THE TARRANT TABOR: THE STORY OF THE ILL-FATED BRITISH HEAVY BOMBER

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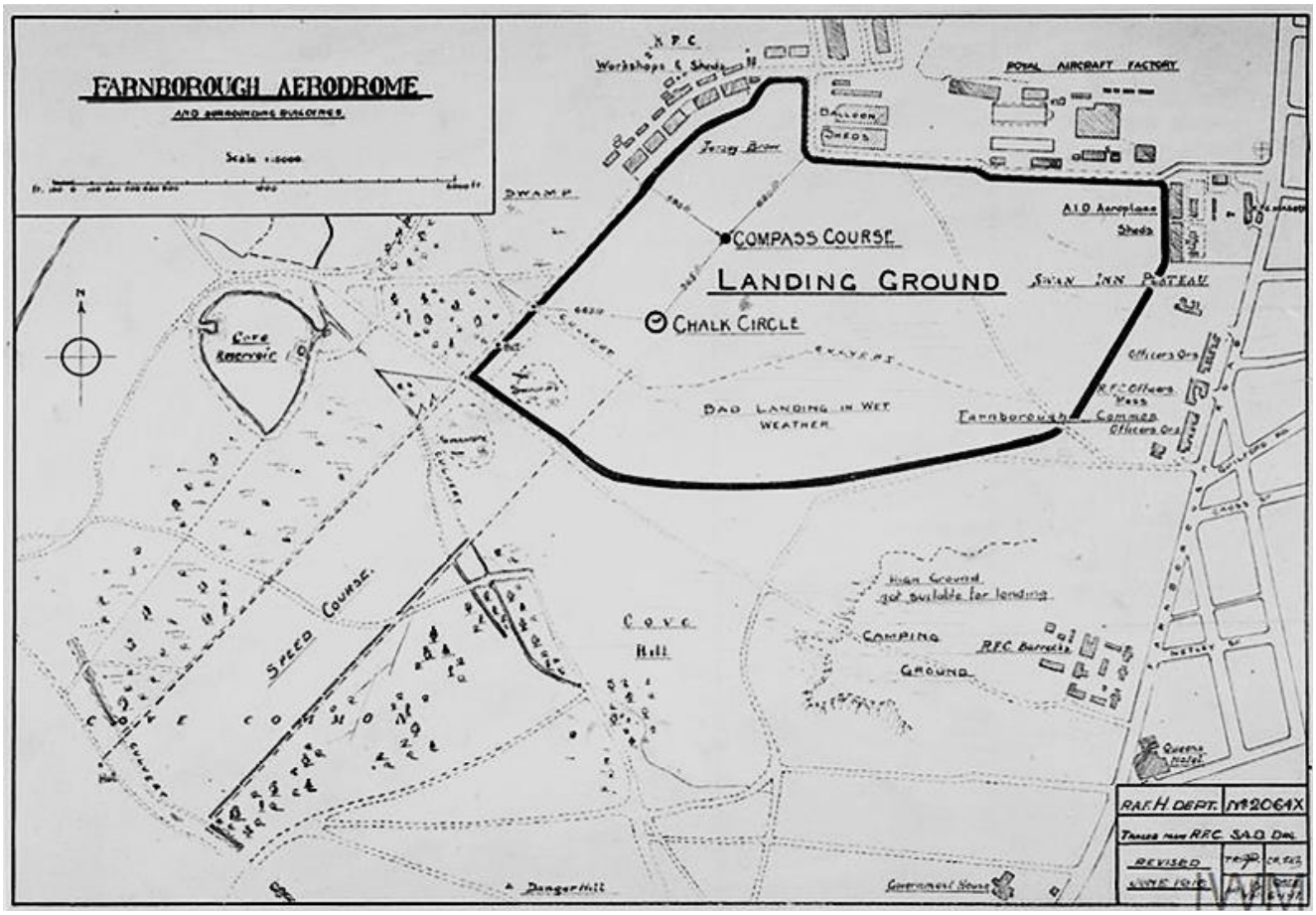
ABSTRACT

In 1917 W. G. Tarrant, a British property developer whose company had previously produced wooden aircraft components, received a contract to design and build two experimental heavy bombers. The Tarrant Tabor triplane weighed some 22 tons, was configured with four (later six) engines, was the largest aeroplane produced at the time, and easily could reach Berlin from bases in England. A series of contentious design problems related to centre of gravity, longitudinal stability and conflicting wind tunnel data, coupled with an ineffective organisational and oversight process, resulted in a premature and ill-considered first flight attempt. The Tabor nosed over during the take-off run, killing the two pilots. The subsequent Accident Inquiry identified design and pilot errors, but the proximate cause was ascribed to the conduct of the trial itself. To save embarrassment, the government never published the report.



Frontispiece: Farnborough Aerodrome in 1916 showing the Royal Aircraft Factory including ‘A’ and ‘C’ Balloon Sheds (top) and the northern landing ground on Farnborough Common, in 1919 the site of the Tarrant Tabor’s fatal test flight.

1. INTRODUCTION

In 1917 Walter George Tarrant, a successful Surrey property developer and constructor, conceived a great patriotic endeavour: to create a giant aeroplane with the strength and range to bomb Berlin. Tarrant soon obtained a government contract for a co-funded project to construct two 'experimental' aeroplanes. He employed his construction company, W G Tarrant Ltd of Byfleet in Surrey, England (hereafter 'Tarrants'), and recruited a skilled design team. Two months before first flight he engaged the services of Ogilvie & Partners ('Ogilvies') as flight safety consultants to the project.

The aeroplane that emerged from the drawing board was spectacular. Known as the 'Tabor', it was the largest aeroplane in the world, standing over 37 ft high, had a fuselage wider than that of Concorde, and was longer than a 66 ft cricket pitch. The original specification was for a four-engine biplane but supply problems led Tarrants to acquire six alternative engines, necessitating the addition of a third wing, significantly affecting the centre of gravity.

The First World War ended before the Tabor was completed, but with the government's continued support Tarrant reconceived the plane to operate commercially, flying the air lanes of the Empire.

Although Tarrants had significant experience in constructing wooden aircraft components, they had never built a whole aeroplane. Consequently, the Government assigned responsibility for metalwork, final assembly and testing to the Royal Aircraft Establishment (RAE), formerly the Royal Aircraft Factory, at Farnborough in Hampshire and only a few miles from Byfleet.

Unhappily the Tabor project had two ultimately fatal flaws: design and testing. The issues with the Tabor itself were recognised and debated among the four main protagonists – the responsible government ministries, RAE, Tarrants, and Ogilvies. Their pressing concerns prior to first flight were whether the aeroplane was tail heavy and how to set the tailplane, both points of considerable moment and over which there was significant disagreement. Tarrant asked the National Physical Laboratory (NPL) to confirm RAE's wind tunnel tests, which it broadly did, but there remained real doubt that tests on a $1/50^{th}$ scale model accurately reflected real world conditions. Clearly this could be resolved only by RAE and NPL conducting further tests. With time apparently running out, there was considerable – if questionable – enthusiasm to move to flight testing before this was fully resolved as most experts considered the Tabor safe to fly for test purposes.

A programme of field testing was planned before a full flight. Only two tests were conducted, however, to gauge overall engine performance and the pitching effect of using the upper engines. Crucially the test pilot, a highly regarded Royal Flying Corps (RFC) veteran, had never flown heavy multi-engine machines. The plan was to stop for a status review after an extended taxi run. Instead, he elected to fly immediately, executing a high-speed turn as he commenced his takeoff run and from which he struggled to recover, before making a final corrective turn to port as he was running out of available ground.

The result was inevitable. Using the top engines at full power in a bid to get airborne caused the Tabor to pitch forward catastrophically, striking its nose into the ground and killing both pilots. The subsequent investigation identified a weakness in not aligning the lower engines so as to provide slipstream over the tailplane. Pilot error was also mooted but the final report was

inconclusive, as were other apportions of responsibilities. No one, it seemed, wanted to discuss the unusual measures taken to address supposed tail heaviness or the whole approach to testing.

The Ministry withdrew. Although a second Tabor was under construction, and Tarrant was initially minded to continue alone, he subsequently abandoned the project entirely.

2. HISTORICAL CONTEXT

The British army founded the Royal Flying Corps to exploit aircraft for reconnaissance, artillery spotting and later aerial combat. Throughout the Great War, its focus was on light aircraft. The Royal Navy, however, in the form of the Royal Naval Air Service (RNAS), had other ideas, particularly the need for strategic bombers which had demonstrated notable success during the war.

The first significant bomber originated in Russia. The Sikorsky Ilya Muromets was a commercial airliner based on the Russky Vityaz or Le Grand, designed by Igor Sikorsky. At the beginning of the war, Sikorsky redesigned the Muromets as the Type V, the world's first purpose-built heavier-than-air bomber, expressly for long-range bombing and reconnaissance roles, equipping a dedicated strategic bombing unit.

Figure 1. Sikorsky Ilya Mouromets Type V, 1914

German bombing of Britain through 1917 was conducted primarily by Zeppelin airships. Subsequently, the ‘Gotha’ heavy bomber was employed successfully in raids on London, other United Kingdom (UK) and Continental cities. From 1916 Germany also experimented with *Riesenflugzeuge* (‘giant aircraft’) bombers, primarily on the Eastern front where these slow machines were less susceptible to concentrated anti-aircraft fire.

Other German bombers such as the Staaken-Aviatik R. VI carried loads approaching those of aircraft of the Second World War. Five R VIs took part in missions over Britain, conducting eleven raids on London by May 1918. By war’s end, R VIs dropped 30 tons of bombs in thirty 340-mile round trips of seven hours’ duration. Four R. VIs were shot down, and six others were destroyed in crashes.

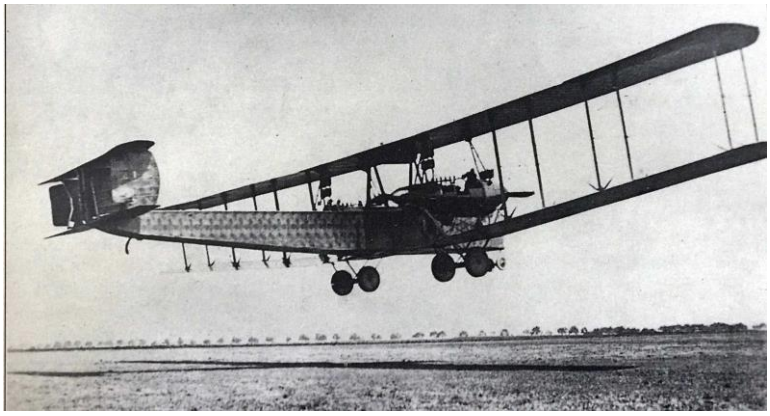


Figure 2. Germany’s Staaken-Aviatik R.VI bomber

Not to be outdone, Britain embarked on a series of experimental bombers. The Royal Navy planned to construct a fleet of long-range bombers to destroy German industry. On 23rd July 1917 the Air Board, however, having determined that existing projects were not ambitious enough, cancelled all orders for experimental heavy bombers then underway. A week later, following protests from the Controller of the Technical Department, the Air Board placed an order for 100 Handley Page O/100 bombers, accompanied by orders for prototype heavy bombers from both Handley Page and Vickers Limited.

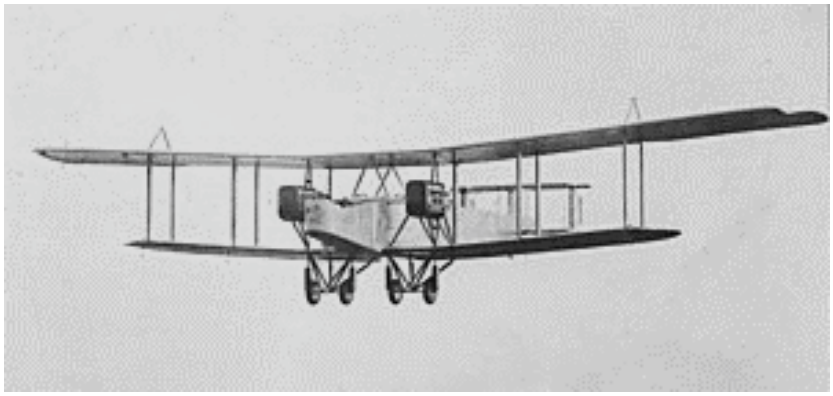


Figure 3. The Handley Page O/100 in flight

The Handley Page Type O was the largest aircraft then available in the UK and one of the largest in the world. Revision of the O/100 led to the hugely successful O/400 bomber. It could carry ordnance up to the 1,650 lb bomb, the heaviest used by Britain during the war. Charged with attacking enemy industrial targets, up to 40 O/400s flew in mass formations, arguably the first true strategic bombing raids in history. Some military leaders saw the O/400s as the future of waging war.

Figure 4. Handley Page O/400

Figure 5. Handley Page V/1500 preparing to fly, 1917

The Handley Page V/1500 was produced to meet the 1917 Air Board requirement for a large night bomber carrying a 3,000 lb bomb load and was nearly capable of bombing Berlin from bases in East Anglia. Three aircraft were delivered to the RAF during October 1918 but no missions were flown before the armistice was declared.

Design and production of the Vickers F.B.27 Vimy prototypes was extremely rapid; the detailed design phase and the manufacture of the three prototypes was completed within four months. The first prototype was dispatched in January 1918 to the RAF for the official trials. Reportedly, it quickly made a positive impression as it was able to take off with a greater payload than the Handley Page O/400 despite having about half the effective engine power.

