DRAG REDUCTION POSSIBILITIES

I'll bet your airplane is not as fast as it could be . . . and because of that your fuel costs are higher than they have to be.

Blame it on drag. Drag is a penalty you have to pay for the privilege of flight. However, why pay the full price when you can get a discount. Let's look into this idea a bit further.

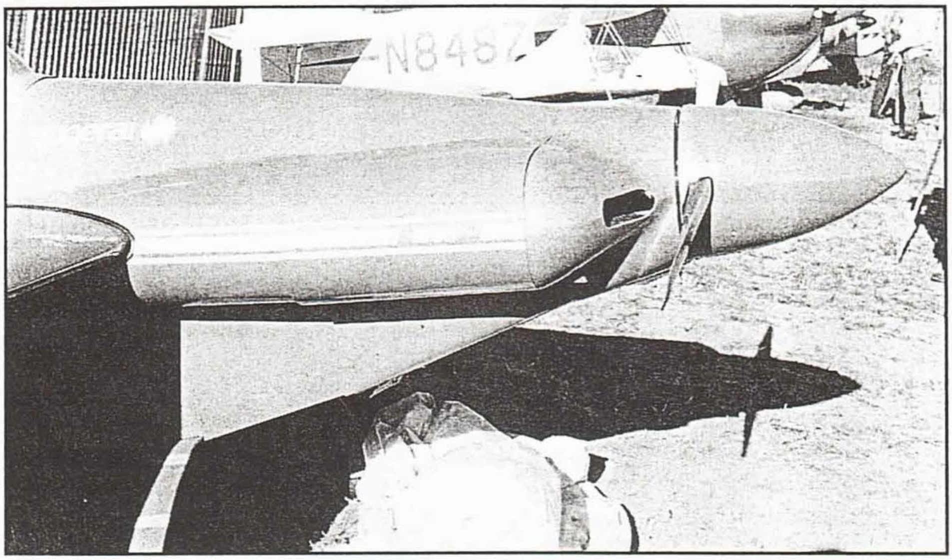
As most of you know, one kind of drag results from the work being done by the wing to sustain flight. It is called induced drag and, like it or not, it is a fair price paid in exchange for the lift produced by the wing . . . after all, it does play a part in keeping us airborne.

There is another kind of drag known as parasite drag. It is not the result of anything productive and serves no useful purpose. In short, it is an airborne freeloader, a parasite that contributes nothing to flight but a needlessly eroded performance.

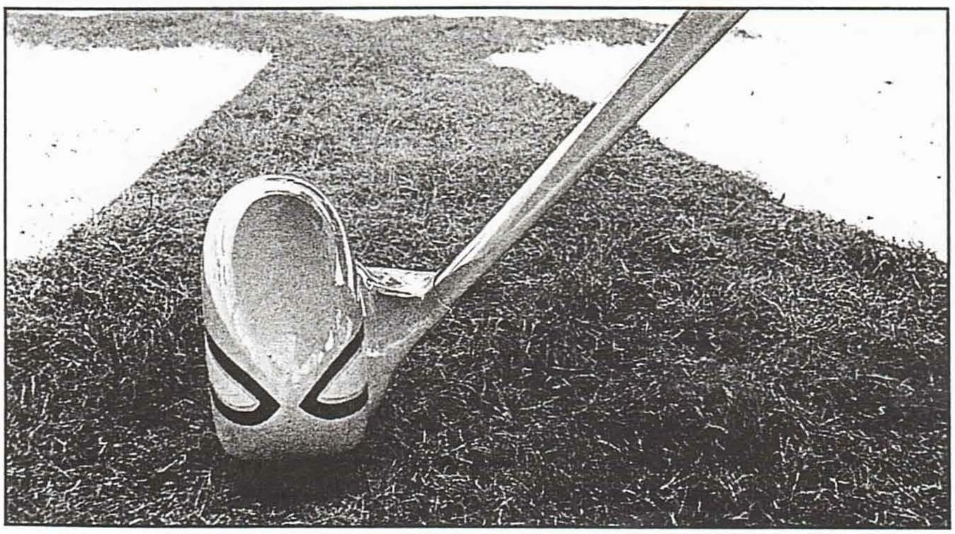
In short, all airplanes suffer from it. This is because parasite drag is produced by most any surface or object protruding from the surface of the airplane that interferes with the smooth flow of the slipstream.

It is reasonable to assume, therefore, that by reducing parasite drag wherever you can, you will enjoy the benefits of reduced fuel expenditures and an ego enhancing increase in airspeed . . . however infinitesimal that may be.

