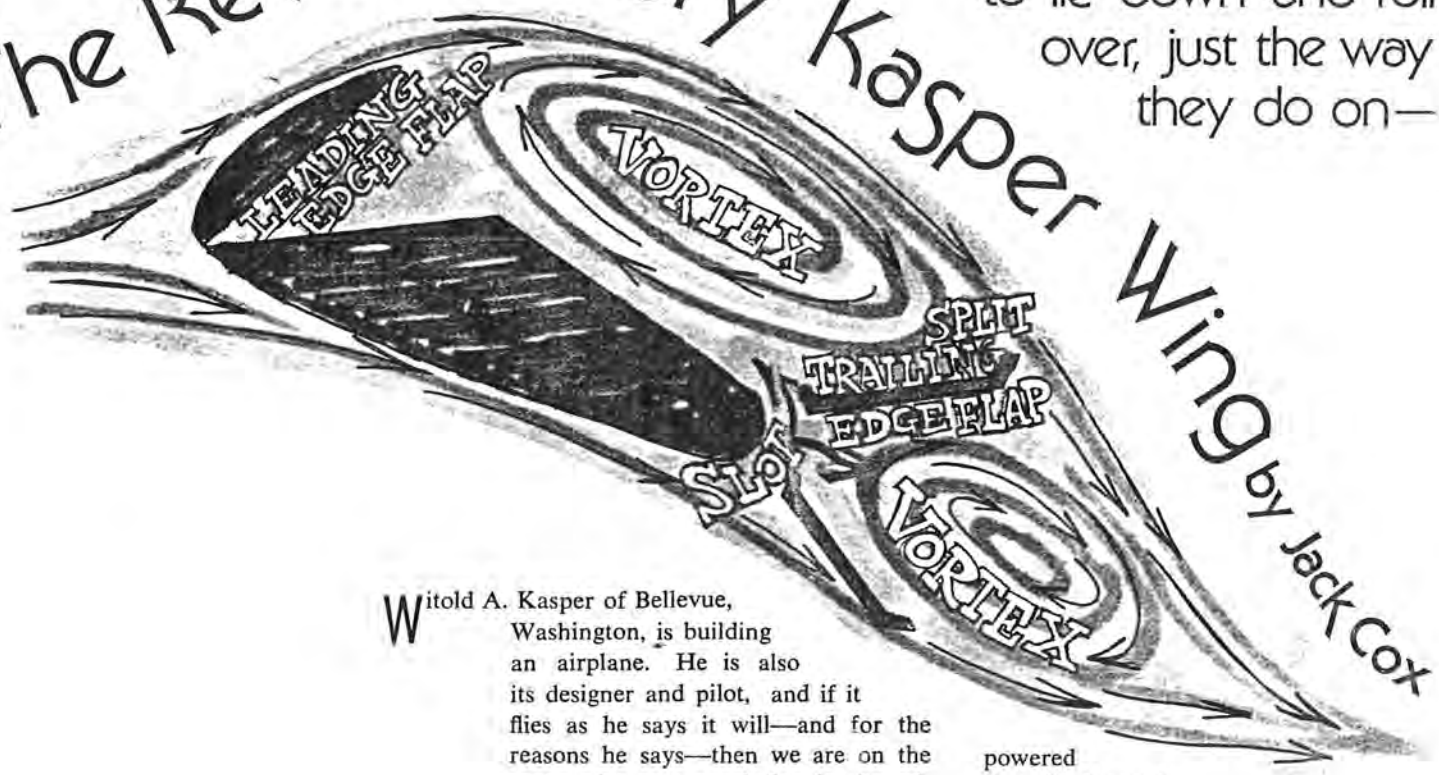
Want a skyhook to end stalls and practically eliminate sink? Just tame a pair of vortices to lie down and roll over, just the way they do on—

The Revolutionary Kasper Wing

by Jack Cox



Witold A. Kasper of Bellevue, Washington, is building an airplane. He is also its designer and pilot, and if it flies as he says it will—and for the reasons he says—then we are on the verge of a true revolution in the science of aerodynamics and in the actual operation of aircraft.

