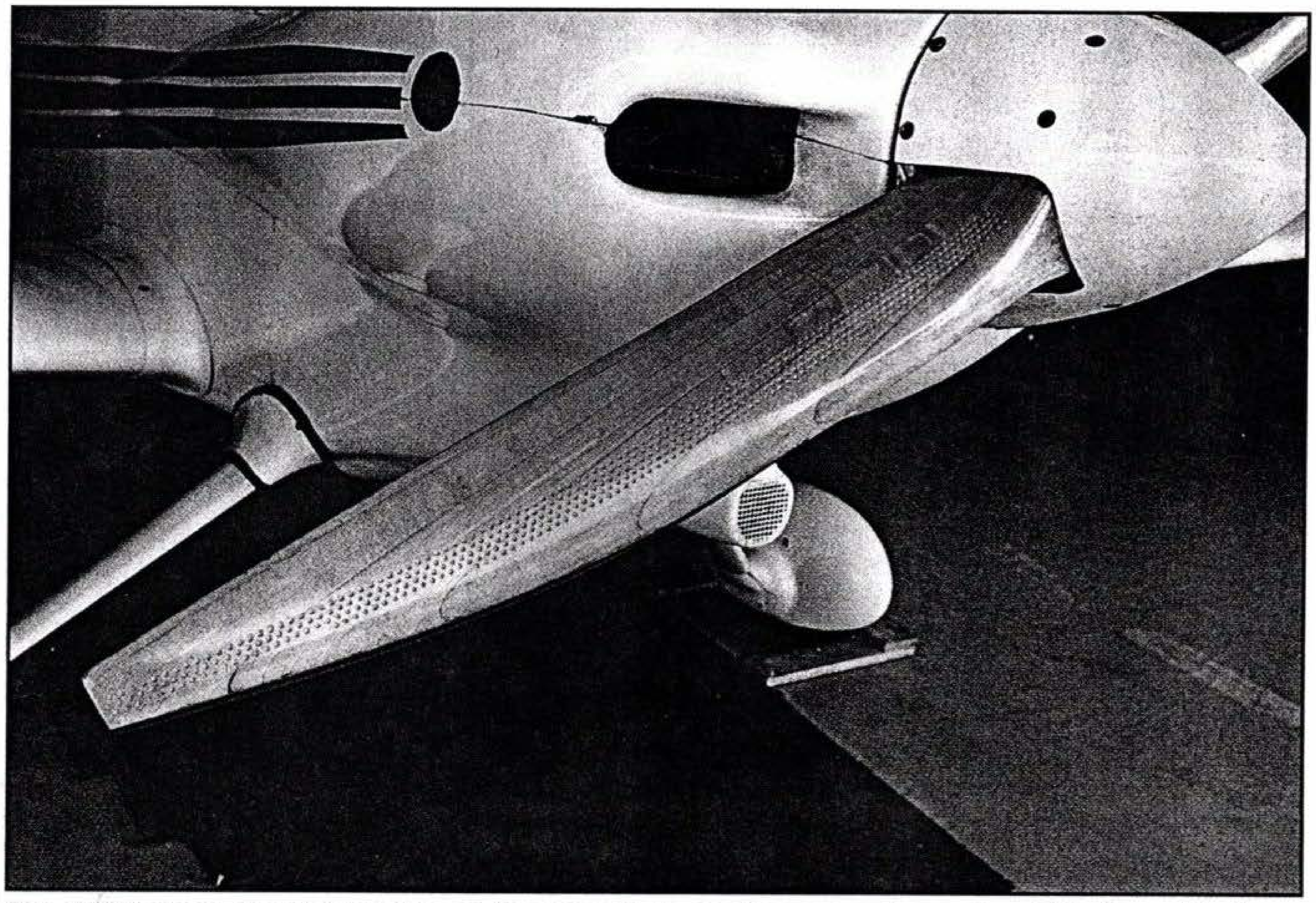
MORE SPEED WITH LESS $$

BY ANTHONY C. OCCHIPINTI

Faster than a speeding bullet? Well, maybe not that fast. However, there is a way you can make your airplane fly faster, with less noise and at a lower cost of operation. Faster, cheaper **and** quieter? That's right. Better performance, less noise and measurably better efficiency can be achieved by simply placing dimples spanwise on the thickest part of your plane's airfoils, wings and propellers.

