AS THE WOOD TURNS

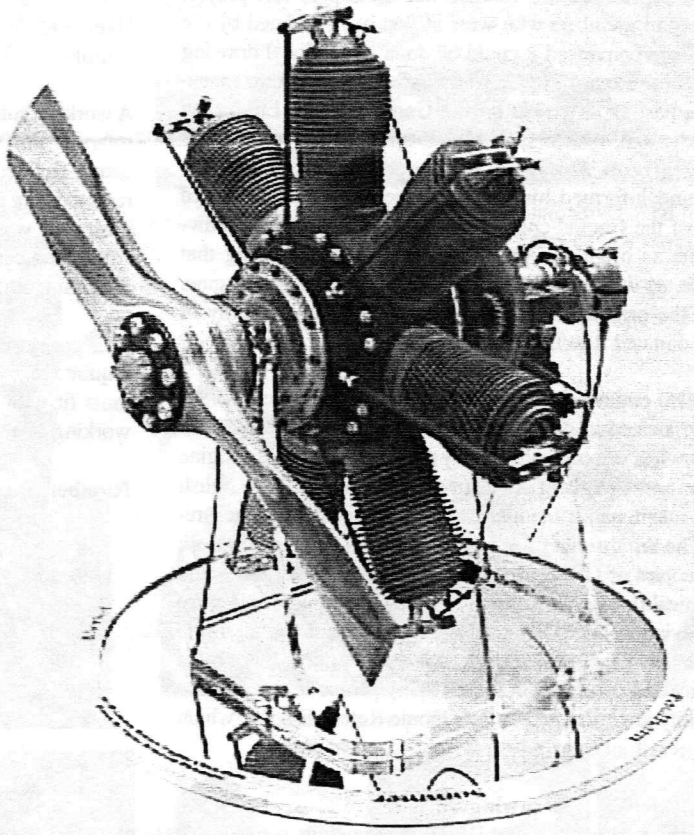
AAW Symposium 2000 Special Edition

The Art of Precision Woodturning

The Hum of the Fifty Gnome

Give me the hum of the Fifty Gnome,
Flying o'er hill and dale,
Taking me whither I care to roam,
To uplands, or sun-kissed vale,
Take me away from the busy street,
Away from the township toil:
Give me the hum of the Fifty Gnome -
The taste of the castor oil.

Give me the hum of the Fifty Gnome,
Give me the chance to go
Over the city's cross-topped dome,
Over the hills of snow.
Never was loved one half so dear,
Never was voice so sweet,
Give me the hum of the Fifty Gnome -
The feeling of icy feet.



50 HP Gnome Rotary Engine Circa 1909
1/2 Size Wooden Replica

MSSW Officers - Year 2000

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Massachusetts South Shore Woodturners

Presenting
Massachusetts South Shore Woodturners
AAW Chapter Collaborative
Challenge 2000

June 30 - July 2, 2000
Charlotte Convention Center
Charlotte, North Carolina

AAW Chapter Collaborative Challenge 2000
MSSW Gnome Rotary Engine Project
Notes by Mal Partridge

Research:

Research started February 1999 and preliminary drawings presented as proposed AAW Challenge project for '99, but due to scope of project and time constraints deferred to project for 2000.

Original idea for project came from noticing rotary aircraft engine in Sopwith Camel model in my computer room and associating rotary with turning/rotation of wood on lathe. With most of the engine components having been turned this seemed like an appropriate project and was presented to members who were at first overwhelmed by the complexity but were convinced it could be done. A sectional drawing of the 50 HP Gnome Rotary Engine was located in WWI Aero magazine issue 96 as part of an article on the Gnome Rotary Engine by Lauren McCready, Rear Admiral, USMS (Ret), a condensation of his thesis for the Degree of Master of Science (History of Science). I contacted him and informed him of our project to create a turned wooden replica of the Gnome engine. He did not have detailed drawings, but sent me an original copy of the cross section drawing that was in his article, as well as photos of various versions of the engine. (He was given the original Gnome engine by the Sequin family of France and has donated it to the Smithsonian.)

