The Revolutionary Kasper Wing

By Jack Cox

A MAN IN SEATTLE, Washington is building an airplane. If this craft flies as its designer/builder/pilot 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.

This man, Witold A. Kasper (EAA 72687) of Bellevue, Washington, has built and flown two gliders and is now nearing completion of a powered version of his concept which features what has come to be known as the "Kasper Wing". Outwardly, the Kasper Wing 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 wing tips. 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. The Kasper method is, in fact, protected by U. S. Patent No. 3,438,597.

At the leading edge of the latest Kasper Wing are forward and upward moving flaps. At angles of attack beyond 20° they help generate and sustain what the designer terms a lift-producing vortex. Special, recently patented automatic tabs on the trailing edges of the elevons eliminate adverse yaw, according to Kasper.

It is what Mr. Kasper says he can do with his aircraft, so equipped, that makes him rather controversial in his profession — aeronautical engineering. Witold maintains that his Wing and its control system allow him to fly just as do birds, after which the system is modeled. As a result, his machine does not stall and is fully controllable at any angle of attack from 0° to 90°, generates sufficient vortex-induced lift at zero forward speed (vertical mush) to allow bird-like zero speed landings . . . and even has conquered that age-old nemisis, the crosswind landing. So claims Witold Kasper.

Unless you live in the Seattle area, are a soaring enthusiast, or have been following the development of super-sophisticated high lift devices for the latest airliners and military aircraft . . . you are probably sitting there wondering, "Who is Witold Kasper?" "Who is this man who says he can fly like the birds?"

The man does not come without credentials. A native of Poland, Kasper received an MS in Mechanical Engineering in Zurich, Switzerland in 1929; an MS in Aeronautical Engineering at the Lwow Institute of Technology in Poland in 1939; and was a Research Fellow in 1938-39 at the Aerodynamics Research Institute, Lwow, Poland. Between 1940 and 1945 he was General Manager of the Light Aircraft Manufacturing Works in Brasow, Rumania; was employed by the Polish Ministry of Air Transport until 1950 at which time he managed to get to Canada where he was a design and liaison engineer for Canadair until 1958. That year Kasper moved to Seattle and went to work for Boeing where he remained until his recent retirement. At Boeing Witold was a specialist in all those devices that come popping, whirring, and clanking out of the wings of 727s, 737s and 747s to slow things down for landing.

(Photo Courtesy Witold Kasper)

Kasper BKB Glider, one of two that have been built to prove out the designer's aerodynamic theories.

Witold Kasper is perhaps more widely known as a pilot — at least in soaring circles (pun intended). He was the soaring champion of Poland in 1937, 1938, 1939 and 1948. He has accumulated over 4,000 hours in both gliders and powered aircraft. In the Seattle area Witold is well known among EAAers for some rather awe-inspiring performances in his tail-less gliders, the BKB and BKB-1A "Bekas". The peculiar flight characteristics of the machines allow him to do some flip-flops not possible in any other aircraft — including what is now being half-jokingly called a "Polish Lomcevak". This is a loop of impossibly small circumference, almost, as well-known EAAer Dick Baxter likes to joke, as if Witold had a pivot point sticking out of each ear around which he whirls! Some months ago Kasper capped an air show demonstration by making a pass down the runway, suddenly tumbling up and over in one of his "loops". He flew right out of it and back down the runway INVERTED, looped again inside, stopped it, looped outside, stopped it, half-looped (or "split-s'ed") and pulled out to settle to a near zero-speed landing! This was before a large crowd, in-

cluding numerous EAAers — many of whom still don't believe it!

But Witold Kasper is not an air show aerobatic pilot. He flies to investigate the unusual characteristics of his Wing and his demonstrations are intended to show the doubting aeronautical "establishment" that his theories are for real.

The most significant flight Witold ever made, however, was a solitary affair. He had built the BKB-1 to prove his bird flight-based control system because in his words, "No respectable scientific establishment nor industry would risk money to test (in a wind tunnel) ideas which **were contrary to the established rules." Flight tests 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 it comparable to existing planes.

Then I started to test it at low speeds. At forty mph, minimum speed obtainable with the up-elevator deflection, the glider's sink rate settled on 600 feet per minute, but remained very stable and the response to the controls remained as lively as at normal speeds. I doubted that I had reached the stall speed.

In order to test this, I glued a tuft at the trailing edge to be able on the next flight to observe whether I was reaching the separation, which is the prerequisite to stall. Additionally, I reset the linkage of the elevator control to obtain a greater "up" deflection.