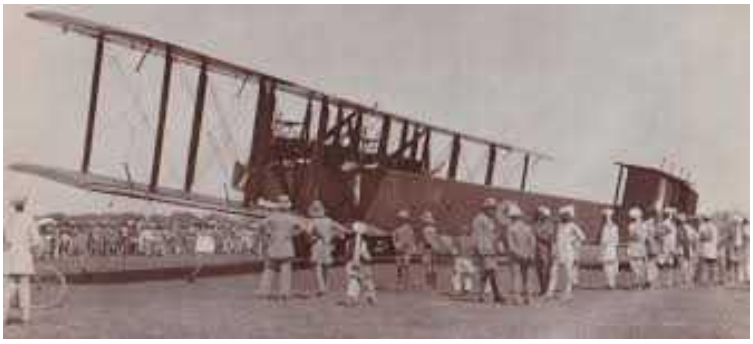


Figure 6. Handley Page V/1500 at Ambala, India

Figure 7. Vickers Vimy, 1918

2.1 British aircraft design and production in wartime

The massive growth in wartime demand for aircraft of all types led to shortages in critical components, chiefly aero engines which – before the arrival of mass-produced 'Liberty' engines from the US – were produced labour-intensively in small production batches. By 1916 the lack of co-ordination between the RFC and the RNAS, particularly in procuring engines, led to serious supply problems. In February the government established a standing joint naval and military committee to co-ordinate both the design and the supply of materiel for the two air services. This Joint War Air Committee lacked any executive powers and proved ineffective, so in May it was recast as an Air Board under heavyweight political leadership, the first chairman being a Cabinet minister, Lord Curzon.

While the Air Board retained responsibility for policy, programme and design, the supply and inspection of aircraft transferred to the Ministry of Munitions' newly established Aircraft Production Department. Following the formation of an Air Ministry in January 1918, responsibility for design also transferred to the Ministry of Munitions. Staff from the Air Board's technical units either transferred or seconded to a new Technical Department to deal with questions of design and experiment. Inevitably, given these constant changes, some disruption resulted.

Aeronautical research in Britain in the early decades of the 20th Century was overseen from 1909 by the Advisory Committee for Aeronautics and centred on two sites, the National Physical Laboratory (NPL) at Teddington in Middlesex, and the Royal Aircraft Factory (later Establishment) at Farnborough in Hampshire.

The National Physical Laboratory was established in 1902 as the UK's principal metrics and standards organisation, as well as applied research while coordinating governmental scientific research with that of industry. One of NPL's earliest areas of research concerned the magnitude and distribution of wind forces on structures such as bridges and roofs. In 1908 these techniques were brought to the study of flight, leading to rapid advances in the efficiency and safety of the aeroplane. During the Great War, activity in aerodynamics expanded dramatically and NPL made major contributions to advances in theoretical and practical aspects of the stability of aeroplanes, airships, kite balloons and parachutes.

The Royal Aircraft Factory,* previously the Army Balloon Factory, reported initially to the War Office and was charged with design of spotter and fighter aeroplanes. It had no remit to manufacture, however, and used subterfuge to continue with production, passing off its output as 'experimental' to overcome strong industry opposition. It played no part in *ab initio* design or production of heavy bombers, which were produced by private constructors under government contracts. The Tarrant Tabor was the only known heavy aeroplane to which the establishment made any significant contribution during and immediately following the First World War.

Britain's first wind tunnel was constructed at NPL in 1903. This was followed in 1907 by the first example at Farnborough, modelled on NPL's design. NPL's 2m by 4m Duplex wind tunnel was completed in 1919. Techniques were developed for testing scale models of wings, ailerons, propellers and of complete models of aeroplanes. As might be expected, there was significant demand for testing time from all the major aircraft constructors, as well as from within the NPL. RAE performed wind tunnel testing of the Tabor, although this was confined to a smaller tunnel. The Tabor was granted limited access to the NPL tunnel in the month immediately before its initial flight in order to validate RAE's test results.

3. AN AUSPICIOUS MEETING

Among the crew of the famous Handley Page O/100 flight to bomb the German battlecruiser SMS *Goeben* (poorly disguised as the Ottoman *Yavuz Sultan Selim*) at Constantinople on 10th July 1917 was Lieutenant Percy Townley Rawlings, DSO, RFC. 'He was manly, open and frank, fearless and honest,' wrote Henry Edmunds, a lifelong friend.

> [Rawlings was an engineer] of an inquiring mind and fond of experimenting... It was at my house at Brighton that Rawlings met Mr W. G. Tarrant, who was spending the weekend with me .... He and Mr. Tarrant were mutually attracted to each other and discussed with much seriousness the construction of a new type of bombing-plane, which eventuated in the Great Tarrant machine.(1)

A King's scholar at Westminster School, he took the Mechanical Sciences exam at Trinity College, Cambridge, in maths and physics. Commissioned into the Royal Engineers Reserve in 1911, he was posted to the Public Works department of Sudan as Assistant Resident Engineer. In

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* In 1918, co-incident with creation of the Royal Air Force and to avoid confusion, the Royal Aircraft Factory (RAF) was renamed the Royal Aircraft Establishment (RAE). For convenience, RAE is used throughout this document.

1913 he became Engineer to the Egyptian Irrigation Service on construction of the Blue Nile dam. At the outbreak of war, Rawlings returned to the UK and was posted to the Royal Engineers, attached to the British Expeditionary Force. The following year he was promoted lieutenant and transferred to the Royal Navy Volunteer Reserve for engineering duties with the RNAS, where he spent the remainder of his wartime service. Shortly after their initial encounter, Rawlings joined Tarrant to work on the bomber project. Later appointed Managing Director of Tarrant's aircraft manufacturing company, he devoted his energies to carrying out the work of the design and construction of the 'Great machine.'

Walter George Tarrant was an imposing figure, over six feet tall, and was said to have a striking resemblance to King Edward VII [Tarrant's paternal grand-daughter told the author that Tarrant and the King would meet to smoke cigars together.] A self-made man with sound Christian principles and equally strong views on how to manage men, he was one of the most influential and prolific builders in Surrey in the first third of the 20th century. The term 'Tarrant-built' came to indicate an exceptionally high standard of material and workmanship. He embraced 'vertical integration', and his operations included workshops for joinery, wrought iron, lead lights and iron casement work. He produced his own bricks and tiles from his local clay pits, sourced all his own timber, and his new houses' gardens were graced with plants supplied from his two local nurseries.

Figure 8. W G Tarrant in his study, 1918

Figure 9. Tarrant's female employees at the hut assembly depot outside Calais, June 1917. © Imperial War Museum Q6763 from Wikimedia

In addition to his building works, Tarrant's construction company specialised in the production of 'Tarrant Huts', three types of portable, pre-fabricated wooden building. By October 1914 he was under contract to the Director of Works (France) to build huts for the British Expeditionary Force. In 1916, when the shortage of timber and labour in France had become acute, he trained women carpenters at his works in Byfleet to build the huts, which were then dismantled and shipped across the Channel, while the women travelled to France to reassemble them. Bought by the army to house 250,000 men, 80,000 horses and 100 hospitals on the Western Front, some 37,000 huts were erected over 18 months by the end of 1918, generating profits considerably over £1 million. (2)

Figure 10. Tarrant huts for hut assembly staff, Calais, France 1917

Tarrant told the Air Board in January 1918 that

> in addition to my various French operations I have every necessary facility for carrying out very large building operations. This business is a very self-contained one. I have here one of Ransom's largest sized band sawmills which converts huge quantities of timber every week. I have also seven ordinary sawmills going within a radius of 10 or 12 miles, converting timber. Also, I have all my own transport consisting of over 60 horses, three traction engines and several motors.(3)

3.1 Leviathan born

After the outbreak of war, Tarrant's introduction to the aeroplane industry arose through his interest in design and construction of aeroplane wing spars, utilising techniques devised for his huts. He invented and patented an ingenious method of building these and soon saw that his idea was applicable not only to the wing spars but to other parts, notably the fuselage. In 1917 he secured a UK patent for lattice-braced circular girders for use in large aircraft.(4) He built experimental wing and fuselage sections utilising his new methods to demonstrate their potential. In confident anticipation of success, he also laid the foundations for a new assembly building at Byfleet, from which he hoped his war-winning aeroplane, a 'leviathan of the air' would emerge.(5)

In early autumn of 1917, Tarrant began to assemble a team for his bomber. He appointed Emile Bouillon to manage his Aviation department, along with Belgian engineer Marcel Lobelle. By November, Tarrant had also completed the enlargement of his works, and was now ready to install the machinery necessary for aircraft production. Under wartime restrictions, a private venture of this kind could succeed only with official sanction, which Tarrant now set out to obtain. On 8th October he contacted Wing Commander Alexander Ogilvie, Head of the Design

Branch in the Technical Department of the Air Board. He followed this with a letter the next day, enclosing a plan for a multi-engine aeroplane and reminding Ogilvie that he had 'a small but exceptionally good staff' in his design team and buildings nearing completion in which to construct the machine. Tarrant added,

Figure 11. 'Alec' Ogilvie in his Wright biplane, about 1909

> In the event of the machine not being acceptable, I should then be willing to devote the works and machinery to the production of ordinary aeroplanes. I agree this in order to remove any obstacles that may be in the way of granting permits for machinery at this stage of the design. My works here, with the additions I have recently made, would be sufficiently large to enable me to turn out at least two or three machines a week, and I have a site and all necessary material ready for a very considerable further extension.(6)

This came to nothing, however, as on 16th October, Ogilvie replied

> With reference to the design submitted by you for a large multiple engine aeroplane … I am directed to inform you that the same has been carefully examined, and to regret that it is not possible to recommend any further action with reference to this particular design.(7)

Tarrant was undaunted. He set his team to redesign the proposed bomber and on 6th December he telephoned Ogilvie, seeking his advice and support for a new proposal. He followed this up the next day with two letters, the first to Ogilvie. 'May I please take it that this machine is so unlike the old one that there is no relationship and treat it as a new design ...' Evidently he did, as the letter on file has a handwritten note by Ogilvie, commenting 'Agreed as above with Mr Bouillon on his visit to [this department] 11.12.17.' (8)

Tarrant's second letter was to Sir William Weir at the Ministry of Munitions.

> I am taking the liberty of enclosing you plans of the aircraft factory that I have designed. I shall be greatly obliged if you can kindly give me an opportunity of explaining these plans to you personally. The factory is especially designed for the output of a new Bombing machine, the plans for which I yesterday had the pleasure of submitting to Wing Commander Ogilvie. It is of course not yet certain that these will meet with his approval, but I feel that the factory has merits of its own that I should much like the opportunity of putting to you.(9)

Also on 7th December, Bouillon wrote to Ogilvie.

> We have started also the construction of a complete full-size sample of monocoque fuselage… using the process of helicoidal laths covered with doped canvas. Thanking you again for the trouble you have taken in going into the designs and for the advice you have given us." (10)

Tarrant was not averse to hedging his bets, so on 11th December he wrote to General Hugh Trenchard, Commander of the RFC in France, offering him a visit when next in England to inspect the new factory and unique construction methods.(11) The reply from Trenchard's Deputy Adjutant and Quartermaster-general, Brigadier-General Robert Brooke-Popham on 14th December was terse.(12)

On 1st January 1918, Tarrant again wrote to Ogilvie, submitting amended drawings embodying his suggestions and alterations.

> I hope you will be pleased with the result. In several ways, the alterations enabled me to introduce improvements beyond those you indicated … I have [also completed design of] a factory, allocating space for every part to be in hand in sufficient numbers to enable one complete machine to be turned out each day.(13)

He took the opportunity to remind Ogilvie of his record of success and his use of female labour – of particular significance in wartime, adding,

> During the last 18 months we have completed almost every one of our [shed construction] contracts to time … we have carried out over 100 contracts, most of them under very trying conditions in various parts of France. I think this speaks for itself.
>
> I would like to mention that the work I had already carried out in training women as carpenters, etc. has given me very considerable experience as to how to handle women labour so as to develop their strength, keep the work interesting and so get the utmost possible results from their labours . … I am satisfied that I can organise for the greater part of this work to be performed by women. (13)

On 7th January Tarrant met with Ogilvie and the Assistant Director General of Aircraft Production, and was promised an order for an experimental fuselage to test his design.(14) Ogilvie reported to his staff later that day

> Mr Tarrant has been working for some six months under our general supervision. Mr Tarrant is a building contractor by profession and appears to have a genius for applying simple principles of construction to light structures … He is very anxious to start in a large machine for bombing and has gradually, with our criticisms and assistance, evolved a machine which is a possibility.(15)

By 30th January, word of the Tarrant machine had reached Sir William, an advocate of retaliatory raids on Germany since 1917. Weir instructed Ogilvie to work with Tarrant and "… put me up a scheme of building 20 machines of very long-range equivalent to the Belfast* machines to be ready by end of August. All woodwork can be got from present facilities. We will also provide assembly facilities. Engines can only be Liberty† or Matebile‡ (*sic*)".(16)

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* -- A proposed heavy bomber carrying 8,000 lbs of fuel and 2,000 lbs of bombs capable of reaching Germany. There is no record of its operation or disposal.

† -- The Liberty engine was commissioned by the United States Government's Aircraft Production Board in May 1917. Designed in only five days, it became one of the most produced and successful early American aircraft engines, and was specifically intended for easy mass production. More than 20,000 were made between 1917-1919.

‡ -- The Sunbeam Matabele was a British 12-cylinder aero engine first flown in 1918. The Matabele was the last iteration of one of Sunbeam's most successful aero engines, the Cossack.

Four days later, Lieutenant Colonel J G Weir (Sir William's younger brother), Controller of the Technical Department, pressed for actions taken.(17) By the end of January, however, Tarrants had received no contract and were thus unable to obtain equipment and consumables as recognised Aircraft Contractors. Tarrant wrote to Ogilvie, discreetly complaining.

> I feel we are often troubling you with little things. Kindly let me know if and when we can send these little worries to some Junior Department. You will probably remember Colonel Weir said, we might now be given priority orders for the machines, etc. we are requiring. We have several important purchases that we have made application for release, for which we are still waiting and should be greatly obliged if you would hasten this for us.(18)

The two men met to expedite matters, following which Ogilvie informed Sir William that

> The order for the fuselage should be hastened and an order for a design (not a machine) should be placed, G.A.s [General Arrangements] of which have been put before the Technical Department. The working out of this design in full detail will enable the weight and strength of such a structure to be accurately ascertained.
>
> The design will probably take five months and the fuselage should be completely ready for trial in about 2 months.