Obviously, the more effective your drag reduction efforts, the greater the rewards.



This Sonerai cowling and spinner installation is a good example of what can be done to reduce overall drag. Note the diminutive size of the air inlet opening. Compare this with the photo showing a single large inlet opening.



The ultimate in drag reduction for a fixed tubular landing gear.

Any Aircraft Can Benefit

How about those speedy composites? Sure, we know that even the slickest high powered composite can be made to be imperceptibly faster by further reducing its parasite drag. Otherwise, what other explanation could there be for two like aircraft differing considerably in performance?

However, the aircraft most likely to benefit from a drag reduction effort is the typical "plain Jane" variety. These aircraft have modest cruise speeds ranging between 100 mph and, let's say, 150 mph.

What about light aircraft and ultralight aircraft? Well, these are obviously designed to operate efficiently on a minimum of horsepower. They fly slow and low and anyone who owns one is more concerned with the importance of keeping the weight down than in trying to go supersonic by reducing parasite drag.

Unfortunately, streamlining efforts usually do equate to added weight, hence most ultralight builders don't bother.

Nevertheless, some parasite drag reduction can often be achieved for these aircraft or, for that matter, for any aircraft without adding appreciable weight.

Is Drag Reduction Worth The Effort?

Yes, indeed. Reducing parasite drag is always beneficial regardless of the aircraft's classification or speed range.

Builders of medium powered aircraft (85 hp to 150 hp) often fail to take advantage of numerous drag reduction opportunities and settle for modest mid-range cruise speeds of 100 mph to 140 mph. And yet, many of these same aircraft have the potential for achieving a 10% to 20% increase in cruise. Of course, how much depends on the basic design of the aircraft and the skill and determination of the builder or owner.

Many of the higher powered homebuilts (160 hp to 200 hp) are already quite fast because their designers took advantage of certain obvious drag reduction options during the basic design process.

Incidentally, except for special purpose aircraft, there is no aerodynamic reason why a one mph per hp (or better) speed cannot be achieved. Naturally, the ultimate refinement and speed that can be achieved always rests with the amateur builder . . . especially one who is not satisfied with just average performance.

We all know from observation that most composites are molded to highly contoured aerodynamic curves and are relatively free of many of the parasite drag elements found in other types of construction. But these designs are not alone in aerodynamic refinement.

The metal RV's, T-18's and Mustangs (I and II), in spite of their rivets and lapped joints, are just about as fast because their builders, as a group, tend to vie with each other in reducing or eliminating parasite drag wherever they can.

This seems to be a good place to spring another generalized observation. Here it is:

The faster the airplane, the more pronounced the benefits of a reduction in parasite drag. For example, removing an externally mounted antenna from a slow J-3 Cub will, at best, result in an imperceptible increase in speed.

However, removing a similar antenna from a Lancair or Glasair would, undoubtedly, net a measurable increase in speed.

Four Ways To Reduce Drag

1. Remove it.
2. Streamline it.
3. Seal it.
4. Smooth it.

Let's explore each method in detail:

1. Remove It - Anything that is not there cannot create drag. So, if you can remove the object from the surface of the aircraft you will reduce its overall drag and increase the cruise speed. Naturally, this will result in a corresponding reduction in the amount of fuel required to push the airplane through the air.

Of course, you should understand that some of your efforts to eliminate parasite drag by removing some small objects from the slipstream may yield only minuscule changes.

Many of you will say it is not worth messing with. However, rest assured, the effect of all gains is cumulative and will be noticeably beneficial . . . very much like the success of the ant in piling up a large impressive mound . . . grain by grain.

By now you may be trying to think of some of the drag producing objects you could remove from the external surfaces of your aircraft. Let me give you a hand. Here are a few that create drag producing turbulent wakes:

a. Landing Gear - Removing (retracting) the gear would, naturally, involve structural changes and I certainly wouldn't consider doing it unless it was a designer offered option . . . but it is the biggest drag producer of them all. Incidentally, a partially retracted gear may actually produce more drag than a well streamlined fixed gear.

b. Antennas - Some homebuilts have an external communications antenna, a navigation antenna, a transponder antenna and a loran antenna - all drag producers. Remove them if you can.

c. Externally Mounted Nav/Strobe Lights - This may not be easy because when you bury the lights inside the wing tip, you may be reducing areas of their projected coverage. The FAA thinks your lights should, ideally, be visible from all directions.

d. Fuel Caps - Some of these project considerably above the cowl or wing surface.

e. Protruding screws, bolt heads, rivets, brackets.

