R.R. 306 (10T) (12318. 26/8/42) DP.

EXPERIMENTAL DEPARTMENT REPORT

REFERENCE :— Dor/Cyr.1/IW 8.4.43.

Subject of Report :—

IMPROVED PERFORMANCE LOW ALTITUDE FIGHTER AIRCRAFT.
'MUSTANG' AL.963 WITH MERLIN 65 (SPECIAL).

General Conclusion :—

Preliminary flight performance data obtained on a Merlin 65 engine re-rated to + 23 lb. boost prior to tests on R.M. 14 S.M. engine.

This engine was fitted with an S.U. injection pump to give the increased fuel flow requirements necessitated by the higher boost.

(1) Level speeds. An increase of 17 M.P.H. is obtained from G.L. up to 7,000 ft. and from 15,000 ft. to 19,000 ft.

(2) Climb. Rate of climb improved by 900 ft/min. from G.L. up to 4,000 ft. and 960 ft/min. from 13,000 ft. up to 15,000 ft.

The R.M. 14. S.M. engine will maintain this improved performance approximately 4,000 ft. higher in M.S. gear and all altitudes above 19,000 ft. in F.S. gear.

(3) S.U. injection pump.

The Mk.II pump with modified setting is a considerable improvement operationally over previous pumps.

Further development and extended flying is required to make this pump mechanically reliable. Two mechanical failures have occurred in 10 hours flying.

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Report to be noted for further action by :— Mr.Foord, R.D.E.2. (M.A.P.) Major Bulman (M.A.P.) Mr.Jones (R.T.O. Hucknall) G/C. Freebody (Fighter Command)

Test carried out on :— 'Mustang' AL.963

By :— Hucknall. Test No. Date :— 8.4.43.

Dor/Cyr.1/IW. 8.4.43.

IMPROVED PERFORMANCE OF LOW ALTITUDE FIGHTER AIRCRAFT.

'MUSTANG' AL.963 WITH MERLIN 65 (SPECIAL).

INTRODUCTION.

With the introduction of a low altitude fighter with Merlin 65 and Merlin 66 engine further development of this engine type with a view to obtaining a still better performance at the lower altitudes has been considered.

A standard Merlin 65 (R.M.10.S.M.) was therefore re-rated to give a maximum permissible boost pressure of + 23 lb.; an S.U. injection pump was also incorporated in place of the Bendix carburettor, since this was the most convenient method of producing the fuel metering characteristics necessitated by the increased fuel flow requirements. The Bendix carburettor would have required major modifications to meet with this condition.

The purpose of this engine was to obtain preliminary flight data prior to tests on the R.M.14.S.M. engine which will have the same boost rating but will incorporate an increased capacity blower giving full throttle altitudes approximately 4,000 ft. higher for the same boost, (i.e.:- Merlin 66 F.T. altitudes at + 23 lb. boost instead of + 18 lb.).

RESULTS OF TESTS.

(a) Performance.

A complete set of level speed in both M.S. and F.S. gears was carried out at altitudes ranging from ground level up to 32,000 ft., and the results are shown plotted on Curve No. HK.6099.

This engine when first installed had a modified valve timing (exhaust valves closing early) and retarded ignition, but after completing the level speed performance the valve timing was reverted to standard and the levels repeated to ascertain if the modified valve timing was giving any loss in power. There was no measurable difference in speed between the two.

Plotted on the above curve for comparison is the speed recorded at the standard Merlin 65 rating of + 18 lb. boost.

During these tests a second injection pump became available, this pump incorporated a modified setting to eliminate two or three undesirable features which were apparent on the original pump. These are described in a separate section in this report.

Check performance tests with the Mk.II pump showed that the speed had not been affected by the change, so that as far as comparative speeds are concerned, the fitting of the new pump can be ignored.

P.T.O.....

The following table shows the comparison between the +18 lb. and + 23 lb. boost rating under both level speed and combat climb conditions :-

LEVEL SPEEDS.

