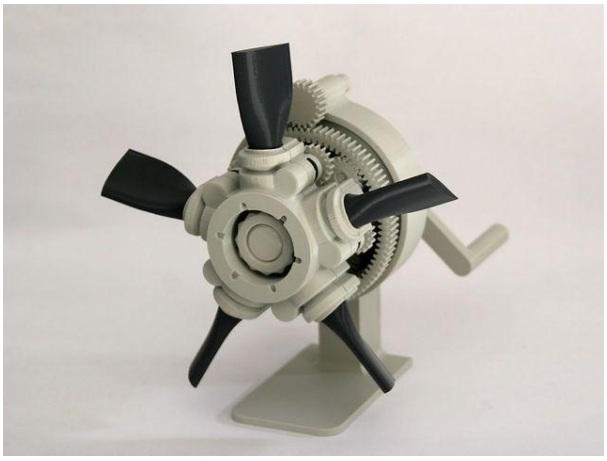

Variable Pitch Propeller Mechanism

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VIEW IN BROWSER

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Summary

A model of a variable pitch propeller mechanism based on a 1935 patent by Robert Stanley.

37.08 hrs	27 pcs	0.20 mm	0.40 mm	PLA	362 g	Prusa MK3/S/S+

Learning > Engineering

Tags: propeller gears engine aircraft airplane planetary aerodynamic propulsion aeronautics

Updates description at the bottom

Overview

A model of a variable pitch propeller mechanism based on a 1935 patent by Robert Stanley, adapted for 3D-printing.

Variable pitch propellers allow the pilot of an airplane to adapt the angle of the blades according to the speed of the airplane for optimal performance. While most variable pitch propeller systems use hydraulic or electric

power, this purely mechanical system uses two planetary gears to control the pitch of the blades on the rotating propeller from a driving gear on the stationary housing.

Using 3D-printing allows for these planetary gear assemblies to be made with print-in-place herringbone gears (impossible to disassemble), which simplifies tremendously the assembly process.

See the mechanism in action :

I included pages of the original patent if you want to read the details.

This system was used on the Curtiss Turboelectric propellers that equipped the Douglas C-133 Cargomaster.

Parts

All parts are 3D-printed. No additional hardware is necessary. The whole assembly is held by three 3D-printed nuts.

You will need to print :

Propeller assembly

- 1 x front-hub (or front_hub_alt, see update Oct 11th)
- 1 x rear-hub (or rear_hub_alt, see update Oct 11th)
- 1 x hub-nut
- 5 x blade
- 5 x spur-worm-gear
- 5 x thust-washer

Housing and shaft assembly

- 1 x front-housing
- 1 x rear-housing
- 2 x bearing-1 (see note 1)
- 1 x shaft
- 1 x spacer-1
- 1 x rear-nut

Final assembly

- 1 x rear-planetary-assy
- 3 x planet-axis
- 1 x spider
- 1 x front-planetary-assy
- 1 x spacer-2

- 1 x bearing-2 (see note 1)
- 1 x spacer-3
- 1 x control-gear (or control-gear-alt, see note 2 below)
- 1 x blade-setting-crank
- 1 x front-shaft-nut
- 1 x motor-crank

And the (optional) tools:

- 1 x front-shaft-nut-socket-wrench
- 1 x hub-nut-spanner
- 1 x rear-nut-spanner

I built all parts from PLA with 0.2mm layers using the default Prusa Mk3S profile. Only the rear housing requires supports.

Notes :

