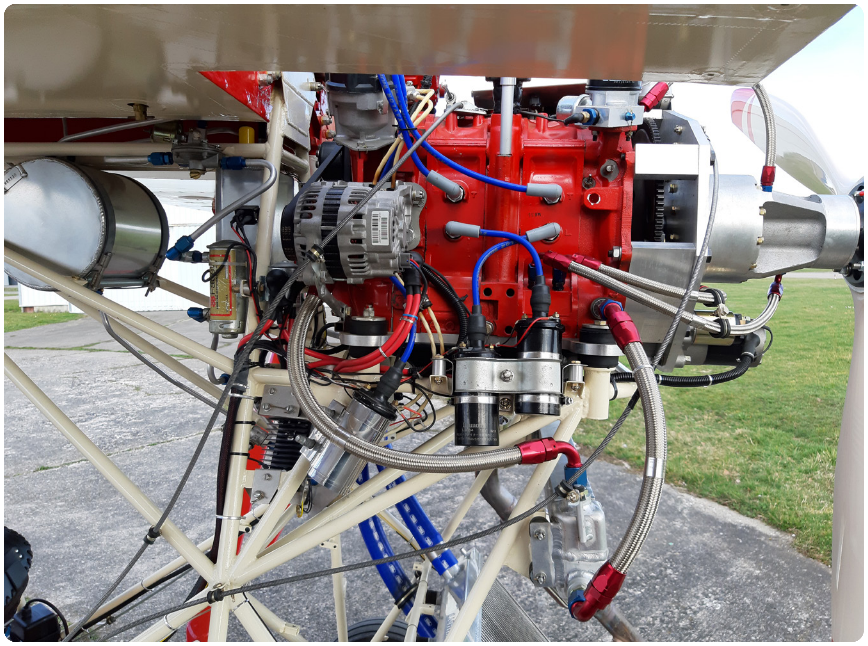
A typical Breezy rotates at a relatively high takeoff speed due to a combination of factors — the wings are at zero angle of incidence, the tail is small, and the center of gravity is well forward of the main gear. To mitigate this, I lowered the main gear by an inch and installed a suspension on the nose gear that raises the nose by another 2 inches. This results in a significantly higher angle of attack during takeoff.

The tail feathers are off a Piper J-3, and I built a Flettner trim with a self-locking lever that is attached to the right of the seat. In order to share the flight experience, I installed a complete set of dual controls from a dismantled J-3. The wheels and brakes are from a Cessna 172, while the foot brake cylinders are from a J-3. The braking effect is good despite the combination — Frankenstein would have enjoyed it.

After years of searching, I finally found my wings. They had been stored in their original crate in a military hangar since 1957 and were intended as a replacement for an L-18C, the military version of the PA-18. The original covering was brittle and had to be replaced by Ceconite, but inside they were like new. By installing a second wing tank, 136 liters (36 gallons) of usable fuel are now available.

From the beginning of the project, it was clear to me that I would likely not be in compliance with mandatory noise regulations, so I was looking for an engine that rotates significantly slower than the C90 with at least comparable power. I came across Edy Schütz on the internet. He had just finished building his Breezy with a Mazda rotary engine from an RX-7 and thus complied with Switzerland's strict noise regulations. I flew to the Speck airfield near Zurich to look at his airplane and its engine. I was skeptical, but the concept and Edy's expertise convinced me.

**BUILDING THE BREEZY**



### WHAT ABOUT THE LEGENDARY OIL CONSUMPTION?

The engine oil only serves to lubricate the eccentric shaft and dissipates a large part of the heat. Therefore, in a typical installation, oil has to be injected into the combustion chamber to lubricate the seals by a metering oil pump. Racing drivers and homebuilders found that it was simpler and more reliable to remove the pump and add two-stroke oil to the fuel, at a ratio of 1-to-140. The whole setup is incredibly simple and robust compared to piston engines.