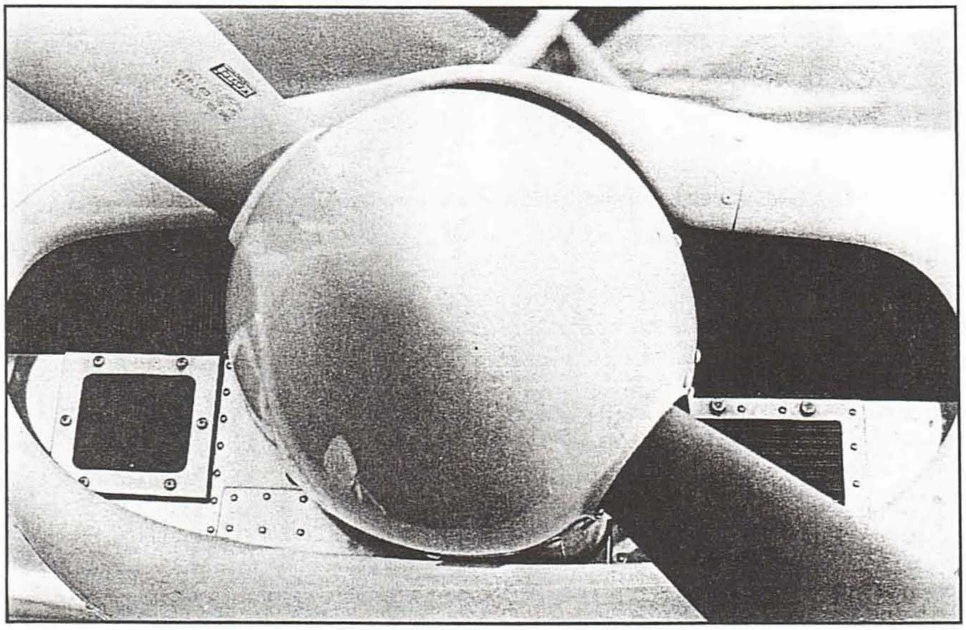
f. Pitot/Static tube installation.

g. Temperature probe.

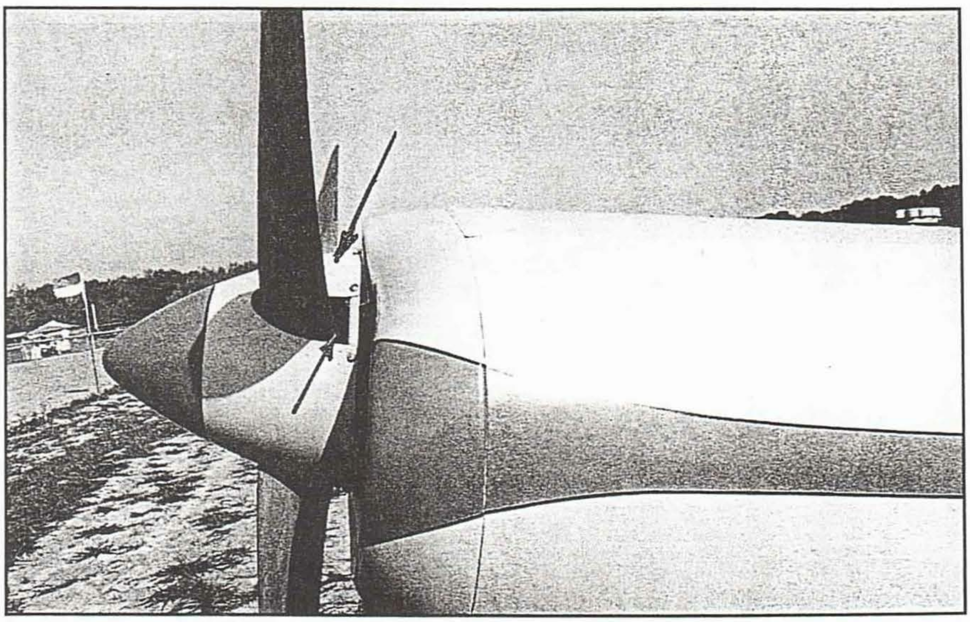
h. External handles.

i. Fuel vents.

