Flying the Messerschmitt Bf.109

On May 4, 1940, a Bf.109E (Wn: 1304) was flown to RAF Boscombe Down, where it was appraised by the Aircraft and Armament Experimental Establishment (A & AEE); then later flown to the Royal Aircraft Establishment (RAE) at Farnborough for handlin gtrials, and allocated the serial number AE479. The results of the RAE's evaluation were discussed on Thursday, March 9, 1944 at a meeting of the Royal Aeronautical Society in London, at which M.B. Morgan and R. Smelt of the RAE lectured on *'The aerodynamic features of German aircraft'*. About the Bf.109E they had this to say:



[Here is a photo of what is believed to be Bf.109E (W/nr. 1304)]

Take-off

This is best done with the flaps at 20 degrees. The throttle can be opened very quickly without fear of choking the engine. Acceleration is good, and there is little tendency to swing or bucket. The stick must be held hard forward to get the tail up. It is advisable to let the airplane fly itself off since, if pulled off too soon, the left wing will not lift, and on applying aileron the wing lifts and falls again, with the ailerons snatching a little. If no attempt is made to pull the airplane off quickly, the take-off run is short, and initial climb good.

Approach

Stalling speeds on the glide are 75 mph flaps up, and 61 mph flaps down. Lowering the flaps makes the ailerons feel heavier and slightly less effective, and causes a marked nose-down pitching moment, readily corrected owing to the juxtaposition of trim and flap operating wheels. If the engine is opened up to simulate a baulked landing with flaps and undercarriage down, the airplane becomes tail-heavy but can easily be held with one hand while trim is adjusted. Normal approach speed is 90 mph. At speeds above 100 mph, the pilot has the impression of diving, and below 80 mph one of sinking. At 90 mph the glide path is reasonably steep and the view fairly good. Longitudinally the airplane is markedly stable, and the elevator heavier and more responsive than is usual in single-seater fighters. These features add considerably to the ease of approach. Aileron effectiveness is adequate; the rudder is sluggish for small movements.

Landing

This is more difficult than on the Hurricane I or Spitfire I. Owing to the high ground attitude, the airplane must be rotated through a large angle before touchdown, and this requires a fair amount of skill. If a wheel landing is done the left wing tends to drop just before touchdown, and if the ailerons

are used to lift it, they snatch, causing over-correction. The brakes can be applied immediately after touchdown without fear of lifting the tail. The ground run is short, with no tendency to swing. View during hold-off and ground run is very poor, and landing at night would not be easy.

Taxing

The aircraft can be taxied fast without danger of bucketing, but is is difficult to turn quickly; an unusually large amount of throttle is needed, in conjunction with harsh braking, when manuevering in a confined space. The brakes are foot-operated, and pilots expressed a strong preference for the hand operation system to which they are more accustomed.

Lateral Trim

There is no procounced change of lateral trim with speed of throttle setting provided that care is taken to fly with no sideslip.

Directional Trim

Absence of rudder trimmer is a bad feature, although at low speeds the practical consequences are not so alarming as the curves might suggest, since the rudder is fairly light on the climb. At high speeds, however, the pilot is seriously inconvenienced, as above 300 mph about 2 1/2 degrees of port (left) rudder are needed for flight with no sideslip and a very heavy foot load is needed to keep this on. In consequence the pilot's left foot becomes tired, and this affects his ability to put on left rudder in order to assist a turn to port (left). Hence at high speeds the Bf.109E turns far more readily to the right than to the left.

Longitudinal Trim

Five three-quarter turns of a 11.7 in diameter wheel on the pilot's left are needed to move the adjustable tailplane through its full 12-degrees range. The wheel rotation is in the natural sense. Tailplane and elevator angles to trim were measured at various speeds in various condition; the elevator angles were corrected to constant tail setting. The airplane is statically stable both stick fixed and stick free.

'One Control' tests, flat turns, sideslips

The airplane was trimmed to fly straight and level at 230 mph at 10,000 feet. In this condition the airplane is not in trim directionally and a slight pressure is needed on the left rudder pedal to prevent sideslip. This influences the results of the following tests:

Ailerons fixed central On suddenly applying half-rudder the nose swings through about eight degrees and the airplane banks about five degrees with the nose pitching down a little. On releasing the rudder it returns to central, and the airplane does a slowly damped oscillation in yaw and roll. The right wing then slowly falls. Good baned turns can be done in either direction on rudder alone, with little sideslip if the rudder is used gently. Release of the rudder in a steady 30-degree banked turn in either direction results in the left wing slowly rising.

Rudder fixed central Abrupt displacement of the ailerons gives bank with no appreciable opposite yaw. On releasing the stick it returns smartly to central with no oscillation. If the ailerons are released in a 30-degree banked turn, it is impossible to assess the spiral stability, since whether the wing slowly comes up or goes down depends critically on the precise position of the rudder. Excellent banked turns can be done in either direction on ailerons alone. There is very little sideslip on entry or recovery, even if the ailerons are used very harshly. In the turn there is no appreciable sideslip.