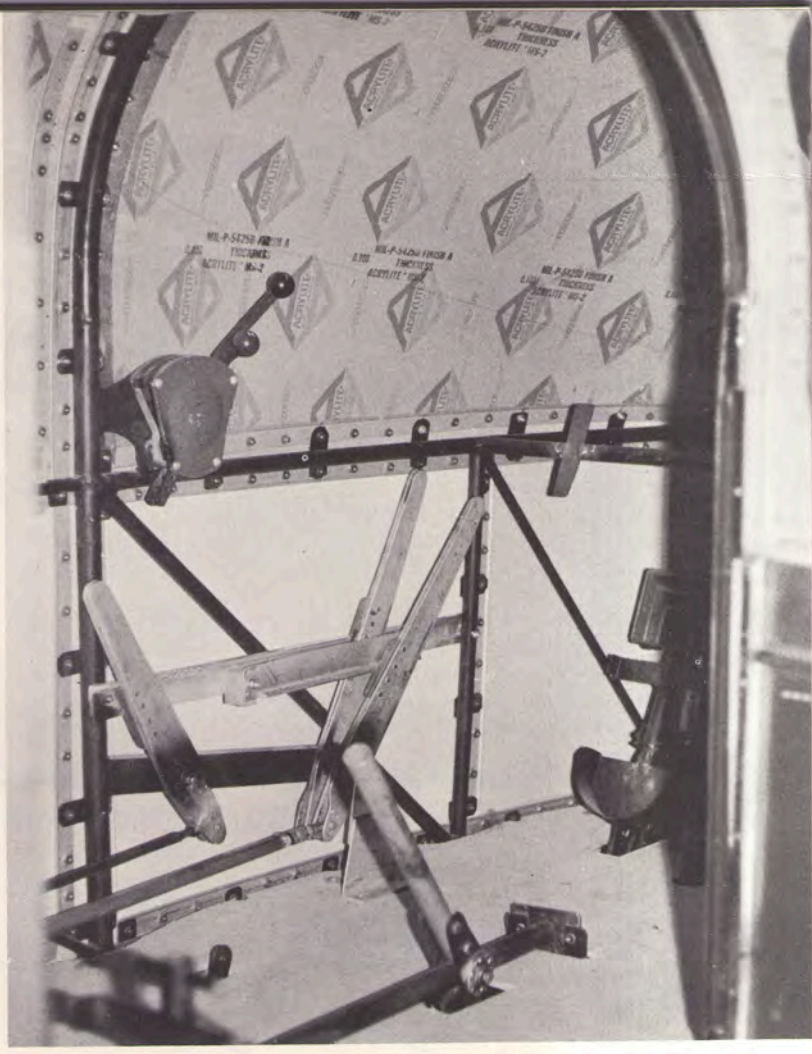
The tow was normal with more forward stick than usual. Soon after the release I tried the stall. At forty mph the tuft curled up and the plane's sink rate increased to 600 feet per minute. The stick was still in a forward position, so I pulled back gently and then an incredible thing happened . . . the sink rate decreased, the variometer indicated 200 feet per minute, speed dropped to thirty mph, stability increased, and control was as good as before. The tuft then curled FORWARD and remained stretched forward, indicating a strong flow opposite to the flight direction. The estimated angle of attack was 30°. I repeated this several times and in each instance the same phenomenon took place after the "stall" was passed.

After landing I did not dare to tell others the story, because no one would believe it anyway. No explanation for this behavior could be found within the body of classic aerodynamics.

In order to get more information about this reverse flow, I glued four rows of tufts on the right wing, from the center (fuselage pod) to the tip. My fellow pilots were joking that I put feathers on the wing. I also added five pounds of lead to the rear of the fuselage pod in order to reach an even higher angle of attack.

Again the tow was normal. 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. The tow went to 5,000 feet. I wanted to be sure no currents were present. It was a hot day with the inversion level at 2,000 feet. Normal sink rate, now measured with three variometers independently hooked up, showed 200 feet per minute at 54 mph indicated. (An angle of attack indicator had also been added.) The conditions were nearly ideal for such a test.

At forty mph the aft most row of tufts started curling up, showing separation. Sink rate increased to 600 feet per minute. Pulling the stick back the aft-most row reversed first, the second followed and with full stick back the third row of tufts whipped to a forward direction. The forward-most row, positioned at 25% of the chord, remained in the flight direction but moved up tangentially to the leading edge curvature.



(Photo by Jack Cox)

The front seat area of the Kasper cabin. The Acrylite windshield and side window panels are in place, but with the protective paper covering still stuck on. The three levers just below the throttle/mixture quadrant are the controls for the various Kasper-designed high lift devices on the wing. Each has its own control so that a separate evaluation of the performance of each can be made selectively.

The speed dropped to 20 mph, the angle of attack indicator showed 35°, but the most astonishing thing happened to the variometers. The sink rate dropped to 100 feet per minute — only half the minimum sink rate in normal flight. All three instruments indicated the same. This was impossible!

I speeded up to normal flight regime to test whether there was not some lift in this area. The air was smooth as before, sink rate was 200 feet per minute . . . no lift. I turned back, went into the ultra slow speed flight and the same phenomenon was repeated. I kept circling for 5 minutes and then tapped the altimeter. The height lost in this time corresponded to the low sink rate.