Ogilvie also recommended that a model of the fuselage should be tested by Gustave Eiffel in Paris before month-end and preferably also by the NPL.(19)

Meanwhile, Tarrant had not been idle. He was pleased to report to Ogilvie that he was recruiting as his Chief Engineer Walter H Barling, hired from RAE. (20) Barling had significant design experience, having joined the RAE's Aeronautical Design team before 1914. He invented the four-bladed variable pitch airscrew in 1915.(21)

The Tarrants contract was raised on 6th February. Fired with enthusiasm, Tarrant promised delivery by the end of March.(22) On 10th February, Bouillon wrote to Ogilvie proposing that tests be performed at the Tarrant works in Byfleet under Ministry supervision to avoid the high costs of transporting the fuselage to RAE at Farnborough.(23) This was agreed.

Bouillon wrote to Ogilvie on 12th February. He agreed to take a model of the bomber to Eiffel's laboratory in Paris but feared that Ogilvie's letter of introduction, referring only to the fuselage, could be rejected, saying '… if the description in the letter does not agree with the model we are going to take with us, we shall experience troubles with the Military Authorities at Southampton.' Ogilvie sent a revised letter by return.(24)

The following week, Bouillon wrote again to Ogilvie:

> With regard to the experimental fuselage which we are making for you … We feel our machine should rely for its defence, not particularly on its ability to manoeuvre with scout-like rapidity, but upon its gun power.* Hence load factors required by such a machine

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* According to the *Aldershot News* of 23rd May 1919, Tarrants envisaged a gunner sitting in front of the pilots to operate two guns. Each pilot would also have a gun. Another gunner could be accommodated immediately behind the top of the wing to fire over the propellers, and one below to fire under the tail. Each could manipulate two guns, totalling eight guns of varying calibre.(5)

> should be considerably lower than is required by a scout machine for the wings and tail, and thus the fuselage. The weight so saved can be used for fuel.' (25)

Tarrants were learning fast, and now had confidence to push back at the Technical Department.

On 12th March, A J Sutton Pippard, Head of Design (C) Section in the Ministry's Technical Department, visited Byfleet to assess progress on the experimental fuselage. He reported to Ogilvie that much time had been lost waiting for irons for the spindling machines required for shaping the strut members. Consequently, Tarrant now estimated that the fuselage would be a month late. In the event, delivery of the test fuselage was further delayed by supply problems.(26)

4. DESIGN OF THE TABOR

4.1 The decision to proceed

Three days later, Ogilvie visited the Tarrant Works and the following day sent a paper to J G Weir.

> A considerable portion of his works and staff are definitely turned over to aeronautical work. He himself is prepared to devote the major part of his time to the aeronautical work and he impresses as a man of great energy, who is prepared to spend a considerable amount of money in order to bring anything which he undertakes to the point of success.
>
> The staff which has been collected now contains some experienced men who are capable of dealing with all points of aerodynamics and construction as they arise.
>
> The designs of two machines are at about the same stage. Mr Tarrant is prepared to go for whichever one is wanted and his staff seemed confident that they can make a success of it.

Ogilvie continued with a close analysis of the best use of the Tarrant designs for day or night bombers.

> The bombing of each other's towns will be in full swing and will be having a really powerful effect on the war … It will be a matter of first-class importance that we should be delivering bombs on Germany at the cheapest consumption of manpower. This will be undoubtedly done by the use of large machines working at night.(27)

Ogilvie considered the high-revving Liberty engine more suitable for lighter bombers, while a geared engine, such as the 600 hp Siddeley or a Rolls engine, was better suited to heavy machines. The Handley Page O/100 could carry about 3 lbs of bombs per hp but was now out of date as regards design. While the possibilities of the heavy night bomber were not yet clear, the HP V type with two 600 hp engines should make a very good night bomber, capable of 4 lbs per hp. If Tarrant's machine could carry four big engines and they could get the machine to be a success, the bomb load should double and 'a great advantage would have been made.'

In his memo, Ogilvie counselled against letting Tarrant proceed with the lighter machine as a precursor to a subsequent heavier bomber, as his particular methods of construction entailed a large number of jigs, and therefore heavy initial outlay. Instead, he recommended giving Tarrant an order for two night bombers, four 600 hp Siddeley engines, and to concentrate all available energies on this combination.(27) Weir endorsed his recommendation, saying, 'I would definitely

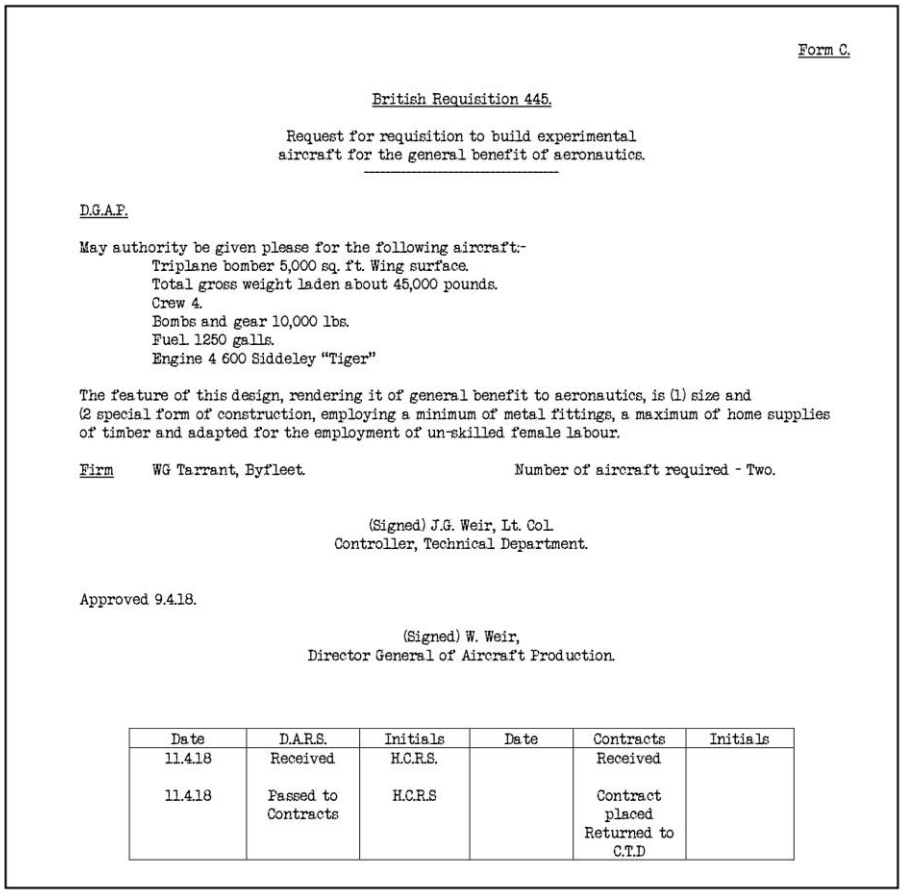
recommend an order for Tarrant for 2 night bombers with 4-600hp engines; the other machines to be dropped.' (28)

Sir William visited the Byfleet factory on 20th March and was impressed by what he saw. He asked Tarrant to submit a proposal to manufacture two 'T1' type aeroplanes in the shortest time, utilising all available resources. Since Tarrants had limited experience of aircraft manufacture, Weir proposed that RAE should help out, writing to Tarrant and directing

> that the aircraft when complete had to be capable of bombing Berlin and returning to England and that all materials employed had to be drawn from home sources with home-grown timber. All wooden parts would be supplied by Tarrants while the Royal Aircraft Factory was to provide the metal fittings, erect, cover and flight test the Tarrant triplane at Farnborough. Provision was to be made for a large proportion of female labour; two machines were to be built at the same time.(29)

Tarrant responded two days later with a proposal that RAE should lend him 22 locally based draughtsmen and six tracers for three months, plus take responsibility for providing virtually all non-wooden elements of the two machines, plus covering and doping them.(30) He further proposed that assembly should be in a section of the Airship shed at Farnborough, with a height clearance of at least 35 ft. He requested land at Farnborough on which to build six huts for the draughtsmen, which Tarrants would provide and assemble. This was agreed, so the way was clear for Tarrant to design two machines, the production of which would commence as soon as the demonstration fuselage had passed all required tests.

The requisition for two type T1 machines was raised in early April. Interestingly, Weir approved a Class C requisition on the Ministry of Munitions.(31) This class was for experimental machines and components of general benefit to aeronautics rather than specifically for the military. Weir presumably considered it inappropriate to tap the military budget in view of the recent large order for Handley Page and Vickers bombers. The minimal use of metal components and a largely female labour



Form C.

British Requisition 445.

Request for requisition to build experimental aircraft for the general benefit of aeronautics.

D.G.A.P.

May authority be given please for the following aircraft:-
Triplane bomber 5,000 sq. ft. Wing surface.
Total gross weight laden about 45,000 pounds.
Crew 4.
Bombs and gear 10,000 lbs.
Fuel 1250 galls.
Engine 4 600 Siddeley "Tiger"

The feature of this design, rendering it of general benefit to aeronautics, is (1) size and (2 special form of construction, employing a minimum of metal fittings, a maximum of home supplies of timber and adapted for the employment of un-skilled female labour.

Firm WG Tarrant, Byfleet. Number of aircraft required - Two.

(Signed) J.G. Weir, Lt. Col.
Controller, Technical Department.

Approved 9.4.18.

(Signed) W. Weir,
Director General of Aircraft Production.

Date	D.A.R.S.	Initials	Date	Contracts	Initials
11.4.18	Received	H.C.R.S.		Received	
11.4.18	Passed to Contracts	H.C.R.S		Contract placed Returned to C.T.D	

Fig. 12 The internal requisition for two Tarrant type T1 bombers

force were cited as particular features of this experimental machine.

Under the 'experimental' contract, Tarrants was to fund design and construction, sub-contracting to RAE for all work that it undertook on behalf of the company. The Ministry would pay the costs of testing incurred by RAE and also reimburse Tarrants on accepting both machines. As this was an experimental project, the contract was at cost. To ensure that costs were controlled, the Ministry would monitor design and construction closely and pre-approve all major purchases. Tarrant wrote to Weir, confirming that 'As of 1st February I am maintaining separate books, indicating the costs I am incurring on your behalf.' (32)

In common with many such projects at the time, the contract was not well defined. A standard *pro forma* document was probably used, with little by way of contract-specific detail included.* This caused considerable difficulty at war's end when the Liquidation & Disposals Commission, tasked with terminating thousands of contracts, found that in many cases the various contracting parties' liabilities were arguable.(33) The Tarrant contract was a case in point. It was not clear who would be responsible for flight-testing. Was it RAE, as Weir's letter to Tarrant seemed to imply, or the Ministry? The precise point of transfer of financial liability – before or after the first flight – was ultimately thrown into sharp relief by the accident on 26th May 1919.

With major work about to commence, Tarrant was keen to keep his project a secret, at least until the plane was nearing completion. Ogilvie concurred, not only for reasons of military security but also because he did not want Tarrant or his design team distracted by advice from third parties.

Accordingly, on 16th April he suggested to Weir that restrictions be put in place to limit access to the Byfleet Works. Following a discussion with Tarrant, Weir declined 'for the time being.' (34) Ogilvie likely felt vindicated when he later reported

> On visiting my home recently, I heard full general particulars of this machine, such as size, engines and power, duration, etc. These particulars were given by a neighbour who is, I understand, a traveller in builders' materials, and were obtained apparently directly from Mr Tarrant.(35)

A suitably embarrassed Tarrant no doubt learned his lesson.

4.2 Availability of resources

Tarrant spent considerable time throughout the first half of 1918 expediting substantial issues of supply with Ogilvie. Obtaining the required 8-9 tons of wood was a significant challenge. Tarrant and his designers wanted Scottish spruce for its high compressive strength but this was increasingly in short supply. Scots pine might suffice but was also increasingly difficult to come by in Scotland. Was pine from the Southeast of England suitable? It was actually found to be superior to the Scottish trees but probably even scarcer.(36) In the event, nothing came of this line of enquiry.

---

* Neither the fuselage and design contract 35A/12/C3, nor the T1 contract 35A/753/C645, has been found

What were the alternatives? Around 15th March, Tarrant and Ogilvie met with responsible officers from RNAS and RFC to review possibilities.(37) Fortunately, one of the advantages of the Tarrant method of construction was that no piece of wood need be large. Tarrant estimated a maximum cross-section of 2 in x 1.5 in. Better yet, wood with small knots was acceptable. Red or white Oregon pine, cypress, and Quebec spruce were each considered but the drawback, aside from lower compressive strengths, was the problem of shipping. Major D B Sanders, RFC, did not foresee difficulties as the wood could be shipped alongside general goods and would be beneficial as flotation aids should the ship be torpedoed. The minutes record no response to this lapse of taste.

The meeting ended without a definitive solution. Poplar looked to be the best timber for all-round construction although Ogilvie was concerned at designing with such a light material and Tarrant considered it unreliable. At least it was available. A few days later, Tarrant drafted a letter to owners of poplar groves that was in effect a requisition. As he needed the Government's imprimatur, he sent it to Ogilvie.