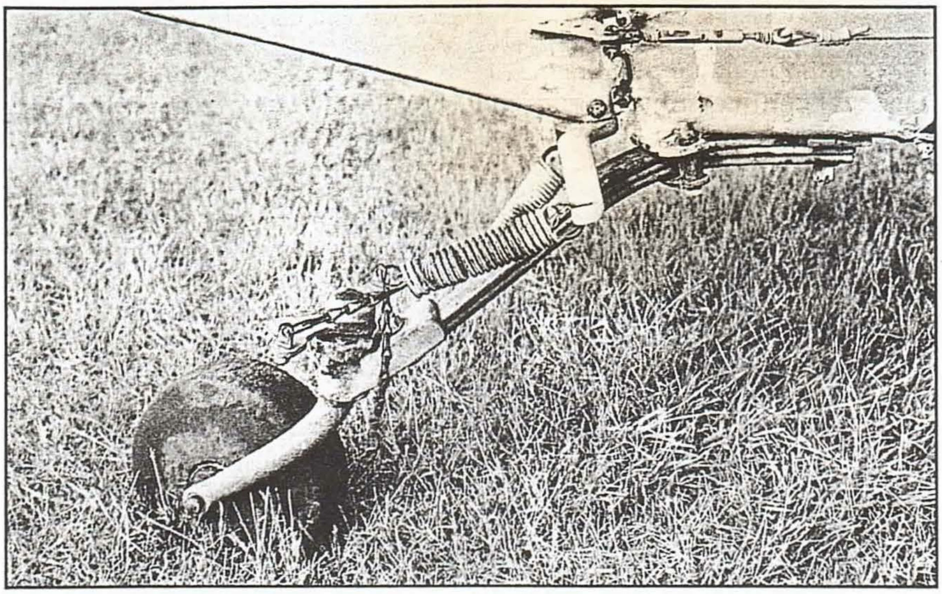
j. Control Balances - Submerging balance weights for control surfaces is a nice effective way to minimize drag. However, making it work may not be worth the effort. It could require a crit-



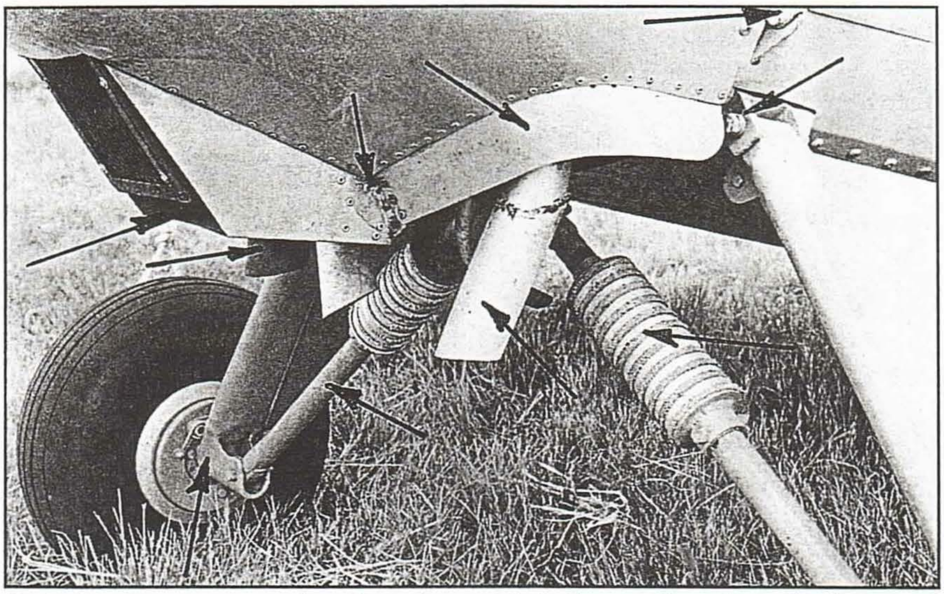
A cowling with a single large opening does not provide the optimum in engine cooling or drag reduction.