There could be no doubt, an unknown phenomenon was keeping the glider afloat at half the normal sink rate and half the "stalling" speed. This would require a lift coefficient of 3.15. Where it came from was a 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 normal attitude — not only had the lift mysteriously increased, but the drag on the wing ruffled up with the 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."

(Continued on Next Page)

KASPER WING . . .

(Continued from Preceding Page)

On a subsequent flight Witold fitted a super eight movie camera in his craft aimed at the tufted right wing. He thus captured on film for all to see the strange effect of the vortex. This film has been regularly shown in EAA meetings in the Seattle area and has been seen by scores of Kasper's fellow scientists.

Kasper was later to make a thorough study of the vortex phenomenon and eventually determined that lift was being produced. He has theorized that it is this vortex-induced lift that allows birds to accomplish zero speed landings. It served to explain, in his mind, the long observed but puzzling fact that when birds are in the process of "flare-out", their tip feathers are spread in such a manner as to cause a forward flow. Kasper believes this is the bird's way of reinforcing the vortex generated during its super high angle of attack flareout, allowing a soft touchdown.

Witold then set out to design a powered version of his "Wing" incorporating, in addition to his patented control arrangement, devices to reinforce the vortex in the over-stall condition. Pictures showing the progress on that machine as of May 22, 1973 appear with this article.

