some "clean" fashion.**

(b) All vehicles on land, sea or air are vulnerable to collision, and no designer is excused if he dismisses the situation. He is especially at fault if a collision condition is due to inadequate visibility from the aircraft he created. There should not be any unduly flimsy structural features that would be critical in some light collision situations.

(c) Safeguards against flutter at normal and even above normal speeds are important. The strength, spacing, rigidity of mounting and alignment of hinges of all controls are especially critical to prevent flutter conditions. Aero elasticity (flutter) is affected hy true airspeeds as well as indicated airspeeds; therefore, at 40,000 feet 80 MPH indicated also has an inherent 160 flutter-inducing MPH while one is exposed to shock-inducing high altitude turbulence.

Note that even a slight deterioration of structural stiffness will markedly reduce "Critical Flutter Speed," especially if the controls are not statically balanced.

Let us assume that a cut-down door, aileron balance weights, elevator balance weights and a slightly huskier tail boom will increase a sailplane's weight by 20 pounds. If the wing area is, say, 125 feet^2 and wing loading, without these additions, is 5 pounds/ft.^{2} then we can compute that (in level flight) a 2 ft./sec. sinking speed will increase by 2%. This means that in a weak thermal one will climb about 97 feet in one minute instead of 100 feet. No thermal is so steady, no pilot so precise that this would make any significant difference, for it amounts to about 180 feet in an hour! This does not mean that one should let a lot of items continue to increase the weight of a sailplane, but those items necessary to its integrity and to the lives of the flyers in it should not be omitted—certainly never to make up for a weight indiscretion elsewhere.

(d) Control brackets and the structures to which they are mounted must be plenty strong. Pulleys should be adequately large, well guarded, sturdily mounted and located or protected to prevent jamming by clothing, straps, dirt, mud, ice, sticks, grass seed, etc. Pull-off angles (out of plane cables) should not be excessive. The effects of low temperature on aircraft are important,*** for steel cables shrink much more than wood does when it gets cold. On the other hand, aluminum shrinks more than steel does.

(e) When wings pull off in flight they can first swing forward. Before putting the pilot's head snugly into such potential pincers the designer should think of this result of excessive high angle of attack loads. Of course, the wings can swing forward in a crash condition, but then so does the head.

As a result of a crash, the wings should not shear off the fuselage and pursue the pilot.

(f) For very little more effort, breakage due to catching a wing tip can be confined to the wing outer structure, the fuselage in the best cases left mostly whole; damage is reduced by the kinetic energy absorbed by the break. This also reduces the kinetic energy absorbed by the pilot.

**(Removable pod—see SCSA Pressure Cabin Strato Sailplane Design; and refer to Larry Edgar's experience in N63195.)

***("Prepare for High Altitude Flying" by the author, *Soaring*, Vol. 24. No. 1, January, 1960).

SAILPLANE ANGLES

Not only does one want optimum flying characteristics, but good take-off, landing, ground handling and tie-down situations. The shape and arrangements of the parts of the glider should be chosen to arrive at the best compromise for these and other (i.e. visibility, entry, exit. structural and aesthetic) qualities. These are affected by certain basic angeles: first is the angle of incidence of the wing, which should bear a relationship to the line of minimum drag of the fuselage. To ascertain fuselage minimum drag (which should not and usually does not vary too abruptly with change of attitude) these features should be studied by a competent aerodynamicst: nose shape, skid, wingroot junction, tail cone and tail surface arrangement, considering the effects of upwash and downwash. If determined within one or two degrees, the results will usually be as good as one can desire. In general, the faster sailplanes could have less incidence ("Texas Bombs"), the slow, low-sink rate craft might tend to higher angles to minimize drag for the preferred mode of flight, depending somewhat on aspect ratio and ground handling characteristics. For the three view drawing and for rigging purposes the angle of incidence is measured with respect to a horiontal reference line.

Ground angles involve these conditions: take-off and landing attitudes especially in rough and gusty conditions and walking, parking and handling the glider when assembling and disassembling it.

When the nose skid is on the ground, brake on (for wheel at or aft of CG), the wing should be at a very low or even negative lift angle with respect to the wind. With the tail down in take-off or tie-down attitude the angle of attack should neither be so low that it is difficult to take off, nor so high that it is vulnerable to every breeze that passes the parked plane. A starting attitude might be that for 60% of C_{Lmax}. This may be influenced by visibility or other considerations.

If the nose skid is normally on the ground with crew on board, the rotation of the sailplane around the wheel should not be execessive when the crew gets out. Also, if the wheel is just at or slightly forward of the c.g. with crew on board the tail may come down—hard—after the ship