

# MCCAULEY™

*Professor Von Kliptip's  
Twelve All-Time  
Favorite Questions  
and Answers About*

## **PROPELLER PERFORMANCE**

**ON PERSONAL AND BUSINESS AIRCRAFT**





## ***About Professor Von Kliptip***

In 1903 as a young boy at Kitty Hawk, Professor Humpertinck Von Kliptip became the first person in history to yell, "It will never get off the ground!" Though wrong about the Wrights, the professor has been going around in the best aviation circles since. As a teacher, he held the Wrong Way Corrigan Chair at Sopwith College for ten years. He is also a renowned engineer and designer of aircraft propellers. Professor Von Kliptip is the author of many books, the most famous being "Whatever Goes Up" and its sequel, "Back to the Old Drawing Board." He is married to the former Hilda Brinker, and they are the parents of four flying Dutchmen.

## ***1. Professor, what is a propeller?***

The propeller is a twisted airfoil that converts the rotating power of the engine into thrust, which propels the airplane through the air. Sections of the propeller near the center are moving at a slower rate of speed than those near the tip, which is why the blades are twisted. Modern propellers are fabricated from high strength, heat treated, aluminum alloy forgings. Some are made up from fiberglass resins into composite materials.

## ***2. Can propellers be interchanged among different engines?***

Goodness, no! You want to end up in the cornfield? A propeller is designed to be compatible with a specific engine in order to achieve maximum thrust or efficiency and reliability from the aircraft. Even though the propeller might fit another engine shaft, only the propeller manufacturer should determine whether it is suitable for use on a particular aircraft. McCauley has lists of the right propellers, governors and installation data for all their props - both fixed pitch and controllable models.





**3. Professor Von Kliptip, in your memorable lecture entitled "Props and the Single Engine Aircraft" you defined the basic types of propellers according to pitch. Do it again, please.**

**Fixed Pitch...** one piece prop with a single fixed blade angle. The pitch must be high enough to offer good cruising performance and yet low enough to achieve acceptable takeoff and climb characteristics.

**Ground Adjustable...** blade angle can be adjusted on the ground but cannot be altered in flight. Once fixed, this prop operates like a fixed pitch propeller. Blade angle can be set low for short fields and/or high terrain or for better load carrying capability; it is set at a higher angle for long runways, low terrain, or light loads when a better cruising speed is desired.



**Two Position...** blade angle may be adjusted during operation to either a preset low angle or a high angle setting. Low angle is used for takeoff and climb, then a shift is made to high angle for cruise.

**Controllable Pitch...** within a preset range, blades may be altered infinitely to any desired angle during flight, starting with a low blade angle and then gradually increasing the angle during takeoff, climb, leveling out and cruise.

**Automatic Pitch...** blade angle change within a preset range occurs automatically as a result of aerodynamic forces acting on the blades, and the pilot has no control over the changes.

**Constant Speed\*...** a governor is used in conjunction with the propeller to automatically provide constant RPM as the pilot selects the proper setting. The governor controls the forces acting on the propeller to automatically change the blade angle within a preset range.

**Full Feathering\*...** blades can be rotated to a high positive angle to stop rotation (windmilling). This feature is common on multi-engine aircraft, because it allows an engine to be shut down and the prop stopped to reduce drag and asymmetric control forces.

**Reversing\*...** blades can be rotated to a "negative" blade angle where they will provide a rearward thrust to slow down, stop or move the aircraft backward. This capability is normally provided for turbine installations.

**Beta Control...** normally used for ground operation, most often in taxiing, where thrust is manually controlled by adjusting blade angle with the power lever.

*\*Types starred are available in various models.*

#### **4. Why are some propellers 2-blade and others 3-, 4-, and 5-blade?**

Multi-blade props are designed primarily, though not exclusively, for twin-engine aircraft. The blades are shorter for increased ground clearance on all aircraft and to provide more fuselage clearance on twins. Other advantages over 2-blade props include higher and therefore less objectionable sound frequency, less vibration, greater fly-wheel effect, generally improved aircraft performance, and a sharper appearance. I am personally designing a compromise-the 2 1/2 - blade prop, just as soon as I iron out the bugs...



