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A FLIGHT INVESTIGATION OF INTERNALLY BALANCED SEALED AILERONS IN THE PRESENCE OF A BALANCED SPLIT FLAP

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SUMMARY

Flight tests were made with a modified Ryan ST airplane to determine the effect on aileron characteristics of various arrangements of balanced split flaps covering that portion of the wing span occupied by the ailerons. NACA recording instruments were used to determine aileron effectiveness.

With the flaps fully extended, the aileron effectiveness was reduced by approximately 18 percent of the effectiveness measured with ailerons alone. For the partly retracted positions of the flap, the corresponding reduction was of the order of 60 percent.

INTRODUCTION

Results are presented herein for part of an extensive investigation conducted by the NACA to develop a satisfactory lateral control device for use with full-span flaps. In the full-span flap arrangement, with which this paper is concerned, balanced split flaps are located over that portion of the wing span covered by the ailerons, the inboard portion of the span presumably being fitted with slotted or Fowler type flaps. The investigation consisted of flight tests in which the full-span-flap lateral control arrangement was simulated by locating a flap of the balanced split type under that portion of the wing span covered by the ailerons. The tests were confined to measurements of the effectiveness of the lateral controls.

These flight tests were conducted by the NACA at Langley Field, Va.

SYMBOLS

p	rolling velocity, radians per second
V	true airspeed, feet per second
V_i	indicated airspeed, miles per hour
b	wing span, feet
c_w	wing chord
δ_f	flap deflection

APPARATUS

The Ryan ST airplane with internally sealed and balanced ailerons is described in reference 1. For the present investigation, balanced split flaps were mounted on fixed brackets over the outboard portion of the span, as shown in figures 1 and 2. The flaps covered 38 percent of the wing span and had a chord of 20 percent of the wing chord.

The airplane was tested with several arrangements of flap deflection, fore-and-aft positions, and of the gap between the flap and the lower surface of the wing. These arrangements are illustrated in figures 3 to 6. Standard NACA recording instruments were used to measure airspeed, control position, control force, and rolling velocity.

TESTS AND RESULTS

The flight-test procedure to determine aileron effectiveness was the same as the procedure described in reference 1. Runs were made at approximately 57 and 85 miles per hour. The corresponding values of airplane lift coefficient were approximately 1.4 and 0.56, respectively. The detailed results of the flight tests are presented in figures 7 to 11 in which the aileron effectiveness factor $pb/2V$ is plotted as a function of the change in total aileron angle. A summary of the results is presented in the following table:

Flap arrangement	Aileron effectiveness (maximum $\frac{pb}{2V}$)		Aileron effectiveness (percent of effectiveness with ailerons alone)
	Right roll	Left roll	
Ailerons alone	0.061	0.078	100
Flap deflection, 40°; gap, 0.02c_w; leading edge under aileron hinge line	.051	.063	82
Flap deflection, 40°; gap, 0.04c_w; leading edge under hinge line	.05	.064	82
Flap deflection, 14°; gap, 0.02c_w; leading edge 0.0325c_w ahead of hinge line	[a].022	[a].0295	37
Flap deflection, 8°; gap, 0.01c_w sealed; leading edge 0.07c_w ahead of hinge line	[a].0263	[a].0323	42

[a]Average value

The low aileron effectiveness obtained with the partly deflected flaps confirms unpublished wind-tunnel data for a similar arrangement and additional wind-tunnel tests are now under way in an attempt to determine a more favorable flap operating path. It is possible, however, that this low aileron effectiveness at partial flap deflections is not, in reality, a serious drawback, because a two-position flap arrangement may be used in which the flap passes quickly through the region of low aileron effectiveness. The balanced split flap is intended for use in the duplex arrangement wherein a

Fowler or a slotted flap is used over the inboard portions of the wing; therefore, partial flap deflections might very well be confined to movement of these inboard portions.

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REFERENCE

1. Williams, W. C., and Kleckner, H. F.: A Flight Investigation of Internally Balanced Sealed Ailerons. NACA A.R.R., Dec. 1941.