Search for detailed engineering drawings started via internet 8/6/99. None have been located to date. My drawings were created from the cross section drawing, photographs and by measuring a Gnome engine displayed at the New England Air Museum. A copy of an English Gnome Engine maintenance manual was also obtained from their research library. The Smithsonian Air & Space Museum Reference Desk supplied some copies of Gnome manufacturer's brochures, but could not locate technical drawings in their archives Other references were obtained from aviation books, magazines, models, and the internet.. They fill a 2" binder. Time spent on research is not logged. It is a most enjoyable activity and continues. It seems many people in the aviation history community are interested in the Gnome Rotary Engine, which gave a young aircraft industry a light weight practical engine.

Drawings:

Detailed computer generated (Corel DRAW9) drawings were started on October 25th, 1999. Over 150 drawings have been made which include jigs and fixture data as well as detailed and assembly drawings. Over 500 hours were spent on the drawings alone. A large Decimal Equivalent chart was also made and given to members as this would be a precision woodturning project requiring working to dimensions not associated with our usual turned art forms.

Drawings were given to nine participating members at the MSSW January 2000 meeting. A meeting of volunteers was previously held at Jesse Meyers shop on January 19th to select wood from his large stock.

Fabrication:

Parts as produced by members were shown at the February, March, and April meetings. A flip chart with photographs and techniques used to fabricate some of the components was used to show members the progress, problems and solutions encountered during the fabrication of various components. An assembly was shown at the May meeting and final assembly with base at the June meeting prior to transporting to AAW Symposium in Charlotte, North Carolina.

Meetings were held at Mal's shop where assembly took place. Hank Cahill, Wally Kemp, John Murphy and Richard Friberg attended at various times as parts were made, modified if necessary to fit and assembled. Mal met at Hank Cahill's and John Murphy's shops to discuss crankcase and cylinder fabrication. Many phone conversations took place as questions over drawing details and methods of producing parts developed.

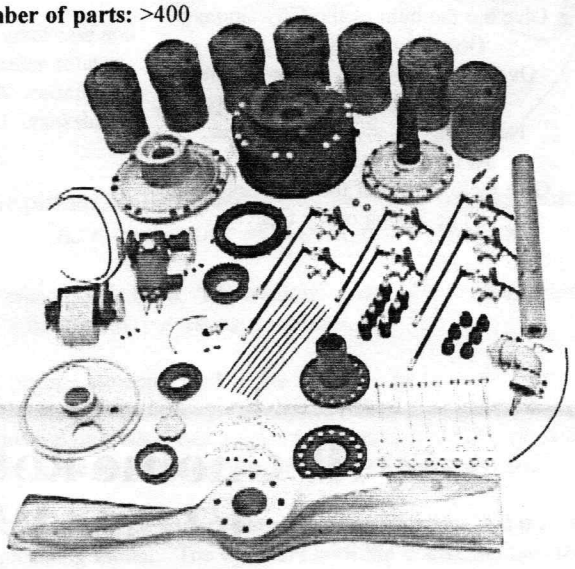
A simple indexing device for lathes was developed to produce the wooden gears and published in the MSSW newsletter. Other methods, tools and jigs developed by members during construction have been presented at meetings. Wally Kemp turned the small diameter ignition wires using tension on the stock. John Murphy used a Sorby fluted parting tool to turn cylinder fins.

Over 500 digital photographs were taken during fabrication and assembly.

A working cutaway model showing the internal workings of the Gnome rotary engine was fabricated. It shows why the engine is not a reciprocating engine. The pistons follow a true circular path, and possess no reciprocating motion. A model showing the action of the cams on the push rods was also made to show the relative position of the exhaust valves at a certain moment in time during the operation of the engine for positioning them correctly on the replica.

This project is a complete departure from what most members turn. It required working to relatively close tolerances and making parts that must fit with other components made by another member. Some reworking or re-turning was necessary at times.

Number of parts: >400



17 Woods used: African Blackwood, Ash, Aspen. Birch, Canarywood, Cherry, Ebony, Hickory, Holly, Katalox, Mahogany, Maple, Partridgewood, Pear, Purpleheart, Reed, Spalted Maple, and Walnut.