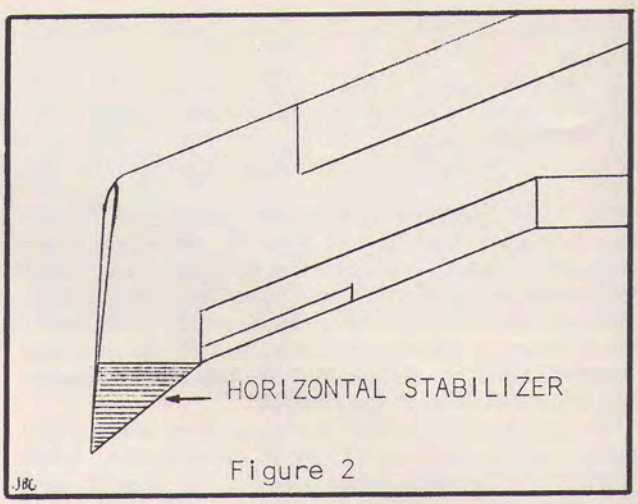


Figure 2

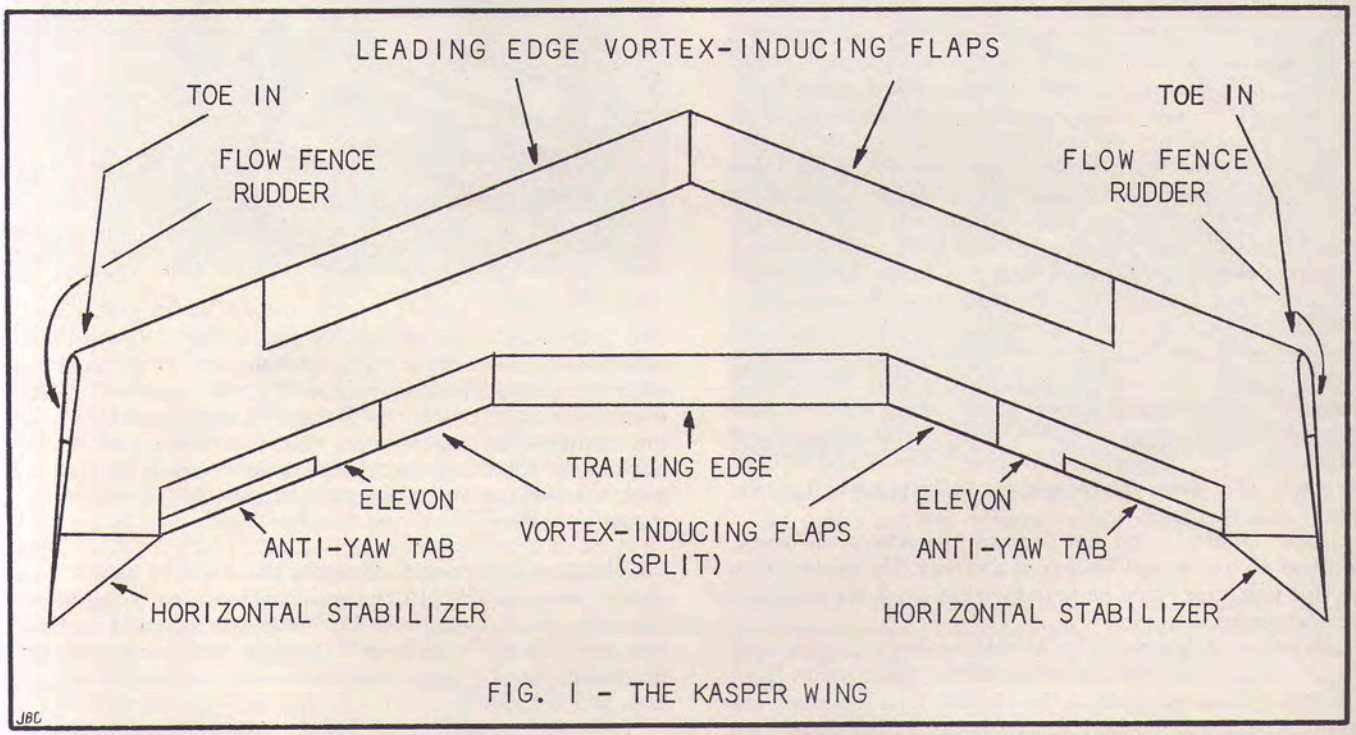


FIG. I - THE KASPER WING

The Kasper wing . . . remember, protected by several patents . . . is a swept wing utilizing a reflex profile — NACA 8-H-12 profiles developed originally for helicopter blades. Wing tip washout is accomplished by means of a triangular horizontal stabilizer located at the trailing edge of each wing tip — 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. 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.

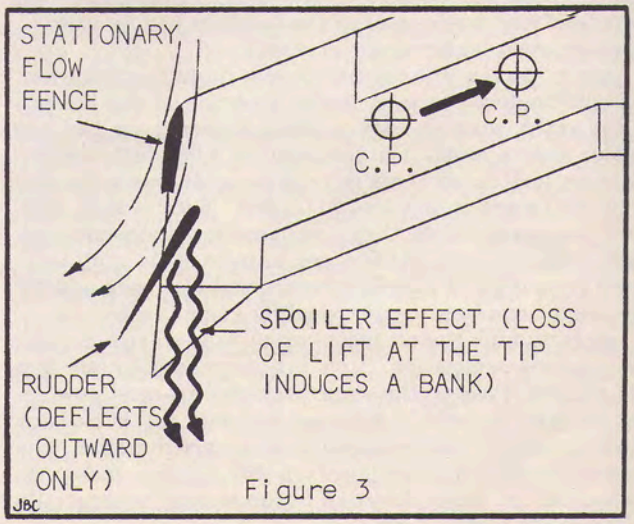


Figure 3

Each flow fence is toed in for added directional stability. By pressing in on both rudder pedals, this toe in 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. Their action is two-fold. One, they generate forces behind the C.G. like an ordinary elevator, but this is only part of their action. Changing the profile of the wing tip, they also change the lift distribution over the wing, shifting the C. P. inboard and outboard and due to the sweep back, forward and rearward. This action is much more powerful than the pitching action due to the deflection and it imitates the movement of the C. P. birds obtain by moving their wings back or forward, according to Kasper. Of particular importance is the fact that this pitching moment created by the shift of C. P. is independent of the forward speed. This way the wing maintains full pitch control at zero forward speed (vertical mush). The loss of control at the so-called "stalling speed" (in conventional aircraft) is completely eliminated.

A traditional problem with tail-less aircraft is the adverse yaw produced when the elevons are deflected 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 in the over-stall condition, new devices have been added to his latest machine, the powered Kasper Wing.

These consist of a very large leading edge or nose flap that opens upward and trailing edge split flaps with a slot at the hinge line. This slot is intended to "feed" the vortex even at zero forward speed by shooting the air forward on the top surface.

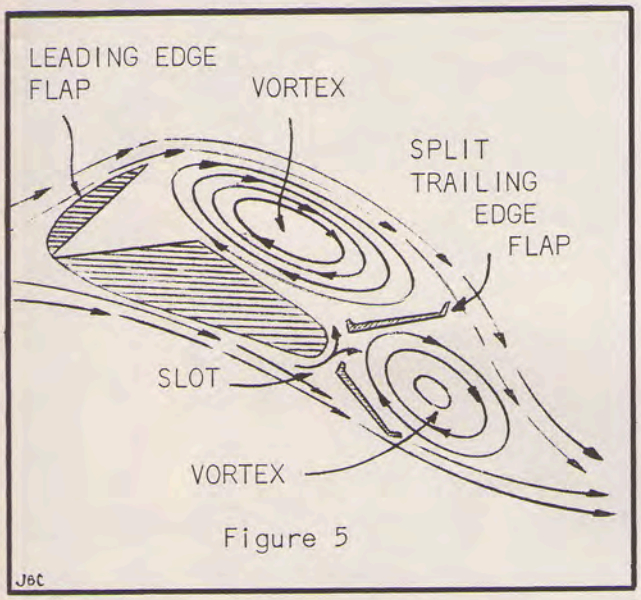


Figure 5

Mr. Kasper claims the following advantages for his aircraft configuration and his Wing as compared to conventional "crosstail" aircraft:

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

2. The total drag of the plane — minus the tail — has decreased about 30%, resulting in a considerable increase in cruising speed or decrease in fuel required.