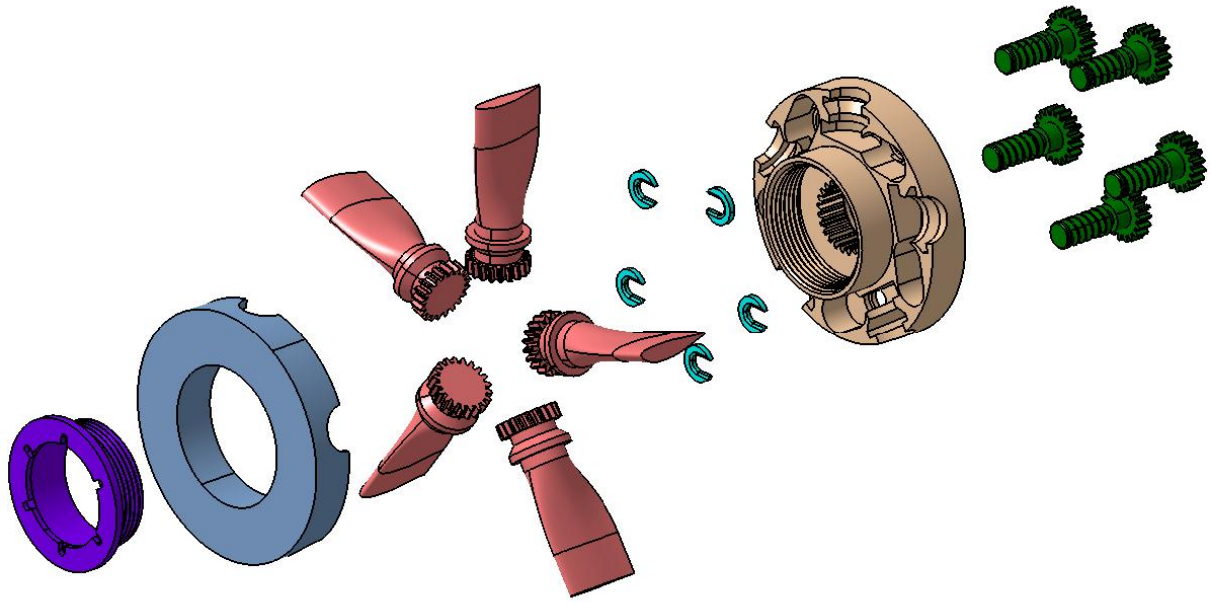
1. I did not manage to get the bearings to run for real, both for bearing 1 and bearing 2 the rollers are either stuck to the cage or they have too much friction so the rollers don't really roll, the best I could do in the limited time before the contest deadline was to have the inner and outer rings move freely. This does not prevent the mechanism from functioning properly.
2. The mechanism was designed for a 20-tooth control gear, but because of freeplay in the assembly, on my prototype it tends to slip easily on the external gear of the front planetary assembly. So on my assembly a 21-tooth control gear which was theoretically too large gave the best results and is therefore provided as an alternative (control-gear-alt) if you encounter the same problem.

Instructions

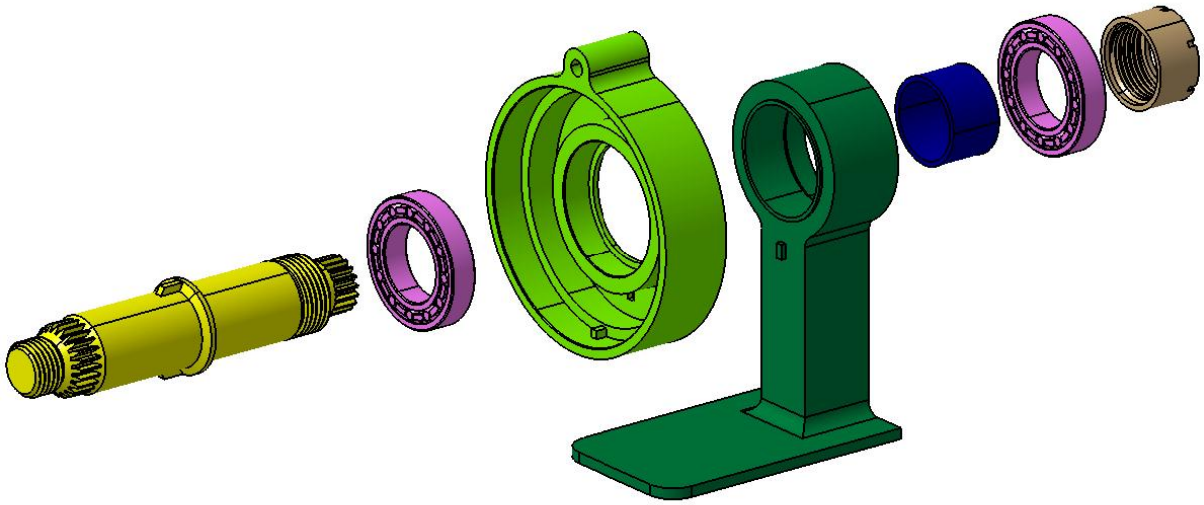
See the build video :