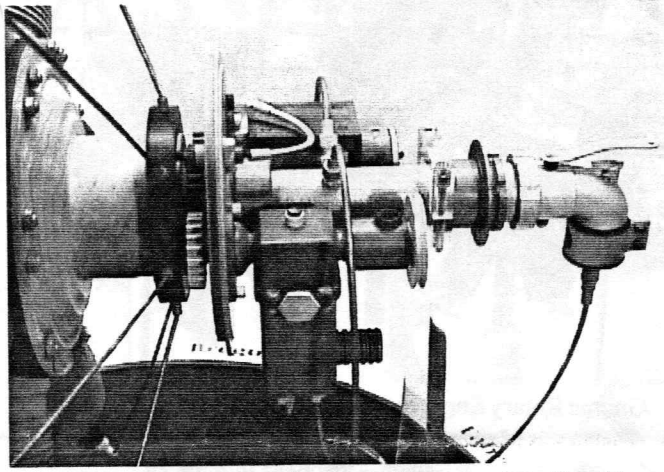
Finish: DEFT semi-gloss clear with KRYLON Matte finish 1311 overcoat

Other material: acrylic, brass, hardboard, felt

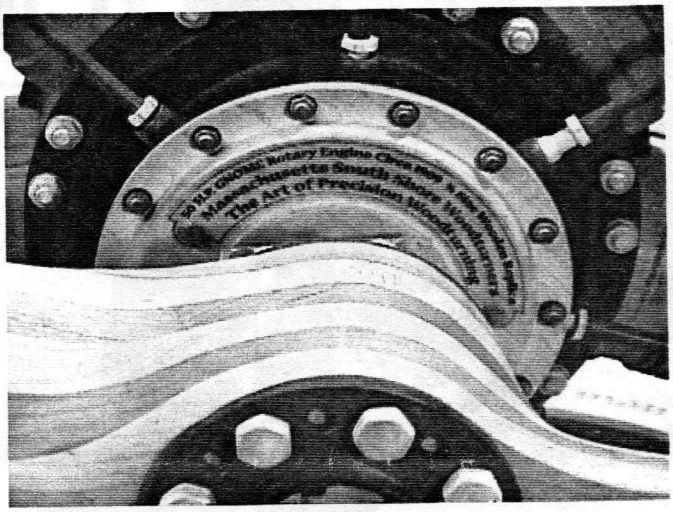
A fantastic work of art fabricated by participating members with support from all

Take time, Take pride, Take aspirin

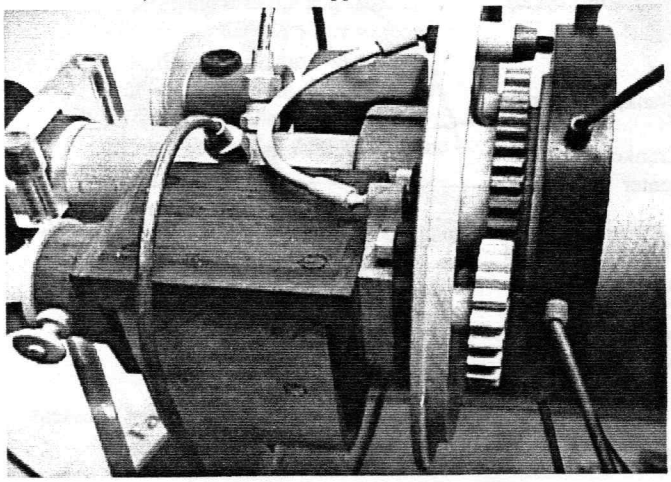
Fabrication Team: Hank Cahill, Richard Friberg, Ernie Grimes, Roger Hill, Emilio Iannuccillo, Jeffrey Keller, Wally Kemp, John Murphy, Mal Partridge

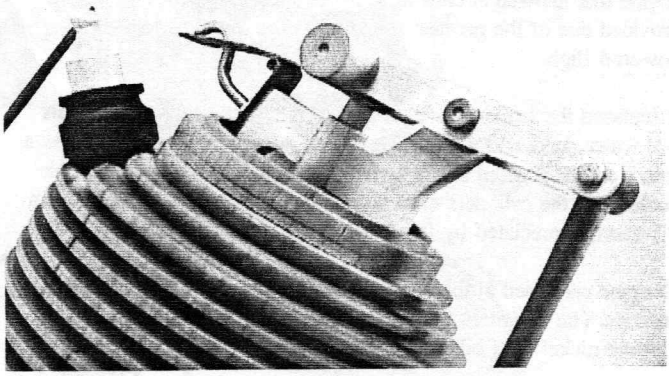


Crankcase rear, ignition wires & distributor, brush holder, drive gears, engine support plate, oil pump, magneto (below), crankshaft, rear crankshaft support and carburetor assembly