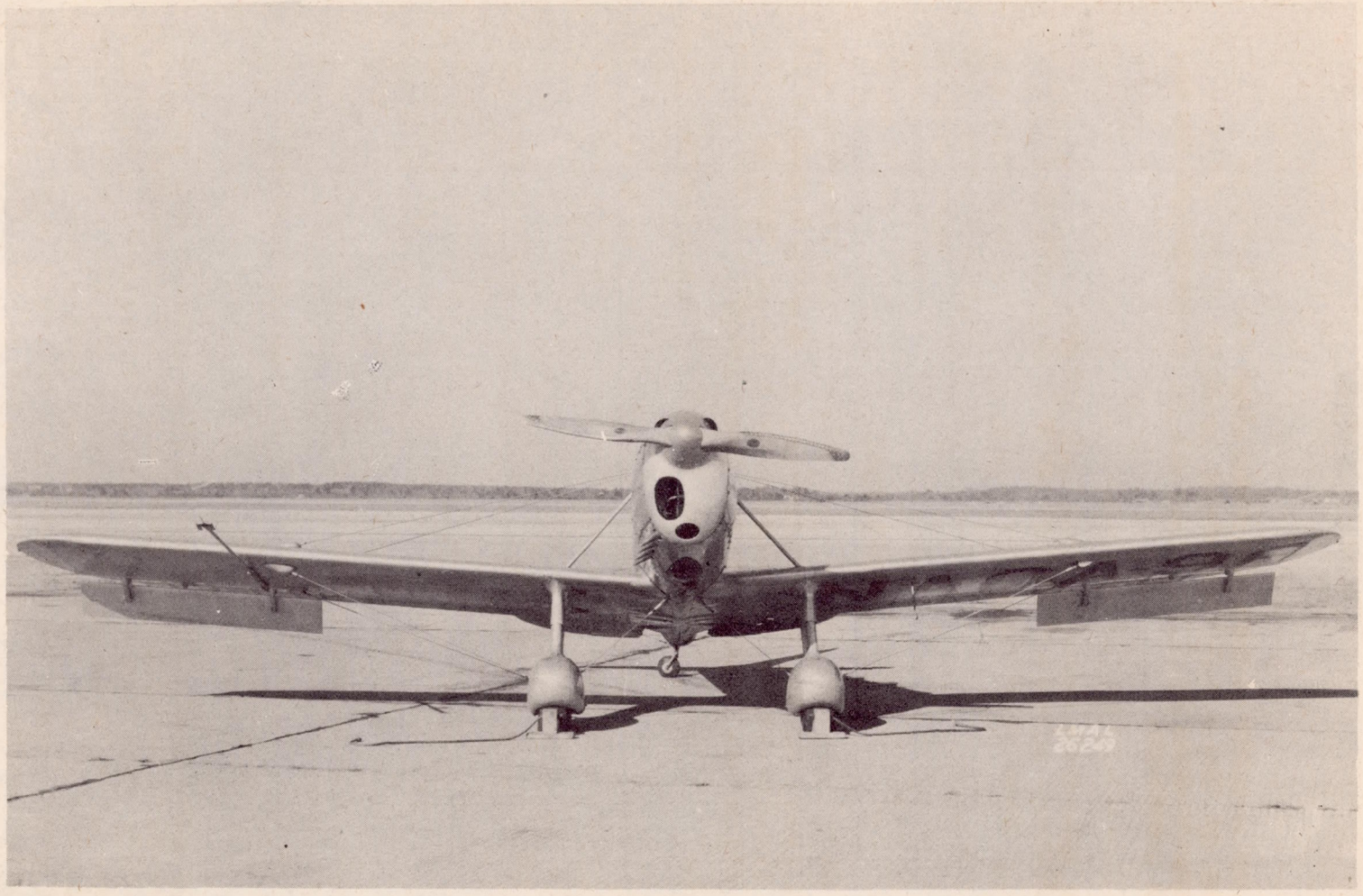

Figure 1.- Front view of Ryan ST airplane equipped with balanced split flaps under ailerons.