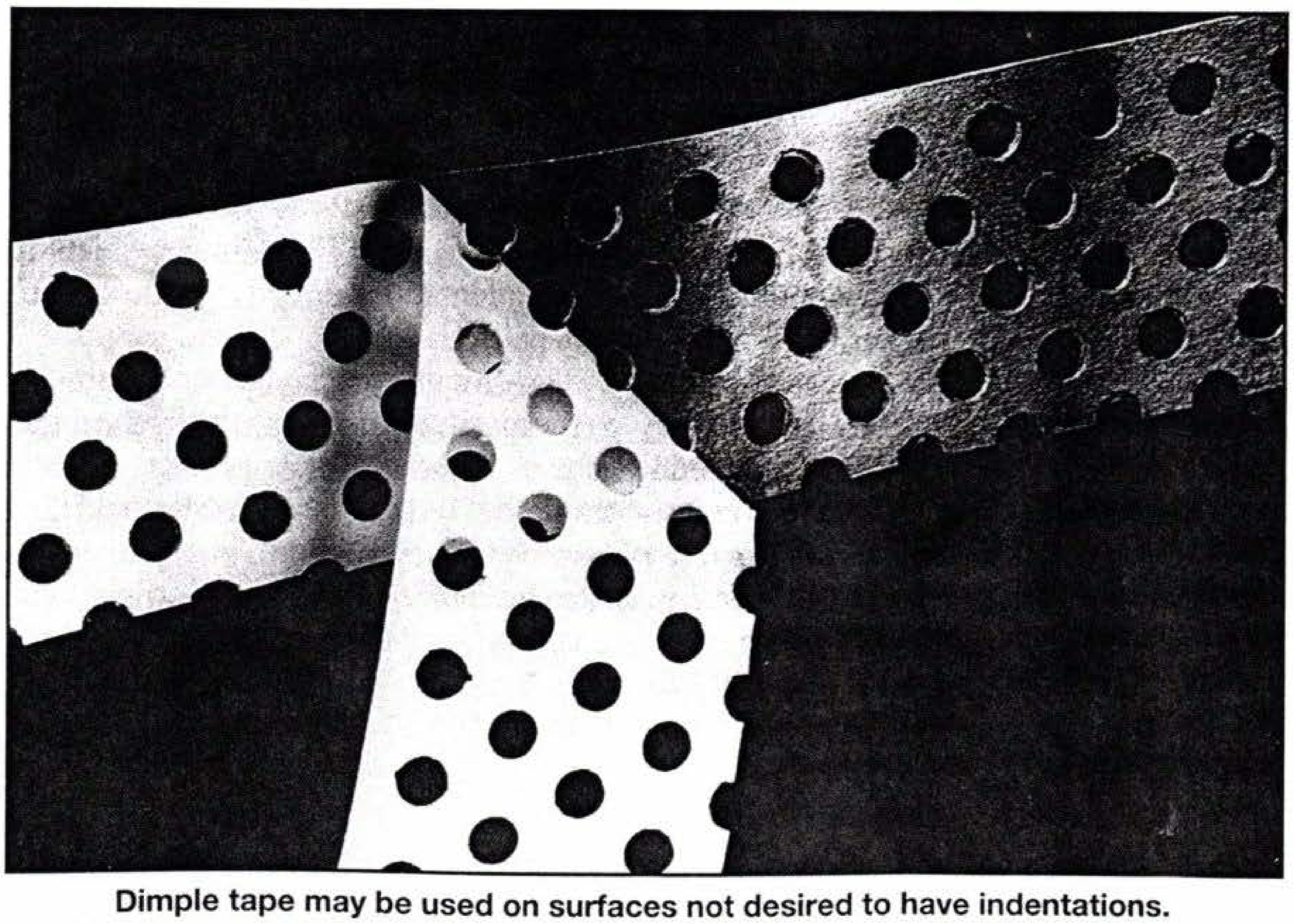
"Wait a minute," you might say. Everyone knows that with things that go fast, smoother is better. Why roughen the wings and propeller with dimples?