Kasper has built and flown two gliders which utilize what has come to be known as the "Kasper Wing." Outwardly this design appears to be simply a moderately swept (approximately 20°) flying wing with a central pod for a fuselage and with rudders and vertical fins at the wingtips. What makes the Kasper Wing unique is an arrangement of control surfaces which, in conjunction with the airfoil used and the wing's planform, constitute a method of accomplishing pitch, roll, and directional control never before used—a method protected by U.S. Patent No. 3,438,597. [Kasper is a professional aerodynamicist with a ten-year academic background in Switzerland and his native Poland. He has recently retired from a fifteen-year association with Boeing where, author Jack Cox writes, "Witold was a specialist in all those devices that come popping, whirring, and clanking out of the wings of 727's, 737's, and 747's to slow things down for landings."]

Excerpted from *Sport Aviation*, Jack Cox, Editor

As a soaring champion of Poland ('37, '38, '39, and '48) with over 4000 hours logged in both gliders and powered aircraft, Kasper's prowess as a pilot is considerable. Some months ago he capped an air show demonstration by making a pass down the runway in his *Bekas* flying wing sailplane and suddenly tumbling up and over in one of his "loops" (a maneuver of impossibly small circumference, now being half-jokingly referred to as a "Polish Lomcevak"). He flew right out of it and back down the runway *inverted*, looped again inside, stopped it, looped outside, stopped it, split-essed, and pulled out to settle to a near zero-speed landing in front of the crowd.

The most significant flight Witold ever made, however, was a solitary affair without an audience. Flight tests of his BKB-1 had proceeded in routine fashion, but one day a very unusual thing happened. Witold describes it:

"The plane behaved like it should, very stable, very sensitive on the controls; in fact, so sensitive that I had to install a differential pitch steering to make response comparable to existing planes.

"Then I started to test it at low speeds. At 40 mph—minimum speed obtainable with the available up-

elevator deflection—the glider's sink rate settled on 600 fpm, but it remained very stable and control response was as lively as at normal speeds. I doubted that I had reached the stall.

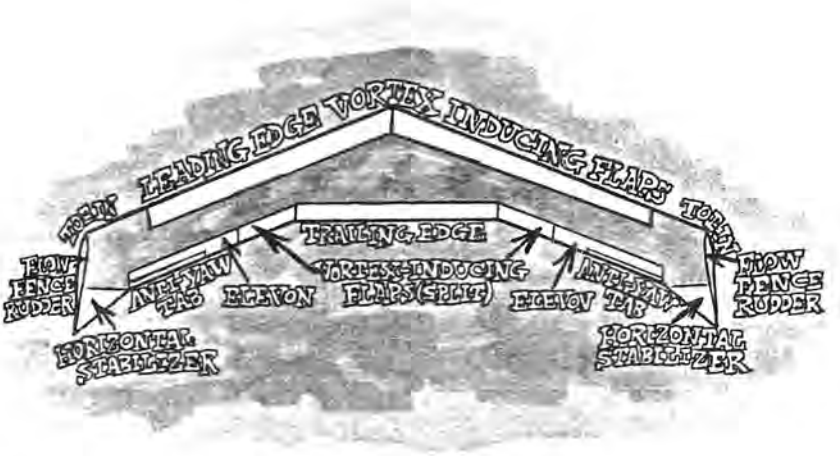
"In order to check this out, I glued a tuft at the trailing edge to observe whether I was reaching the separation of airflow prerequisite to the stall condition. In addition, I reset the linkage of elevator control to obtain a greater 'up' deflection.

"On the next flight the tow was normal but with more forward stick than usual. Soon after release I tried the stall. At 40 mph the tuft curled up and the sink rate increased to 600 fpm as before. The stick was still in a forward position, so I pulled back gently . . . an incredible thing happened! *The sink rate decreased to 200 fpm, speed dropped to 30 mph, stability increased, and control was as good as before!* The tuft curled forward and remained stretched forward, indicating a strong airflow opposite to the flight direction. [*See diagram.*] I repeated this several times, and in each instance the same phenomenon took place after the 'stall' speed was passed.