### DOESN'T IT DRINK A LOT?

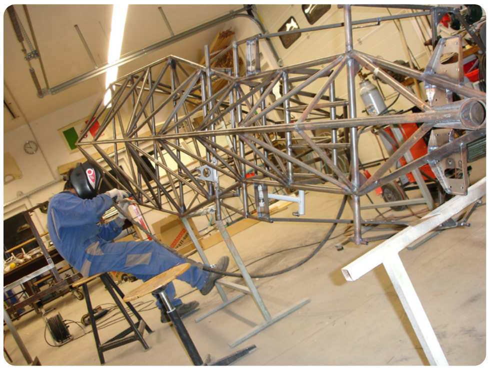
Compared to traditional engines, the specific fuel consumption of a rotary engine like the Mazda 13B is up to 30 percent higher. This is largely due to the imperfect combustion chamber geometry of the Wankel, which is only as efficient as comparable gasoline engines at relatively high engine speed/power output. But, typical car engines on the road mostly work at 15-30 percent power, while aircraft engines are mostly operated at 60-80 percent power. The 13B is a stable engine, provided it is supplied with sufficient cooling and lubrication, and can easily handle continuous operation at 70 percent power. 13Bs have flown for 2,000 hours with 6000-7000 rpm without complaint. Because of their efficiency at higher power settings, they do not consume more than comparable aircraft engines.

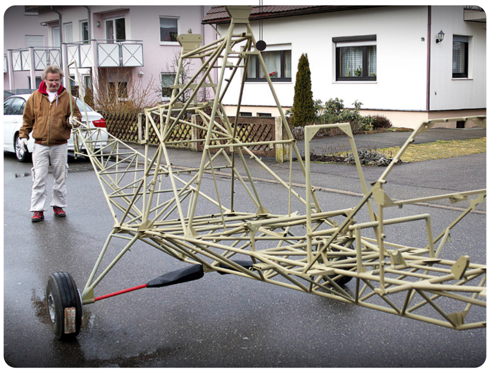
I had my engine block built by Bruce Turrentine, a well-known rotary supplier in American racing. I built the periphery like carb setup, double ignition, cooling, exhaust system, etc. Firewall forward, my 13B, including coolant and oil, weighs about the same as an O-360, has about 180 hp, and consumes about 35 liters (9 gallons) of mogas per hour.

### THE ROTARY ENGINE

Mazda built about 1 million(!) 13B rotary engines. The engine has been used with great success in car racing and in experimental aircraft since its appearance in the United States, where the RX-7 was introduced as a Porsche killer in 1978. It is a two-chamber Wankel with three essential parts that move to generate power — the crankshaft and two rotors. The crankshaft is actually not a crankshaft at all, because there are no connecting rods or crank pins. Rather, it converts the circular movement of the rotors into movement of the shaft. The rotors drive the eccentric shaft directly, without a connecting rod, and rotate three times as slowly as the shaft. Even at speeds of up to 8000 rpm, the speed of the apex seals is no higher than the piston speed of comparable traditional engines. The 13B rotary engine is a four-stroke engine without valves and camshaft, slot-controlled through the side inlets and the rotors.

***I estimate that in the past 14 years I've spent about 3,000 hours building and about twice as much time researching online.***





## IGNITION

The 13B I used has electronic ignition and injection in the car, while the direct predecessor had transistor ignition and was carbureted. The engine control unit of the RX-7 is considered to be robust and reliable, but it is not redundant and stops the engine when it overheats.

The 13B has two spark plugs per rotor housing (trochoid) for better combustion. The first (leading) spark plug ignites at full load about 20 degrees before top dead center (TDC), the latter (trailing) spark plug at about 10 degrees before TDC. It is quite easy to split the two plugs between two ignition systems and thus obtain the desired redundancy. The loss of the leading ignition leads to about a 15 percent loss of power. If the trailing plugs fail, the loss is very small and can only be detected on the dynamometer.