#### **5. Professor, what are the correct terms for the various parts of the propeller?**

On the blackboard I will draw an enormous propeller and label the parts with my chalk.

No horseplay, now, while I formulate my definitions:

**Blade...** one arm of a propeller from hub to tip.

**Hub...** center section of the propeller that carries the blades and is attached to the engine shaft.

**Blade Tip...** that part of the blade furthest from the hub.

**Prop Diameter...** the diameter of the circle circumscribed by the blade tips.

**Blade Root...** section of a detachable blade nearest the hub.

**Blade Shank...** the thick portion of a blade near the hub.

**Blade Station...** one of the designated distances along the blade as measured from the center of the hub.

**Blade Camber Surface...** the cambered or most cambered side of a blade (as seen from in front of the aircraft).

**Blade Face or Thrust Surface...** the flat or least cambered side of the blade (as seen from in back of the aircraft).

**Blade Thickness...** the maximum thickness between the cambered surface and the face or thrust surface at a given blade station.

**Blade Leading Edge...** the forward full "cutting" edge of the blade that leads in the direction of rotation.

**Blade Trailing Edge...** the continuous edge of the blade that trails the leading edge in the direction of the rotation.

**Blade Width...** the measurement between the leading edge and the trailing edge at a given station.

**Blade Angle...** an angle (less than 90°) between the chord line of a propeller blade section and a plane perpendicular to the axis of propeller rotation. The chord line is a theoretical straight line drawn between the leading and trailing edges of the blade.

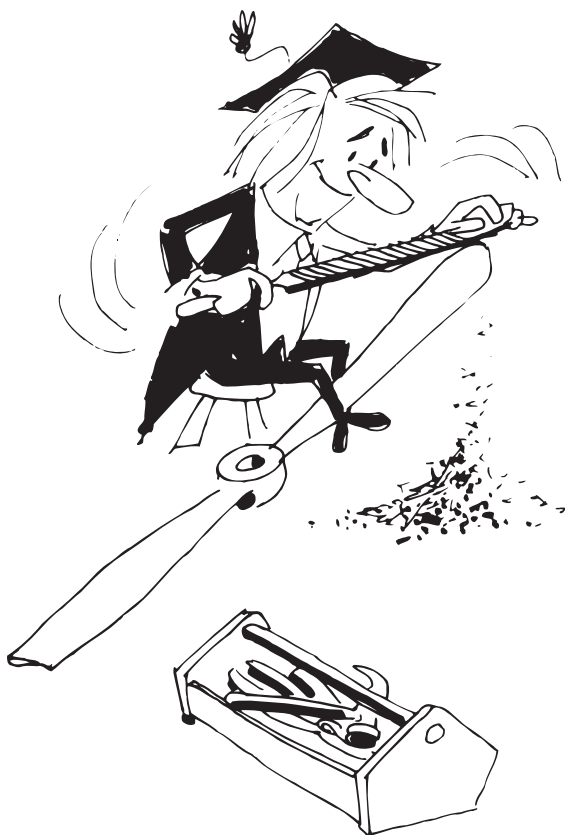
**Blade Angle Settings...** low and high angle settings of a controllable pitch prop, as determined by built-in stops, for feather, reverse, latch and start locks.

## 6. *What is the importance of propeller diameter?*

Ideally, the propeller diameter should be greater for efficient low airspeed operation and smaller for high airspeeds. A propeller with a variable diameter would solve the problem, but the structural and control problems involved would increase the cost and weight to a point where the advantage is not practical. The diameter of a fixed pitch propeller is generally reasonably large to favor low airspeed operation. At the same time, the blade size is kept small to favor higher airspeeds and permit faster turning at low airspeeds so that higher power is available from the engine. The diameter and blade size of a constant speed propeller can generally be greater because of the variable blade angle provision.