"After landing I did not dare to tell others the story, because no one would believe it anyway. No explanation could be found for this behaviour within the literature of classic aerodynamics. I determined to continue my search for an explanation.

"Seeking more information on this reverse flow, I glued four parallel rows of tufts on the right wing from the fuselage pod to the tip. I also added five pounds of lead to the rear of the fuselage pod to enable me to reach an even higher angle of attack.

"Again the tow was normal except that in free flight the plane had a slight tendency to turn in the direction of the heavily-tufted right wing so that a slight pressure on the left rudder was in order. With an inversion layer at 2000 feet I towed to 5000 feet to be sure no currents were present and where conditions were nearly ideal for the test. Normal sink rate—now measured with three independent variometers —showed 200 fpm at 54 mph. (An angle of attack indicator had been also added.)

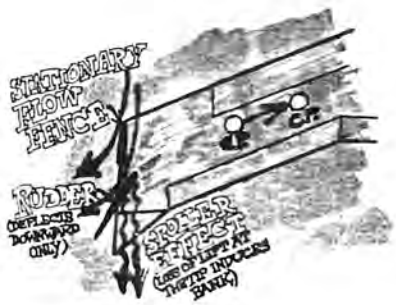


"At 40 mph the aft row of tufts started curling up to indicate airflow separation. The sink rate again increased to 600 fpm. Continuing to pull the stick back reversed the aft row of tufts, then the second, until with full stick back the third row whipped to a forward direction. The fourth (forward) row, positioned at 25% of the chord, remained in the flight direction but lifted tangentially to the leading edge curvature.

"The speed dropped to 20 mph, with the angle-of-attack indicator showing 35 degrees. But the most astonishing thing was the variometer readings. The sink rate had dropped to 100 fpm—*half the minimum sink rate in normal flight!*

"I speeded up to normal flight regimes to test whether there might be some lift in the area. The air was smooth as before. Sink rate was still 200 fpm. No lift. I turned back, went into ultra-slow speed flight. The same phenomenon was repeated. I kept circling for five minutes and then tapped the altimeter. The height lost during this period corresponded to the low sink rate.

"There could be no doubt. An unknown phenomenon was sustaining the glider at half its normal sink rate and half the 'stalling' speed. This would require a lift coefficient of 3.15. Where it came from was the puzzle. What was even more astonishing was that in straight flight in this 'overstall' configuration, the glider had a tendency to turn to the left, opposite to the tendency in nor-



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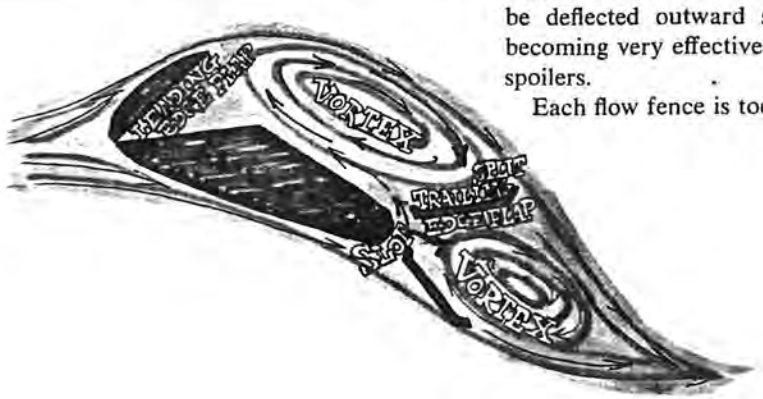


mal attitude. Not only had the lift mysteriously increased, *but the drag of the wing 'dirtied' up with tufts was decreased.*

"Analyzing the entire phenomenon, it was clear that past the stall a lift-producing vortex was forming on top of the wing."

Kasper recorded the behaviour of the tufts with a motion picture camera and later made a thorough study of the vortex that determined that lift was being produced. He theorizes that it is vortex-induced lift that allows birds to achieve zero-speed landings. It explains, in his mind, the long-observed but puzzling fact that when birds flare out in landing, their tip feathers are spread in such a manner as to cause a forward flow. He believes this is the bird's way of reinforcing the vortex generated during its super high angle-of-attack flareout, allowing a soft touchdown.