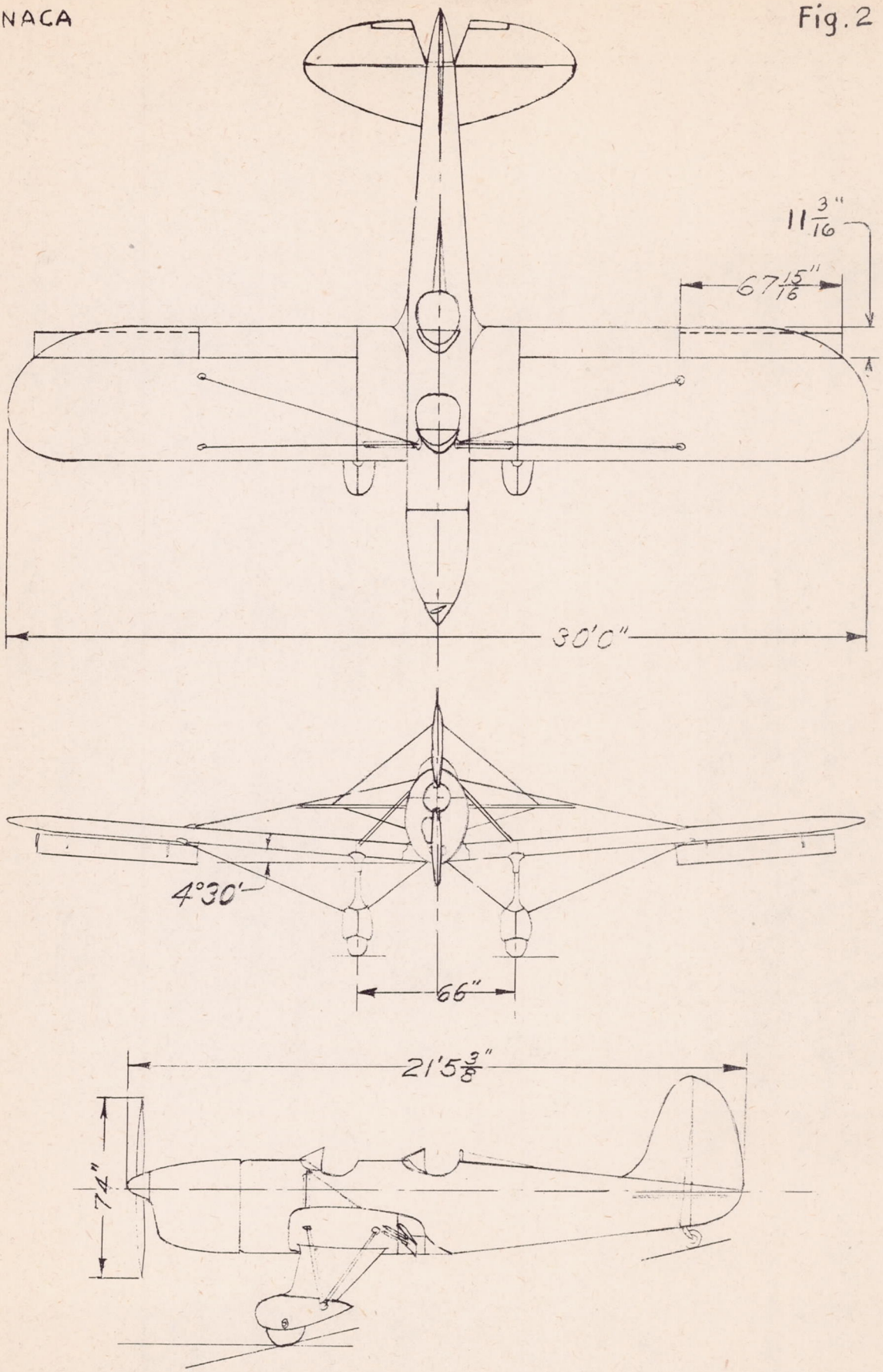

Figure 2. - Three-view drawing of the Ryan ST airplane with fixed balanced split flap.