I bought an older distributor secondhand, overhauled it according to the manual, and modified it so that the respective leading plugs of the two trochoids are individually controlled with their own ignition coil. The trailing plugs have their own power supply via the additional electrical system, consisting of an additional battery and an alternator from a forklift located on the engine where the air conditioning compressor was previously. An additional advantage is that the water pump is now driven by two V-belts instead of one. The described conversion of the ignition system comes from the American racing scene and is called DLIDFIS (dual leading ignitor direct fire ignition system).


## CARBURETOR

A redundant electronic injection would certainly be possible, but I prefer the old-school variant with a carburetor. Conversions to Weber racing carburetors are popular and easy to work with, provided you understand what all the screws and nozzles are for. I bought a 45 DCOE Weber twin flat-stream carburetor, a custom intake manifold, and two detailed manuals.

It took me weeks to understand everything and months until the engine ran smoothly. When tuning the carburetor, I used a wireless oxygen sensor in addition to the EGT sensors. The search for the cause of a stumbling engine run at around 3000 rpm cost me weeks, because I was looking for the fault in the jetting of the carburetor. Finally, it turned out that the pickup coils for the GM ignition modules had to be polarized the other way. Now, the engine starts better than my Daimler in any weather, and runs silky smooth and transitions perfectly over all three carburetor circuits in the entire speed range. On top of the carb heat box is a large K&N air filter. My examiner, Werner Koch, said I should build a different cover to keep out any rainwater flowing in from the side. After two weeks of unsuccessful thinking, the problem was solved with a trip to the kitchen cupboard where I found a frying pan lid.

## COOLING

A rotary engine emits 30 percent of its heat through the oil and 70 percent through the coolant. The original oil cooler of the RX-7 is well built and big enough — much bigger than that of an O-360, for example. As for a radiator, I wanted to have a nice, shiny aluminum one that is sufficiently sized and fits exactly into the fuselage compartment under the engine. After some research I found an aftermarket cooler from Mishimoto, which is actually for a Mitsubishi Eclipse. Of course, the connections had to be moved and brackets welded on. I also installed a SPAL fan, which I never really needed except for the engine test runs in the hot summer.

## EXHAUST SYSTEM

The exhaust from a 13B is like the breath of a fire-breathing dragon. With the lack of valves, the engine is really terribly loud and the exhaust gases can reach temperatures of up to 1,800 degrees Fahrenheit (980 degrees Celsius). The target EGT in cruise is 1,650 degrees Fahrenheit. Paul Lamar, an American rotary guru whom I met at AERO, recommended that I use a pre-silencer and a muffler. The material had to be highly heat-resistant, so apart from the expensive and difficult-to-process Inconel, only stainless steel was considered. The front silencer is actually just an empty can, crossed from front to back by a pipe that cools from the inside and uses the heated air to preheat the carburetor.

The pipes, clamps, and the Hushpower Flowmaster rear muffler are made of SAE 321, all from a hot rod shop in Chicago. I imagined reaching a gentle, pleasant tone — it worked. I have no concerns about complying with noise restrictions.


*To power his Breezy, Carl-Friederich chose a modified Mazda 13B rotary engine and a custom Catto propeller.*

## REDUCTION GEAR

To get closer to the goal of lower speed and thus less noise, you obviously need a gearbox. Tracy Crook, a Florida Wankel pioneer, designed a reduction gear for the 13B and has operated it successfully in his RV for many years. It is directly bolted to the engine and contains a planetary gear set from a GM automatic transmission. It can be used both as a tractor and as a pusher and is connected to the engine's oil circuit. My gearbox has a reduction of 2.85-to-1. When cruising at 65 knots, the engine is running at 5200 rpm while the propeller turns at 1825 rpm. The takeoff settings are 6000 rpm and 2100 rpm.

