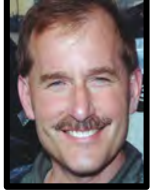

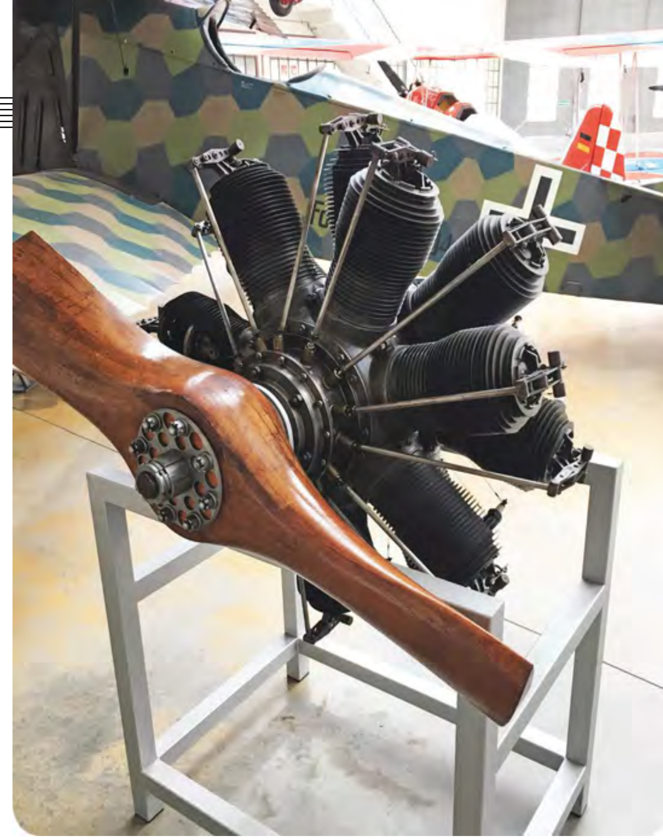

The Rotary Engine

A forgotten technology from aviation's past

BY JEFF SKILES

WHAT IS A ROTARY ENGINE? Note that I wrote rotary and not radial. Radial engines are still seen regularly at air shows and fly-ins, particularly those catering to antique/classic or World War II aircraft. Rotary engines, however, are an entirely different breed rarely seen today except among those who build replicas of early pioneer aircraft.

Rotary aircraft engines were primarily built and flown in the years leading up to and through World War I. Their time was short, however, as improvements in other engine technologies rapidly eclipsed the rotary's place in history. Rotary engines were small — generally less than 160 hp — but they had advantages over other early aircraft engines and were technological marvels of their period.

HOW AN ENGINE WORKS

To understand a rotary, let's first discuss how a more conventional engine works. Engines of today have a stationary case and cylinder heads that are attached to the airframe through an engine mount. Within the cylinders the pistons go in and out propelled by the ignition and expansion of gases driving connecting rods that turn a crankshaft. The crankshaft is connected directly or through a gearing mechanism to the propeller. As the crankshaft turns, so does the propeller. This concept is true in virtually all internal combustion aircraft engines commonly employed today, horizontally opposed, radial, inline, gas, diesel, you name it. The key point is that, with the cowling off, the engine itself doesn't appear to be doing much of anything when running. All the action is occurring internally, only the crankshaft and propeller are turning. The rotary, however, works quite differently.

A rotary engine has a crankshaft that is stationary and connected firmly to the aircraft. When in operation the engine's case and cylinders spin around the stationary crankshaft like a whirling dervish. Let's look at that again — the cylinders and engine case are spinning rapidly around a central stationary crankshaft, and the aircraft's propeller is then connected to the engine case.

While a rotary engine looks almost exactly like a radial engine when at rest, it is a blur of motion when running as not only the prop, but also all of the cylinders and case are whirring around as well. This might be a bit hard to comprehend, but there are several YouTube videos showing a rotary in action to help you understand the concept.