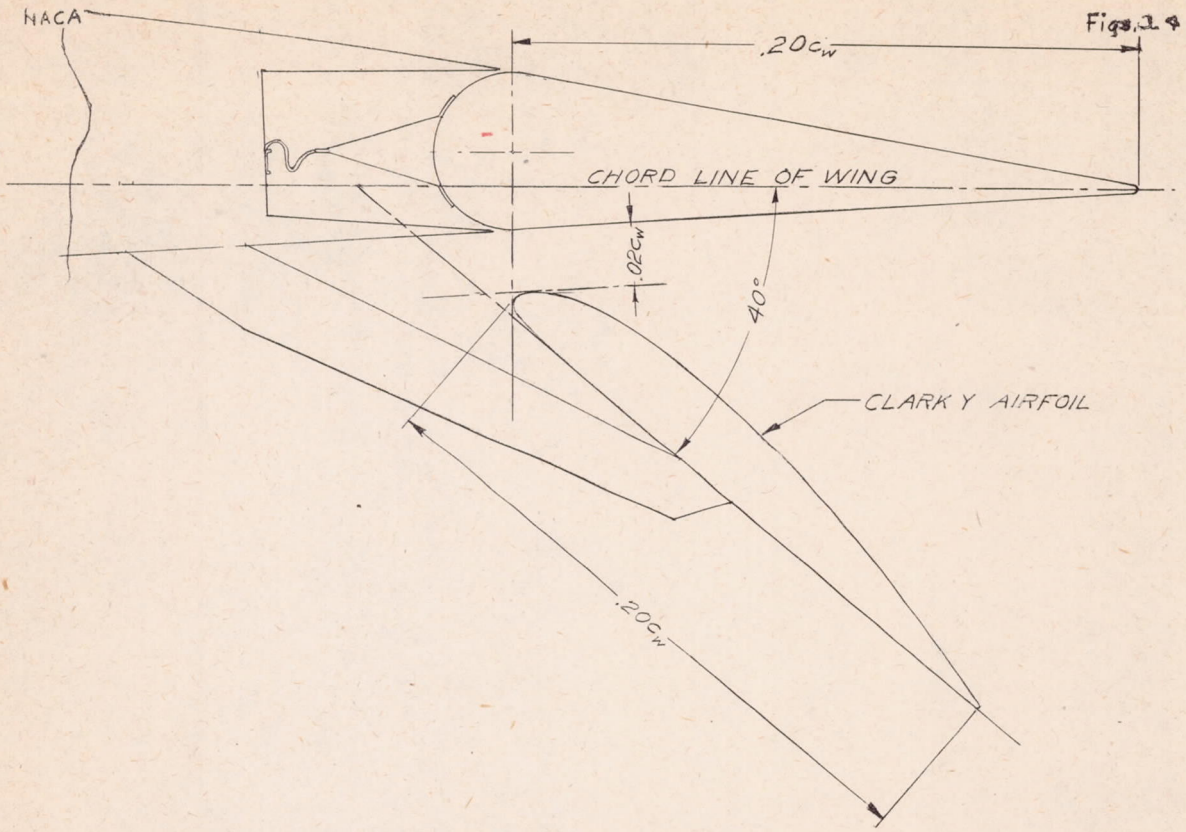

Figure 3. - Sketch of internally balanced aileron and balanced-split-flap arrangement as used on Ryan ST airplane; fully extended position with 2-percent gap.

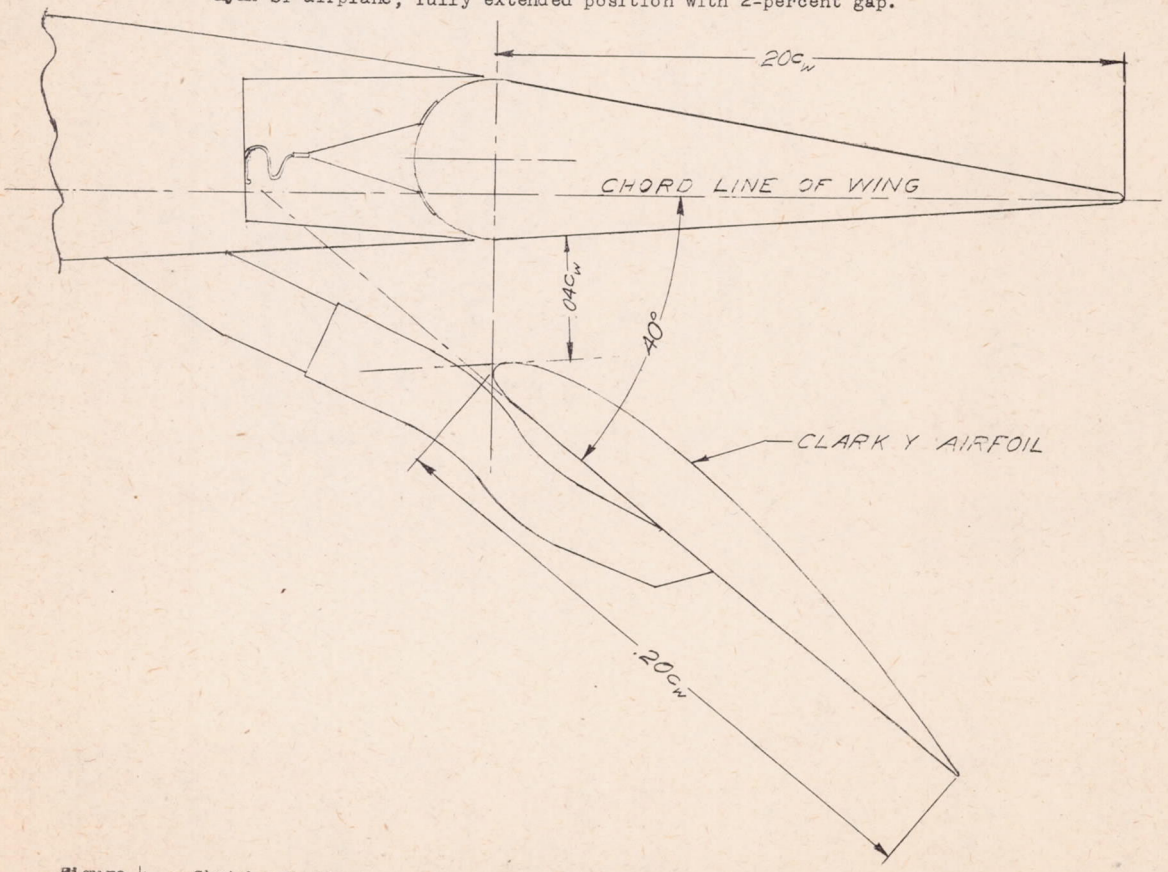

Figure 4. - Sketch of aileron and balanced-split-flap arrangement as used on Ryan ST airplane; fully extended position with 4-percent gap.