> I am directed by the -------- to cut down before the sap rises at least 500 Poplar trees. You will appreciate that we have only two or three weeks in which to act. I should be so greatly obliged if you would give your consent for suitable trees on your Estate to be cut down at once, the measuring to take place after the trees are down. Full measurement over bark will be given and the maximum price allowed by the Timber Controller will be paid.
>
> It may be impossible to remove the trees for two or three months but if you suffer any loss of crop or damage to surrounding property, this will also be paid . … The trees are required for exceedingly urgent aircraft work and as they have to be used in machines within the next four or five months, you will appreciate the necessity of getting them out before the sap rises.(38)

Ogilvie forwarded the letter to Sanders for consideration by the Director of Home Grown Timber, but in the event this letter was not required as Tarrant managed to secure a local supply of poplar sufficient for immediate needs.(39)

Although Ogilvie accepted that poplar would have to suffice, he continued to investigate alternatives, corresponding with Professor Percy Groom, FRS, Professor of the Technology of Woods and Fibres at Imperial College. Writing on 8th August, Ogilvie informed Groom that

> I have arranged with [Tarrant] that the first two machines to be constructed will in general be of "white wood" of 25 lbs per cubic foot weight and 3,500 lbs per square inch compressive strength, with the exception of the upper rear spars, which it is proposed to construct of a wood giving 6,000 lbs per square inch and with the weight of 32 lbs per cubic foot. The skin of the fuselage is to be of poplar. I should be glad to have your comments on these arrangements.(40)

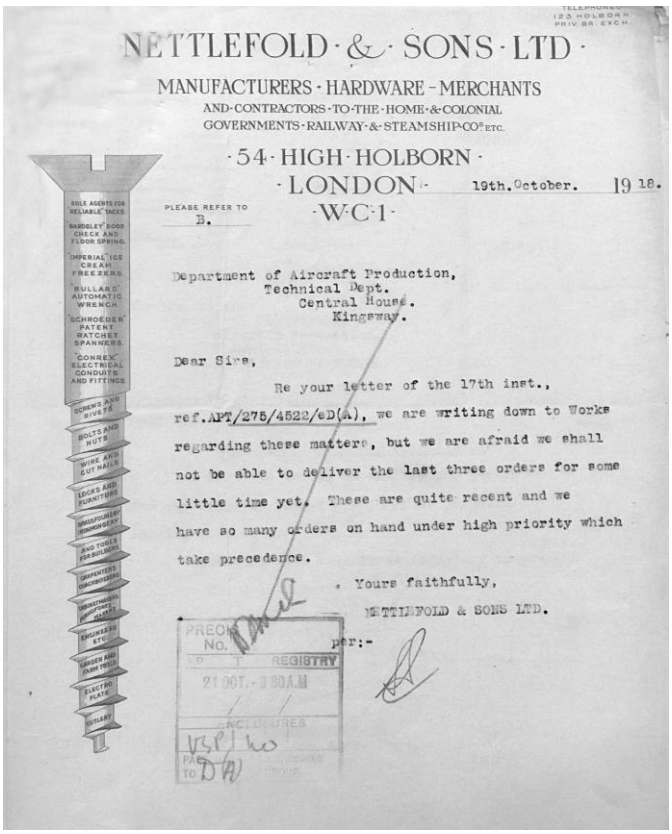
Groom was able to reassure him, but that was not the end of the matter. It was accepted that parts of the machine, particularly the skids and undercarriage, were doubtless best constructed of English ash. Some experts recommended oak for struts, and the debate continued as late as March 1919.(41)

The restrictions of the war-time economy meant that everything necessary for manufacture was either in short supply or tightly regulated. Ogilvie had to approve major consumables such as

screws, wood, and oxygen for acetylene welding. Major items funded by Tarrants outside the contract included lathes, cutting, grinding and nibbling machines, steam glue kettles, a time recording clock, two automated spindle saw benches, a photocopying machine, 200 rolls of Ruberoid roofing material for the new assembly plant, and additional telephone extensions.(42) These all required official sanction by the local Area Clearing House Board (ACHB) or the Area Engineering Board, and Tarrants experienced difficulties with them both. The Boards' directive was to allocate critical resources, minimising unnecessary use. They achieved this by the simple expedient of denial, apparently reasoning that only those with a genuine need would fight for it. An exasperated Bouillon had first written to Ogilvie on this matter on 14th February saying, 'as verbally stated, we understand that the ACHB have made it a rule to refuse release [of orders] to firms where a night shift is not being worked. It is obvious that we cannot in the present stage of our experimental work fulfil such a condition.' (43)

Ogilvie presumably responded to the Board but it is not clear that it subsequently released these orders, as on 5th April E W Wright, Tarrant's London manager, wrote to Ogilvie.

> We are sorry to have to again write you … We understood from Colonel Weir on previous occasions that every assistance would be afforded us in the way of obtaining materials or tools that were necessary. But it appears that every application we make, there seems to be some hitch in the thing going through. We have applied for the release of a 10½" centre lathe and a cutter grinder and I understand from the Area Clearing House Board that no recommendation has been made in support of our claims and they know nothing of the matter whatever.
>
> We experienced this difficulty some few weeks ago and this has meant to us about a month's waste of time through the machines which we purchased not being released.(44)



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· 54 · HIGH · HOLBORN ·
· LONDON · · 19th. October. 19 18.
· W · C · 1 ·

PLEASE REFER TO B.

Department of Aircraft Production,
Technical Dept.
Central House.
Kingsway.

Dear Sirs,

Re your letter of the 17th inst.,
ref. APT/275/4522/eD(A), we are writing down to Works regarding these matters, but we are afraid we shall not be able to deliver the last three orders for some little time yet. These are quite recent and we have so many orders on hand under high priority which take precedence.

Yours faithfully,
NETTLEFOLD & SONS LTD.
per:-

REGISTRY
21 OCT. 9.30 A.M.

Figure 13. Competing supply priorities

Wright asked Ogilvie again to intercede with the appropriate authorities. Ogilvie eventually wrote to Sir William on 1st May, seeking urgent action.(45) An inspector visited Byfleet immediately, his internal memo on 5th May reporting considerable confusion as to actual needs. In particular, 'the firm's engineering shop is not yet in running order and the works manager could not tell what work the [lathe] was required for.' A smaller lathe had been approved and delivered but was not yet in use, and the inspector found that existing machine tools could adequately address other stated needs (an assessment with which the works manager had to agree). For another machine, an order had been made, then withdrawn, and only two days later re-issued. The inspector's memo acknowledged that:

> The importance of the experimental work undertaken by this firm is recognised, but it seems very difficult to obtain from the management a definite statement of the necessary requirements. In view of the above, and bearing in mind the strong support from Sir [Henry] Fowler [Assistant Director General of Aircraft Production] and the Technical Department, we are making further inquiries in order to endeavour to obtain a definite programme of the plant necessary for the experimental work in hand.(46)

Bouillon clearly had more work to do.

It wasn't just the Area Boards, however. Tarrant had to write to the Technical Department, for example, to get sanction for a road map from the Ordnance Survey to enable company journeys between Byfleet and Farnborough.(47) Other suppliers trying to fulfil wartime contracts also had to prioritise their deliveries. Most of these issues were resolved by memoranda to other departments, or letters to defaulting suppliers, pointing out that 'Mr Tarrant is engaged on important contracts for experimental work, and we would be grateful…' (48)

One particular annoying matter was a request in July to the Mineral Oil Production Department for a petrol licence for the company car. Eventually this was granted for use between Byfleet, Leatherhead and Guildford. Wright wrote to Ogilvie pointing out that this was useless, as their centres of operation were Byfleet, Weybridge and Farnborough.(49) No doubt a long-suffering Ogilvie reached for his pen.

Tarrant also found it necessary to write to Ogilvie on 3rd April requesting to expedite the fuselage contract signed with the Director of Aeronautical Supplies, which was still not forthcoming. Tarrant reminded him that: '[My] firm had been obliged to purchase quite a lot of machinery and tools, etc.' (50)

Material resources were not Tarrants only challenge. In March he requested 20-30 joiners be found, but delays in obtaining them meant that by September the backlog of work required upwards of 50 men. Ogilvie sought support. 'I understand from [Tarrant] that he does not require a necessarily very high grade of workman as they are required for making up fairly simple jigs which are just beyond the capabilities of the women that he has trained.' (51)

An attempt to co-opt skilled technicians from the RFC – including some specifically named (Rawlings knew of several) – was rejected, however, following a recent policy decision by the military authorities to withdraw all servicemen from civilian firms.(52) The following day brought good news in a letter from Captain R H Mayo of the Technical Department. 'I now hear from the Labour Authorities that you have in the first instance been allocated super-priority for twenty [joiners], and subsequently priority has been granted for an additional 36, making a total of 56.' (53)

Feeding his new employees was also a problem. Tarrant housed them in huts constructed on site and they took their meals in the works canteen, including those on Sunday which was not sanctioned as a working day. Required to obtain approval for his 1918-19 cheese order, for example, Tarrant asked Ogilvie to intervene once again, resulting in a memo to the Controller, Ministry of Food.(54)

Tarrants' design team sought guidance wherever they could. The first Ogilvie knew of Tarrants' discussions regarding armaments was a minute he received on 14th April from Air Armaments

branch, to which he firmly replied that the 'general scheme of armament rests with me, and in view of the fact that this is a Class C machine and a constructional experiment, it is not desirable to make any definite decisions at the present time.' (55)

This tension was not all one-way, however. Ogilvie was able to write to Colonel John Porte of the Seaplane Experimental Station, Felixstowe in Suffolk with a blueprint and details of Tarrants' method of spar construction, together with an offer from Tarrant.

> I should be pleased for any War Department to use any part of our construction for the duration of the war without any fee or royalty. But I should like some sort of recognition so that I could commence charging royalties after the war, if I thought it desirable.(56)

On 3rd May Ogilvie wrote to Tarrants, formally informing them that 'Tabor' was accepted as the designated name* for aeroplanes F1765 and F1766.(57)

4.3 Construction proceeds

Tarrants were at last able to inform Ogilvie in their 11th May report, the first of a regular weekly series that ran throughout 1918, that they had begun final construction of the experimental fuselage and were well advanced in working up the design of the T1 machines.(58) In his accompanying letter, Bouillon advised that Ogilvie's proposed changes to wing fixings would entail a fortnight's delay as jigs, etc., were reconfigured. He proposed instead continuing with production, suggesting that they could work up the new designs and necessary jigs in the background, in the hope that the production schedule, the new designs, and associated jigs could be married up at a later date. Ogilvie responded immediately, impressing upon Tarrants that 'the evolving of a suitable design of construction requiring the use of no very elaborate dies, jigs etc., is of greater importance than the acceleration of the completion of the first machine by a fortnight.' (59) Ogilvie believed strongly in simplicity of design and construction, a point he was to make more than once as the design advanced.

On 15th July, Lieutenant Thomas M Wilson, who during the war acted as technical expert for the Air Council and Air Ministry on flight preparedness of new types of aeroplanes, observed the destructive test of the fuselage, which failed at a load of 4 tons 8 cwt – four times the minimum required weight.(60) It was observed that failure was due to structural inflexibility, the side that was bradded (nailed) failing before the side that had been screwed. Accordingly, the use of screws was adopted for all subsequent production. On 16th August, Pippard reported to Ogilvie on the past day's structural failure test of the tail skid and two-ply skin, with the skid failing at 4,000 lbs, 3.25 times the worst possible static conditions and the skin showing only 'some distress.' (61) All now looked ready for construction of the T1 design.

The design that Tarrants first drew up was for a biplane of unprecedented size, fitted with four 43.5 litre water-cooled Siddeley Tiger engines then in development, arranged in co-axial push-pull pairs at mid-gap, each intended to produce 600 hp of thrust. This configuration offered substantially reduced drag on the rear engine compared to engines mounted side by side. It also

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* It is not known why Tarrant chose this name, alliteration aside. It may have had some association with the Tabor Methodist chapels, prevalent in South Wales, where Tarrant took holidays. Mount Tabor was the site of a significant Old Testament battle and also of Christ's transfiguration.

avoided the need for stronger outer wing spars. Although the rear engine in this configuration lost 20% efficiency due to the disrupted airflow from the front engine, reduced drag significantly outweighed this loss of performance.

The huge fuselage, 73 ft long and 10 ft in diameter at the cockpit, was a streamlined, cigar-shaped monocoque structure, which carried a tail unit comprising three horizontal tailplanes and two rudders. The tail assembly was itself the size of a scout plane. The wings were conventional in construction, based on the Royal Aircraft Factory 15 aerofoil, but of enormous dimensions. At 131 ft the top wing was almost 33 ft greater in span than the bottom wing, while the gap between the wings was 14 ft 9 in. As an excited *Aldershot News* later told its readers in a lengthy report, 'By its enormous size and possibilities, it has created an epoch in aviation.' (5)

The initial design was refined through a series of iterations over several months assisted by the Technical Department. Analysis showed, for example, that the pilot's forward view only extended to 20^{o} below the horizontal, dangerously limiting during landing. Accordingly, the cockpit was brought 6 in further forward, affording a 40^{o} downward view.(62)

Figure 14. The design staff at WG Tarrant of Byfleet, Surrey, in March 1918. A bearded W G Tarrant is centre back. The shorter man to his immediate right is Walter Henry Barling.

By late April 1918 it was known that the planned Tiger engine was beset by problems – in fact it would not be delivered before 1920 – so at the Ministry's request the design was changed to accommodate 600 hp Napier Lion engines instead.(63) The Lion entered production in June 1918, with the first 24 litre versions delivering up to 450 hp, making it the most powerful Allied aircraft engine, surpassing the Liberty L-12.

Barling asked the Ministry to approve acquisition of a prototype Lion to enable his production designers to mock up the engine installation.(64) The Ministry authorised early supply of the two available experimental engines, but when the engine logbooks arrived Barling found that bench tests showed they produced only around 400 hp. A testy letter to the Ministry resulted.(65) Following the Napier representative's visit to Byfleet shortly thereafter, the Technical Department was able to tell Barling that Napiers hoped to be able to fit new induction pipes to the engines to get the desired extra power.(66) In the event, only 450 hp was ever attained.

Work to develop the design to lower levels of detail progressed through the summer, closely monitored by the Technical Department with occasional inspections by other Ministry teams. By 3rd June, Ogilvie was able to note that 'Tarrants have given about 400 details drawings to RAE. Means fittings will now go faster, probably by end of this week complete wing fittings, controls and tail fittings.' (67) The proposed main plane fitting was found to be prohibitively heavy, however, and Ogilvie advised that it would be necessary to adopt some other system. He took the opportunity in his letter of 7th June to '… impress upon you once more the absolute necessity of keeping the whole of the work on this machine as simple as possible.' (68)

4.4 Design concerns

A visit on 27th July from the Ministry's Criticism of Construction section highlighted that 'rudder control is insufficient to keep the machine on a straight course, if two engines on one side break down. This lack of control is due chiefly to the fact that the fin and rudder area is entirely outside the slip stream of the propellers.' (69) Tarrants responded on 9th August, challenging the need to design for such a freak occurrence and warning that to do so would probably require incorporating an adjustable fin in the centre of the machine. Would Ogilvie confirm that the rudder would balance the lost thrust of one engine only? In this regard, Tarrants argued that 'we purposely arranged the fin and rudder to avoid the slip stream as it is our experience that sometimes, turning effects occur due to this cause and any such effects might easily be impossible to overcome by any simple means in a machine of this size.' (70) Nothing more came of this issue at the time but it would resurface in the months before first flight.