The dimples are placed spanwise on the propeller's maximum camber as taught by the author's U.S. Patent No. 5,540,406.

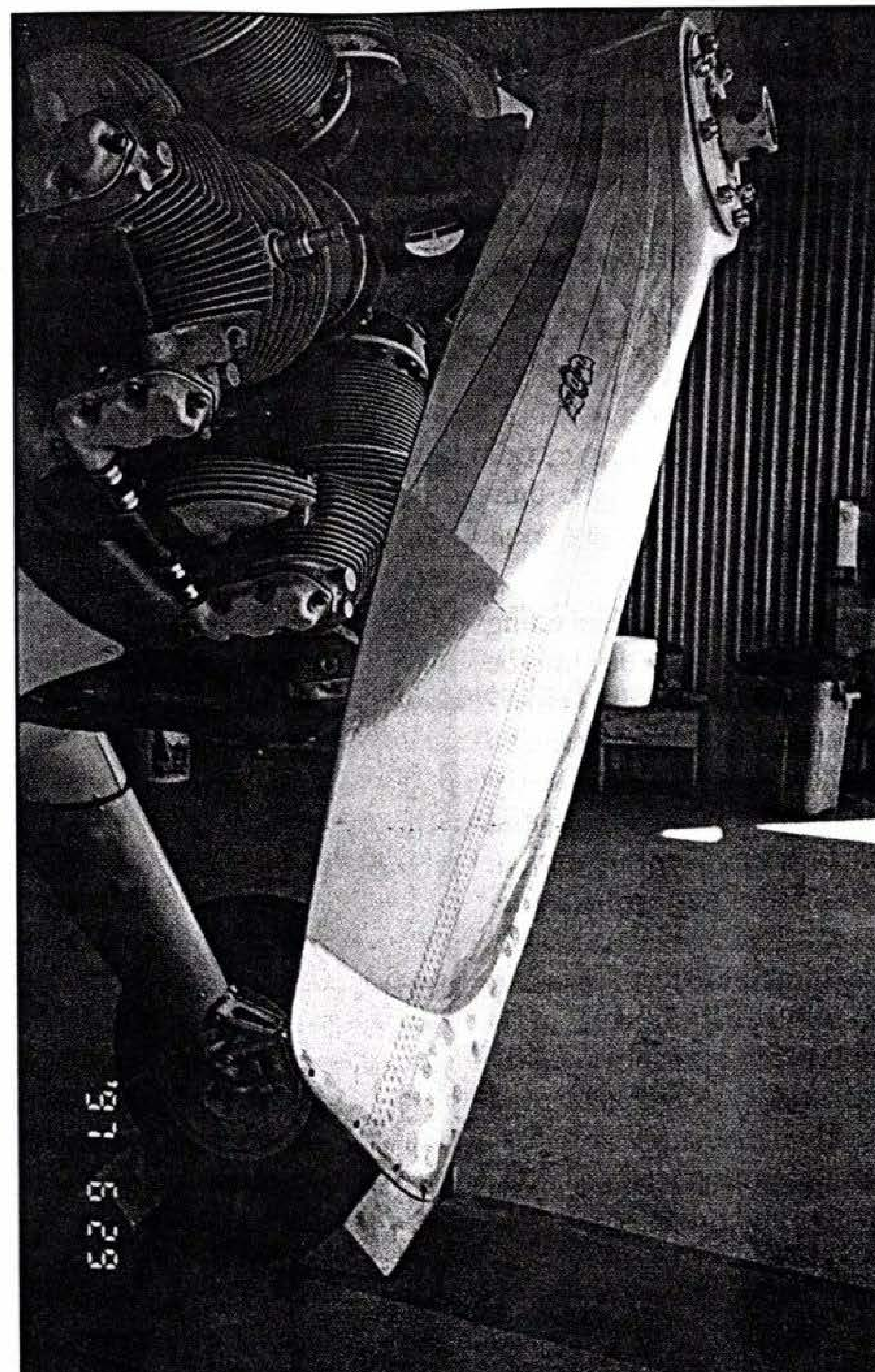
An easy way to understand how dimpling an airplane can increase its efficiency is to examine the golf ball. A smooth golf ball will only go about half as far as a dimpled golf ball. The dimples of a golf ball decrease the ball's trailing wake, which is the separation of air that results when any object moves through the air. The dimples or indentations keep the separation of air as close to the surface of the ball as possible, decreasing drag and allowing it to travel 2.5 times farther than it would as an undimpled blunt object.