3. Utilizing the stable system for pitch and yaw, the pilot's task is greatly eased.

4. The pitch control being independent of the forward speed of the plane permits the maintaining of full pitch control at any low speed, thus eliminating the falling off to the side and uncontrolled diving, which at low altitude inevitably leads to a fatal crash. The wing can be mushed to a landing with very little forward speed in a level or slightly nose up attitude. Thus, in addition, 180° turns can be safely made in this flight position, greatly reducing the fatal "engine failure at take-off" crashes.

5. The end-loading action of the wing-tip elevators (elevons) permits the limitation of the safety load factor to 3.5 Gs (the gust load factor), resulting in great weight savings, increasing at the same time the maneuvering strength of the wing.

6. The absence of the tail eliminates the torsional forces on the wing at pull out. The wing has to be calculated only for bending - 3.5 Gs. The obtained weight economy can be converted into additional payload.

7. The absence of the "crosstail" eliminates all bending and torsional forces on the fuselage, making it a non-stressed member in flight, like the fuselage of a helicopter. This allows for lighter structure — another weight saving.

PERSPECTIVE

What is the reaction when a man comes along and starts telling the aviation "establishment" that they have been doing things wrong since 1903, or, at best, that there is a better way of doing things? What sort of reception does a Witold Kasper get from manufacturers who have years of work and millions in research and development in their products . . . which he says are inferior to his new concept? As you might imagine, Witold has not been walking many red carpets of late, however, if his powered machine proves successful, the aviation part of the world might well start beating a path to his door.

Last September 13 the National Transportation Safety Board adopted a report entitled "General Aviation Stall/Spin Accidents 1967-1969". The report decried the fact that although modern aircraft are generally more stall and spin resistant than those of the 30s and 40s, still the stall/spin accident accounts for approximately 25% of the fatalities recorded today in lightplane crashes. This was true despite the fact that stall/spin accidents account for a relatively small 8% of the total number of accidents.

NTSB made nine recommendations aimed at improving the stall/spin accident record. One of these suggested the FAA go back to requiring spin training for all pilot applicants. Another stated: "The Federal Aviation Administration, the General Aviation Manufacturers Association, and the National Aeronautics and Space Administration conduct a joint study to determine the potential and feasibility for reducing stall/spin accidents through enhanced airplane design *consistent with current technology* (my emphasis — Author). Specific consideration, for example, might be given to using applicable STOL technology, improved stall warning equipment, modification kits aimed at improving the handling characteristics of present aircraft, direct lift systems, etc."

Shades of the Guggenheim Safe Airplane Contest of 1929, the "$700 Airplane" contest of 1933, etc.! — wonder if anyone will remind NTSB, FAA, NASA, et. al. of the work that went into such aircraft as the Curtiss Tanager, Weick W-1A, Stearman-Hammond, Gwinn Aircar and even the Ercoupe over three decades ago before they start letting juicy contracts to spend great hunks of our tax money to go over previously trodden ground?

(Continued on Next Page)