***7. Professor, it is a well-known fact that as a pilot you have pulled many a blooper. Can aluminum blades on propellers be cut back to fix nicks?***

Yes, and am I grateful! The fact is, most propellers are produced with square tips because it leaves extra material available for repair. Material can be removed from the square tip to make it into a round or elliptical form and still maintain diameter. My personal collection consists of one prop with a square tip and 43 with round ones. An approved mechanic can correct minor blade surface damage such as nicks by “dressing” it out. Propeller performance is not impaired provided the repair is within acceptable limits.



## **8. What are the effects of engine horsepower and RPM on the propeller, and vice versa?**

I could take all day on that one, but the strudel's getting cold-so briefly, here it is. For fixed pitch propellers, assuming a fixed throttle setting, the propeller (and engine) RPM will change as the airspeed changes. With a constant airspeed, the fixed pitch propeller (and engine) RPM will change if power is increased or decreased. The constant speed propeller employs an engine governor to automatically provide constant RPM at whatever throttle setting the pilot selects. The blade angle is changed automatically and increases or decreases if RPM setting is decreased or increased, or if power is increased or decreased. With fixed RPM and power setting, the blade angle will change automatically as airspeed increases or decreases. The RPM range is determined by a propeller control in the cockpit which may be adjusted to any setting between high and low. Most governors are designed to return automatically to high RPM setting.

## 9. *What is the effect of balance on a prop?*

The mass moment arm of one blade of a propeller with respect to the other(s) is held within reasonably close limits to avoid roughness. Since the length of a propeller is relatively short in the direction of the axis of rotation, as opposed to its length in the plane perpendicular to this axis, the balance can be determined and adjusted statically after the propeller has been removed from the airplane. Dynamic balancing may also be accomplished but is done with the prop on the airplane.



## 10. *How is propeller resonance avoided?*

First I tell you a funny. I once designed a propeller with terrible resonance problems. When I flew it, every dog within miles would howl. Such a racket! Anyway, a propeller has natural frequency, and it increases in operation because of the stiffening effect of centrifugal force on the rotating blades. To avoid resonance, forces which cause vibration must be studied so they do not coincide with the propeller's natural frequency. Some of these vibratory forces are engine torque impulses, engine shaft bending, motion of the engine on its elastic mounts, irregular airflow interference and many other disturbances.



## **11. Why is propeller overhaul needed?**

A fixed pitch prop does not need overhaul. It requires blade reconditioning only, as necessary. Constant speed and full feathering props do require periodic overhaul. Overhaul of the propeller is needed to increase safety, prolong the propeller life, and improve function or operation. Overhaul is the periodic disassembly, inspection, reconditioning, and reassembly of the propeller. The overhaul interval is generally based on hours of service (operating time) but a calendar limit also applies. After being disassembled, the propeller is inspected for wear, cracks, corrosion or other abnormal conditions. Certain parts are replaced, while other parts are reconditioned and refinished. Reassembly and balancing complete the job.

## 12. Who is qualified to overhaul a propeller?

Overhaul should be performed by the propeller manufacturer or by an approved propeller repair station\* and follows manufacturer's service manual instructions and service bulletins and letters as applicable. An approved propeller repair station is one that is certificated by the Federal Aviation Administration to service, recondition, repair or overhaul propellers, in accordance with the requirements established by the propeller manufacturer or the FAA. These firms have demonstrated that they have equipment, technical information and skills to perform such work. They are licensed and



limited to working only on specified propeller models which are listed by manufacturer and model on their authorization.

*\*A listing of McCauley direct factory dealers can be obtained by accessing our website at: [www.mccauley.textron.com](http://www.mccauley.textron.com)*



## *A final serious word....*

McCauley takes flying very seriously. For this reason we are anxious to disseminate helpful information accumulated over years of designing and manufacturing all kinds of aircraft propellers. We urge owners and operators of our propellers to read all placards, operating restrictions and limitations (including verifying engine tachometer) to assure product reliability and longevity.

Professor Von Kliptip is our cartoon character who helps make the technical information a little more interesting. Any resemblance between the Professor and a real person is purely coincidental.





*This booklet is presented in the interest of  
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5800 E. Pawnee, Wichita, KS 67218  
Telephone: 800-621-7767 Fax: 316-831-3858  
[www.mccauley.textron.com](http://www.mccauley.textron.com)



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