Steady flat turns Only half-rudder was used during this test. Full rudder can be applied with a very heavy foot load, but the nose-down pitching movement due to sideslip requires a quite excessive

pull on the stick to keep the nose up. When flat turning steadily with half-rudder, wings level, about half opposite aileron is needed. The speed falls from 230 mph to 175 mph, rate of flat turn is about 110.

Steady sideslip when gliding Gliding at 100 mph with flaps and undercarriage up the maximum angle of bank in a straight sideslip is about five degrees. About 1/4 opposite aileron is needed in conjuction with full rudder. The airplane is faily nose-heavy, vibrates and is a little unsteady. On release of all three controls the wing comes up quickly and the airplane glides steadily at the trimmed speed. With flaps and undercarriage down, gliding at 90 mph, the maximum angle of bank is again five degrees 1/5 opposite aileron being needed with full rudder. The nose-down pitching movement is not so pronounced as before, and vibration is still present. Behaviour on releasing the control is similar to that with flaps up.

Stalling Test

The airplane was equipped with a 60 foot trailing static head and a swiveling pitot head. Although, as may be imagined, operation of a trailing static from a single-seater with a rather cramped cockpit is a difficult job, the pilot brought back the following results:

Lowering the ailerons and flaps thus increases C_L max of 0.5. This is roughly the value which would be expected from the installation. *Behaviour at the stall*. The airplane was put through the full official tests. The results may be summarized by saying that the stalling behaviour, flaps up and down, is excellent. Both ruddera nd ailerons are effective right down to the stall, which is very gentle, the wing only falling about 10 degrees and the nose falling with it. There is no tendency to spin. With flaps up the ailerons snatch while the slots are opening, and there is a buffeting on the ailerons as the stall is approached.. Withs flaps down there is no aileron snatch as the slots open, and no pre-stall aileron buffeting. There is no warning of the stall, flaps down. From the safety viewpoint this is the sold adverse stalling feature; it is largely off-set by the innocuous behaviour at the stall and by the very high degree of fore and aft stability on the approach glide.

Safety in the Dive

During a dive at 400 mph all three controls were in turn displaced slightly and released. No vibration, flutter or snaking developed. If the elevator is trimmed for level flight at full throttle, a large push is needed to hold in the dive, and there is a temptation to trim in. If, in fact, the airplane is trimmed into the dive, recovery is difficult unless the trimmer is would back owing to the excessive heaviness of the elevator.

Ailerons

At low speeds the aileron control is very good, there being a definete resistance to stick movement, while response is brisk. As speed is increased, the ailerons bevome heavier, but response remains excellent. They are at their best between 150 mph and 200 mph, one pilot describing them as an 'ideal control' over this range. Above 200 mph they start becoming unpleasantly heavy, and between 300 mph and 400 mph are termed 'solid' by the test pilots. A pilot exerting all his strength cannot apply more than one-fifth aileron at 400 mph. Measurements of stick-top force when the pilot applied about one-fifth aileron in half a second and then held the ailerons steady, together with the corresponding time to 45 degrees banbk, were made at various speeds. The results at 400 mph are given below:
Max sideways force a pilot can apply conveniently to the Bf.109 stick 40 lbs.
Corresponding stick displacement 1/5th.
Time to 45-degree bank 4 seconds.
Deduced balance factyor Kb2 - 0.145

Several points of interest emerge from these tests:
a. Owing to the cramped Bf.109 cockpit, a pilot can only apply about 40 lb sideway force on the stick, as against 60 lb or more possible if he had more room.

b. The designer has also penalized himself by the unusually small stick-top travel of four inches, giving a poor mechanical advantage between pilot and aileron.
c. The time to 45-degree bank of four seconds at 400 mph, which is quite escessive for a fighter, classes the airplane immediately as very unmaneuvrable in roll at high speeds.

Elevator

This is an exceptionally good control at low air speeds, being fairly heavy and not over-sensitive. Above 250 mph, however, it becomes too heavy, so that maneuvrability is seriously restricted. When diving at 400 mph a pilot, pulling very hard, cannot put on enough 'g' to black himself out; stick force -'g' probably esceeds 20 lb/g in the dive.

Rudder

The rudder is light, but rather sluggish at low speeds. At 200 mph the sluggishness has disappeared. Between 200 mph and 300 mph the rudder is the lightest of the three controls for movement, but at 300 mph and above, absence of a rudder trimmer is severely felt, the force to prevent sideslip at 400 mph being excessive.

Harmony

The controls are well harmonised between 150 mph and 250 mph. At lower speeds harmony is spoiled by the sluggishness of the rudder. At higher speeds elevator and ailerons are so heavy that the worn 'harmony' is inappropriate.