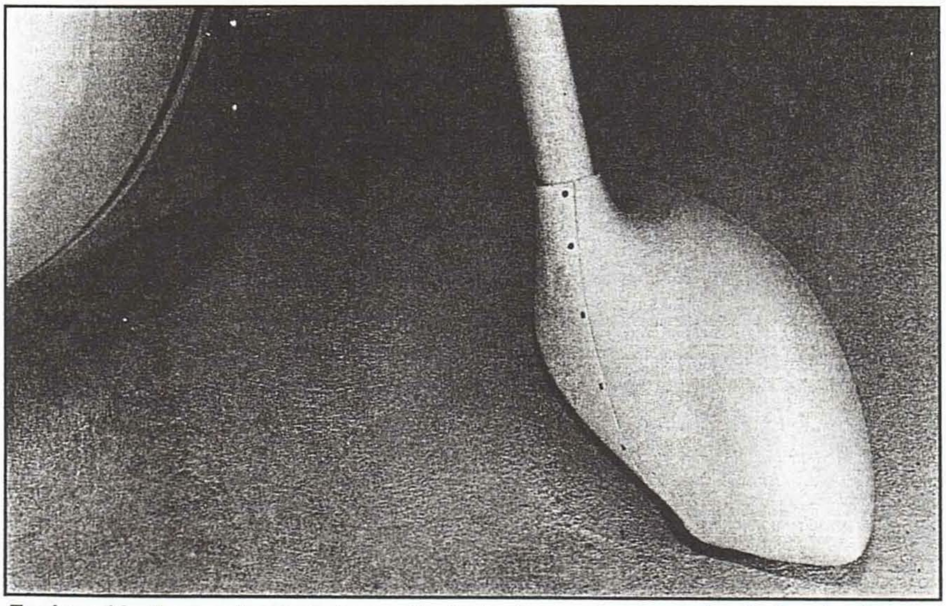
A larger spinner would reduce drag and improve the flow of air into the cowl inlets. A plate installed behind the prop hub cut-out would also help smooth the flow of air.



A typical tailwheel installation produces a lot of drag and looks lousy. Using a tubular strut instead of flat springs would be an improvement. I would, however, question the merit of enclosing tailwheels in streamline wheel pants.



Reducing drag on some aircraft can be a real challenge. Sometimes the improved appearance would be more rewarding than the reduced fuel consumption increase in cruise speed.



Enclosed in these wheel pants are the high drag scissors and axle-to-shock-strut intersection. Result, reduced drag and an enhanced appearance.

ical structural and aerodynamic change. Changes like that should be cleared with the designer.

k. Steps - You could make them retractable. Note: Drag producing elements located within the propeller slipstream are more detrimental than similar objects located outside the slipstream.

2. Streamline It - If you can't remove it, streamline it by fitting it with a fairing of some sort.

In this respect, the tubular landing gear legs and the tail gear installation are about as dirty (drag wise) as they come. Streamline them and you will realize a fairly large increase in speed.

It is very important that the interference between parts be reduced by reshaping the intersection. To do this you may have to reshape the area by adding material (foam, wood, fiberglass, etc.) to it. This reshaping can be in the form of an add-on fairing, or it can be one permanently attached to the structure.

Keep in mind the need for future disassembly of some parts. These should be fitted with removable fairings.

The juncture between the landing gear leg and wheel pants needs to be faired as does the point of attachment for a wing strut.

The junction between the wheel pants and the landing gear leg is another drag area requiring streamlining.

Exhaust pipes that jut straight down out of the cowling are big drag producers. Slant the pipes so they exit the cowling more or less parallel with the slipstream and you may even benefit from the jet-like effect of the exhausts.

Cowling inlets on many aircraft are excessively large. Reduce the inlet openings and you will obtain an increase in speed. Unfortunately, you may also obtain an increase in oil temperature. It is a delicate process and you should approach it with caution. Carve foam fillers to fit the inlets and attach them with strips of duct tape to reduce the openings temporarily.

If your oil temperature is still in the green, close off a bit more. Get the idea?

On my Falco I obtained a very noticeable airspeed increase along with an uncomfortably high oil temperature on my first try.

You may have to readjust the inlet openings two or three times before you hit on the ideal size openings for your airplane.

3. Seal It - Every gap on the airplane is a drag producer. The most

common offenders include cabin doors, canopies, oil inspection doors, fairings and cowls. These must seal tightly and should not suck open in high speed flight. You might have to get someone in a chase plane to check your airplane for improperly closed landing gear doors.

Control surface gaps are notorious drag producers. Sealing them, in addition to reducing drag, also enhances the effectiveness of the rudder, elevator and aileron controls.

Most everyone who has ever raced an airplane has spent much time taping over all gaps and openings with masking tape before a race. This preparation alone can result in a faster airplane.

If ordinary masking tape is offensive to your aesthetic senses you could use colored or transparent tape for sealing the gaps and openings.

The basic idea is to keep the inside air in, and the outside air out. But, most of all, you want to keep the air on the bottom of the wing from leaking up through the top surfaces.