## PROPELLER

The choice of propeller was relatively easy — it had to be a Catto. Craig Catto, EAA 224433, is my age (60) and has built propellers his whole life. An adjustable-pitch propeller was out of the question, because the different speeds of a Breezy that you have to know as a pilot are: $V_R$ = 60 mph, $V_X$ = 60 mph, $V_Y$ = 60 mph, $V_{REF}$ = 60 mph, etc. Craig had already built several propellers for my engine-gearbox combination. Although he had a delivery time of 18 months at that time, he sent me a gem after just six weeks. It is three-bladed with a 68-inch diameter and 60-inch pitch. The blades are as wide as shoeboxes, and the sound is incredibly smooth and bubbling at my low speeds.

## ELECTRICS

The aircraft has two separate electrical systems due to the double battery ignition. The main switches, fuses, circuit breakers, and instruments are separated from each other in the panel on the left and right side. If an alternator fails, you can still charge both batteries with the remaining alternator via a cross-feed switch. All electrical components are distributed between the two electrical systems, e.g., fuel pump 1 left, fuel pump 2 right, etc. Both alternators have a combined output of 115 amps. This means I not only have enough power for avionics, beacons, strobe, Harley-Davidson landing lights and a large taxi light, but also can easily operate electrically heated clothing on both seats.


glittering like mica on bumper cars, like gold or something." He had a residue of 24K gold dust from a previous order. The girl was scanned from a poster, and the clouds behind it were painted with airbrush. Afterward, clear lacquer was applied over it and the finish is glossy and smooth like a billiard ball.

### COCKPIT AND INSTRUMENTS

In a Breezy, you usually sit completely unprotected in the open air. In principle, that's very nice, but other things were more important to me. My engine is significantly heavier than a C90, so I needed a counterweight in the nose. The batteries started their journey from the very back to the very front after the weighing. I've also always enjoyed flying long distances, so the instrument panel, done for me by Schaeffer AG, is total overkill but still much more helpful than not. The instrumentation consists mainly of the round gauges that I have always liked, with a Plastimo boat compass on top of the front cowling to protect it from interference. Of course, all instruments are illuminated, and I connected a small Bluetooth receiver to the radio — after all, I'm a musician.

A comprehensive engine monitor developed by Tracy Crook can display almost everything conceivable. All recorded engine data from the last 20 minutes can be read out via a USB stick, which is very practical for testing. I installed sensors for oil temperature, oil pressure, water temperature, water pressure, fuel flow, two EGT sensors, oxygen, outside temperature, carburetor intake temperature, pitot, and static. The device shows, among other things, fuel burn, miles per gallon, pressure altitude, indicated airspeed, Hobbs time, oil change intervals, onboard voltage, and much more.

### NOSE ART

Finally, I widened the fuselage and adjusted everything to my body size. My friend Klaus Hoppe, who did all the painting work, is a gifted car mechanic. He built and painted a beautiful fiberglass hood for me. I wanted the lettering "like Coca-Cola font and somehow

### FIRST FLIGHT

My EAA chapter recommended Ingo Luz as the engineer and Werner Koch as the examiner for my project. There was trust and cooperation from the beginning with both of them that gave me a lot of pleasure. My project is exotic, and the result looks like a children's carousel, so I'm all the more grateful for having been taken seriously.

It would certainly have been easier to build a kit airplane, because kits available today are well documented and make certification easy. The options for changing a plansbuilt experimental are extremely tempting and a blessing and a curse at the same time. Fortunately, Edy Schütz made the structural calculations of his Breezy available to me, which were already recognized by the Luftfahrt-Bundesamt, or Federal Aviation Office (FAO) — the German equivalent of the FAA. He had calculated a maximum takeoff weight of 794 kilograms (1,750 pounds). The empty weight is 520 kilograms (1,145 pounds), and these values correspond to a comparably equipped Super Cub without windows, roof, and fabric. The complete printout of the structure calculation is as thick as a telephone directory, and I don't understand a single line of it. The luggage area behind the back seat is designed for 40 kilograms and offers enough space for a complete set of camping gear for two people. To the left and right of it, external load carriers are also welded on just in case.