Over the summer, an internal memo to the Controller, Aeronautical Supplies sought early decisions on a number of outstanding issues likely to govern the Tabor's final design. One of these related to flight distance, hence fuel requirements and the Tabor's overall weight. 'It is suggested that these machines, if successful, will be operated from the coast of Norfolk against the Hamburg district or from the coast of Kent against the Duesseldorf district … a distance of 300-350 miles.' (71) On 14th September the Technical Department reported on a comparative assessment of the Tabor with respect to the Handley Page V/1500 bomber.(72) It concluded that with the present engine configuration and overall weight the Tabor would be inferior in range, speed, and operational ceiling over target. Tarrants' designers set about finding a solution to this unexpected problem. They could not achieve miracles, however, and in order to bolster the power/weight ratio Tarrant had to write to Ogilvie a month later, asking for permission to install a further two Lion engines, adding another 900-1,000 hp of thrust. He also proposed to add a third, upper wing. This would have the same dimensions and structure as the bottom wing, bringing the Tabor's area of wing and control surfaces up to an enormous 5,800 sq. ft.(73)

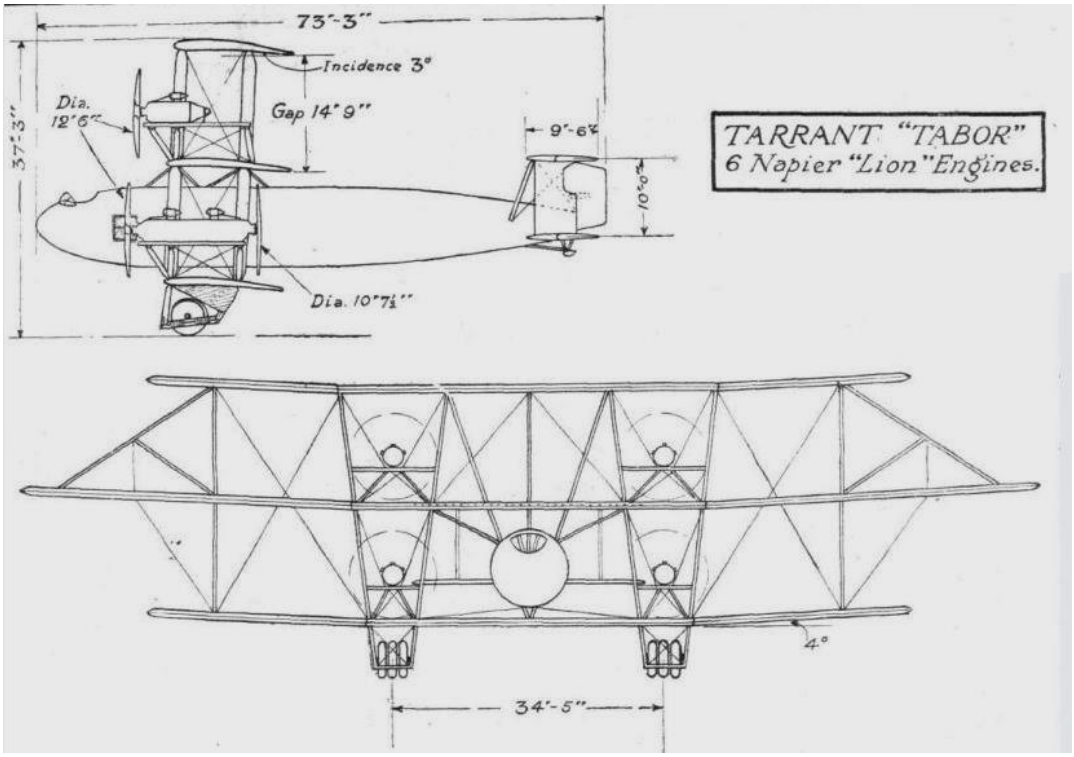

Figure 15. Plans of the Tabor with third wing and six Napier Lion engines

Although almost 50% heavier than the Handley Page V/1500 – 13½ tons empty and 22 tons fully loaded – it was now expected to be able to carry a total armament load of 5,030 lb reaching 30% farther, thus bringing Berlin safely within range. With a total power approaching 3,000 hp, the aeroplane would keep to the air with only two engines running, a substantial margin of safety.(5)

On 26th September, RAE reported to Ogilvie that work was well in hand. Practically all the metal fittings had been made, while fabric work and doping of the top centre portion was proceeding. Other portions, including the fuselage, were expected during the next fortnight and erection of the machine would commence as soon as they arrived.(74)

A month later – 23rd October – Tarrant wrote reassuringly to Ogilvie, saying 'I am having CG [centre of gravity] found again, so that we can tell exactly what to do as soon as you can say if we can use six engines or not. We find we need not lower the engines, so very little alteration will be necessary.' (75) Approval for six engines was given shortly thereafter, and Tarrants were able to report on 2nd November good progress with the fittings for the six engines, most of the details for the metal parts having been drawn. As regards the second machine F1766, all the woodwork for the contract would be completed and dispatched by the 28th of the month.(76) Mounting the upper engines so far above the centre of gravity was unusual, but Tarrants' designers were confident that downdraught from the upper wing would act on the tail to keep it down. This might be possible when in full flight, but what of the takeoff run? Tarrants were confident that the top engines would only be needed in flight, and that the elevators could be used to counteract any tendency for the tail to rise.(77)

Tarrants advised Ogilvie in the following weekly report of 9th November, that 'Design and detail drawings have been considerably hampered on account of more than 50% of our Technical staff

being away with the epidemic.' [78] This was the second wave of the so-called Spanish 'flu, on its way to killing an estimated 20 million people worldwide.

Two days later the Armistice was signed, and production work halted temporarily. In the meantime, since the Tabor's design had been altered to take two additional engines, the Admiralty Air Department commenced a 6-8 week project at the Technical Department's request to check the machine's structural strength.[79] Letitia Chitty, an undergraduate mathematician on secondment to the Air Department and reporting to Pippard, was given this task. Given the lower compressive strength of the 'white wood', the Tabor's designers had to increase the dimensions of certain components and thus the overall weight. Chitty's analysis confirmed that the giant machine was physically sound. Whether she doubted the Tabor's operational viability at that time we do not know but she later recalled

> Mr. Tarrant was an inspired timber merchant who dreamed of a super-Camel. It hadn't a chance. It was too big, too heavy – that wasn't its fault, but Grade 'A' spruce had by now run out and it had to be built of white wood. In my language [a compressive strength of] 3,500 instead of 5,500 lb/sq in.[80]

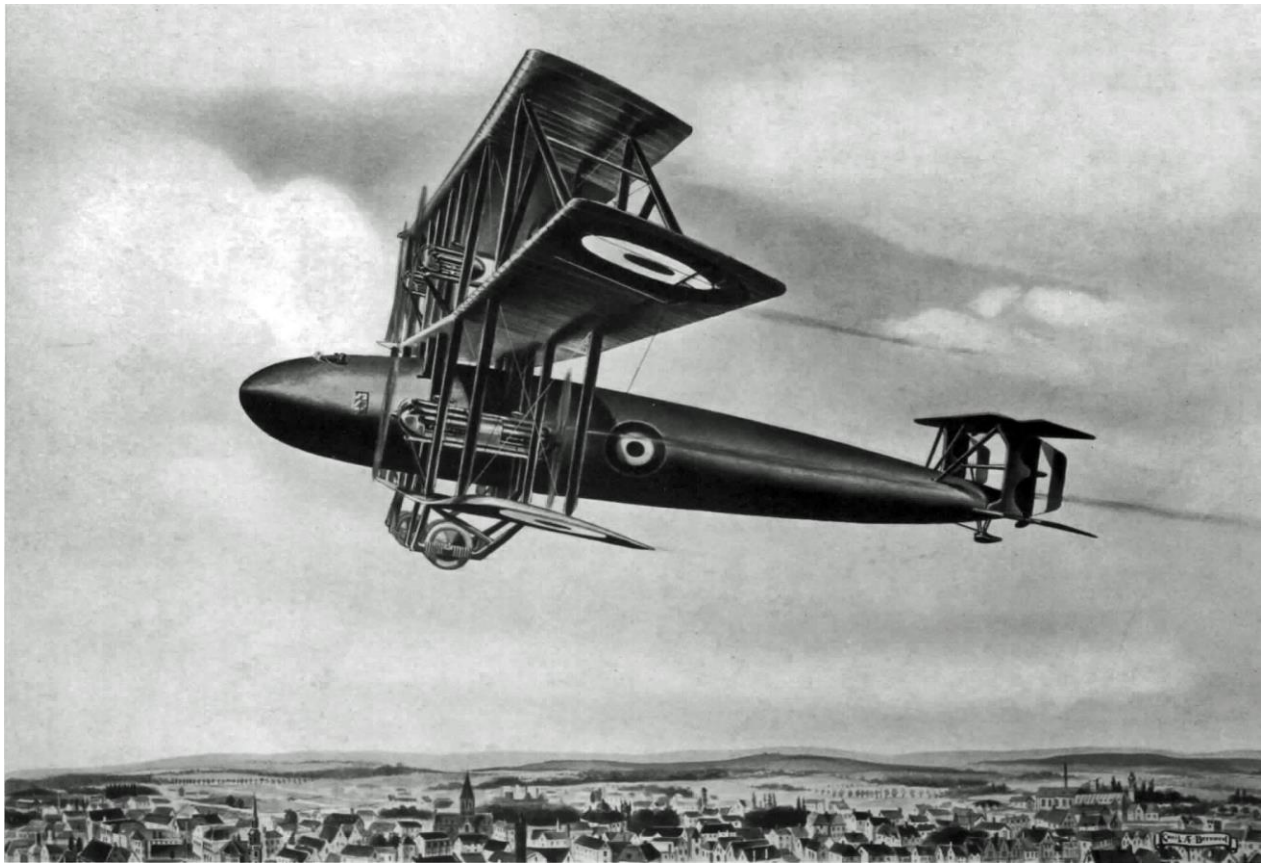

Figure 16. Artist's impression of the Tabor in flight. The pilots may just be seen in their open cockpit

The war was over but Tarrant was not deterred. The Tabor might still be a great means for England to preserve the peace of the world, and he hoped that his triplane *would* in fact be a help to this end.[5] An exciting new field was also opening up for commercial aircraft. The Tabor was still the biggest aeroplane in the world, capable of carrying almost 100 passengers as far as Bombay with but a single stop. It could be a forerunner of a whole fleet of airliners spanning the Empire. There was official enthusiasm for Tarrants' re-conception of the Tabor as a transport

aeroplane, and construction on the first Tabor recommenced. Hitherto, the Tabor's existence had been an official secret. Now, on 13th March 1919 Major General John Seely, Under-Secretary of State for Air and Vice-president of the Air Council,* made passing reference to a giant transport aircraft when introducing the 1919-20 parliamentary Air Estimates.(81)

5. BUILDING THE TABOR

The Tabor's construction was primarily wood with conventional strut-braced staggered wings.† The monocoque fuselage comprised four sections, covered throughout by a skin made of two-ply veneers, protected by doped fabric. For the fuselage, Tarrants developed a special form of longeron of the Warren girder type, which had normally been applied to metal structures, but offered the advantages of strength and lightness. As a result, the inside of the fuselage looked like the skeleton of an airship and was free from internal bracing. Using circular girders of decreasing diameter, the nose was brought to a cone, a significant improvement on the 'boxy' high drag front ends of earlier aeroplanes such as the Vimy and V/1500. Somewhat surprisingly, the cockpit containing the pilot and co-pilot positions was open to the elements, a considerable drawback on long international flights.

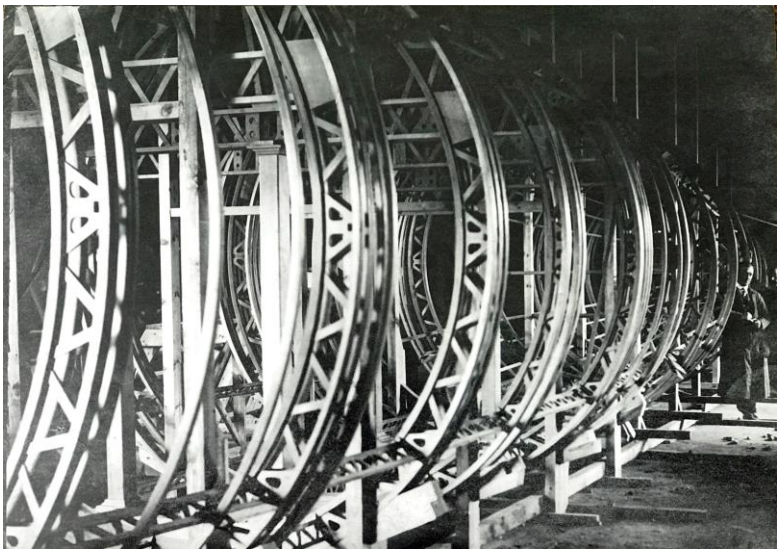

Figure 17. View of the interior framework, looking from the mid-section to the rear. Note a longeron running along the bottom of the frame

RAF Museum

Immediately behind and below the cockpit and partitioned by a bulkhead was the engineer's station, from which he could monitor the engines and, if necessary, climb out onto the wings via side hatches to maintain the engines. Aft of the engineer's position, located over the centre of gravity were the fuel tanks, contoured to the round fuselage section. Various other crew positions were situated about the fuselage. (Originally Tarrants had anticipated a crew of five or six, but in peacetime a crew of four would suffice.)

In between the bottom and middle wings, the two pairs of two 450 hp Lions were mounted back-to-back in tractor-pusher combination while between the top and middle wings a single pair of tractor Lions were fitted. Two-bladed 12 ft 6 in propellers were used on the four tractor engines, while each pusher turned a four-bladed 10 ft 7.25 in propeller, all manufactured by RAE. The additional Lion tractor engines were mounted directly above the lower pairs.