Above: *An Oberursel U.III twin-row rotary engine (note the single-valve Gnome design).*

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WHY BUILD SUCH A RUBE GOLDBERG DEVICE?

So why would anybody design an engine like this, and why don't we see any today? Well, the rotary was initially designed for very sound reasons, and they were even used in automobiles and motorcycles. Rotary engines were simpler and had fewer parts. As a result, they had a more favorable power-to-weight ratio as compared to other engine types.

Also, since the cylinders were spinning around in space they provided their own cooling both on the ground and in the air. Cooling was a problem with early engines, and with the rotary, no heavy radiators and water cooling jackets were needed.

The spinning mass of cylinders and case also produced considerable inertia leading to a very smooth running engine. Other engine types require a flywheel attached to the crankshaft to oppose the force of the firing pistons and smooth out the operation. Rotary engines have no need for this since the mass of the engine itself acts as a flywheel, saving considerable weight.

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WHY DON'T WE SEE ANY TODAY?

Of course, there were disadvantages to the rotary engine, which is why you don't see them today. While the rotary was a four-stroke Otto cycle engine, it had a total loss oil system. While the oil wasn't mixed with the gasoline in the tank as with a two-stroke engine, it was metered into the cylinders along with the fuel/air mixture through a hollow crankshaft and then exhausted out of the cylinders through the exhaust valves in the normal course of operation. In this fashion a rotary could consume between 1 and 2 gallons of oil for every hour of flight. The exhaust of a rotary was thick with oil and exhaust smoke that covered everything behind it, the pilot included. Castor oil was typically used because it would retain its lubricating properties even when diluted with gasoline. Castor oil is also a laxative in humans, and it is claimed by some that an unfortunate side effect of flight behind a rotary engine was a perpetual case of diarrhea for the pilot. I'm not sure this is factual, but if true, it would certainly behoove the pilot to keep his mouth closed in flight.

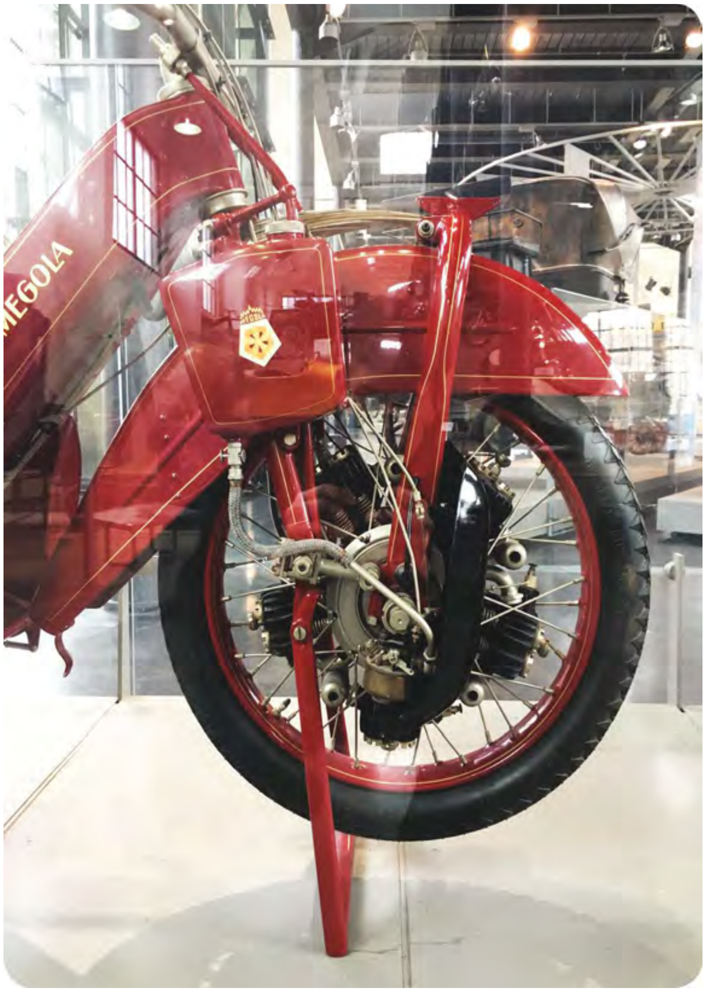
One major rotary manufacturer, Gnome, was known for its innovative solutions in engine design. In an effort to limit the number of moving parts, Gnome built its Monosoupape (single valve) engine without a throttle to control the engine speed. The engine ran at full power much of the time and only had a mixture control to refine the fuel/air mixture. The big, slow-turning props of the day produced a surprising amount of thrust, and airplanes that go up must also come down.

