A MEANS OF ACHIEVING MAXIMUM DIFFERENTIAL WITH A RIGID CONTROL SYSTEM

Some swept wing tailless designs require two rudders, one on each wing tip. The idea is to have the rudder on the inside of the turn deflect outward while the opposite rudder remains motionless. A challenge is presented, however, when the rudders are connected to the same servo wheel.

In a previous column, "Some Notes on the Construction of a Storch IV," we described a system analogous to a commonly used method of deploying spoilers for accomplishing this function. Bill Kubiak, our Minnesota friend, described an alternative linkage in a recent letter to us. As Bill's suggestion is explained in terms of aileron differential, as for a conventional aircraft, we thought we'd pass on the text of the letter to RCSD readers.

"I've been reading your February 1992 column ('Construction notes for the Storch IV') and I think I have to disagree with your Figure 2. I don't like the idea of the loose string through the control horn.

"I think the loose string will allow the rudders to flap (or flutter). I think that all control surfaces should be controlled with rigid linkages. I think that a simple modification of the linkage used for 2:1 differential aileron movement would work OK.

"Figure 1 shows the usual setup for equal aileron deflection. Both push rods come off a common point on the servo wheel.

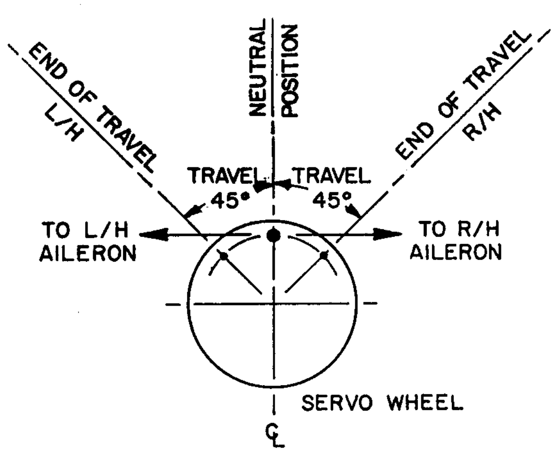

FIGURE 1

"For a 2:1 differential movement the servo wheel has two pivot points, one for each aileron, as shown in Figure 2. Each is located 39^{o} off the common center.

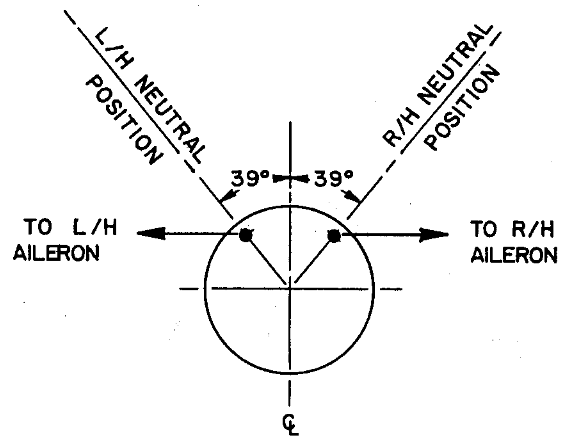

FIGURE 2

"When the servo wheel turns counterclockwise the down left hand aileron movement is equal to

$$\sin 84^{o} - \sin 39^{o} = .3652$$

"For clockwise motion the up L/H aileron movement is equal to

$$\sin 39^{o} + \sin 6^{o} = .7338$$

as shown in Figure 3.

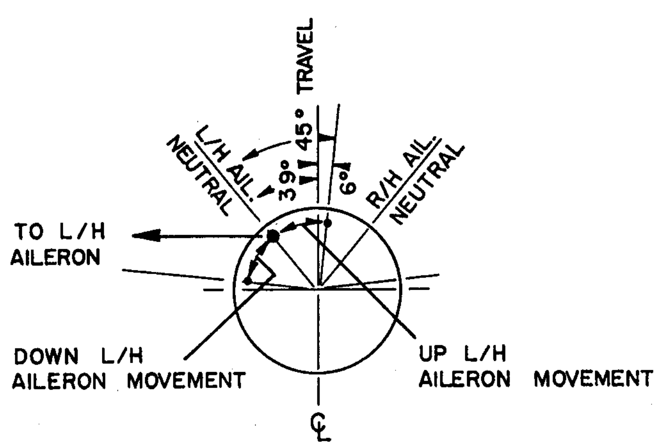

FIGURE 3

"So the ratio between up aileron movement and down aileron movement is

$$\frac{.7338}{.3652} = 2.0094$$

or 2:1.

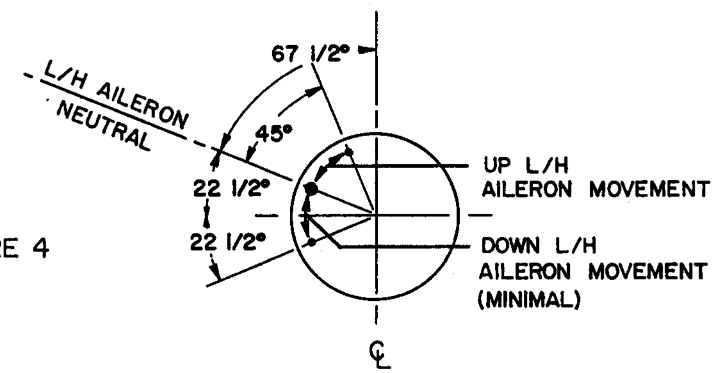

FIGURE 4

"If this method is carried to an extreme the pivot point for the L/H aileron would be moved around to 67.5^{o} off the servo center line (see Figure 4.). When the servo wheel is turned counterclockwise the down L/H aileron movement is equal to

$$\sin 90^{o} - \sin 67.5^{o} = .0761$$

"When the servo wheel is turned clockwise the up L/H aileron movement is equal to

$$\sin 67.5^{o} - \sin 22.5^{o} = .5412$$

"And

$$\frac{.5412}{.0761} = 7.11$$

"This is the maximum aileron differential obtainable through servo wheel geometry alone.

"The down going aileron would not remain motionless while the other aileron moved up. The down going aileron would wave back and forth a little but this would be acceptable to me because the linkage would be rigid.

"Only the position of the left hand aileron linkage pivot is shown in Figures 3 and 4. The right hand aileron pivot position is symmetrically opposite to the left hand, just as for the two pivot points in the 2:1 linkage shown in Figure 2."

As stated at the beginning, the mechanics of aileron differential as described here translate equally to rudder differential as used in our applications. Bill's information is therefore helpful to designers/builders of conventional tailed aircraft, as well as to enthusiasts of tailless configurations.

Thanks, Bill!