ENGINE CONDITION.	MAXIMUM SPEED M.P.H. AT :-						
	1,000'	5,000'	10,000'	15,000'	20,000'	25,000'	30,000'
STANDARD MERLIN 65. 3,000 RPM. + 18 lb. BOOST.	353	370	390	393	412	420	409
SPECIAL MERLIN 65 3,000 RPM. + 23 lb. BOOST.	370	387	394	409	424	420	409

CLIMB (COMBAT RATING)

ENGINE CONDITION	RATE OF CLIMB IN FEET/MIN. AT:-					
	GROUND LEVEL	3,000'	5,000'	10,000'	15,000'	20,000'
STANDARD MERLIN 65. 3,000 RPM. + 18 lb. BOOST.	3,800	3,800	3,800	3,480	3,040	2,840
SPECIAL MERLIN 65 3,000 RPM. + 23 lb. BOOST.	4,700	4,700	4,490	4,000	3,980	3,160

From the above tests it will be seen that the increased boost pressure from + 18 lb. to + 23 lb. sq.in. gives an increase in speed of 17 MPH. ground level up to 7,000 ft. in M.S. gear and 17 MPH. from 15,000 ft. up to 19,000 ft. in F.S. gear.

The initial rate of climb is improved by 900 ft/min. from ground level up to 4,000 ft. This improvement gradually decreases up to changeover altitude from M.S. to F.S. (8,000 ft.) where it is 200 ft./min. increase. Above this altitude a further benefit is obtained of an increase in rate of climb from 200 ft./min. at 8,000 ft. to 960 ft./min. at 15,000 ft.

Contd.....

The R.M.14.S.M. engine should give a substantial improvement on this figure, particularly between 7,000 ft. to 12,000 ft. in M.S. gear, and 18,000 ft. upwards in F.S. gear, since the throttled speed lines on the attached curve will be continued up to the 14 S.M. full throttle altitudes or 11,000 ft. in M.S. and 22,000 ft. in F.S.

(b) Operation of S.U. injection pump.

The general operation of the Mk.II pump originally fitted was reasonably satisfactory, but a number of undesirable features existed which would have to be eliminated before this unit could be considered. These were as follows :-

(1) Starting up.

It was necessary to warm up until the oil inlet temperature had reached 40°C. before attempting to 'take-off', since if the main engine oil pressure reached 150 lb/sq.in. the engine would immediately cut out. This was caused through the excessive oil pressure pushing the injector pump plungers to the bottom of their stroke and holding them in this position with the result that the swash plate ceased to operate the injectors and just windmilled free.

(2) Slow running.

Excessive richness was apparent under slow running, and taxying conditions. When opening up after taxying clouds of black smoke emanates from the exhausts, particularly B.1. port, and this does not clear under approximately 2200 RPM.

(3) In flight.

Excessive richness was again apparent at small throttle openings; the engine would not run at boost pressures below -2 lb. and if the throttle was opened from this position up to, say, - ½ lb. or 0 lb. boost, black smoke again emanates from the exhausts, the engine then picks up normally. This feature was most marked at high altitudes of 30,000 ft. upwards.

With the exception of this feature opening up and acceleration is very good and positive.

The second pump with a modified setting was a considerable improvement and eliminated all the above undesirable features.

Slow running was excellent and opening up with the normal oil inlet temperature of 15°C. was very satisfactory.

Normal acceleration and deceleration showed no signs of the excessive richness previously experienced.

P.T.O.....