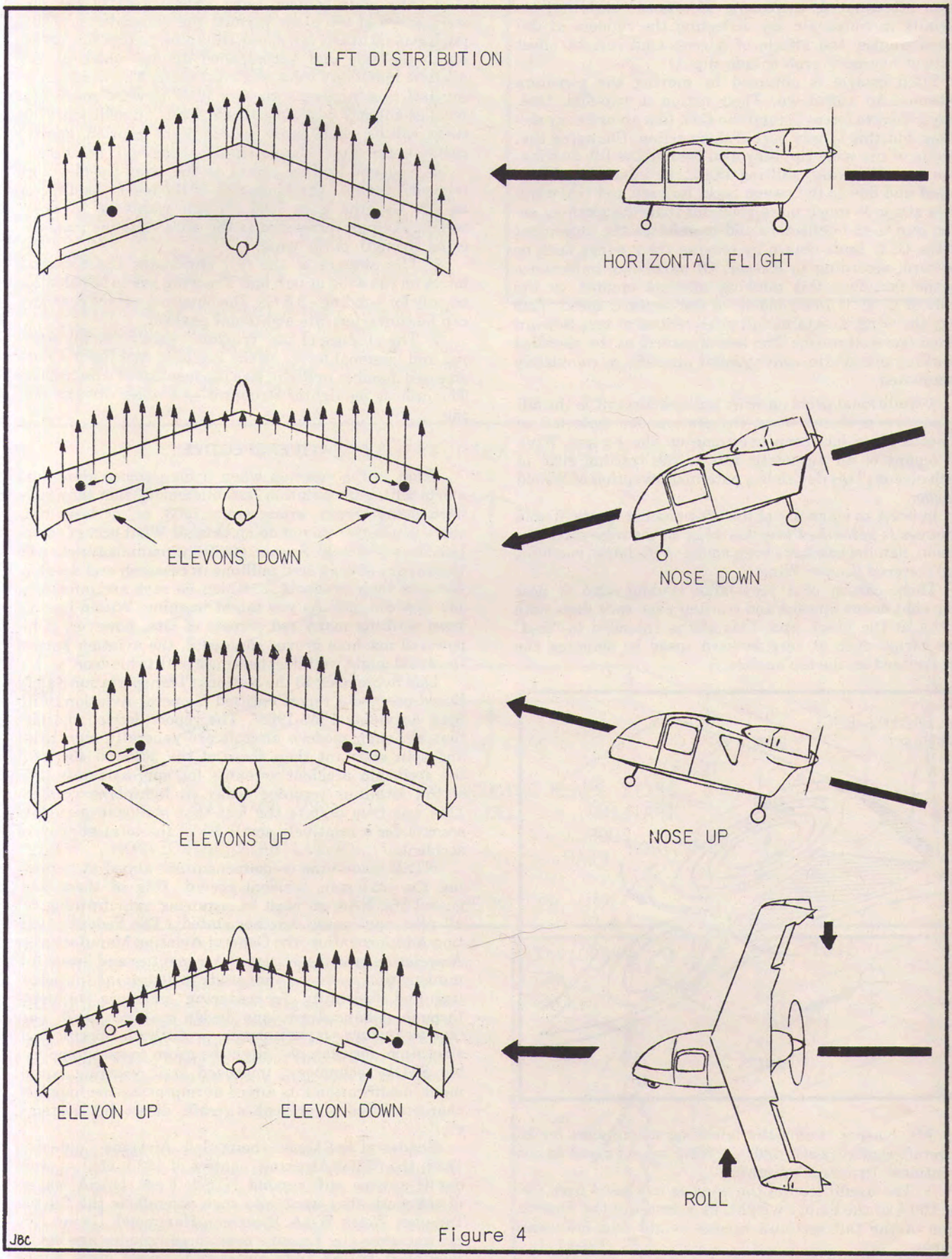
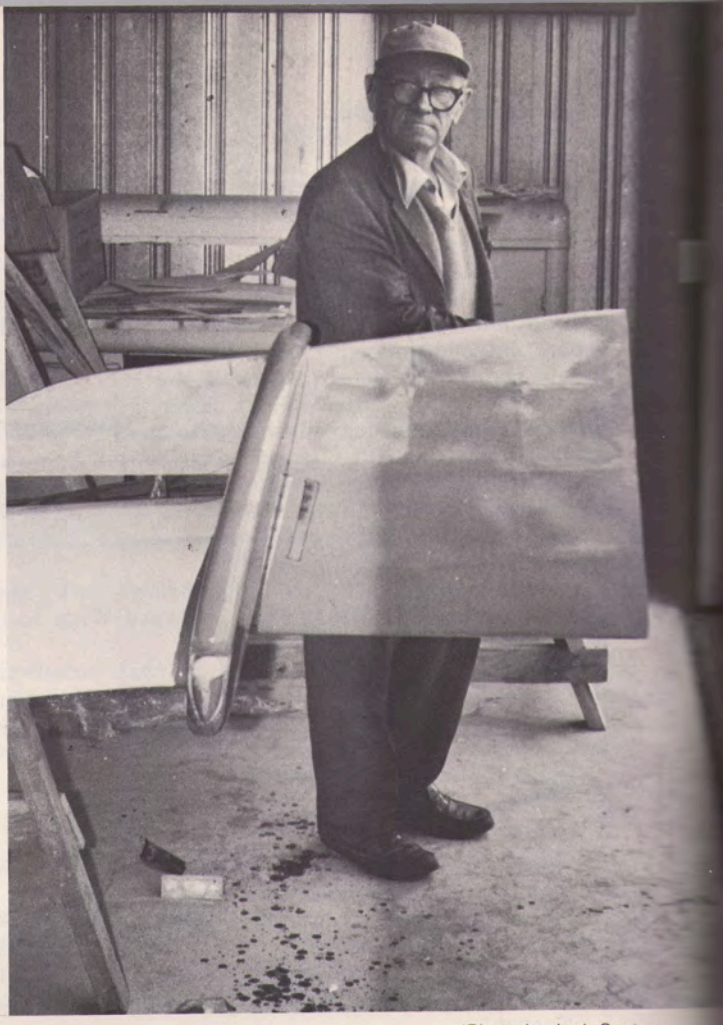

LIFT DISTRIBUTION
HORIZONTAL FLIGHT
ELEVONS DOWN
NOSE DOWN
ELEVONS UP
NOSE UP
ELEVON UP
ELEVON DOWN
ROLL
JBC

Figure 4

(Photo by Jack Cox)