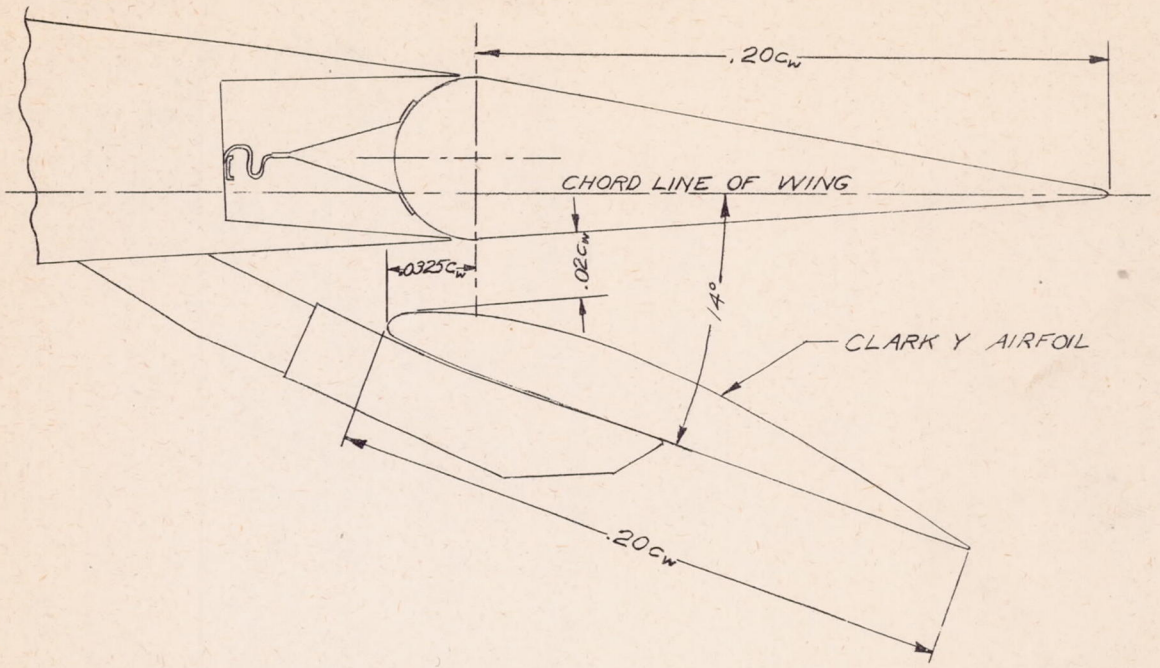

Figure 5. - Sketch of aileron and balanced-split-flap arrangement as used on Ryan ST airplane; partly retracted position with 2-percent gap.

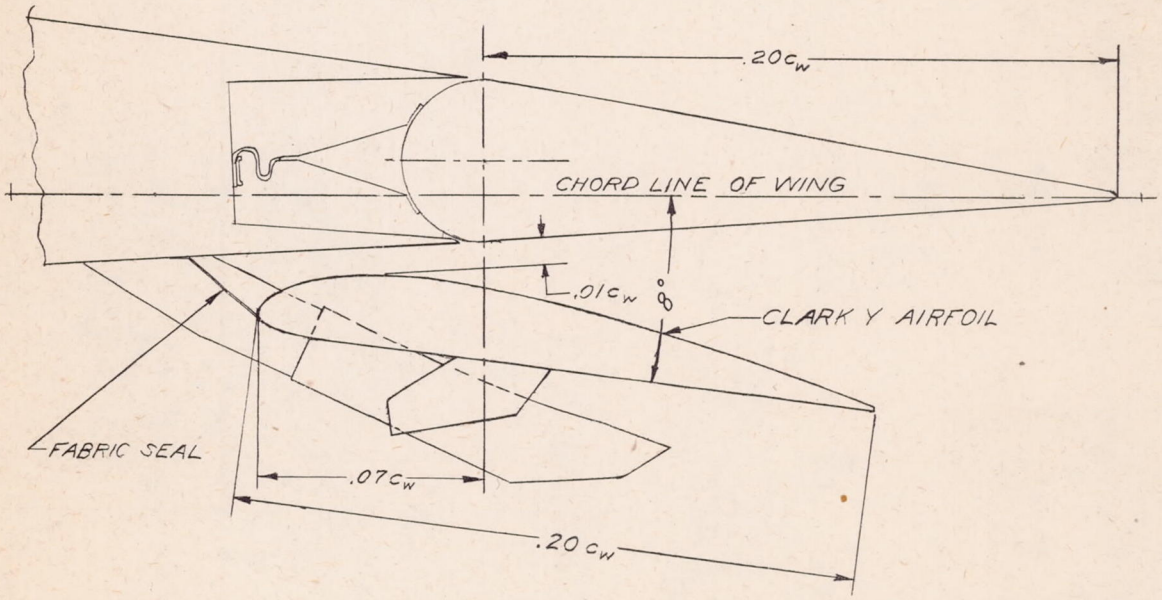

Figure 6. - Sketch of aileron and balanced split flap as used on Ryan ST airplane; partly retracted position with sealed gap.

