Improvement of Self-Connecting Joints on Sailplane Controls

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Although the structures of the new fiberglass sailplanes are considerably stronger and much less susceptible to major or minor damage than their wood and metal precursors, there still exist certain areas of potential danger in even the newest designs. Component flutter is one of the more dangerous phenomena, and the one with which these remarks are concerned. This problem stems from several factors, some of which are the lower relative stiffness of the glass composite structures; the trend toward higher aspect ratios; the higher cruising and maximum allowed airspeeds; and the addition of more appendages, such as flaps, etc.
The occurrence of this unpleasant phenomenon is fortunately not common in new sailplanes when the limitations of the design are observed, in particular with respect to airspeed in rough air. Flutter can, however, occur in both old and new sailplanes, at much lower airspeeds if the control surface linkages, joints and bearings permit excessive play whether due to looseness, improper assembly, old age, too much wear, or design deficiencies.
Several of the newer sailplane designs employ a type of self-connecting joints which, although they are a great convenience during rigging, by their design are also susceptible to excess wear, hence control surface play, because of high contact forces on small contact areas. It therefore appears worthwhile to make a small modification to this type of joint before either wear or permanent deformation occur, thus ensuring a tight, durable connection between the control levers and the respective control surfaces.
On the Glasflügel BS-1 and other sailplanes of this type, the airbrakes and flaps are controlled by torque shafts. These control connections are self-joining during assembly via a fork and pinned ball arrangement as shown in figures 1 and 2. The potential wear problem originates in the very small contact area of the pin on the equally small contact area in the fork when high control forces are required, for instance during opening or closing airbrakes at very high airspeeds. The possibility of play developing in these joints due to wear or spreading of the fork branches due to high torque loads can be reduced by sleeving the forked ends of the torque shafts in the manner shown in figure 3, showing a sleeve installation on a BS-1.
The sleeves were each made in two pieces, as shown in figure 4. The inner sleeve was machined to a fine match with the pin grooves in the fork, thus providing a larger contact area. Furthermore the wall thickness exceeds the pin protrusion by about 1 mm to provide clearance at assembly. The outer sleeve can therefore be placed

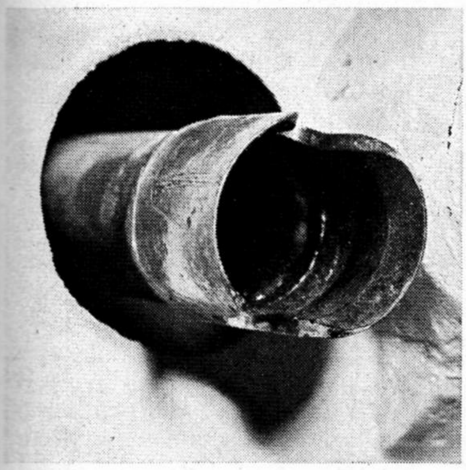

Fig. 1. Standard joint as installed on BS-1 No. 12 fuselage – female fitting.

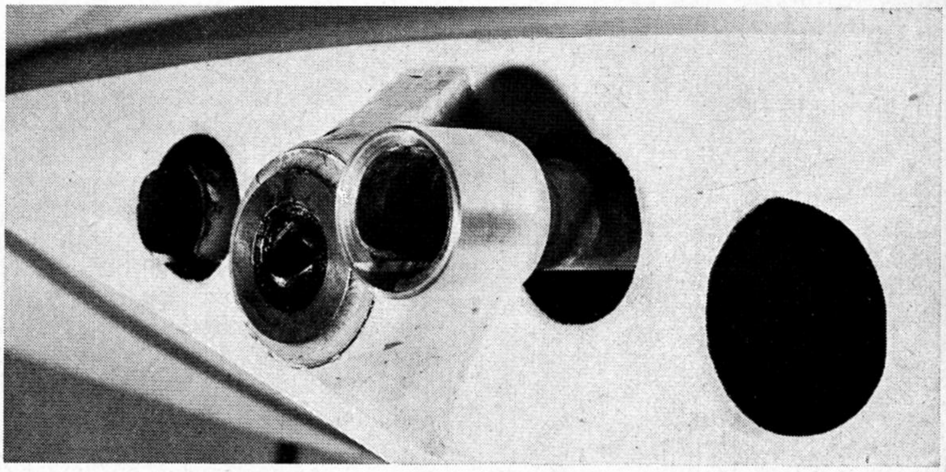

Fig. 3. Sleeved joint after modification on BS-1 No. 12.

Fig. 2. Standard joint as installed on BS-1 No. 12 fuselage – male fitting.

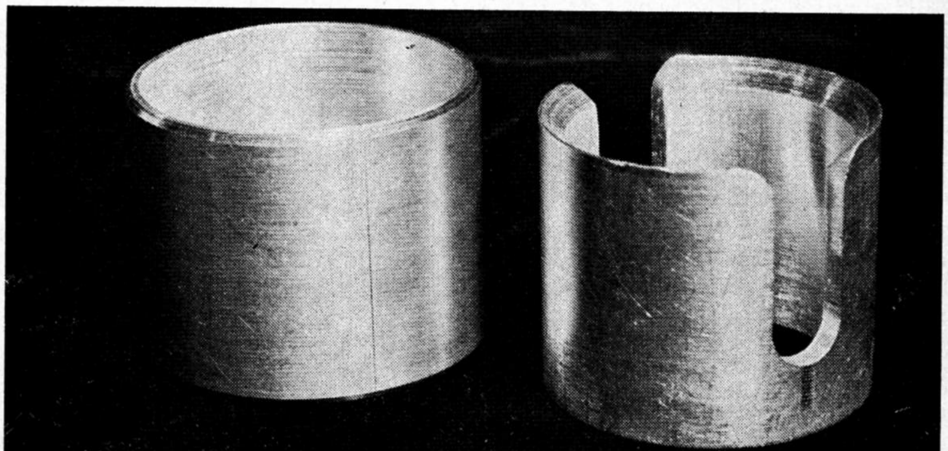

Fig. 4. Details of inner and outer sleeves.

over the full length of the fork without interfering in any way with assembly while at the same time insuring the dimensional stability of the joint by preventing expansion of the fork branches.
Different attachment methods were tried and the simplest way was found to be; machining of the inner ring to a tight press fit over the forked end, pressing both sleeves on together and welding a light bead around the rear sleeve edges as shown in figure 5.

ATTACHMENT OF INNER AND OUTER SLEEVES TO FORKED END

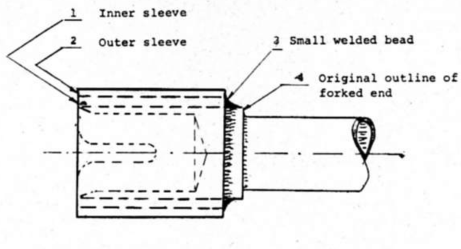

Fig. 5. Attachment of sleeves to forked end.

The materials for the sleeves should be compatible with the steel in the torque arms. The German specifications call for their type 25 Cr Mo 4 steel:

Ultimate tensile strength
9,800 km/cm² 114,000 lb/in²
Tensile yield strength
5,500 kg/cm² 78,400 lb/in²
Shear strength
5,400 kg/cm² 77,000 lb/in²