The Kasper wing is a swept wing utilizing a reflex profile (the NACA 8-H-12 profiles originally developed for helicopter blades). Wingtip washout is accomplished by means of a triangular (in planform) horizontal stabilizer located at the trailing edge of each wingtip—adjustable from the cockpit. Upward displacement of the elevons also contributes to the washout effect.

To counteract the problem of spanwise flow of the boundary layer and resulting tip stall (characteristic of the swept wing), flow fences are located at each tip. The aft end of each flow fence is a rudder which only deflects outward. [*See diagram.*] Each rudder has a large aerodynamic balance which, when deflected inward, creates a spoiler effect causing a loss of lift that induces a bank. The rudders can be deflected outward simultaneously, becoming very effective air brakes and spoilers.

Each flow fence is toed in for added directional stability. By pressing in on both rudder pedals, this toe is accentuated, increasing directional stability, especially in rough air. By deflecting the rudders at different angles, the effects of a crosswind can be offset without having to crab or side slip.

Pitch control is obtained by moving the elevators (elevons) up and down. The action is two-fold. They generate forces behind the *cg* like an ordinary elevator, but this is only part of their action. In changing the profile of the wingtip, they also change the lift distribution over the wing, shifting the center of pressure inboard or outboard, and—due to the sweepback—forward or aft. This action is much more powerful than the pitching action due to deflection and it imitates the movement of the center of pressure obtained by birds in moving their wings back or forward, according to Kasper. Of particular importance is the fact that this pitching moment created by the center-of-pressure shift is independent of the forward speed. This way the wing maintains full pitch control at zero forward speed (vertical "mush"). The loss of control that usually accompanies stall in conventional aircraft is completely eliminated.

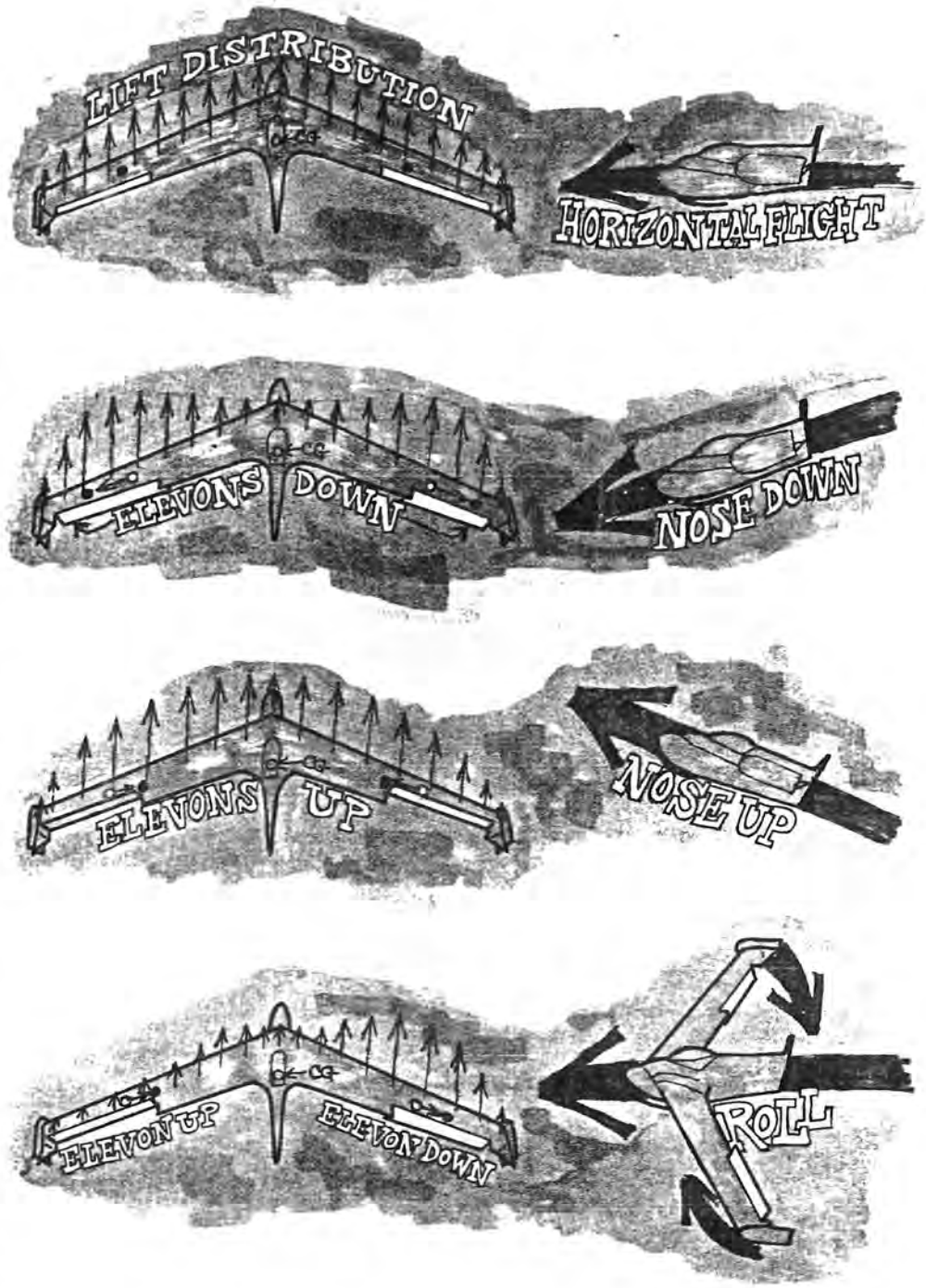
A traditional problem with tailless aircraft is the adverse yaw resulting from the deflection of elevons when functioning as ailerons. This has been overcome on the Kasper Wing by means of an automatic tab at the trailing edge of each elevon. This device is a patented invention of Witold Kasper.