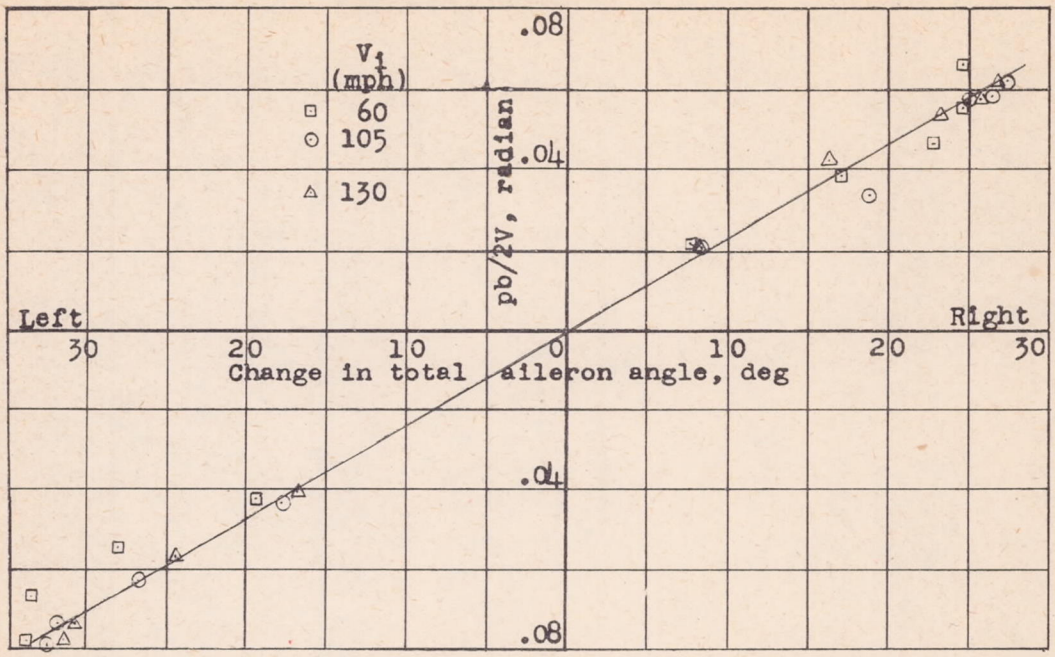

Figure 7.- Variation of helix angle pb/2V with change in aileron deflection. Ryan ST airplane with internally balanced ailerons alone.

