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Hellcat Mk.II JV.224
(Double Wasp R.2800-10W)

Brief handling trials with spring tab ailerons.

This report deals with the aircraft or equipment as tested. Action to remedy defects or decisions to accept items not in strict compliance with the specification are matters for decision and action by the Ministry of A/c Prodn.

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Period of tests: 14th to 24th August, 1944.

Progress of issue of report.

Report No.	Title.
1st Part of A.&A.E.E./809,a	JV.224 - Position error trials.

Summary.

The aileron control of the Hellcat Mk.I was extremely heavy at high speed, and spring tab ailerons were employed on the Hellcat Mk.II in order to improve this feature. Brief handling trials were made on Hellcat Mk.II JV.224 to investigate the effect of the spring tab ailerons on handling characteristics, and some measurements of rate of roll were taken by stopwatch in order to compare with similar measurements on Hellcat Mk.I FN.322.

It was found that the fitting of spring tab ailerons gave a considerable improvement in lateral control as compared with the Hellcat Mk.I fitted with normal ailerons. The control forces were reduced, so that much larger aileron displacements and rates of roll were obtained at speeds above 200 mph (175 knots) ASI. Full lateral stick movement could be applied up to a maximum speed of 360 mph (310 knots) ASI, but as speed was increased above this the stick movement was restricted by a sharp increase of stick force, apparently due to full spring compression.

There were no serious disadvantages, but a minor effect was that at speeds above 200 mph (175 knots) ASI, the rudder felt heavy in comparison with the ailerons and elevator.

1. Introduction.

The aileron control of the Hellcat Mk.I was extremely heavy at high speed, and therefore spring tab ailerons were employed on the Hellcat Mk.II, in order to provide improved lateral control at speeds up to the maximum permissible.

Brief handling trials have been made on Hellcat Mk.II JV.224 to investigate the effect of the spring tab ailerons on handling characteristics. During the course of these trials some simple measurements of rate of roll were made by stopwatch in order to compare them with similar measurements on Hellcat Mk.I FN.322. The results of the trials are given in this present part of the Report.

2. Condition of aircraft relevant to tests.

2.1 General. The following items of equipment were fitted to the aircraft :-

Hamilton Hydromatic three-bladed right hand tractor propeller, Type 23E50-495
Two sealed cabin heater air intakes, one in the leading edge of each wing centre section.
Six .50 in. Browning guns, three in each wing, with muzzles and ejection chutes sealed.
Bomb rack beneath starboard wing centre section.
Aerial mast above fuselage behind cockpit with an aerial to a short mast on the fin, and a lead to the starboard side of the fuselage.

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Courtesy Neil Stirling

2.2. Airspeed system. The airspeed indicator was connected to the pitot and static sides of a Kollsman AN.5816-2 type pressure head mounted at the starboard wing tip.

2.3 Spring tab ailerons. A ground check of the preload was made, by holding both ailerons fixed, applying a lateral stick force, and noting the force at which the spring tabs began to move. This force was measured at the hand grip of the control column and found to be 7 lb. either to left or right.

The ailerons were of the Frise type, with fabric covering, and were similar aerodynamically. There were no separate aileron trim tabs, and the aileron trimmer control moved the port spring tab only. The range of the aileron trimmer was from 1⅞ div. left to 1⅞ div. right. Fixed tabs, adjustable on the ground, were fitted to both ailerons. A sketch of the port aileron is given in Fig.1.

2.4 Loading. The following loading was used throughout these tests :-

Weight lb.	CG in. aft of datum		CG U/C up		Remarks.
	U/C down	U/C up	S.M.C.	A.M.C.	
12,220	32.3	34.5	.263	.277	Fighter overload no external load

The datum point was the leading edge of the mainplane root. For this loading the main wing and auxiliary fuel tanks were full, and full ammunition was carried.

The design c.g. limits were 29.3 ins. and 35.4 ins. aft of the datum point.

2.5 Airframe limitations. At the time of these tests the limiting diving speed was 475 mph (410 knots) ASI, below 10,000 ft. The maximum permissible speed for the application of full aileron displacement was 365 mph (315 knots) ASI.

3. Scope of tests.

Brief handling tests were made to investigate the effect of the spring tab ailerons on handling characteristics, particularly at high speed. During the tests some simple measurements of rate of roll at 10,000 ft. with rudder fixed were taken by stopwatch to compare with similar measurements (unpublished) on Hellcat Mk.I FN.322, (a normal Mk.I without spring tab ailerons).