Exploded views

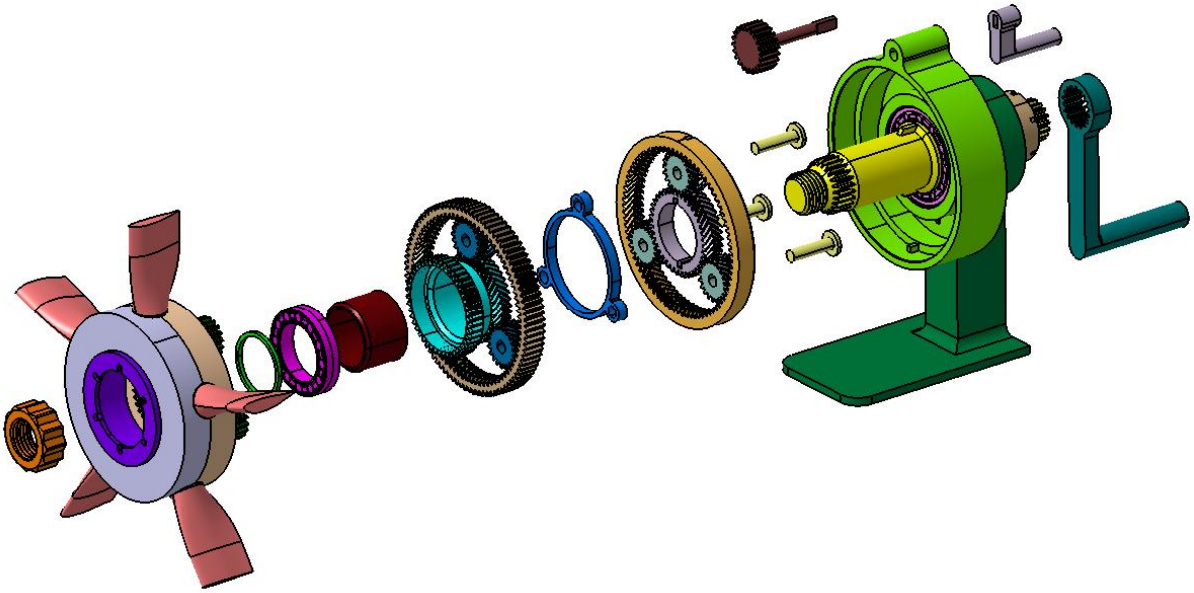
Propeller assembly



Housing and shaft assembly



Final assembly



Reminders :

- Don't tighten the nuts too much, it's only plastic !
- Some gears and bearings will require a bit of breaking in before they run smoothly so be sure to do this before final assembly in order for things to run properly without overstressing the parts.

Design notes

Information that may be useful for remixes :

All the gears have a module of 1 and a contact angle of 20°.

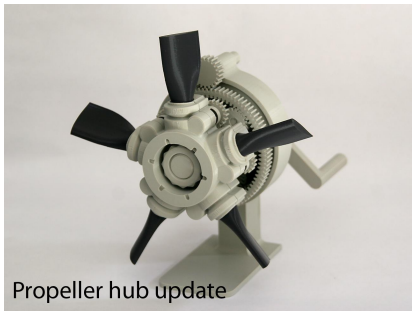
The planet gears are scaled down to 97% in lateral and vertical to give enough clearance to print the planetary assemblies "in-place".

Updates

October 11th, 2022: New propeller hub

Updates

October 11th, 2022: New propeller hub



I designed an alternative propeller hub (file names **front_hub_alt** and **rear_hub_alt**), that works exactly like the original but looks much better.

The new parts are however a bit harder to print and you will need to use supports.

The only difference in the assembly is that now the thrust washers have to be inserted in the small side slots on the rear hub rather than from its front face.