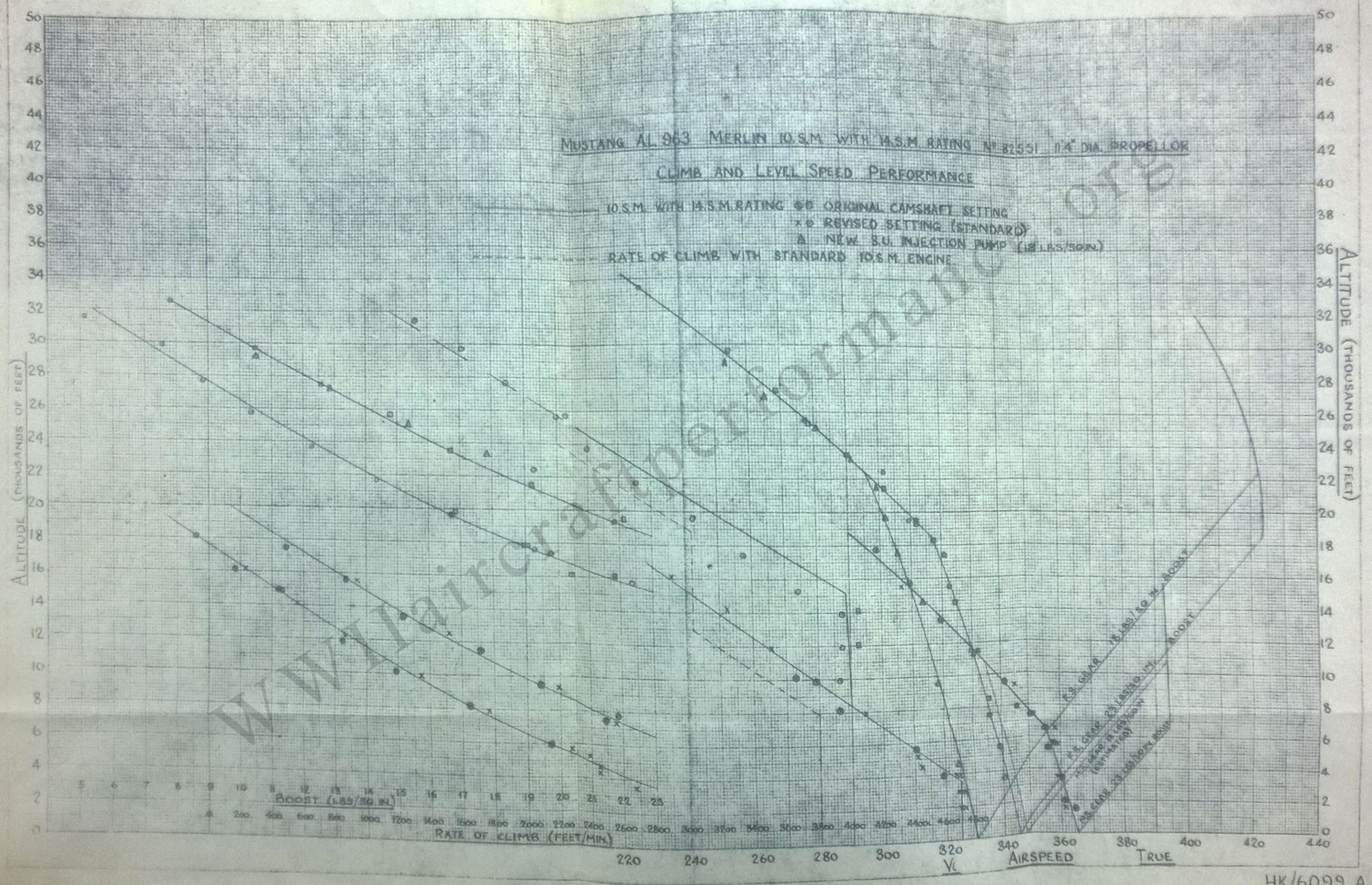
There was, however, a definite "flat spot" if the throttle was opened very rapidly from the fully closed position. This feature could be dangerous in the case of an aircraft requiring a sudden burst of engine for emergency.

After completing 2¾ hours flying, which included some severe handling tests to check rapid opening up and acceleration, an internal mechanical failure of the pump occurred, the engine running became over-rich and after switching off it was impossible to start again.

A failure with similar symptoms occurred on the first pump after 7¼ hrs. running. Both pumps were returned to Derby for examination.

A third pump has been fitted and is awaiting test.

Dor/W.T.Collyer.



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