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* Winston Churchill, Secretary of State for Air, was President of the Air Council.

† For a complete description, see *Flight*, 8 May 1919, pp.592-3 and *Flight*, 15 May 1919, pp.626-632.

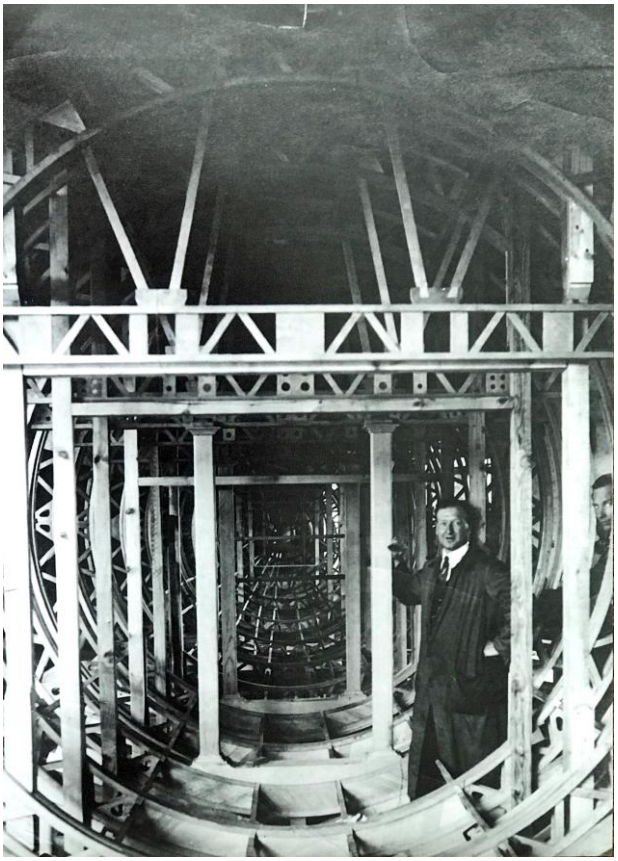

Figure 18. Forward section, looking aft. The uprights are temporary supports

RAF Museum

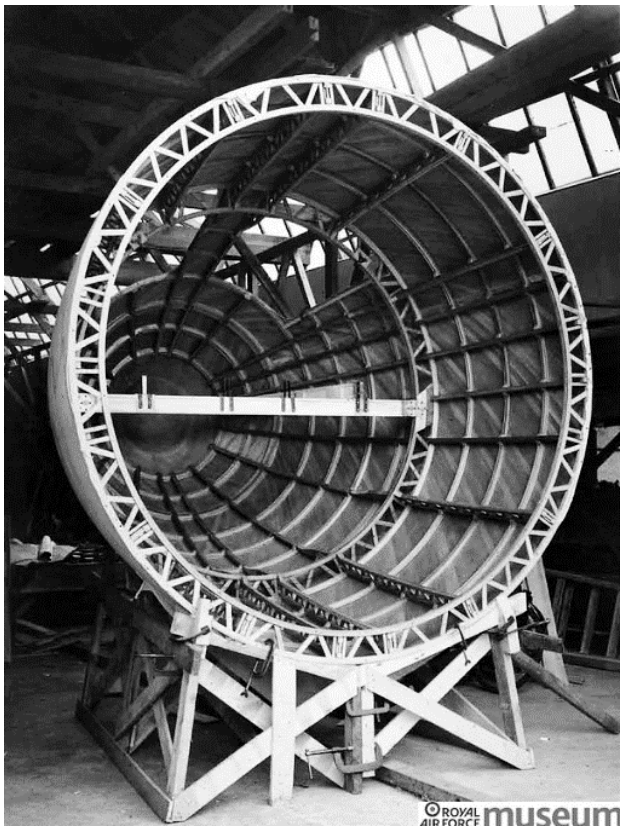

Figure 19. The Tabor's nose section, skinned and ready to be mated to the main fuselage

RAF Museum, X003-2602/16771

Diagonal centre section struts passed from the upper wing through the central wing to meet on the aircraft's centreline below the fuselage on the lower wing, thereby forming, in effect, the section of a huge Warren truss of great strength. The tail assembly comprised two rudders and three tailplanes, the lowest of which incorporated a horn-balanced elevator to which the middle tailplane was slaved. A trimming elevator on the top tailplane was actuated from a hand-wheel in the cockpit.

The undercarriage comprised two massive structures, each carrying three 5 ft diameter rubber-tyred wheels on a 6 in axle. With each wheel assembly attached by struts directly beneath the engine mounting inter-plane struts, the landing loads were distributed directly between the three wings and provided a wheel track of no less than 31 ft 5 in.

The Tabor was projected to carry sufficient fuel for a flight of 33 hours' duration at a speed of 100 mph. The petrol supply from the main tanks would be pumped to the carburettors by an air-screw pump, a constant head being kept on the system by a branch pipe leading to a small header tank situated in the top wing. The surplus pumped fuel would overflow into this tank and return to the main tanks by gravity via a drain pipe.(82)

The interior of the aeroplane and the cockpit were reached through a porthole door situated halfway along the length of the fuselage, a distinct advance to the other large aeroplanes where there was some danger of being struck by the propeller when entering the machine.

Electricity generated by a propeller-driven engine or from accumulators provided interior lighting. Fans kept the fuselage ventilated and free of fumes, and there was provision for six glazed windows in the body.

The great overall height (37 ft 3 in) and wingspan (131 ft 3 in) exceeded facilities at Byfleet so, as agreed, assembly moved to the giant 'C' Shed at Farnborough. The fuselage and inter-wing struts had arrived from Tarrants on the 22nd October 1918 and the wing centre sections on 26th October.(83) Rawlings also arrived at Farnborough at this time to establish himself there for the duration.

Assembly of the Tabor was a major undertaking involving many dozens of engineers and fitters from late November through to early April 1919. The man responsible for assembly was John Grosert, section head in charge of RAE's Aeroplane Erecting Shop. Majors H Grinsted, Controller of Experiments, and G B Turner, Engineer in Charge of Production (both reporting directly to the RAE Superintendent Sydney Smith) gave considerable assistance on stress and structural problems.(84)

Wilson visited Farnborough on 29th November to inspect various parts of the machine. He found the fuselage in position and the lower wing covered and ready for installation, and the centre wing awaited covering and chassis parts were ready for assembly. He had only two criticisms: the lugs securing the struts to the wings were overlong and liable to excessive vibration, and the structure securing the undercarriage to the cross-beams was too weak. The former was readily resolved; the undercarriage became a recurring concern.(85)

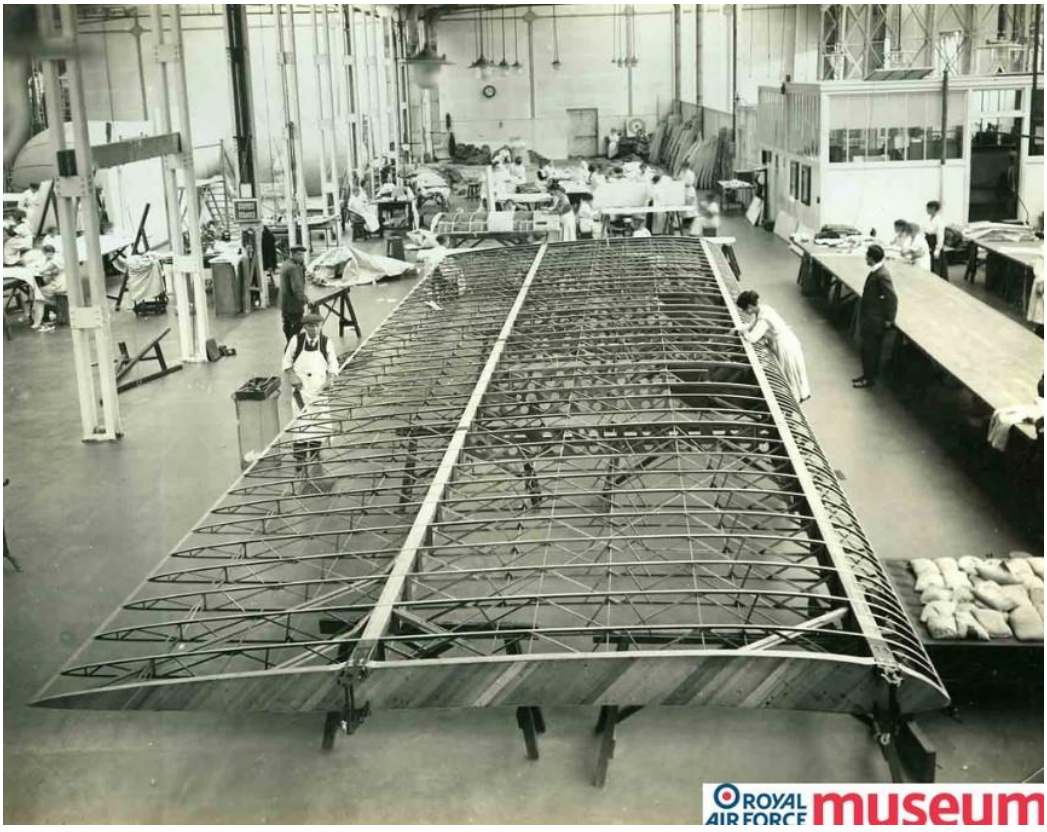

Figure 20. A port main wing section undergoing final inspection at RAE, prior to skinning with fabric. J Grosert is centre right

RAF Museum, X003-2602/16772

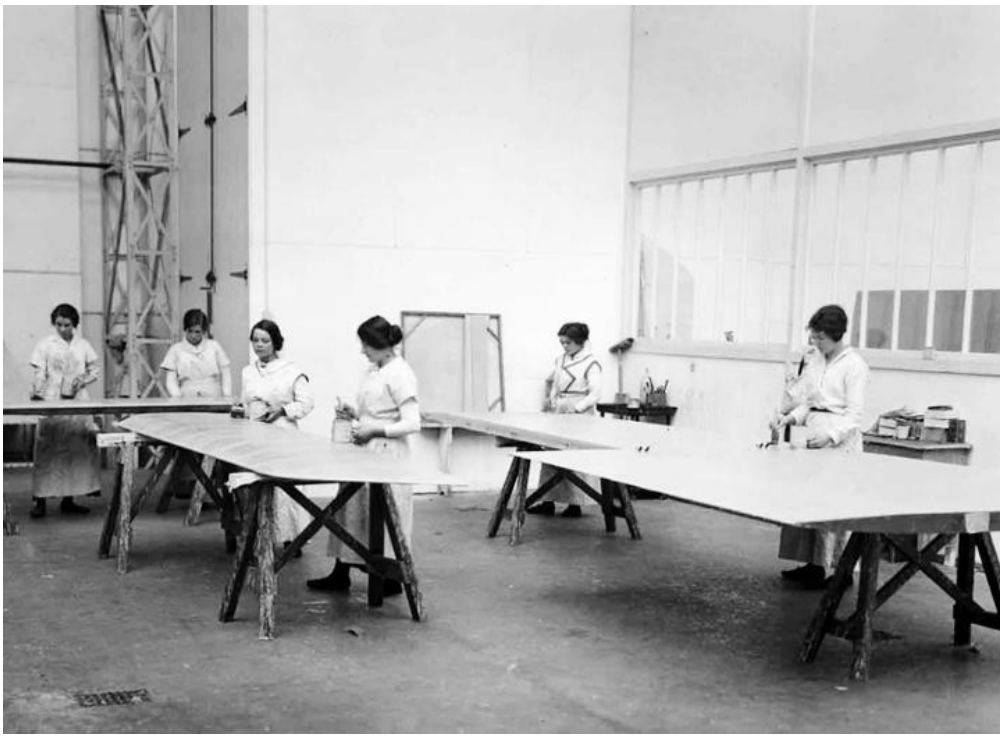

Figure 21. Doping sections of the tail assembly by hand
RAF Museum

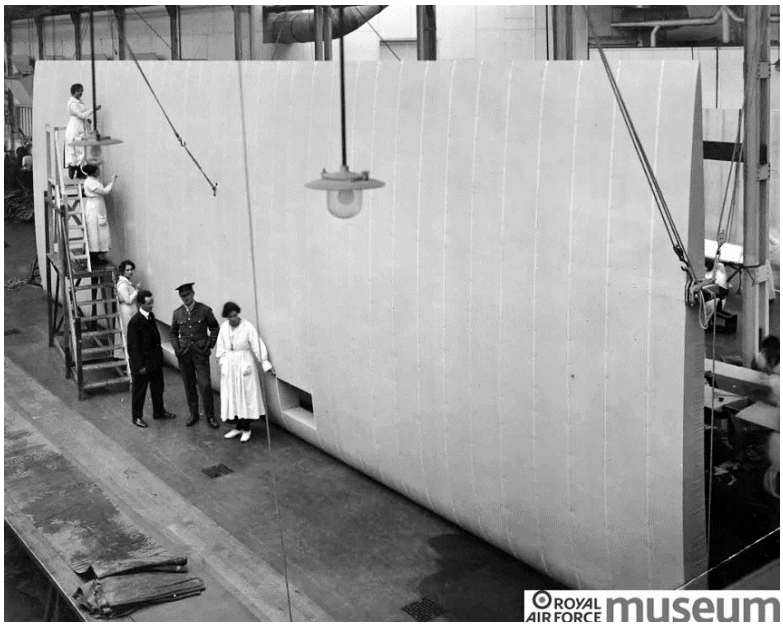

Figure 22. A wing centre section receiving touch-up doping at RAE. The officer with J Grosert is believed to be Captain Wilson
RAF Museum

Work also progressed on erecting the second machine, F1766. The fuselage was assembled and most parts were fabricated. Tarrants anticipated that the first machine would fly by June, and the second, by now half complete, about two months later.(86)

5.1 Static Testing Results

At this point, however, Tarrants received bad news. On 2nd December, RAE conducted a static test of wing spar strength. Ogilvie wrote to Tarrant next day.