Model files

Propeller Assembly 9 files

front_hub_v2.stl

rear_hub_v1.stl

blade_v1.stl

spur-worm-gear_v4.stl

thrust-washer_v2.stl

hub_nut_v1.stl

hub-nut-spanner.stl

front_hub_alt.stl

update from 11 oct 2022

rear_hub_alt.stl

update from 11 oct 2022

Housing and shaft assembly

7 files

front_housing_v1.stl

rear_housing_v1.stl

shaft_v1.stl

bearing-1_v5.stl

spacer-1_v1.stl

rear_nut_v2.stl

rear-nut-spanner.stl

Final assembly 13 files

rear-planetary-assy_v2.stl

planet_axis_v2.stl

spider_v1.stl

front-planetary-assy_v4.stl

spacer-2_v2.stl

bearing-2_v4.stl

spacer-3_v1.stl

control_gear_v2.stl

blade_setting_crank.stl

front_shaft_nut_v3.stl

front-shaft-nut-socket-wrench.stl

motor_crank_v1.stl

control_gear_alt.stl

3mf for parts requiring supports 3 files

rear_housing.3mf

rear_hub_alt.3mf

front_hub_alt.3mf

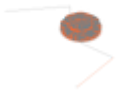
stanleypatentpropeller.stp

Print files

tools_full_set_02mm_pla_mk3s_1h37m.gcode

PLA 0.40 mm 0.20 mm 1.62 hrs 19 g Prusa MK3/S/S+

all three tools



rear_hub_v1_02mm_pla_mk3s_3h59m.gcode

PLA 0.40 mm 0.20 mm 3.98 hrs 46 g Prusa MK3/S/S+

front_hub_v2_02mm_pla_mk3s_2h36m.gcode

PLA 0.40 mm 0.20 mm 2.60 hrs 31 g Prusa MK3/S/S+

blade_v1_02mm_pla_mk3s_1h15m.gcode

PLA 0.40 mm 0.20 mm 1.25 hrs 7 g Prusa MK3/S/S+

spur-worm-gear_v4_02mm_pla_mk3s_28m.gcode

PLA 0.40 mm 0.20 mm 0.46 hrs 2 g Prusa MK3/S/S+

thrust-washer_5x_v2_02mm_pla_mk3s_7m.gcode

PLA 0.40 mm 0.20 mm 0.12 hrs 1 g Prusa MK3/S/S+

prints 5 parts

hub_nut_v1_02mm_pla_mk3s_51m.gcode

PLA 0.40 mm 0.20 mm 0.85 hrs 9 g Prusa MK3/S/S+

rear_housing_02mm_pla_mk3s_4h19m.gcode

PLA 0.40 mm 0.20 mm 4.31 hrs 54 g Prusa MK3/S/S+

front_housing_02mm_pla_mk3s_3h36m.gcode

PLA 0.40 mm 0.20 mm 3.61 hrs 51 g Prusa MK3/S/S+

bearing-1_v5_02mm_pla_mk3s_1h23m.gcode

PLA 0.40 mm 0.20 mm 1.38 hrs 9 g Prusa MK3/S/S+

shaft_02mm_pla_mk3s_3h36m.gcode

PLA 0.40 mm 0.20 mm 3.61 hrs 34 g Prusa MK3/S/S+

spacer-1_02mm_pla_mk3s_26m.gcode

PLA 0.40 mm 0.20 mm 0.43 hrs 4 g Prusa MK3/S/S+

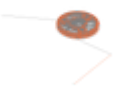
rear_nut_v2_02mm_pla_mk3s_33m.gcode

PLA 0.40 mm 0.20 mm 0.56 hrs 5 g Prusa MK3/S/S+

planet-axis_3x_v2_02mm_pla_mk3s_29m.gcode

PLA 0.40 mm 0.20 mm 0.48 hrs 2 g Prusa MK3/S/S+

prints 3 parts

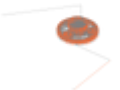


rear-planetary-assy_v2_02mm_pla_mk3s_3h17m.gcode

PLA 0.40 mm 0.20 mm 3.29 hrs 25 g Prusa MK3/S/S+

spider_02mm_pla_mk3s_19m.gcode

PLA 0.40 mm 0.20 mm 0.32 hrs 3 g Prusa MK3/S/S+



front-planetary-assy_v4_02mm_pla_mk3s_4h13m.gcode

PLA 0.40 mm 0.20 mm 4.21 hrs 30 g Prusa MK3/S/S+

spacer-2_v2_02mm_pla_mk3s_35m.gcode

PLA 0.40 mm 0.20 mm 0.59 hrs 6 g Prusa MK3/S/S+

bearing-2_v4_02mm_pla_mk3s_49m.gcode

PLA 0.40 mm 0.20 mm 0.82 hrs 5 g Prusa MK3/S/S+

spacer-3_v1_02mm_pla_mk3s_3m.gcode

PLA 0.40 mm 0.20 mm 0.05 hrs 1 g Prusa MK3/S/S+

control_gear_v2_02mm_pla_mk3s_30m.gcode

PLA 0.40 mm 0.20 mm 0.50 hrs 3 g Prusa MK3/S/S+

blade_setting_crank_02mm_pla_mk3s_27m.gcode

PLA 0.40 mm 0.20 mm 0.45 hrs 2 g Prusa MK3/S/S+

control_gear_alt_02mm_pla_mk3s_30m.gcode

PLA 0.40 mm 0.20 mm 0.51 hrs 3 g Prusa MK3/S/S+

print only if standard control gear slips during use

front_shaft_nut_v3_02mm_pla_mk3s_25m.gcode

PLA 0.40 mm 0.20 mm 0.42 hrs 4 g Prusa MK3/S/S+

motor_crank_02mm_pla_mk3s_1h10m.gcode

PLA 0.40 mm 0.20 mm 1.17 hrs 9 g Prusa MK3/S/S+

front_hub_alt_02mm_pla_mk3s_2h50m.gcode

PLA 0.40 mm 0.20 mm 2.83 hrs 23 g Prusa MK3/S/S+

update from 11 oct 2022

rear_hub_alt_02mm_pla_mk3s_4h3m.gcode

PLA 0.40 mm 0.20 mm 4.06 hrs 38 g Prusa MK3/S/S+

update from 11 oct 2022

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