Aerobatics

These are not easy. Loops must be started from about 280 mph when the elevator is unduly heavy; there is a tendency for the slots to open at the top of the loop, resulting in aileron snatching and loss of direction. At speeds below 250 mph the airplane can be rolled quite quickly, but in the final stages of the roll there is a strong tendency for the nose to fall, and the stick must be moved well back to keep the nose up. Upward rolls are difficult. Owing to elevator heaviness only a gentle pull-out from the dive is possible, and considerable speed is lost before the upward roll can be started.

Fighting Qualities

A series of mock dogfights with our own fighters briought out forcibly the good and bad points of the airplane. These may be summarised as follows:
Good Points;
High top speed and excellent rate of climb
Engine does not cut immediately under negative 'g'
Good control at low speeds
Gentle stall, even under 'g'
Bad Points;
Ailerons and elevator far too heavy at high speeds
Owing to high wing loading the airplane stalls readily under 'g' and has a relatively poor turning circle
Absence of a rudder trimmer, curtailing ability to bank left in the dive
Cockpit too cramped for comfort

Further Comments

At full throttle at 12,000 feet the minimum radius of steady turn without height loss is about 890 feet in the case of the Bf.109E, with its wing loading of 32 lb/sq ft. The corresponding figure for a comparable fighter with a wing loading of 25 lb/sq ft, such as the Spitfire I or Hurricane I, is about 690 feet. Although the more heavily loaded fighter is thus at a considerable disadvantage, it is important to bear in mind that these minimum radii of turn are obtained by going as near to the stall as possible. In this respect the Bf.109E scores by its excellent control near the stall and innocuous

behaviour at the stall, giving the pilot confidence to get the last ounce out of his airplanes turning performance.

The extremely bad maneuvrability of the Bf.109E at high speeds quickly became known to our pilots (RAF). On several occasions a Bf.109E was coaxed to self-destruction when on the tail of a Hurricane or Spitfire at moderate altitude. Our pilot would do a half-roll and quick pull-out from the subsequent steep dive. In the excitement of the moment the Bf.109E pilot would follow, only to find that he had insufficient height for recovery owing to his heavy elevator, and would go straight into the ground without a shot being fired.

Pilots verbatim impressions of some features are of interest. For example, the DB 601 engine came in for much favourable comment from the viewpoint of response to throttle and insusceptability to sudden negative 'g'; while the throttle arrangements were described as 'marvellously simple, there being just one lever with no gate or over-ride to worry about'. Suprisingly though, the manual operation of flaps and tail setting were also liked; 'they are easy to operate, and being manual are not likely to go wrong'; juxtaposition of the flap and tail actuating wheels in an excellent feature.

Performance by 1940 standards was good. When put into a full throttle climb at low air speeds, the airplane climbed at a very steep angle, and our fighters used to have difficulty in keeping their sights on the enemy even when at such a height that their rates of climb were comparible. This steep climb at low air speed was one of the standard evasion maneuvres used by the German pilots. Another was to push the stick forward abruptly and bunt into a dive with considerable negative 'g'. The importance of arranging that the engine whould not cut under these circumstances cannot be over-stressed. SPeed is picked up quickly in a dive, and if being attacked by an airplane of slightly inferior level performance, this feature can be used with advantage to get out of range. There is no doubt that in the autumn of 1940 the Bf.109E in spite of its faults, was a doughty opponent to set against our own equipment'.

Selected comments from the men who flew and fought in the Bf.109E make interesting footnotes to the foregoing 'enemy' opinions:

Hauptmann Gunther Schack, 174 victories;
'In March 1941, as a Gefreiter, I joined Jagdgeschwader Molders, JG 51, stationed at St. Over, France. By then I had only taken off with the 109 straight into wind, and never from a concrete runway. On April 4th, during a cross-wind take-off on the concrete runway, the 109 swung so much to the left that I feared it would crashinto some other machines parked along the edge of the field. I closed the throttle and my first crash began. The machine swung left even more, the left undercarriage leg broke, and the 109 dropped on its left wing. This happened to me twice - the second time on April 10th - and my future as a fighter pilot seemed sealed.... In all, I was shot down 15 times.... On one occasion I saw the right wing of my 109 flying right alongside me ! During an attack on a bomber formation, I was hit by an enemy fighter, right in one of the main spar attachment lugs. Luckily, I was over 2,000 metres high, but even then I only succeeded in getting out of the crazily-spinning machine close to the ground. I crashed against the tailplane, and for the next two weeks I could only walk bent in two....'

Major Gunther Rall, 275 victories;
'The 109? That was a dream, the non plus ultra. Just like the F-14 of today. Of course, everyone wanted to fly it as soon as possible. I was very proud when I converted to it.'

Generalleutnant Werner Funck, Inspector of Fighters, 1939;
'The 109 had a big drawback, which I didn't like from the start. It was that rackety - I always said rackety - undercarriage; that negative, against-the-rules-of-statics undercarriage that allowed the machine to swing away.'