With that concept in mind, consider the effect of placing dimples on an airplane. At first you might conclude that placing dimples over the entire surface of an airplane's airfoil (wings and propellers) will increase performance. There is more to it than that. Putting dimples all over the airfoil would actually decrease performance because



Dimple tape may be used on surfaces not desired to have indentations.

Dimple tape placed on either side of the wing struts of a Stearman.



Another Stearman with dimple tape on its wooden propeller.

dimples are drag items. Thus, too many dimples would result in too much drag. The golf ball is the exception to this rule in that once the ball is hit by a golf club, it spins very rapidly on its axis, with the result being there is no wrong place for the dimples to be located.

Recent applications of this airflow adherence technology have been made on two biplanes, three monoplanes and a radio controlled 50" rotor helicopter with remarkable success: a PT-13 Stearman (N66607) airspeed was increased by 8 mph by the addition of dimples to the propeller and the wing struts; a second Stearman (N813LG) with dimples on its propeller only increased its airspeed 6 mph; a 150 hp RV-3 (N107SS) airspeed was increased 10 mph by adding dimples to the propeller and airfoils; a second 180 hp RV-3 (N894FS) airspeed was increased 8 mph by dimpling the propeller only; a 125 hp Wittman Tailwind W-8 (N314T) airspeed was increased 9 mph by adding dimples to the propeller and airfoils; and a 50" rotor radio controlled helicopter used less throttle and angle of attack of rotor for takeoff and makes softer landings during autorotation. Each of the aircraft are noticeably quieter. The airplane's takeoff and landing are at slower airspeed, which resulted in longer tire life. Pressure sensitive perforated urethane .015 tape was used to make the indentations when it was inconvenient to place indentations directly on the surface of the airfoils and propellers.

The dimples must be placed spanwise on the maximum camber (usually the thickest part) of the airplane's airfoil, wings and propellers. But in order to understand how the process works, it is important to understand the concepts of smooth airflow, flow separation, trailing edge separation and the trailing edge wake.

In the past, "smooth" airflow experienced by an airfoil, whether a wing or a propeller, has been a hopeless dream. The passive approach to obtaining an ideal (laminar) flow has been dependent on the shape and smoothness of the airfoil (or hydrofoil), and its accomplishment has been hindered by the airflow separating from the airfoil. A particular type of flow separation airplanes experience is called trailing edge separation; this is a big problem in achieving the perfection of the ideal "laminar airfoil."

Realistically there is no such thing as a "laminar airfoil." What we call laminar airfoils are ones that are smooth surfaced and have maximum camber of more than 50% of chord measured from the leading edge. The air passing above the airfoil has a greater distance to travel to the maximum camber than it has from the maximum camber to the trailing edge. Surprisingly, it experiences less drag during the longer wedge up the slope of the airfoil and the shorter downslide than other types of airfoils with a shorter wedge up and a longer downslide. The longer slide down with longer separation develops more drag.

