Rudder Differential Revisited

Our February 1992 column (also in "On the'Wing... the book") explored some of the details involved in Gregory Vasgerdsian's building of a scale model of the Storch IV, a swept wing tailless design of the late 1920s which has rudders mounted at the end of each wing tip. Ideally, the inboard rudder should move outward during a turn, while the outboard rudder remains in its neutral position. One of the problems Greg encountered during the pre-building stage was finding a simple but effective method of achieving this maximum rudder differential without relying on a computer radio.

Figure 1 shows the simple cable mechanism we described in that February 1992 column. A small spring or rubber band forces the rudder against a stop at the neutral position. The cable then pulls against the spring and moves the rudder outward, but slips when it pushes. Rudder movement is thus in one direction only. There is an inherent conflict in this set-up: the spring or rubber band must be strong enough to hold the rudder firmly against the stop, while the servo must be strong enough to overcome both this force and the air loads imposed on the deflected rudder.

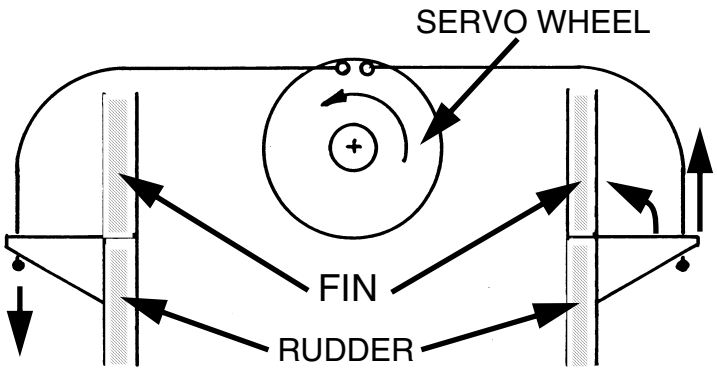

Figure 1

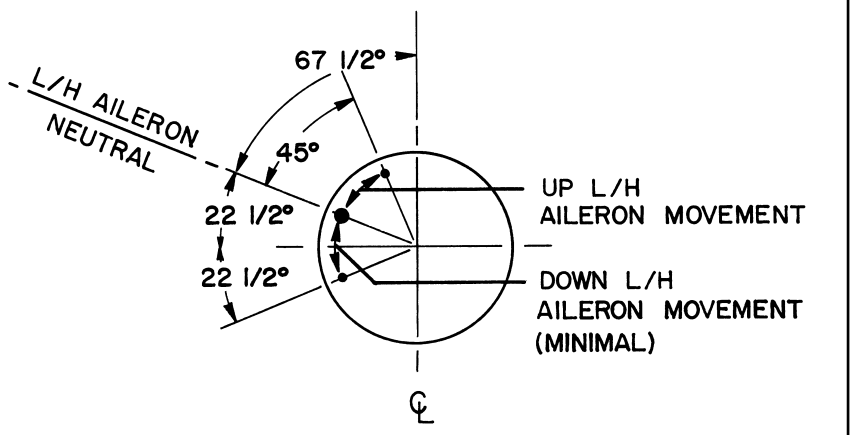

Figure 2

A rigid mechanism which overcomes these failings was submitted by our Minnesota friend Bill Kubiak. This system, presented in the September 1992 issue of *RCSD*, uses stiff pushrods and relies on servo wheel geometry to achieve differential action. This set-up is shown in Figure 2. When properly built, the mechanism allows no extraneous rudder movement, as the rudder is locked in the neutral position by the servo wheel. This rigidity makes the system less likely to flutter.

Bill Foshag, of Carlisle Pennsylvania, recently sent a packet of information to us which included a means of achieving maximum rudder differential by means of a "walking beam." The walking beam mechanism itself, shown in Figure 3, appears to be easily constructed and quite robust. (In the accompanying letter, Bill relates its successful use in a centrifugal field!) It has the additional advantage of being able to be placed remote from the single servo needed to drive it. The walking beam's role in providing 100% - 0% differential to outboard rudders is covered by a U.S. Patent given to Bill and Gabriel D. Boehler in 1966. That Patent (3,2662,656) is now in the public domain.