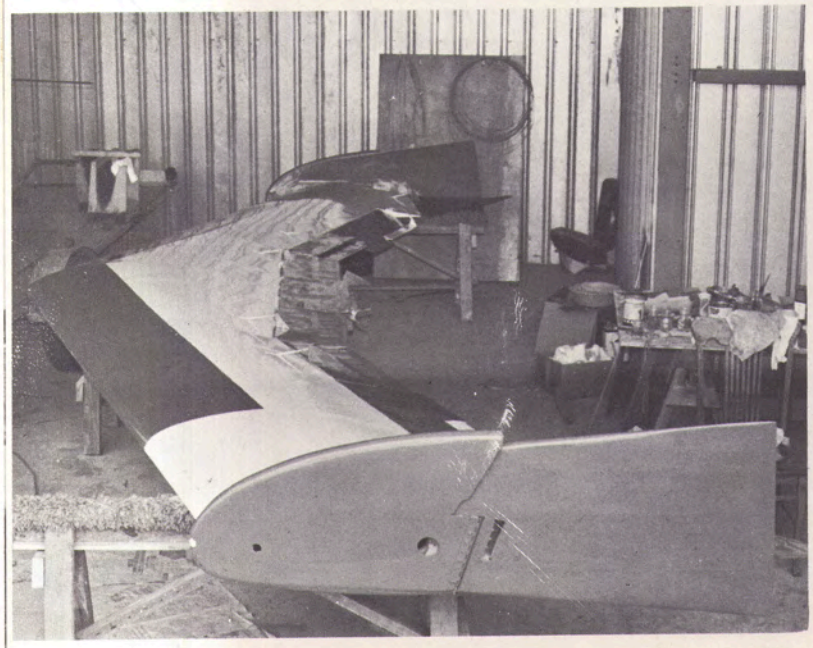
Photo 1A — Here Mr. Kasper points out the vertical cant and toe-in of his tip mounted rudder/flow fence. This double angling of the surfaces aids the natural stability of the wing.



(Photo by Jack Cox)

Photo 1B — The outward deflection of the rudder is illustrated here. Note the inboard extension of the rudder's aerodynamic balance which produces a spoiler effect that induces a bank.

KASPER WING . . .
(Continued from Preceding Page)



(Photo by Jack Cox)

Photo 2A — The Kasper Wing in cruise condition — with all the various control and lift inducing devices tightly closed.

(Photo by Jack Cox)

Photo 2B — Witold Kasper and his Wing with the vortex-inducing flaps open. With the Wing in this configuration, Mr. Kasper is confident he will be able to achieve a zero forward speed landing, using the same aerodynamic principles as do large birds.

Our hard earned bucks might be better spent if our benevolent protectors would take a close look at what has already been done . . . and ignored . . . and also take a look at such existing machines as Burt Rutan's Vari-Viggen and Witold Kasper's glider — plus his powered version when it is ready.

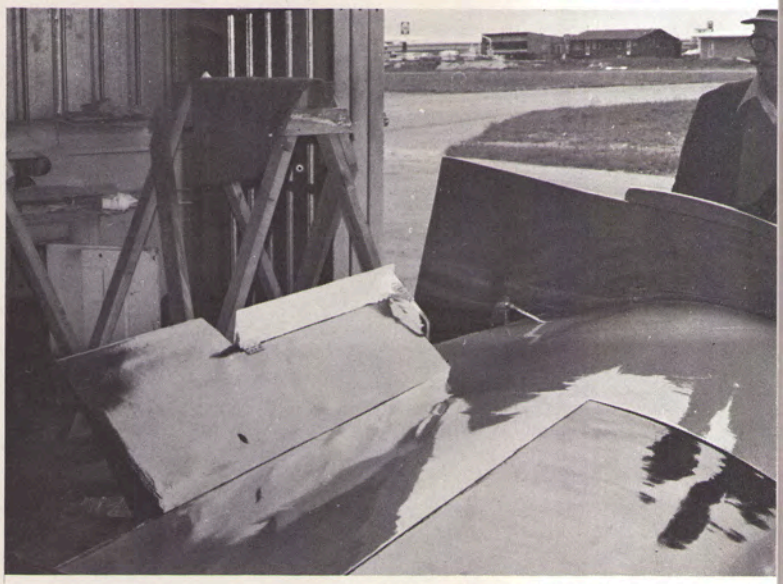
IF Witold Kasper's theories are correct, IF his Wing will do what he thinks it will, we will have an aircraft that will not pitch over or off on a wing at the boundary flow separation, and thus, also will not spin. This would drastically change the consequences of the 180° turn back toward the runway after a total power failure on take-off — the often fatal maneuver that so many pilots seemingly cannot resist. 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.

Is Witold right? Will his Wing perform such "miracles"? With the first flight of his powered Wing so imminent, what good is idle speculation?