> The ribs of this aeroplane failed under test at the Royal Aircraft Establishment yesterday with a load of just over three times normal. I think that you will admit that this result is unsatisfactory, and I shall be glad to receive your proposals for modifying the design. The wings already built will, of course, need some strengthening and I should also be glad to hear what you propose in this connection.(87)

According to the 1918 letter from Sir William Weir, RAE was responsible for all testing of the Tabor, which would be free of charge to Tarrants. The Ministry's Technical Department, which gave direction to RAE on required tests, envisaged two types of static test: stress testing and wind tunnel testing.

The experimental fuselage and tail skid had been tested to destruction at Byfleet, so the main stress tests at RAE were on the wings to gauge the breaking strain on the ribs. Figure 24, an RAE drawing, shows the approach adopted.

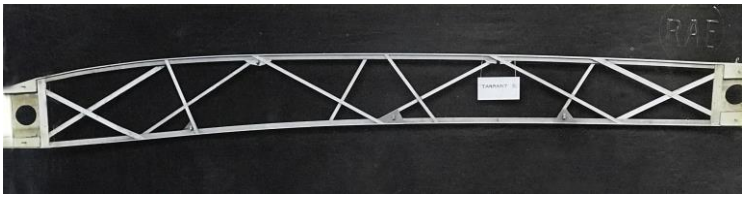

Figure 23. Partial cross-section of the wing showing arrangement of internal members

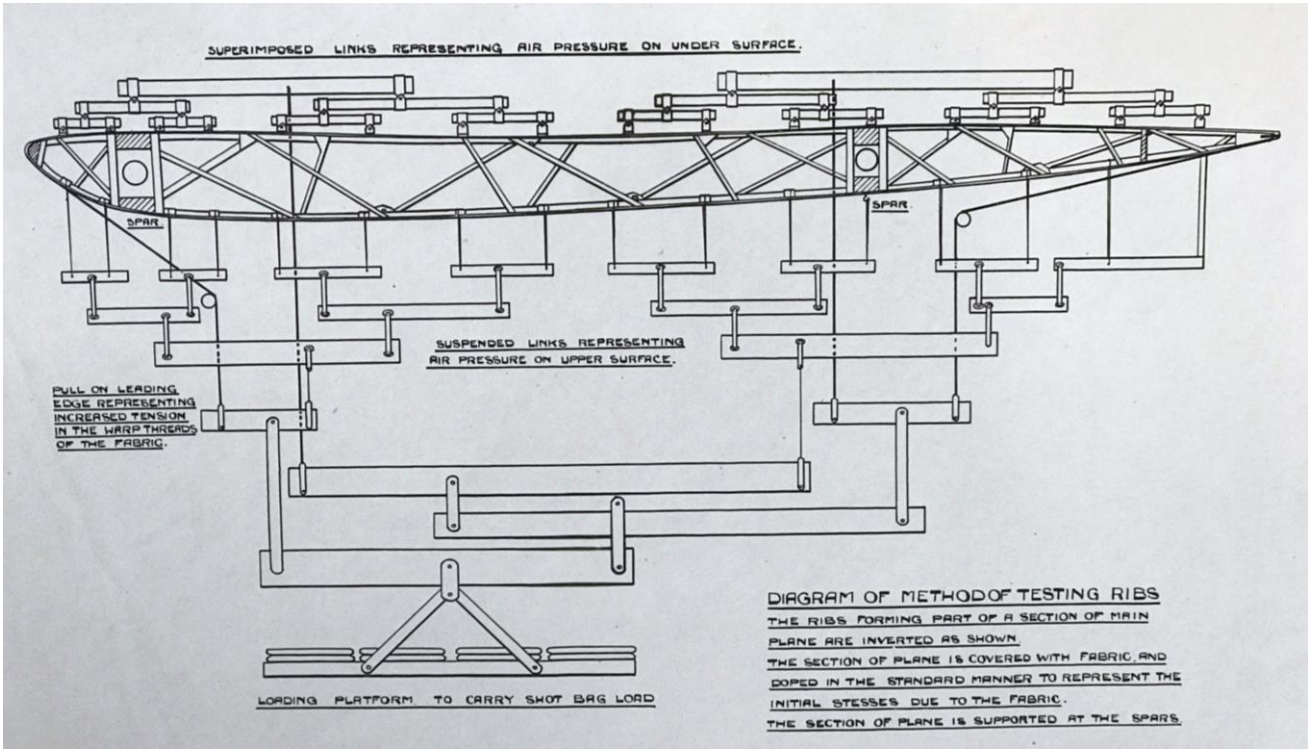

Figure 24. RAE workshop drawing showing the arrangement of weights to simulate aerofoil forces

A separately prepared wing section was mounted upside down so that weights could be used to simulate positive air pressure on the underwing surface and negative air pressure (lift) on the upper surface. The wing section was supported at the front and rear spars and a set of nested weights applied to the upper and lower surfaces. Loading was increased until a fracture occurred. Unfortunately, this did not meet the minimum loading required for the Tabor.(88)

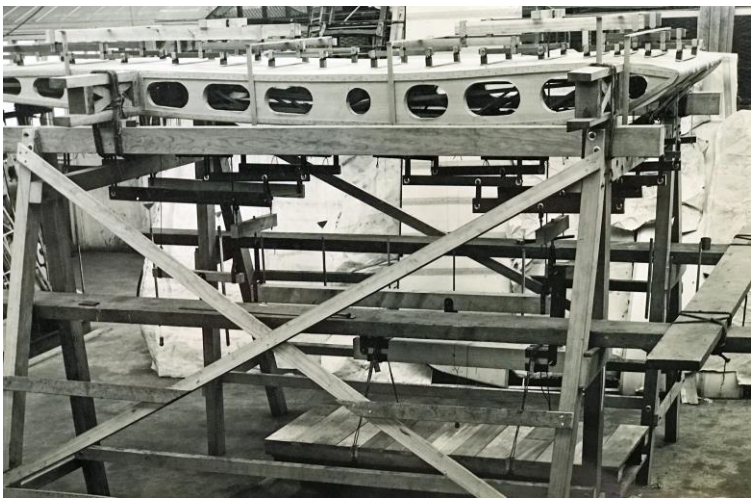

Figure 25 Stress testing jig in operation on a section of the upper wing. Weights were placed on the platform at bottom.

Discussions followed, which Wilson greatly assisted. By 12th December, Tarrant was able to write to Pippard. 'It has been definitely agreed with Farnborough that, in order to avoid delay, they will undertake to make the necessary alterations to bring the main plane rib up to strength to meet Air Board requirements.'(89) RAE stripped out all ribs from each wing section and substituted the latest RAF 7 aerofoil, retaining only the original nose pieces.(90) This process extended into April 1919 but at least the centre sections were available by early March, enabling the engines to be mounted a week later.

In parallel, Tarrants examined the source of failure in their original ribs and identified weakness in the glue employed to bond the various subcomponents. They substituted a new glue and had RAE repeat the original stress test. On 10th March, RAE reported to Pippard that the spars failed with a load factor of 6.5, a satisfactory result. Tarrants could at least content themselves that their design was sound, even if original manufacture had not been.(91) A new test section, fitted with RAE spars, was tested on 23rd. RAE was able to report that the strength of ribs was sufficient for the assumed conditions of loading.(92)

One other outstanding problem to do with weak engine struts and drag bracings on the wings was also resolved. On 20th March, following protracted discussions, Colonel William Sempill, Assistant Controller of the Technical Department, wrote to Tarrants to acknowledge that certain assumptions relating to engine torque and thrust had been too severe and that, under the new test criteria, 'the wings were up to strength throughout.' (93)

5.2 The Cost of Doing Business

While test and assembly were under way at Farnborough, the Ministry's Finance Department approached Ogilvie. They had contacted the Technical Department the previous July, seeking a view on a reasonable production budget for the Tabor (Capital Expenditure would be sanctioned separately). Ogilvie had proposed basing the estimate on the production cost of the Handley-Page V type, adjusting for the Tabor's far greater size, probably up to £80,000.(94)

Finance now advised Ogilvie that Tarrant had incurred an estimated capital expenditure of £27,000 for buildings, plant and equipment just to get set up for aircraft production. By 23rd October 1918 they calculated he had also spent £76,000 on constructing the two T1 aeroplanes. Tarrant had written to the Ministry requesting a payment on account, something which, if approved, normally attracted an interest charge of Bank Rate + 1%. The Finance Department asked Ogilvie for a suitable statement in support of their bid to get Tarrant an interest-free interim payment from the Treasury.(95) On 11th February Ogilvie replied; he did not disappoint.

> Very valuable data is being obtained by this department in connexion with the construction of Mr Tarrant's two large bombers, and the data of even considerably more interest will be obtained when flying trials commence. It is considered to be a matter of urgent importance by this Department that every possible action should be taken which will enable flying trials to commence at the earliest possible date and no consideration, financial or otherwise, should stand in the way of this.
>
> I note that it is estimated that the total value of the contract is somewhere between £80,000 and £100,000 and, without being well acquainted with Mr Tarrant's financial capacities, it appears to me that it would be a considerable strain on his resources and to that extent tend to slow the progress of the machine, if he had to bear the whole of this cost up to the date when the second machine is accepted and the contract completed.(96)

On 21st February 1919 the Finance Department again contacted Ogilvie, seeking his views on the cost of the contract. Tarrant had advised a forecast spend exceeding £80,000.(97) In almost his last act at the Ministry, Ogilvie advised Sempill that the position as regards utility of the Tabor remained as set out by Weir in his minute of 12th November 1918 . 'It is recommended therefore that the necessary financial assistance is given to Mr. Tarrant.' (98) Sempill, replying to the Finance Department, responded.

> The nature of this work is so essentially experimental that it would have been impossible for the firm to estimate the cost accurately in advance. As it is important that the construction of the machines should proceed without hitch, I think a further expenditure to say £100,000 should be approved.' (99)

5.3 Outstanding Issues

Captain A S Ellerton of the Technical Department had visited RAE on 3rd February to review progress. He reported back that engines, fuel and oil tanks and systems were in place, as were cockpit and engineers' controls and all instruments, radiators and propellers were ready for fitting, and the details for small levers and rods for connecting the main controls to the controlling surfaces were either made or on purchase from Handley Page or Vickers. The main outstanding items were the skid, landing gear and engine bearers, which were either expected shortly from Tarrants or awaiting final drawings. However,

> alterations were in progress with the drawings of the landing gear struts in accordance with criticisms made by this department … Taking everything into consideration, there does not appear any likelihood of the machine being ready to fly before the end of June.(90)

There was clearly an issue with Tarrants' drawing office. Colonel J S Buchanan, Head of the Design Inspectorate at the Ministry and Ellerton's superior, went to Farnborough on 7th February

1919 and noted that construction was proceeding very slowly, largely due to lack of proper co-ordination between Tarrants at Byfleet and RAE. Modifications from Tarrants' drawing office were not notified to RAE in time to prevent useless labour in manufacture. 'The planes are now held up for a week on account of a modification to the main plane fittings. This could have been done some time ago if details had been available.' Buchanan also noted that 'RAE are not talking to the Technical Department, resulting in much rework; this also needs addressing.' (100)

During his 7th February visit, Buchanan noted that the chassis was probably under strength and he warned RAE of this. He arranged for Hamlin to visit Farnborough on 11th February with Pippard to consult with Rawlings on this and other points. This visit concluded satisfactorily, Hamlin accepting a temporary solution to strengthening the undercarriage pending changes made to subsequent machines. He also advised Rawlings to replace the control stick mounting with a more substantial arrangement.(101)

On 15th February Tarrants received a letter from the Ministry. 'The means of strengthening the undercarriage of this aeroplane is approved.'(102) This last major outstanding issue apparently resolved, it seemed that the Tabor was back on track.

Figure 26. The Tabor's massive tail assembly comprising two rudders and three elevators. Wilson stands at the rear, Rawlings before the tail and the test pilot Dunn inside the fuselage (the position Wilson took on the test flight.)

RAF Museum, X003-2602/16779.

6. PREPARATION FOR FLIGHT

6.1 A Pilot's Perspective

On 24th February 1919, Captain R M Hill, Officer Commanding Experimental Flying Department, RAF, undertook a critique of the Tabor's control surfaces from a pilot's perspective. His report was damning.

> Re the middle elevator, no satisfactory elevator of this type [slaved to the bottom elevator] has been found to work, except on a very small scale .... It seems undesirable to try out a new type of elevator on an aeroplane of this description without any previous satisfactory experimental work.
>
> The bottom elevator is unsatisfactory as regards design, position relative to slipstream and rigidity. An elevator of this type had to be taken off the Handley Page O/400. In my opinion the elevator control is unsatisfactory for flight in an untried aeroplane of these dimensions. I feel operation would be extremely unlikely to prove even and consistent. Its heaviness or lightness is problematical; its lack of rigidity certain.
>
> The rudders are also very small, comparing unfavourably with other large aeroplanes. They are roughly the same size as the early V/1500, which was proved to be highly unsatisfactory, and about 2/3 as good as the O/400. None of the rudder area is in the slipstream. With the present size of rudders the plane may swing violently when getting off, and once it starts to swing there will probably be insufficient rudder control to counteract it.
>
> The ailerons are unusually small. They do not appear to work even half as good [*sic*] as those on the O/400 and V/1500 and little over half as good [*sic*] as the Vimy. Control will probably prove inadequate.

Overall, Hill concluded

> It seems that advantage has not been taken of much experience already gained on large aeroplanes. The dimensions of the control surfaces appear to have been deliberately kept down so that one or two pilots may operate them. The result is that, although the control surfaces may be moved by the pilots, they will only be sufficient to control the aeroplane in the calmest weathers. If the aeroplane should be out of trim, the pilot's task will be almost a hopeless one. It is recommended that the control surfaces be increased in size and some form of relay introduced to operate them.(103)

Hill's analysis would resonate in the 1921 Air Accident Report.

