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AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN.	STOCK
DATE 4/1/53	9
Kittyhawk A.K.579.	
Allison VI710.F3R	
Flame damping trials with American design fishtails.	
12	DATE 5.1.53.

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 M.A.P.

A. & A.E.E. Ref:- 4484/1-A.S.76/2  
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Progress of issue of report.

Report No.	Title.
1st Part of A. & A.E.E./783.	A.K.572 & A.K.764 - Carbon Monoxide contamination tests.
2nd do.	A.K.764 - G.45 - Camera gun installation.

SUMMARY.

The flame damping qualities of the American designed fishtails as fitted in the Kittyhawk come within present requirements except at maximum power for continuous cruising weak where the exhaust flames are visible from a distance of 130 yards. The present requirements state that the exhaust flame shall not be visible at a greater distance than 100 yards from any position under all engine powers. As the discrepancy is so small and the flame damping qualities of the system are the best yet obtained from any unducted flame damping system fitted to an in line engine, it is recommended that the system be accepted without further modification. It is suggested that this system be adopted for the Mustang and the Airacobra and that a set modified to suit a Merlin engine be manufactured as this system shows considerable promise from the flame damping point of view.

1. Introduction.

Ground to air and ground tests with photographic records were made to estimate the efficiency of the flame damping system of the Kittyhawk fitted with Allison VI710.F3R engine. The flame dampers consist of six fishtails per side, each fishtail being connected to two exhaust ports and having an exit area of 3.45 sq.inches. (5½"x8"). The fishtails are of American design manufactured in England from drawings supplied by the U.S.A. (See photograph).

2. Scope of Tests.

The engines were run on the ground under the following conditions

- (1) Max.power for continuous cruising weak 2300 R.P.M. 30½ inches Hg.boost.
- (2) " " " " " rich 2600 " 37 " "
- (3) Full throttle 2800 " 44 " "

Visual observations and photographic records were made of these tests and ground to air tests were also conducted.

3. Results of Ground Tests.

At maximum power for continuous cruising weak, blue grey flames of low luminosity appeared to be concentrated in two bands on either side of the fishtails, and a small amount of red glow was discernable on those portions of the shanks of the fishtails which were shielded from the direct effect of the slipstream by the engine cowling. No glow was visible from the fishtails themselves.

At maximum power for continuous cruising rich the luminosity and volume of the flames decreased considerably leaving a pale yellowish grey haze, approximately the same width as the fishtails and extending from the front fishtail to 3 inches behind the rear fishtail. Very similar conditions prevailed at full throttle but the volume of the flame was slightly greater.

4. Analysis of photographic records of ground runs.

/Table

Engine conditions.	Densitometer readings	
	Infra Red	Panchromatic
Maximum power for continuous cruising weak.	0.19	nil
Maximum power for continuous cruising rich.	Faint trace.	nil

These records are the smallest yet obtained from any unducted fishtail flame damper fitted to an "in line" engine either British or American.

5. Ground to air tests.

The ground to air tests were conducted on 29/3/42 under the following weather conditions. Moon  $\frac{7}{8}$  full obscured by  $\frac{9}{10}$  cloud horizon visible. Six runs were made at height of approximately 200 feet under the following engine conditions.

- (1) Max. power for continuous cruising weak: 2300 R.P.M. 30 $\frac{1}{2}$  inches Hg. Boost.
- (2) " " " " " " " rich 2600 " 37 " " "
- (3) Full throttle 2800 " 44 " " "

Two runs were made in each condition the aircraft passing directly over an observer; the times during which the exhaust flames were visible being noted by stop watch.

6. Results of ground to Air Tests.

Engine conditions.	Distance in yards exhaust flame or glow visible.	
	Aircraft approaching.	Aircraft receding.
Max. power for continuous cruising weak.	130	130
Max. power for continuous cruising rich.	Not visible beyond 100 yards.	Not visible beyond 100 yds.
Full throttle.	do.	do.