While their reign was brief, the rotary engine and the acceleration of technological development inherent in any war had a hand in shaping aviation as we know it and placed the rotary solidly in the heritage of the aircraft engines we fly behind today.

Reducing engine power on the Gnome was facilitated by a "blip" switch that would interrupt the ignition and limit power. Initially, all cylinders would lose ignition with the use of the blip switch, but in later Gnome models some of the spark plugs would be left firing, reducing power while keeping the engine in balance. With the ignition disabled either partially or completely, however, the cylinders would still pump fuel and oil that would be exhausted out through the single valve and could then collect in the cowling and other aircraft recesses. It was said that too much use of the blip switch could lead to fires that would quickly engulf the entire airplane.

Cutting the ignition to control engine speed was primarily associated with Gnome-produced powerplants, but all rotary engines expelled oil in the normal course of operation. Therefore, most rotary engine aircraft didn't have a lower engine cowling allowing the oil to drip/spew away rather than collect in hidden recesses and become a fire hazard.

Other rotary manufacturers built their engines with a throttle to meter the fuel/air mixture but still had unusual methods of control. One of them, Clerget, recommended the opposite approach to Gnome. Its suggested power-reduction procedure for landing was to shut off fuel to the engine. The slipstream forces would keep the propeller, and therefore the engine, rotating and the ignition would be left firing to keep the plugs from becoming covered with oil. Should you subsequently need to add power, the fuel could be reintroduced. Remaining high on approach would be an asset it would seem.



An early 20th century German Megola motorcycle powered by a wheel-mounted rotary engine.

AIRCRAFT AT WAR

Rotary engines were produced for military aircraft on the western side of World War I by Gnome, Le Rhône, and Clerget and on the German side by Oberursel. Even back then the world was a small one, and licensing of technology led to versions of the same rotary engine powering airplanes on both sides of the conflict. More than 100,000 aircraft engines were built by Gnome et Rhône (merged in 1915) and its licensees alone.

The German aircraft manufacturers had a stronger preference for big water-cooled engines, but they still used rotaries as well. Baron Manfred von Richthofen, commonly known as the Red Baron, flew a Fokker Dr.I triplane powered by an Oberursel rotary engine that was a clone of the French-built Le Rhône. Roy Brown, a Canadian, attacked the Baron just before he was shot down. Brown was flying a Sopwith Camel that was also powered by a rotary (most evaluations conclude that it was Australian ground fire however that downed the Red Baron). Several years ago, I flew in a German World War II-era Junkers 52 trimotor and was surprised to find that the BMW engines roaring on the wings were license-built Pratt & Whitney Wasps. Such is the way of things in international business when the world goes to war.

While the rotary engines had their failings, they were the best engines available at the time and by some accountings powered 80 percent of the aircraft on both sides of the conflict. After the war the rotary engine quickly became obsolete as the difficulties inherent in its operation and the improving technologies of more traditional air- and water-cooled engines made other options more attractive. While their reign was brief, the rotary engine and the acceleration of technological development inherent in any war had a hand in shaping aviation as we know it and placed the rotary solidly in the heritage of the aircraft engines we fly behind today. *EAA*

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