aspect ratio 14 and 22.9 wings, vanishes at the higher twist angles.

Figure 8 shows the increment of total drag (induced plus profile drags) that is caused by the twist in each of the wings studied. Except for some variation caused by the low drag "bucket" type drag polars used on the aspect ratio 14 and 22.9 wings, the increment of drag due to twist is almost identical to the increment of induced drag caused by the twist. Similar results would be found for the swept wings also. A plot of the induced drag due to twist versus wing twist angle is shown in Figure 9. This figure shows that the drag added by twisting the wing is very small for twist angles of less than 4 degrees. A small speck of dirt or insect on the wing leading edge could cause as much drag as 3 degrees of twist.

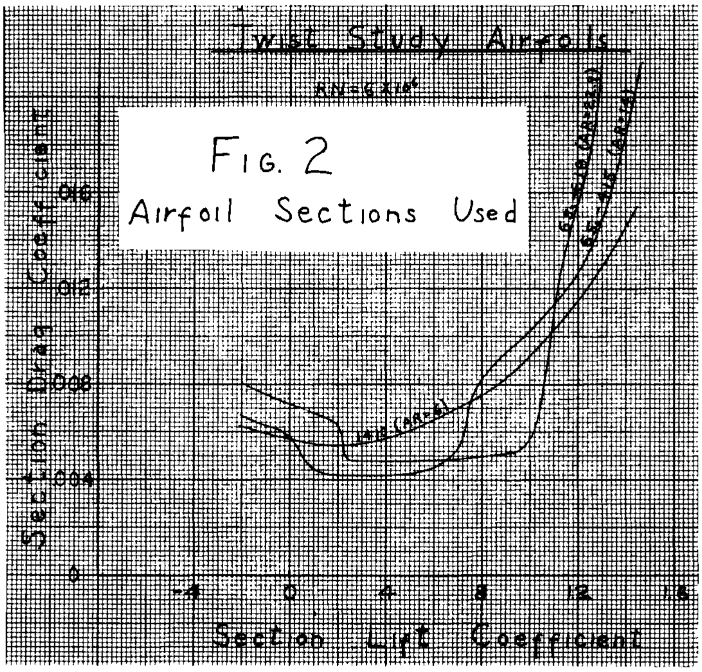

FIG. 2

Airfoil Sections Used

Quite naturally a designer does not wish to increase the drag of his sailplane even by small amounts unless there is something to be gained. That which can be gained by the sacrifice of this drag are the satisfactory stalling characteristics obtained by twisting the wing (washout) or sweeping it forward. Let me emphasize that satisfactory stalling characteristics are quite essential even for the highest performance sailplanes and if they are not provided a considerable penalty will result in the sailplane's performance while thermal or cloud flying.

Now that we have found how much drag is caused by wing twist and sweep forward, it is time to determine just how much twist or sweep is necessary for satisfactory stalling characteristics. For this part of the study the span lift distributions are shown in Figure 10 for the aspect ratio 14 wing for the twist and sweep angles shown in Figures 3 and 6. These span lift distributions show the section lift coefficients which our aspect ratio 14 wing would have while flying near their stalling speeds.

When a wing begins to stall, it does so first at the portion of the wing at which the lifting ability of the wing section is first exceeded. If a wing uses the same airfoil section along its entire span, such as has been used in this study, then its lifting ability is affected only by Reynold's number. In general the lower Reynold's numbers, associated with the shorter chords toward the tip of a tapered wing, provides less lifting ability toward the tip. Reference (2) shows that for our 65_2-415 airfoil, used with the aspect ratio 14 wings in this study, the maximum lift coefficient available at a Reynold's number of 6 million is 1.61 while at 3 million it is only 1.48. Since the taper ratio used on our

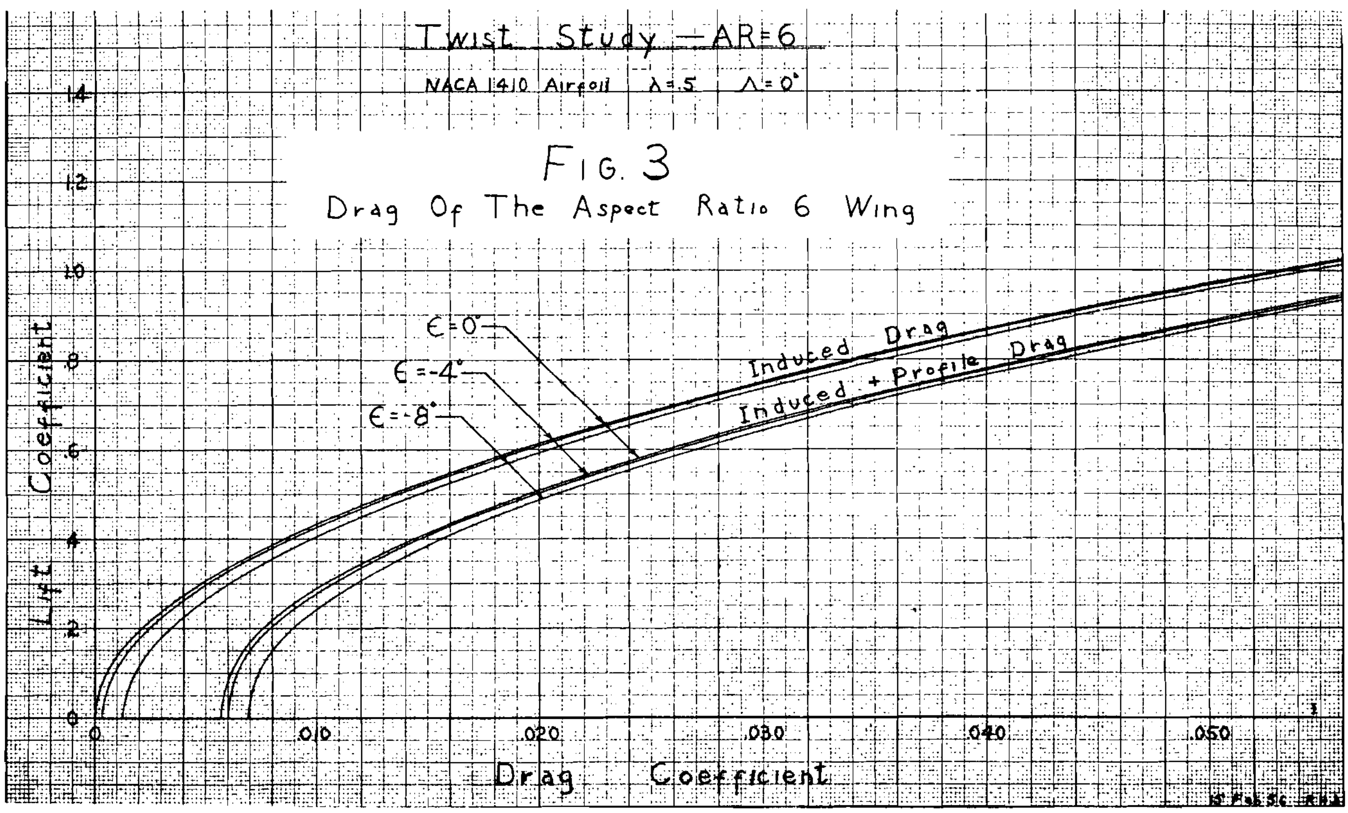

FIG. 3

Drag Of The Aspect Ratio 6 Wing