The point of this article is simply that, 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.

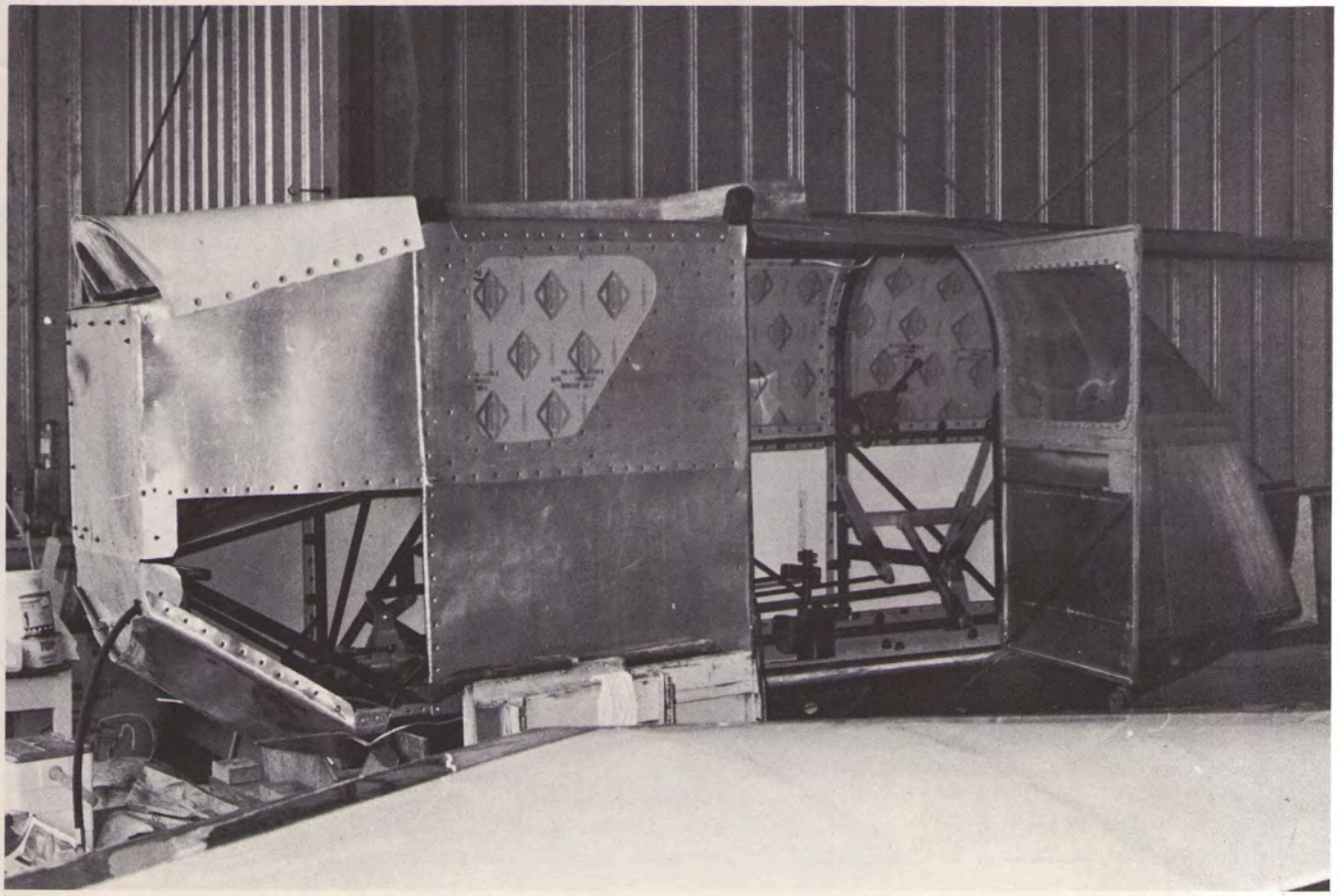
REFERENCES

1. "Stability and Control of the BKB-1 Tailless Airplane" — paper by Witold Kasper.
2. Industrial Proposal for Development of KASPAIR 200 — by Witold Kasper.
3. Two untitled papers dealing with the Kasper Wing and Witold Kasper's aerodynamic theories — by Witold Kasper.
4. Personal conversations between the author and Witold A. Kasper.



(Photo by Jack Cox)

Witold, with his cigarette holder at a characteristically jaunty angle, looks at his patented device (the white tab on the up raised elevon) which eliminates adverse yaw.

(Photo by Jack Cox)

The nearly completed fuselage of the powered Kasper Wing. It seats two in tandem and has dual controls. The engine, a 125-hp Lycoming, is mounted on the aft end of the fuselage. The structure is steel tube covered with metal panels fastened in place with screws for quick removal when additional experimental work is to be done. The engine and tricycle, fixed gear have already been fitted to the aircraft, but were off when this picture was taken.