All airfoils (or hydrofoils) in motion through the air (or fluid) experience a flow separation which results in a trailing wake. This trailing wake is considerable resistance to the motion of the airfoil. The flow separation gap is widest at the trailing edge of the airfoil, and understandably it is called trailing edge separation. Extreme separation will sometimes result in a complete stall (which causes an airplane to quit flying). The trailing edge separation is the beginning of the airfoil's trailing wake. The larger the wake, the more it costs to operate, whether it be an airplane, automobile or boat. All moving objects experience trailing wakes. Some designers of computer-generated airfoils will go so far as to effectively alter the shape of the airfoil that the computer sees by enlarging the airfoil's separation thickness, or a proportion thereof, in order to obtain the design values of the actual airfoil.

Remember that an airfoil actually moves through the air, and in so doing the air is forced upward (downward if the air is going under the airfoil) by the wedged shape slope of the airfoil until the air reaches the thickest part of the airfoil called the "maximum camber" of the airfoil. The vertical acceleration of the air mass starting at the leading edge and flowing up the airfoil slope must then dissipate before the airflow can then accelerate down the airfoil slope past the trailing edge. This start-up, stop and start-down mechanism contributes to the separation of the airflow, and a reduction of lift. The combination of the air not wanting to change direction after being wedged up the slope of the first portion of the airfoil, beginning at the leading edge, and then reluctantly, because of its inertia, start down the airfoil slope to the trailing edge, contributes to separation. But as it crests reaching the maximum camber of the airfoil, the airflow begins to separate from the airfoil as the air then starts down the airfoil shape to the trailing edge. This separation void in turn results in wake drag.

The use of dimples on the airfoil surface will result in the thin layer of air passing over the surface becoming energized. Only this thin layer of air on the surface, called the boundary layer, then becomes turbulent, which will cause it and the laminar airflow above to adhere to the airfoil the rest of the way over the airfoil. The dimples reduce the trailing edge separation, and this in turn decreases the magnitude of the wake drag; all of which increase performance and efficiency. Also the dimples will cause a more rapid reattachment of the airflow in stall recoveries.

The use of dimples spanwise on maximum camber of a wing or a propeller is a passive treatment that is easy to apply, and is safe, dependable, and inexpensive. Should the dimples become covered by dirt, oil, ice and/or bird droppings, the wing will continue to perform almost as before. The dimpling is below the surface and does not have the high drag of above-surface vortex generators currently being used. The dimpling causes the airflow to follow the contour of the airfoil. Dimpling alters the characteristic of the laminar flow from being prone to separate. It makes any reasonably designed airfoil perform nearly as efficiently as the so-called "laminar airfoil."

The loudest airfoil of an airplane is its propeller. And the reduction in the noise level of a dimpled propeller is noticeable. Tests have shown the dimpled propeller to be only half as loud as a propeller not dimpled. The continuous collapsing of the separation void following the airfoil passage makes noise. Just like clapping hands, the further apart the hands, the louder the clap. The fact that dimples reduce the trailing edge separation gap or the distance the air travels in collapsing into the void results in less noise being generated. ◆

ABOUT THE AUTHOR

Anthony C. Occhipinti (EAA 13021), 1353 Lake Ave., Apt. A, Metairie, LA 7005, 504/831-1816, is a Professional Engineer and Attorney at Law. He learned to fly in the Air Force during the early 1950s and was a teacher at the Tulane School of Engineering. His retractable gear Wittman Tailwind was awarded several trophies at the 1966 Rockford Fly-In, and he has been flying it "on cloud nine" ever since. He has done considerable work on rotary engines as well as on the subject of this article. Tony is the holder of several U.S. Patents.