A Retractable Propeller for Self Launching Sailplanes

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A propulsion unit to give a sailplane Self Launching capability combines the convenience of operation of powered aircraft with the desirable features of sailplanes. Self Launching sailplanes have been used mostly as training aircraft and have proven their usefulness in that application. The adaptation of a suitable propulsion unit to high performance sailplanes would make the sport accessible to many people who can not afford the time needed to participate using conventional launch methods.

A completely retractable propulsion unit is needed to give the Self Launching sailplane the performance capability of the conventional sailplane when it is used in unpowered flight. A number of powered sailplanes have been built that have completely retractable propulsion units. The Nelson Hummingbird was one of the first such aircraft and the SF-27M and Motor Nimbus in Germany are two more modern examples. In all of these the entire engine and propeller assembly is moved in and out of the aircraft. In the design proposed here, the motor would remain fixed in the fuselage and only the propeller mounted on a pylon would be extended for powered flight. Advantages of this arrangement are:

1. The weight of the engine does not have to be moved in and out. The engine could have a quiet exhaust system fitted without restrictions imposed by aerodynamic drag of an exposed engine unit or consideration of the retraction mechanisms. It would be comparable to the nose mounted engines in this respect.
2. A transmission needed to drive the propeller would allow a speed reduction for a large diameter efficient propeller.
3. If a clutch is used, the motor could be started before the propeller is extended, avoiding an uncertain period of high drag when the motor has been extended but not yet started.

A propulsion unit incorporating the features mentioned above was designed and tested full scale in the University of Alberta low speed wind tunnel.

Pylon and transmission

The pylon and retraction mechanism are shown in Figure 1. It is supported by a slider bearing, shown in detail in Figure 2, and is extended by means of an electric motor driving the bottom of the pylon along a track.

Power transmission is by means of a toothed timing belt allowing a two to one reduction in speed between engine and propeller. A centrifugal clutch mounted on the engine drive shaft is positioned inside the lower pulley when the pylon is up, and it engages when engine speed is increased above 1800 r. p. m.

Doors in the top of the fuselage are only 55% of the propeller diameter in length.

Propeller

A 54 inch diameter propeller with 30 inch pitch was chosen for good propulsive efficiency and high static thrust. A combined blade element-momentum theory analysis of this propeller gave good agreement with results of wind tunnel tests, allowing some confidence in the use of such analysis to predict performance.

Static thrust of more than 8 lbs per horsepower was measured. On the basis of analysis and wind tunnel tests, a thrust of 110 lbs. would be produced by this propeller at 50 knots forward speed, using 23 brake horsepower and with a propeller r. p. m. of 2500. This would be enough thrust to provide 300 feet per minute rate of climb in a sailplane with an all up weight of 1200 lbs. (Provided that the glide ratro of the sailplane is at least 30 – Editor.)

Engine

The engine used was a two cylinder two stroke Kohler model 440-2AX. It was intended for use in snowmobiles and has an integral cooling fan needed for an internally mounted engine.

Dynamometer tests of this engine showed a maximum power output of 27 brake horsepower at 6000 r. p. m. This is considerably below the power rating given by the manufacturer even when due allowance is made for atmospheric density at the local altitude of 2300 feet above sea level. It may be that users are generally not able to obtain rated horsepower from small engines and this would account for use of more installed power than would appear to be required in order to obtain good performance.

Improved propeller efficiency made possible by a larger diameter, slow running propeller will reduce motor horsepower requirements.

Weight

The dry weight of this propulsion system is 115 lbs., not including the battery needed for the electric starter.

Figure 1 Schematic Diagram of the Propulsion Unit

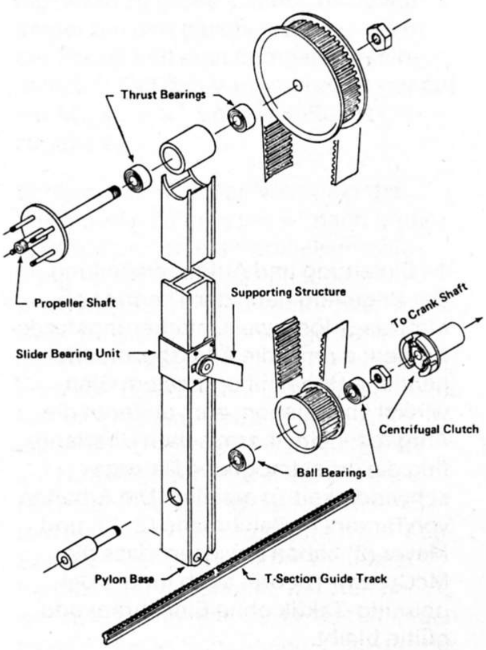
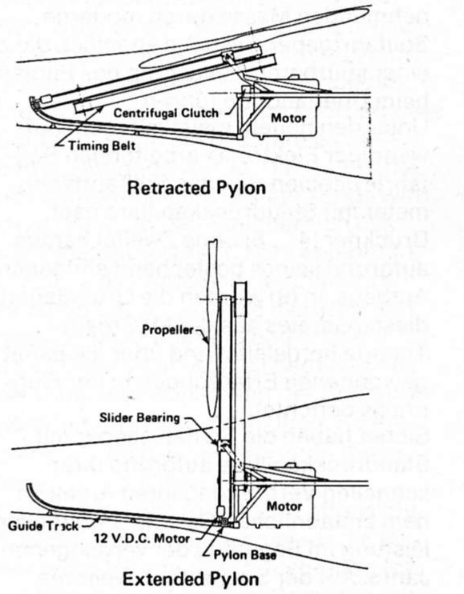


Figure 2. Exploded View of Pylon



Conclusions

A new design for a completely retractable propulsion system for high performance powered sailplanes is presented. Advantages of this design are; a fixed motor with the propeller only being extended, a two to one reduction in speed to allow the use of a large diameter efficient propeller, and a clutch arrangement so the motor can be started befor the propeller is extended.

Wind tunnel tests show that the propeller does indeed produce enough thrust for good climb performance even with the relatively low (23 horsepower) output of a small two stroke engine.