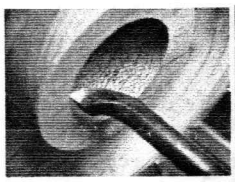


Front crankcase push rod cam housing cover with nameplate
Propeller shaft is integral part of this cover

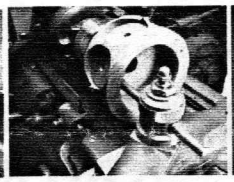


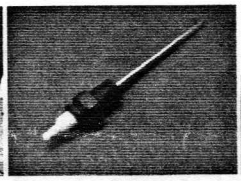


Exhaust valve/push rod assembly & spark plug

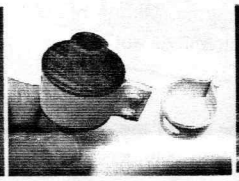


Precision boring a crankshaft hole and crankcase center section

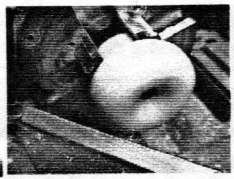




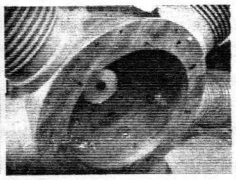
Hex wrench for stand with spark plug handle



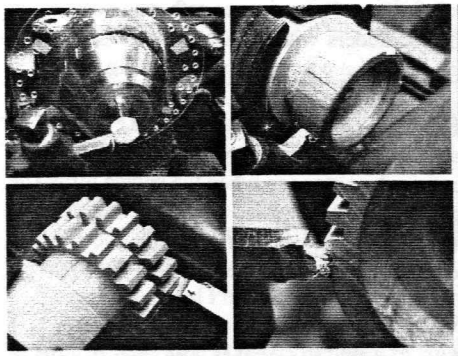
Laminated birch veneer carburetor air adjuster



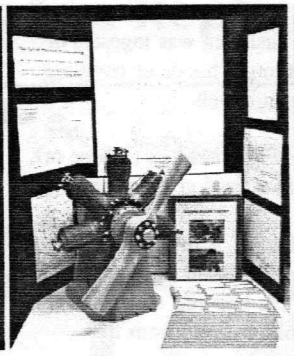
Donut (not Dunkin) for carburetor elbow



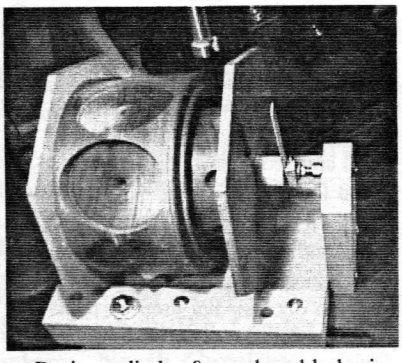
Cylinder attachment to crankcase



Skiving gear teeth on turned blanks using acrylic index disk
Same technique used for large hex heads and spanner grooves



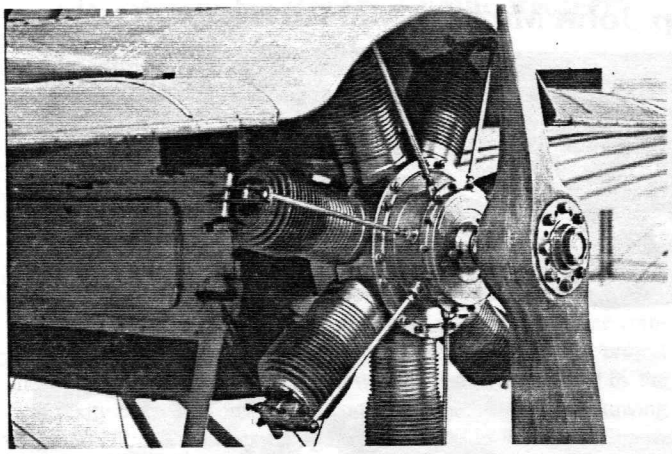
Presentation board, engine, drawing set and research data