I estimate that in the past 14 years I've spent about 3,000 hours building and about twice as much time researching online. During my numerous visits to Oshkosh, I got to know some Breezy pilots who helped me a lot, but the most important was my friend Arnold Zimmermann, EAA 205374, who first invited me to Oshkosh in 2005 to show me his Breezy. Arnie has given 12,000(!) free rides with his Breezy, N3AZ. A close friendship developed, and I was even welcomed as a guest in his house. Arnie let me fly his Breezy as much as I wanted, so I was able to gain valuable experience before my first flight. As expected, the airplane is very docile, but you really have to get used to the missing horizon reference before you feel reasonably safe. You sit right in the front and the rest of the airplane is behind you, but you quickly get a feel for it by trying to feel the seat turning under your bum. Due to the open fuselage, the plane is insensitive to crosswinds, but it always stumbles a bit like a dead leaf in the wind. Yawing around the vertical axis stabilizes by itself from about 10 degrees left and right.

Since I was probably the pilot in Germany with the most Breezy experience, the FAO entrusted me with the supervision of the test flights. The first attempts at taxiing were unspectacular until the moment it suddenly took off unexpectedly in autumn 2019. But after about 150 meters (490 feet) I wrangled it down again and was overjoyed to have left the ground for the first time. Then summer 2020 came and I was on part-time work, so I had all the time in the world to prepare for my real first flight. On June 30, under the best conditions, I was at the field early in the morning and did two short hops on the runway first. Then one last run-up and full throttle. The first 20 seconds were pure adrenaline, but after a short instrument check to make sure that temperatures and pressures were okay, it was nice and relaxed. I only flew one traffic pattern and then taxied back to the hangar. I expected to be very excited after this moment, but I was totally calm and almost emotionless as if it had been routine. I think I was well prepared. In the evening, of course, I partied like I was 17 again.

The subsequent 22 short test flights to date have led to the following findings: The trim tab was just big enough to trim the required speeds from $V_S$ to $V_A$. It has been replaced by a larger one and is now perfectly dimensioned. The target cruise speed could not be maintained. The airplane just didn't want to hold altitude and wasn't as stable as I expected. A stabilized cruise only occurred at around 70 knots. The immense resistance of the iron monster at slow speeds and the proximity to the back of the power curve were the cause, in my opinion. I installed a set of micro vortex generators that I bought at Oshkosh years ago. These things are really magical — it now flies incredibly stable. On my last flight, I was able to trim to 50 knots without any problems and now have significantly lower fuel consumption. If I want to I can still fly 80 knots, but that's not much fun. I have not yet flown the entire envelope, but the stall speed is now probably around 40 knots. The fine-tuning of the carburetor is also still in progress. I'm still flying a little rich and slowly feeling my way up to the optimal engine temperatures by carefully changing the jets. The carburetor has no manual mixture adjustment, but I don't plan to fly higher than 6,000 feet on a regular basis, and the rotary engine can withstand large differences in density. Short videos of my test flights can be found via the link at EAA.org/Extras.

## CONCLUSION

The construction of this flying machine was the most creative time of my life. During this time, I learned a lot, met many interesting people, and made good friends. People on the airfield and on the ground always wave at me. Why? Because Breezy flying is like swimming naked. EAA

**Carl-Friederich Schmidt**, EAA 774690, works as a trumpet player in a symphony orchestra. During a concert tour of the U.S. and Canada, he ran into a cropduster who ignited his passion for flying. Since then, he has been flying as a freelance commercial pilot and CRI. After obtaining his seaplane rating, he wanted to build a small amphibian, but instead found the Breezy on the internet. Learn more about him on his website at Charly-Sunshine.com.