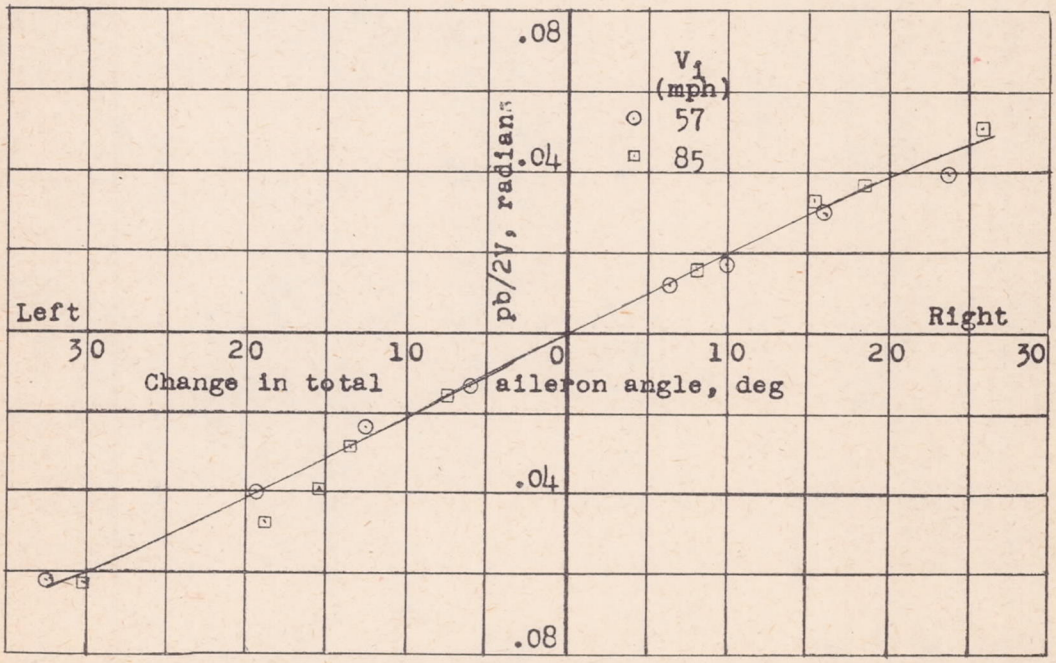

Figure 8.- Variation of helix angle pb/2V with change in total aileron angle. Ryan ST airplane with internally balanced ailerons in the presence of the $0.20c_w$ balanced split flap. $\delta_f = 40^\circ$; gap = $0.02c_w$; leading edge of flap directly under aileron hinge line.

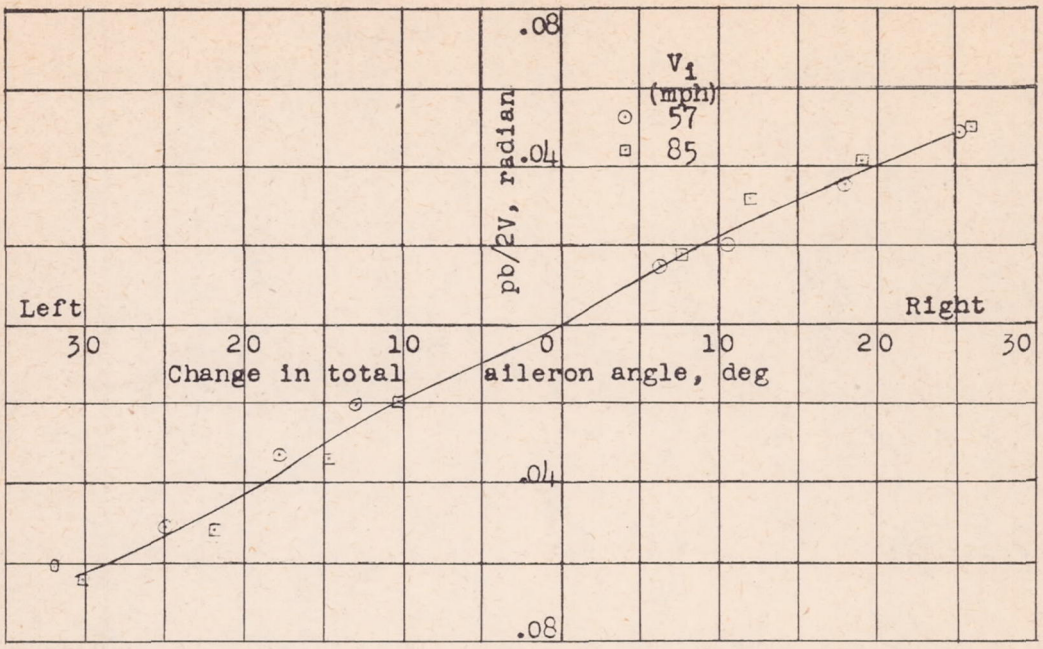

Figure 9.- Variation of helix angle pb/2V with change in aileron deflection. Ryan ST airplane with internally balanced ailerons in the presence of the $0.20c_w$ balanced split flap. $\delta_f = 40°$; gap = $0.04c_w$; leading edge of flap directly under aileron hinge line.