4. Smooth It - The objective is to achieve and maintain a smooth flow of air from the nose of the airplane to the tail and beyond.

If your airplane is still under construction, don't miss the opportunity to get all external surfaces as smooth as possible. Fill all dents and imperfections before priming the aircraft.

After your airplane is completed, a little cosmetic smoothing is still possible but you may be reluctant to undertake it because the paint job will be affected.

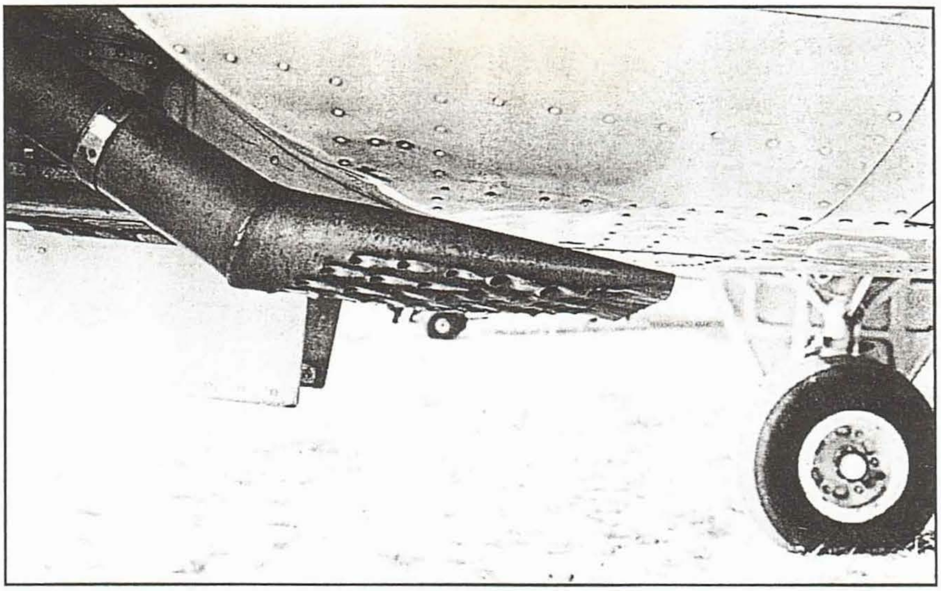
Wing walks as large and as coarse as they are will destroy the laminar flow in that area and produce turbulence and drag. This is because the surface texture of the wing walks is larger than the aircraft's boundary layer. The boundary layer next to the surface skin is extremely shallow . . . something on the order of 1/1000 of an inch for average lightplane speeds.

You can make your wing walks smaller or install them in narrow strips rather than as a single large carpet-like mat.

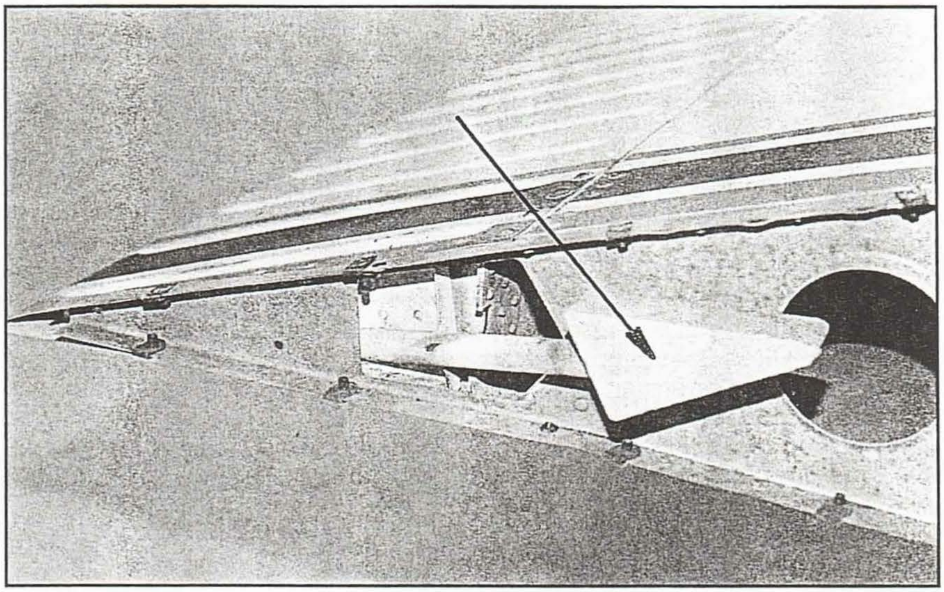
Other Drag Reduction Options

Installing smaller wheels or tires and closer fitting wheel pants could be considered. Remember, however, if you are operating from unpaved strips, smaller wheels may not be advisable as they would transfer higher taxiing and landing stresses to the structure.