4. Results of tests.

The fitting of spring tab ailerons gave a considerable improvement in handling characteristics, chiefly in rate of roll at high speed. Details of the results are given below:-

4.1 Lateral control characteristics. The lateral control forces were light at low speed, and the spring tabs were observed to begin operation at a minimum speed of 160 mph (140 knots) ASI for normal smooth application of the ailerons, or at 130 mph (115 knots) ASI for sudden application. As speed was increased, the forces gradually became heavier, but full lateral stick movement could be applied at speeds up to 360 mph (310 knots) ASI. Above this speed full stick movement was restricted laterally owing to the high forces required. This increase in aileron control force required after a restricted movement above 360 mph (310 knots) ASI, was so sharply marked as to indicate the limitation of assistance caused by full compression of the spring. Up to the limit imposed by this build up of stick force the control forces were moderate at high speed, but at speeds in excess of 400 mph (350 knots) ASI, the amount of aileron that could be applied, and hence the effectiveness of the lateral control was reduced.

A roll through 90° from straight flight at 440 mph (380 knots) ASI took 3 seconds using 2/3 stick movement with an applied force of 47 lb.

A secondary effect of the improvement in lateral control was that the rudder forces felt relatively large, and out of harmony with the moderate aileron and elevator forces at speeds of 200 mph (175 knots) ASI and above.

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4.2 Aileron upfloat and distortion. When the aircraft was at rest the ailerons had approximately $\frac{1}{8}$ in. droop, and with increase of speed they tended to float up, the port aileron having $\frac{1}{8}$ in. negative droop, and the starboard one being neutral at 430 mph (375 knots) ASI.

Distinct ballooning of the upper surface of the fabric-covered ailerons, particularly at the inboard ends of the controls, was observed at speeds in excess of 300 mph (260 knots) ASI.

4.3 Aileron trimmer. At high speed the aileron trimming was very ineffective, possibly due to the fact that trimming was done via the port spring tab. At 400 mph (350 knots) ASI for full left setting of the aileron trimmer a stick force of 14 lb. right was needed to hold the aircraft laterally level, and for full right setting a force of 8 lb. left was required.

4.4 Changes of trim with speed and power.

4.41 Lateral. Neutral aileron trimmer setting could be used throughout the speed range, because the lateral changes of trim encountered required negligible stick forces to counteract them.

4.42 Longitudinal and directional. The changes of trim with speed and power appeared to be normal for the type, and similar to those for standard Hellcat Mk.I aircraft, without external load.

4.5 Rates of roll. Brief rate of roll measurements were made at a height of approximately 10,000 ft. Rolls were made in either direction with rudder fixed, and the time to roll through 360° was measured by stopwatch. The results are given below, and at any particular speed the result quoted is a mean of the results obtained in several rolls.

Similar measurements are given for Hellcat Mk,I FN.322, which did not have spring tabs on the ailerons, The aircraft was flown at a weight of 12,140 lb. during these tests.

Aircraft	Roll to port			Roll to starboard		
	ASI mph (knots)	Time to roll 360° (secs.)	Rate of roll (°/sec.)	ASI mph (knots)	Time to roll 360°(secs.)	Rate of roll (°/sec.)
Hellcat Mk.I FN.322	150 (130)	7.0	52	150 (130)	6.0	60
	180 (155)	6.6	55	180 (155)	5.4	67
	220 (190)	7.2	50	220 (190)	6.0	60
	270 (235)	7.0	52	270 (235)	6.4	56
	290 (250)	7.0	52	300 (260)	7.4	49
	310 (270)	7.8	46			
Hellcat Mk.II JV.224.	190 (165)	6.4	56			
	230 (200)	5.2	69	225 (195)	5.5	65
	255 (220)	5.2	69	250 (215)	5.3	68
	300 (260)	5.2	69	290 (250)	5.4	67
	325 (280)	5.5	65	320 (280)	5.5	65
	360 (300)	5.5	65	355 (310)	5.7	63
	370 (320)	6.6	55	370 (320)	6.3	57

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5. Discussion of results.

The rate of roll measurements (para.4.5) showed that at all speeds tested the rolling performance of Hellcat JV.224 (spring tab ailerons) was better than that of Hellcat FN.322. As would be expected, the improvement was small at low speeds, becoming fairly large at higher speeds.

6. Conclusions.

The fitting of spring tab ailerons to Hellcat Mk.II aircraft, as tested on Hellcat Mk.II JV.224, gave a considerable improvement in lateral control as compared with Hellcat Mk.I aircraft fitted with normal ailerons. The control forces were reduced, so that much larger aileron displacement and rates of roll were obtained at speeds above 200 mph (175 knots) ASI, Full lateral stick movement could be applied up to a maximum speed of 360 mph (310 knots) ASI, but as speed was increased above this the stick movement was restricted by a sharp increase of stick force, apparently due to full spring compression.

There were no serious disadvantages, but a minor effect was that at speeds above 200 mph ASI the rudder felt heavy in comparison with the ailerons and elevator.

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