In order to make use of the lift-inducing vortex Witold believes is generated over his wing during the overstall condition, new devices have been added to his latest machine, a powered version of the Kasper Wing. These consist of a very large leading edge or nose flap that opens upward plus trailing edge split flaps with a slot at the hinge line. [*See diagram.*] This slot is intended to "feed" the vortex by shooting the air forward on the top surface even at zero forward speed.

Kasper claims the following advantages for his aircraft as compared to conventionally-tailed ships:

1. The useful load of the wing is increased from 60% to 100% of the empty weight as a result of eliminating the tail section's excess weight and its downward forces.

2. The total drag of the plane—minus the tail—has decreased about 30%.
3. The stability of the pitch and yaw system greatly eases the pilot's task.
4. The pitch control being independent of the forward speed permits the maintaining of full control at any low speed. This eliminates the falling off to the side in an uncontrolled dive, which at low altitude usually results in a fatality. One-hundred-eighty-degree turns can be safely made in this flight position, greatly reducing engine-failure-at-takeoff crashes. [And towline-break-at-takeoff crashes.]
5. The end-loading action of the wingtip elevators (elevons) permits the limitation of the safety load factor to 3.5 *g's* (the gust load factor), resulting in great weight savings while at the same time increasing the maneuvering strength of the wing.
6. The absence of the tail eliminates the torsional forces on the wing at pullout.
7. The absence of the traditional tail eliminates all bending and torsional forces on the fuselage making it a non-stressed member in flight. This allows for a lighter structure and further weight saving.

If Witold Kasper's theories are correct, *if* his design will do what he thinks it will, we will have an aircraft that will not pitch over or off on a wing at the boundary flow separation, and thus also will not spin. This would drastically change the usually lethal consequences of the 180° turn back toward the runway after a total power failure [or rope break on takeoff.] *If* Kasper's machine will be able to make slow vertical descents under full control and near zero forward-speed landings, then think of the sting that would be taken out of forced landings, power failures at night and/or above solid overcasts. [*One is also tempted to speculate on motorless circling capability at 20 mph and 100 fpm sink.*—Ed.]

Is Witold right? Will his design perform such miracles? Considering the probable government alternative to a continuing high lightplane accident rate, *someone* should be investigating new aerodynamic concepts. Witold Kasper is doing just that . . . and you should know about it.