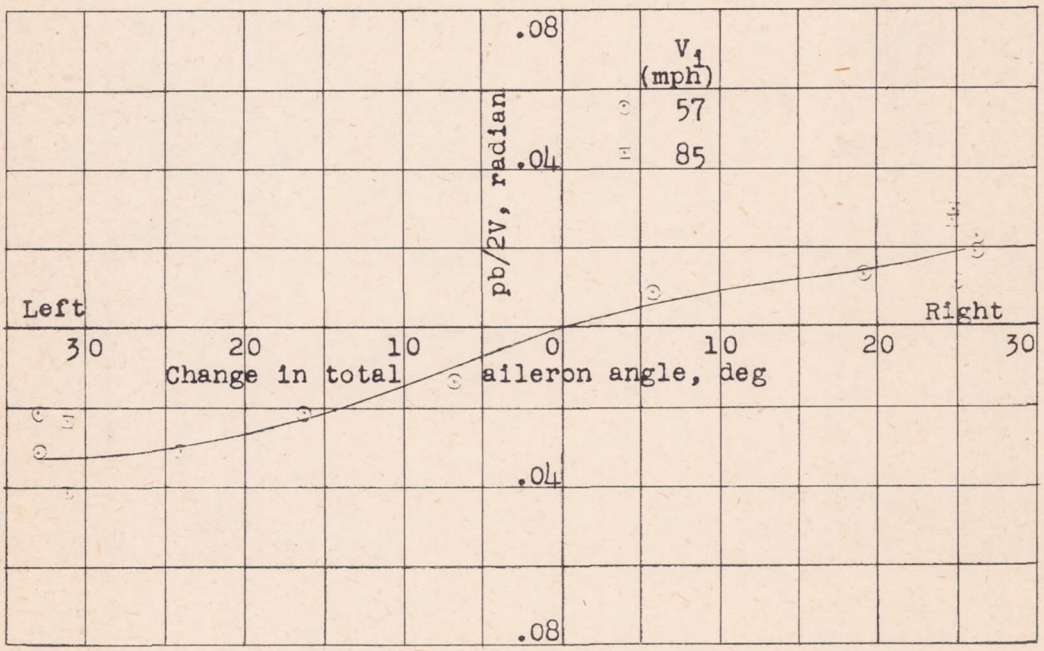

Figure 10.- Variation of helix angle pb/2V with change in aileron deflection. Ryan ST airplane with internally balanced ailerons in the presence of the $0.20c_w$ balanced split flap. $\delta_f = 14°$; gap = $0.02c_w$; leading edge of flap $0.0325c_w$ ahead of aileron hinge line.

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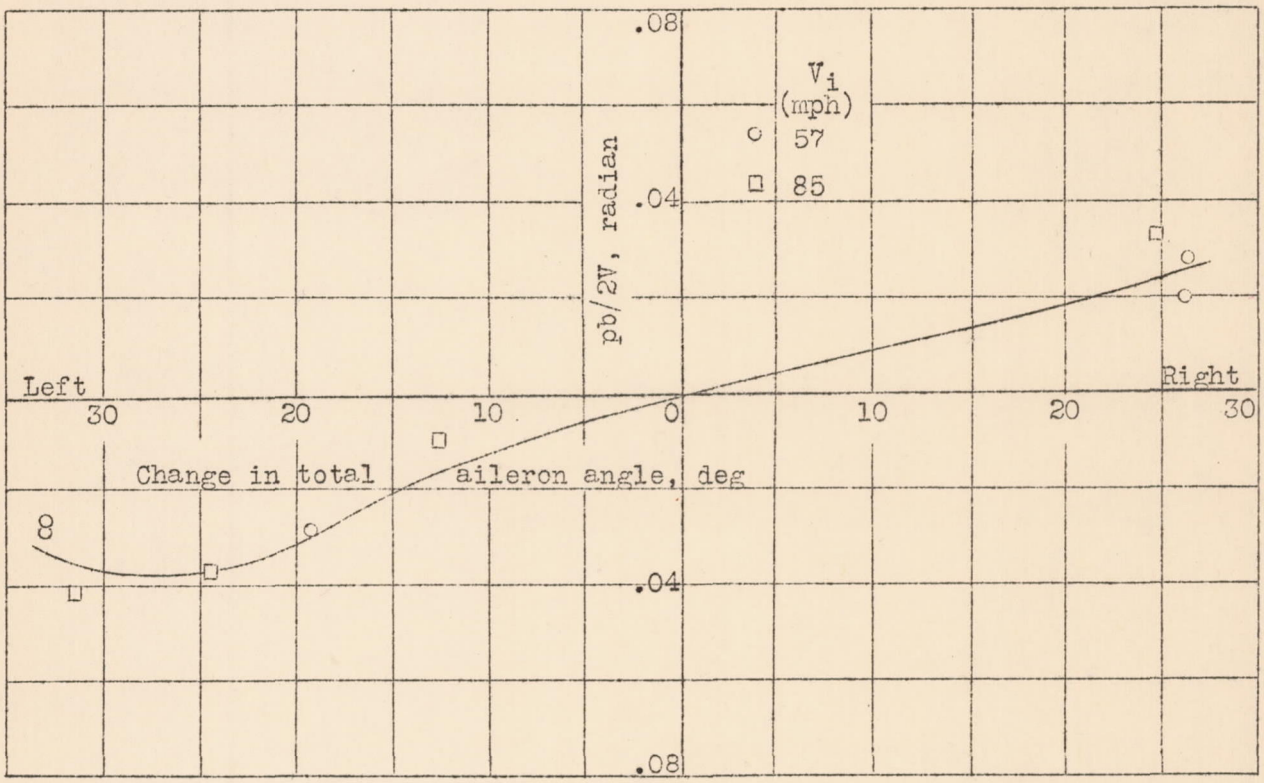

Figure 11.- Variation of helix angle pb/2V with change in aileron deflection. Ryan ST airplane with internally balanced ailerons in the presence of the $0.20c_w$ balanced split flap. $\delta_f = 8^\circ$; gap = $0.01c_w$ sealed; leading edge of flap $0.07c_w$ ahead of aileron hinge line.