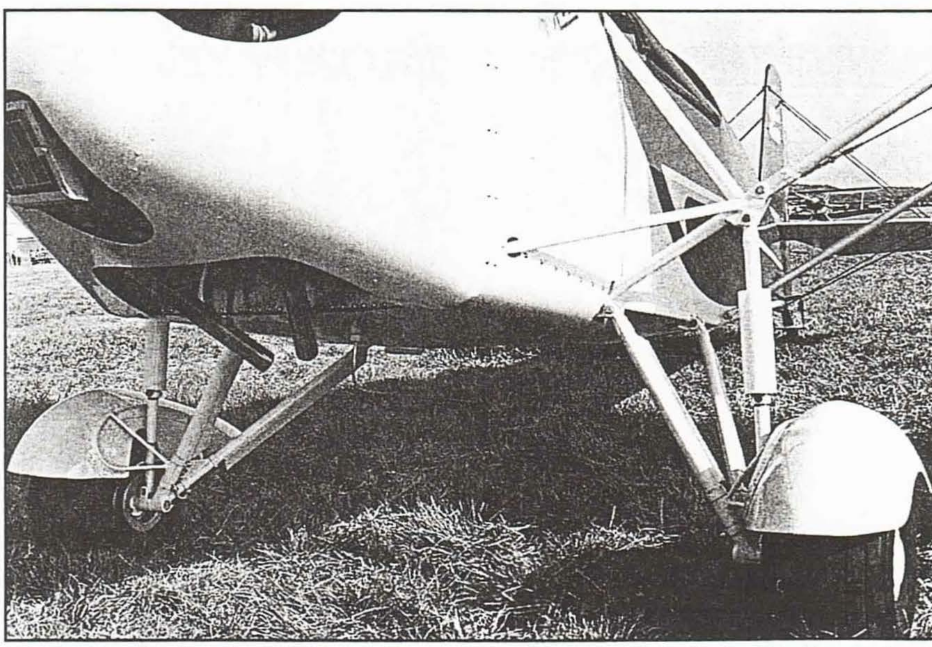
A poor job of rigging could saddle



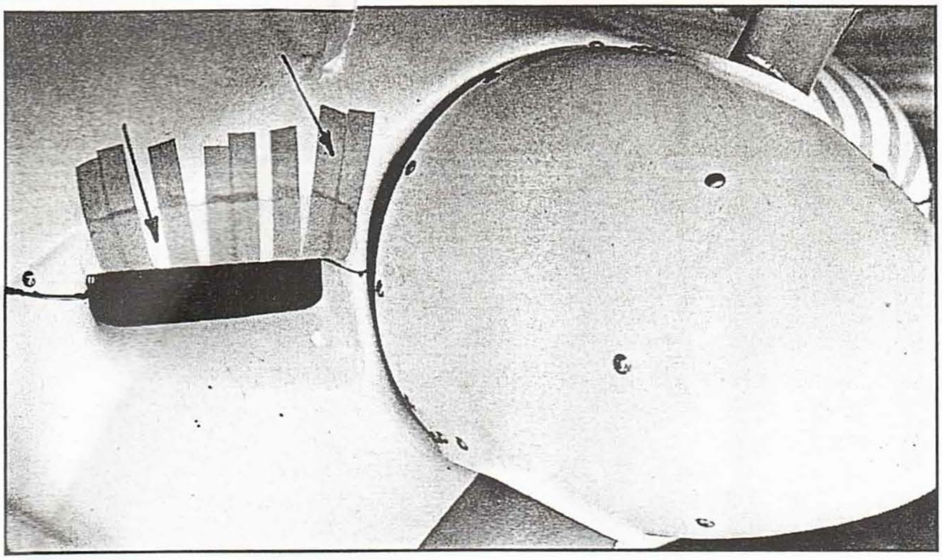
Can this be the optimum in low drag exhaust outlets?



Submerged aileron balance weights create no drag at all. The fiberglass wing tip has been removed to show one way aileron balance can be achieved.



The most effective drag reduction efforts are those implemented while the design is still on the drawing board - not those attempted after the airplane has been built.