7. Conclusions.

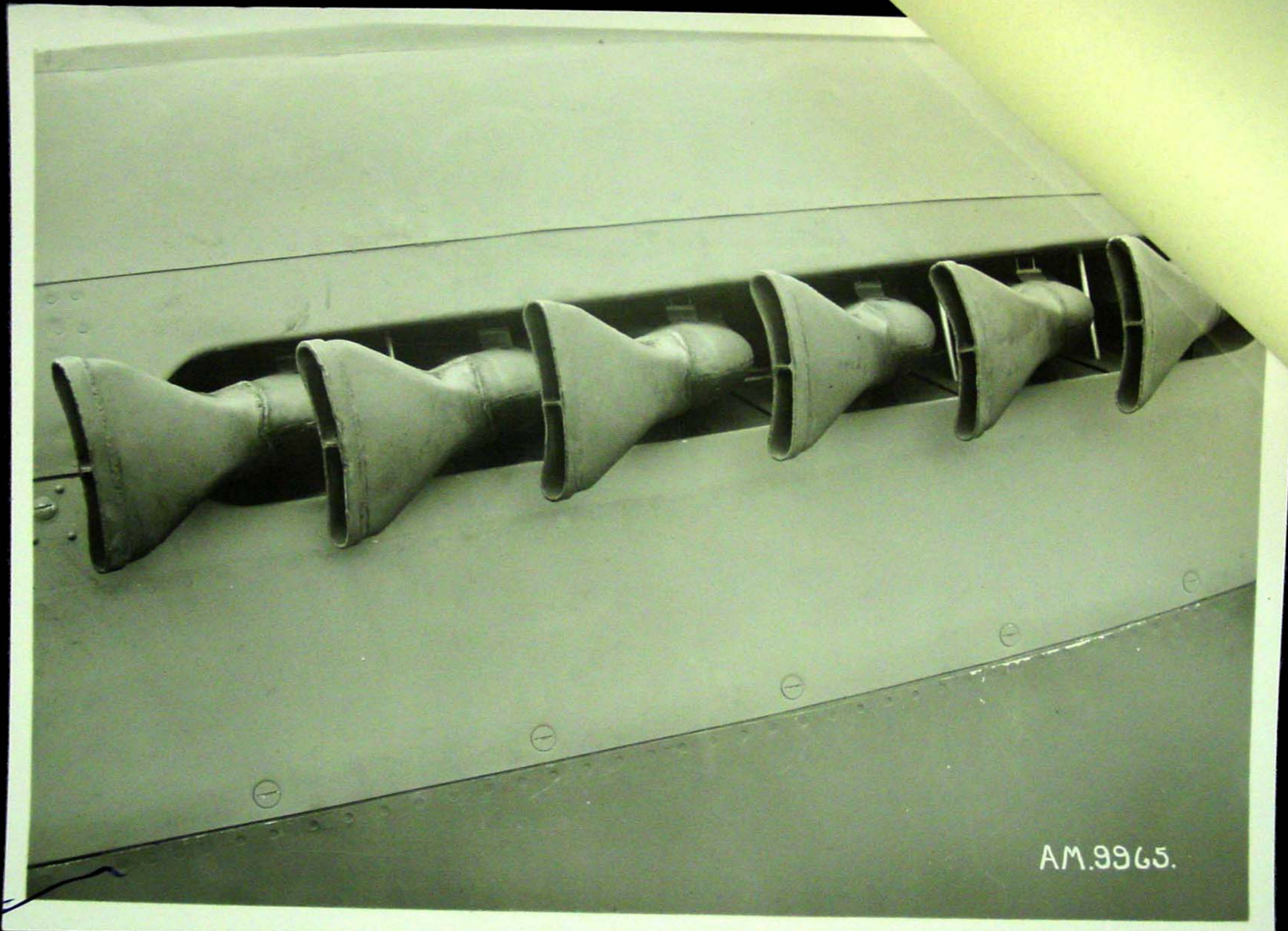
The flame damping qualities of this system of fishtails is the best yet obtained from an unducted exhaust system fitted to an "in line" engine. Although the visibility of the exhaust flame from this system at maximum power for continuous cruising weak does not quite come within the present requirements, namely that the exhaust flame shall not be seen at a greater distance than 100 yards from any direction under all engine powers, the discrepancy which only occurs under cruising weak conditions is sufficiently small to suggest that the system be accepted without further modification.

8. Further Developments.

It is recommended that a similar fishtail exhaust system be fitted to the Mustang and the Airacobra both of which have Allison engines. A similar set of exhausts modified to suit a Merlin engine might possibly offer a better solution to the flame damping problem than the standard triple ejector fishtails which do not approach present requirements.

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