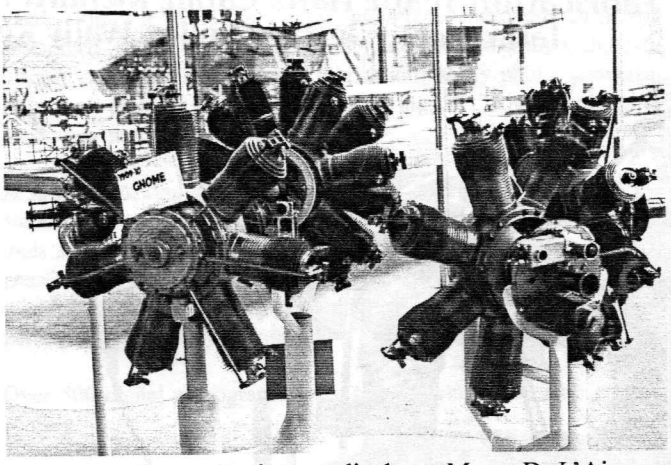
Boring cylinder & push rod holes in crankcase - note 7 sided fixture

Note: The entire replica Gnome Rotary Engine can be disassembled for "maintenance"

The 50 HP Gnome Rotary Engine Circa 1909



Gnome Rotary Engine in Deperdussin B aircraft at Musee De L'Air, Meudon, France, August 1997



Gnome Rotary Engines on display at Musee De L'Air, Meudon, France, August 1997

Development

The Gnome rotary engine, developed in France by brothers Louis & Laurent Sequin, gave early aviation pioneers a light weight practical engine that allowed aircraft to develop at a rapid pace. This engine provided one of the greatest single advances in the history of powered flight.

It replaced the heavy liquid cooled engines that required flywheels and water tanks and were derived from automotive technology. As a rotary engine it acted as it's own flywheel and produced forced air cooling for the cylinders even at low flying speeds. It was free from vibration, appreciated by fragile aircraft of the time.

Extreme care used in the fabrication of the engine contributed to it's success. The cylinders were precision turned from top quality chrome nickel steel billets.

Fuel was drawn thru the crankshaft to the crankcase. Oil was pressure fed thru the crankshaft to lubricate the engine. Mixing of fuel and oil was prevented by using castor oil which does not mix with petrol.

The intake valves on the 50 hp engine were in the top of the pistons. The exhaust valves located at the top of the cylinders.

Castor Oil Distress

The excess castor oil spewing back in the airstream was ingested or inhaled by the pilots in open cockpits. Although hoods or cowlings over the engines were tried it did not contain it well.

As oil covered their goggles and faces, they used scarves to wipe off the oil for visibility. They were not used as a fashion statement.

Upon landing, pilots would hurry to the latrine. A milk and brandy combination helped neutrilize the effect of the castor oil. Paregoric was also occasionally used by pilots but this impared their performance. The concept of flight surgeons evolved from this problem.

" Keep 'em flying!"

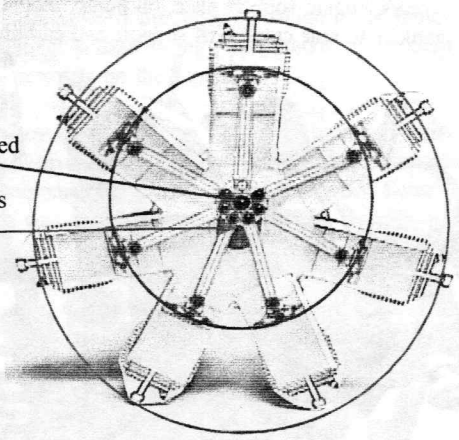
Rotary Engine Operation

The Gnome is a 4 cycle (Otto cycle) engine

Crankpin center fixed

Crankcase/cylinders center

The crankcase and propeller rotate CCW around the fixed crankshaft



The pistons, unlike those of all stationary engines, possess *no reciprocating motion* in space whatever.

The crankshaft is fixed. The crankpin is part of the crankshaft, therefore a fixed point, possessing no motion.

The pistons are connected to the crankpin by the connecting rods, which cannot become longer or shorter. Therefore, the motion of the pistons can only take place around the circumference of a circle whose center is the crankpin, and whose radius is a connecting rod.

In other words, the pistons follow a true circular path, and possess no reciprocating motion. The cylinders with the crankcase, also revolve around a fixed center, and likewise possess no reciprocating motion in space.

How then do the pistons go in and out in the cylinders? The cylinders are on a different center than the pistons so when the engine turns 180 degrees there is a displacement of the pistons in the cylinder which corresponds to twice the distance between the centers: and this distance is clearly that between the crankshaft center and the crankpin center, or the "throw".

The above excerpt is from The 80 HP GNOME ENGINE manual by J. Fulton, Major, Royal Flying Corps, dated 1915.