Reducing the size of the air inlets can net a significant increase in airspeed. However, a corresponding increase in oil temperature might limit the degree to which this can be carried. Above the opening you can see the foam inset temporarily taped in place. After you determine the best size openings they can be molded permanently to the cowling.

you with unnecessary drag. For example, if the wing/tail incidence is incorrect, drag may be excessive for all flight regimes. Or if the flaps are not properly rigged, you may be flying with the flaps partially deployed all the time. For that matter, one side may even be set lower than the other.

A mismatch between the spinner and the cowling is a common drag producer. A spinner can be much too small or too large.

The propeller blade cut-out behind the prop hub should be sealed with a plate. Try to provide a clearance all around of about 1/8".

A large gap or space between the rear of the spinner and the face of the cowling could mess up the smooth flow of air and cause a turbulent entry into the air inlets. This, in turn, might also affect engine cooling.

A wing that is painted with spanwise stripes will produce drag because the slipstream may burble across the paint line ridge left after the masking tape was removed. Maybe you can minimize the protruding ridge by buffing it out. Be careful though, because you might mess up the paint line.

At any rate, remember that the smooth flow of air over the first top third of the wing is the most critical drag-wise.

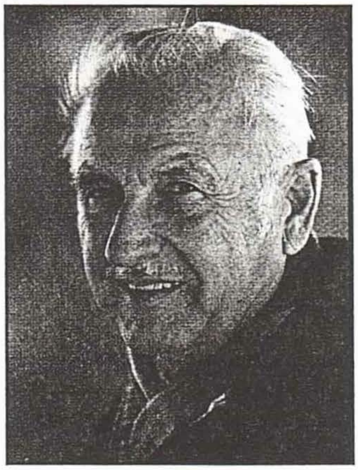
Afterthoughts

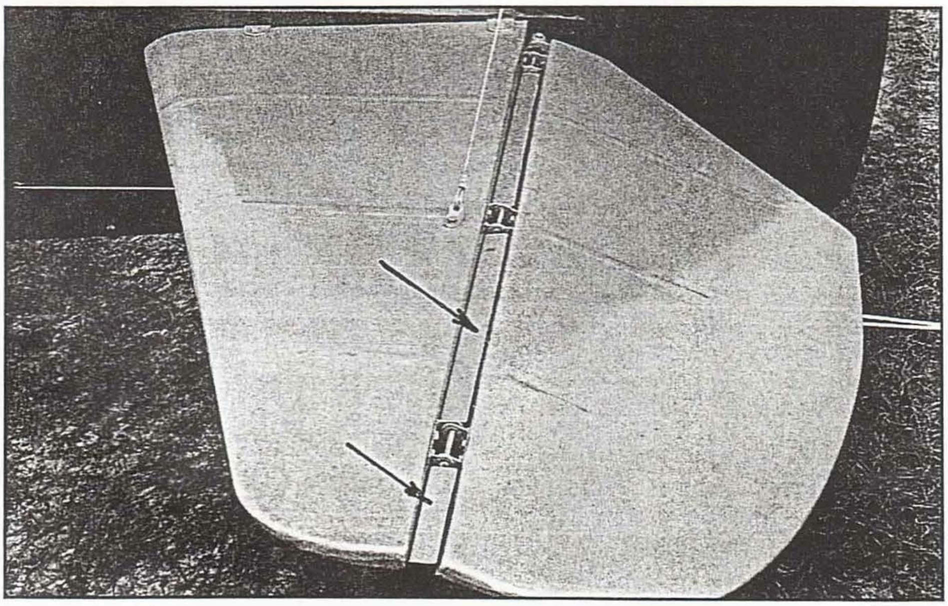
Some of you can undertake this business of drag reduction as a casual matter and be happy with whatever increase in indicated airspeed shows up on your airspeed indicator.

Others of you with a scientific bend will not be content until each and every drag reduction change you make has been calibrated, flight tested and duly documented. Lotsa luck, amigo, this may be difficult to do because the smaller changes will yield almost unmeasurable results. However, I'm sure that won't deter the true experimenters among you.

Back in 1977 an all out drag reduction effort on a 150 hp Mustang II reportedly paid off with a top speed increase from an original 170 mph to 229.66 mph at 11,000'. This speed was clocked during one of the Pazmany contests conducted at Oshkosh.

Can you top such an astounding increase over the original top speed?





Sealing control surface gaps along the hinge line improves the effectiveness of the controls and helps reduce drag.

If you wish to contact the author of this column for additional information, please send a SASE to Tony Bingelis, 8509 Greenflint Ln., Austin, TX 78759.