The walking beam mechanism consists of three interconnected beams. Beams A and B are connected by a movable joint, as are beams B and C. The beam ends A' and C' are mounted to the mixer frame, and the servo pushrod is connected to the center of beam B. The movement of joint A-B is limited by pin E, and that of joint B-C by pin F. As the servo pulls beam B, the joint A-B is held in place by pin E, and the joint B-C moves in the same direction as that of the servo pushrod. When beam B is pushed by the servo, the joint A-B moves away from pin E and the joint B-C is restrained by pin F.

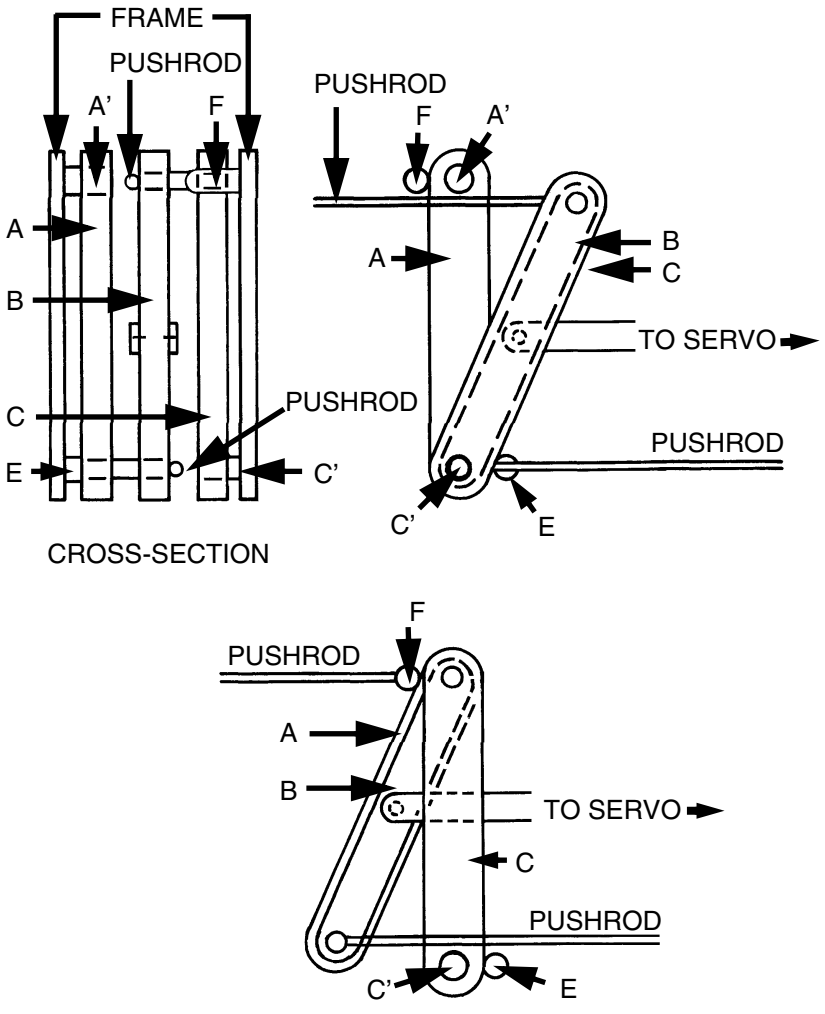

Figure 3

It should be noted the geometry of this walking beam magnifies the movement of the servo pushrod - a lever effect which places a proportionally larger load on the servo - so care should be exercised in the choice of the servo used. By adjusting the placement of pins E and F and the control surface pushrods, it should be possible to create a situation where the control surface is locked in the neutral position by a “toggle-over-center” action.

Make a mock-up of a walking beam mechanism from popsicle sticks. This will familiarize you with all the intricacies of operation with very little cost. You will find, once a mock-up is made, that it is extremely important to line

up the holes with the center of each arm. Lastly, sweep may affect the overall geometry of the walking beam. This may not be a problem if the walking beam pulls cables, but will be a critical issue if pushrods are used.

The walking beam shown in Figure 3 is a generic device, and this drawing should be used as a guide only. Materials and specific methods of construction are left to the builder. Plywood, plastic, or metal could be used. In fact, a small device consisting of three modified nylon bellcranks is an attractive alternative. No matter the construction method or materials used, a substantial load test needs to be successfully completed before the device is installed in an aircraft.

As mixers of various types are always of interest to *RCSD* readers, we invite individuals building a walking beam mechanism to provide construction details.