A report such as this could not be ignored. Tarrant wrote to Hill, informing him that 'I have discussed your report with my consulting engineers and we are going into the whole question thoroughly.' (104) The Technical Department asked Handley Page to meet with Tarrants' designers to provide any information that might be useful, so Wilson visited Martlesham Heath, Handley Page's headquarters.(105) No doubt design modifications were considered, although as Hill identified, a limiting factor was the ability of a single pilot to operate control surfaces on such a large aeroplane. (The V/1500 had only recently had its control surfaces extended following experience gained in flight, and subsequent testing had so far been only in low-wind conditions for just this reason.)

Tarrant was evidently not unduly concerned at how this setback would be viewed by the Ministry, as only one week later he wrote to the Undersecretary of State, including a positive statement of progress and requesting an order for a third T1 machine. He may have been encouraged to do this, as someone in Ogilvie's office noted, as early as 31st December. 'As soon as things straighten out Colonel Ogilvie wishes to put thro' an order for a third Tarrant Tabor at a fixed price, in order to keep the staff together for another 3 months.' (106)

Ogilvie responded to the Undersecretary of State with his department's view, broadly supporting Tarrant's letter. He reminded the minister that the 'Tarrant method' undoubtedly took the possibilities of timber construction a stage further than the ordinary methods but that the final stage would, in his opinion, be metal. Ogilvie concluded:

> As to the request for an order for a third machine, I recommend that this should be placed, in order to keep the staff and works together until flying trials have demonstrated the possibilities of the machine. I suggest that the price for the third should be considerably lower than for the first and second, the firm to be made to definitely understand that great economy is now necessary.(107)

6.2 Enter Ogilvie and Partners

Handley Page and Vickers approached heavy bomber design and construction with experience gained on their earlier multi-engine aircraft, and thus generally had no need of external support. Tarrants, however, had no such experience. As Ogilvie had politely put it the previous year, referring to Tarrant, 'The gaining of experience is all before him.' (34)

Throughout the assembly phase, RAE advised Tarrants on practical aspects of construction and reported back on the findings of the various stress tests they were conducting. Design changes resulted, such as strengthened wing struts and ribs. In parallel, the Technical Department advised on aerodynamic and mechanical aspects of the design and construction. This profusion of expert advice caused some difficulties. Indeed, it appeared that on occasion, advice offered to Tarrants by RAE was in ignorance of, and sometimes directly contradicted, the Technical Department's established position, resulting in some peevish memoranda.(108)

At this juncture the new firm of Ogilvie & Partners entered the project. Tarrant engaged this aeronautical engineering consultancy to advise him on the Tabor's flight readiness. In January 1919 Ogilvie – formerly Controller of the Air Board's Technical Department – became Head of the Aeroplane Design section in the Ministry of Munitions' Aircraft Production Group. His colleagues included Sutton Pippard and A H Watts. At this time Sir William resigned as Director-General of Aircraft Production, leaving Ogilvie and Sempill as the only senior government officials with a comprehensive view of the Tabor contract. In March 1919, Ogilvie resigned his commission in the RAF, left the Ministry and set up his consulting firm of Ogilvie and Partners, taking with him Watts and Pippard. He also recruited Colonel W A Bristow, lately Chief Engineer in the Field to the British Army and Royal Navy. It is not known whether these moves resulted from organisational changes within the Ministry or whether Ogilvie saw the increasingly high-profile Tabor project as an opportunity to establish his new company, with Tarrant's tacit support.

In January Wilson had been promoted to captain and seconded to Tarrants. (As *Flight* later reported, 'It was to a very great extent due to Capt. Wilson that the machine was turned into a practical proposition.') In March Wilson also left the Ministry of Munitions, joining Tarrant's recently created Aircraft Construction Company as General Manager.

With Ogilvie gone from the Ministry and the Tabor approaching its first flight, Sempill assumed the Ministry's principal relationship with Tarrants and the Tabor project. Almost his first act was to remind RAE that in matters of design relating to the Tabor, the Ministry's Aeroplane Design section had pre-eminence.(109)

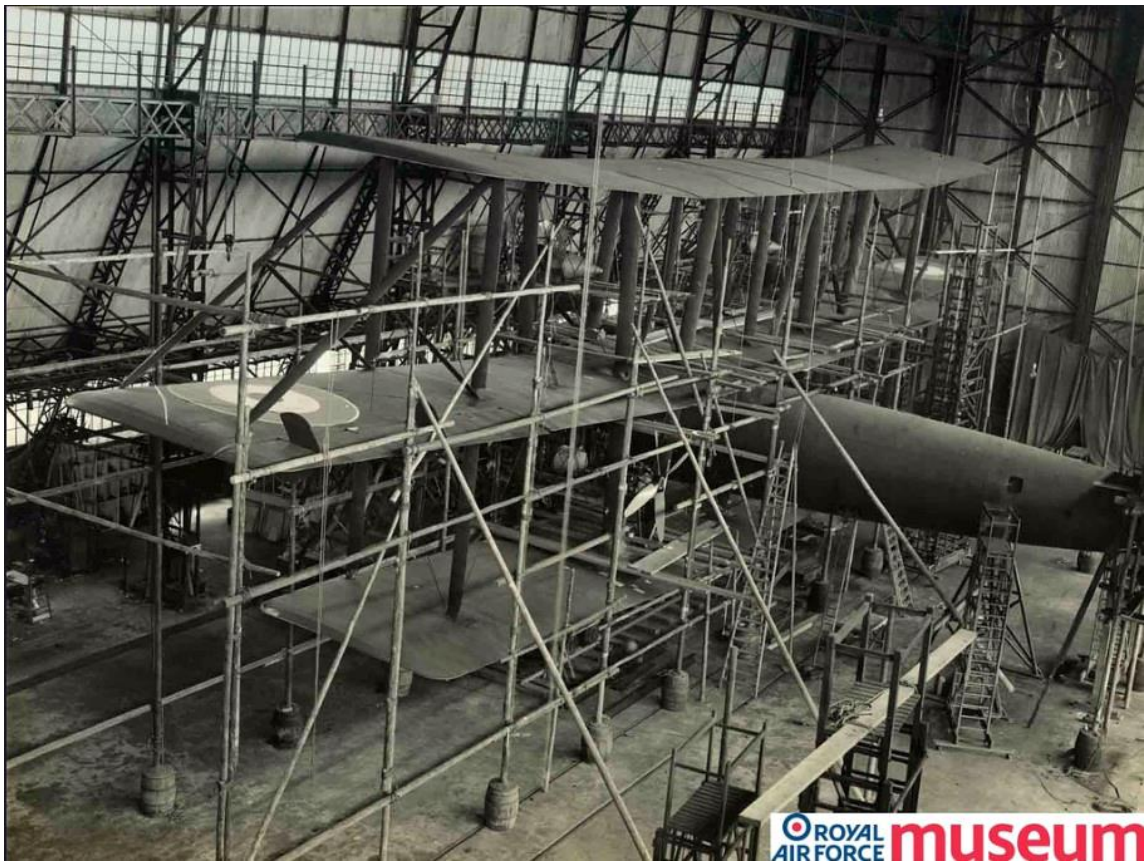

Figure 27. The Tabor inside 'C' Shed in the closing stages of construction, all engines fitted
RAF Museum, X003-2602/16775

6.3 Flight Safety

With delivery confidently projected as less than three months away, Captain Frederick G. Dunn, Tarrant's recently appointed test pilot, arrived at Farnborough on 20th February 1919. After familiarising himself with the Tabor he joined the discussions on flight safety, centred on three conferences which started two weeks later.

The first Tabor Flight Safety conference, in which Ogilvie's team at the Ministry participated, along with Tarrants, RAE and the Aeronautical Inspection Directorate (AID), Ministry of Munitions, was held on 5th March.(41) This all-day conference addressed many of the significant changes considered necessary to control surfaces and levers, chassis, keel and tail skid, and methods of crew access and egress. These changes were largely left to the RAE representatives to effect.

There was an inconclusive discussion regarding control surfaces. The issue of aileron size, and whether to install ailerons on the top wing, in addition to those on the middle wing, was considered, and not for the first time. (It was known that ailerons mounted on the middle plane of a triplane were generally the least efficient.) Wilson said that this had been previously reviewed by the Air Board's Technical Department and they had considered the Tabor's aileron control to be adequate. Moreover, even should the control surfaces prove inadequate this was not dangerous, and resolution could be left until after trials.

Grinsted suggested it would be 'an advantage' to have the rudder in the slipstream. However, the Tarrants participants were adamant that it was impossible to arrange this at short notice and Barling had always been against having the tail unit in the slipstream.

Regarding the means of control,

> It was pointed out that there was insufficient travel on the joystick with hand control. The centre of the control column should have been about 6 in further forward. It would be impossible to alter this on the present machine but same would be put further forward on the next machine.(41)

Wilson also reported that according to new calculations, the Tabor's CG had moved rearwards slightly, prompting Grinsted to ask, 'Would the fixed top elevator be sufficient to trim the machine in flying?' Wilson said he would look into the matter and took this opportunity to suggest that the current tailplane elevators should be replaced by an inverted section of RAE 15 aerofoil. In addition, the top elevator should be the controlling surface with its trimming function swapped with the bottom elevator. However, all agreed that this proposal, introduced so late in the day, would entail too many alterations.(41)

Missing from this meeting (in fact all three flight safety conferences) was Tarrant's original design team. Possibly this merely reflected the fact that the main design work was over, but it may also have some connection with what happened in the second meeting.

By the second conference, on 24th March (Ogilvie was absent), most issues raised at the first meeting had been satisfactorily addressed or were well in hand.(105) The major outstanding issue, relating to the area of control surfaces, was again left for later consideration, as Tarrants were examining the use of servo-assisted power controls. There must have been much consternation when, in the closing minutes of this meeting, Bristow of Ogilvie's team dropped a bombshell. As the Minutes record,

> Col. Bristow announced that he was strongly of the opinion that it should be pointed out that if the people who were handling the machine at the present time had handled things from the beginning, things might be very different, as the machine was originally very badly designed and does and will continue to suffer from this. When handed to this committee to deal with, the machine was unflyable and unsafe, and the design of the machine showed some extremely flagrant errors. He wished this to be officially reported in the Minutes.(105)

Grinsted moved quickly to distance RAE from any responsibility, while stating he was prepared to second a motion to the effect that the machine could have been improved in many respects. He thought the mistake was made in not having model tests carried out of the type of controls, etc. at the commencement of the design.

Rawlings, chairing the meeting, had no option but to accede to Bristow's request, acknowledging that they had had to alter 'almost every vital point of the machine.' Tarrant cannot have been pleased when Rawlings reported back to him. No doubt this was behind a comment in Tarrant's last letter to Ogilvie, confirming termination of their arrangement, wherein he declared 'one or two incidents in connexion with the action of your Partner that I feel I shall have to have some explanation of.' It might also help to explain why, at the fateful meeting on 24th May, Tarrants discounted Bristow's adamant advice not to proceed with a test flight until the issue of tail plane settings was resolved.

Following the second conference, Grinsted visited Martlesham Heath to inspect a Handley Page V/1500 and make a comparative assessment of control surfaces with respect to the Tabor.(110) He found that the type of aileron employed on the Tabor, fully balanced along its entire length, was comparable but that the surface area and hence ability to manoeuvre, was about half that of the V/1500, confirming Hill's earlier assessment.

Tarrants held a third flight safety conference on 3rd April, attended by representatives from the company, RAE, the Ministry and Ogilvie's team (as of next day formally retained as Tarrants flight safety consultants).

The minutes of this meeting record a lively discussion among participants before Ogilvie's team arrived, regarding the Tabor's control surfaces in the light of Grinsted's visit to Martlesham Heath.(111) The general conclusion was that the aileron surfaces would likely need to be doubled, possibly requiring extension of the length of the upper wing to match the middle wing. However, it was agreed and subsequently confirmed with Ogilvie's when they arrived that the plane could fly for test purposes, provided the wind conditions were favourable, that is, near calm. Rawlings and Wilson confidently announced that the Tabor should be ready for flight testing within four weeks.

Figure 28. Close-up of the Tabor showing the six Napier Lion engines and the problematic undercarriage. Note the limited ground clearance of the cross-beams at front.

RAF Museum

Ogilvie then raised the issue of horizontal stability, about which he was 'more anxious than anything else.' (111) Had any tests had been made on the fore and aft stability? Grinsted assured him that RAE were doing experiments on the tail setting that very afternoon.

There followed an interesting discussion on transatlantic flight, with Ogilvie asking, 'What would be the possibilities of the machine, assuming she is as successful as she is now.' (111) It was concluded that an Atlantic crossing of 2,200 miles was feasible, assuming a 20 mph headwind. Wilson thought they should aim for a cruising speed of 80 mph; Bristow thought 90 mph would prove more economical.

Two aspects of this meeting are particularly striking. How phlegmatic everyone appears to have been regarding control surfaces, a possible transatlantic flight and how late in the project significant design issues were still being discussed.

By 10th April, Grinsted's report on RAE's tests of the tail assembly reached Buchanan. He sent a note to Sempill.

> With reference to Major Grinsted's report on lateral control for the above machine, this question has been discussed with Tarrant's designer on several occasions during the construction of this machine. It has always been considered by Design branch that the lateral control was insufficient.

However, Barling strongly disagreed, for reasons previously stated. Lacking data on actual performance, the two parties agreed to wait until quantitative data from flight tests was available to size the problem.(112)

Figure 29. The Tabor on its track outside the gigantic 'C' Shed. The rails sank below the wide dirt road, allowing the machine to be winched forward onto solid ground.

RAF Museum, X003-2602/16777

6.4 Man versus machine

The Tabor's unprecedented size and weight would place extreme demands on the men who flew her. Previously, engines would be kick-started by priming the engine then rotating the airscrew manually. The power of the Tabor's geared engines and their height above ground made this impossible. Hill noted that the weight of the aeroplane and size of its control surfaces would undoubtedly exceed the physical strength of a single pilot to operate in all but the lightest winds. Some form of mechanical assistance would therefore be needed, both for the engines and all control surfaces.

At the first flight safety conference, Grosert raised the issue of how to start the engines, opining that it would be detrimental '… as far as public opinion is concerned, if the engines were not arranged to start up immediately.' (41) Possibly he anticipated public witness of the first flight, the first time that this topic appears to have been discussed openly. Rawlings told him he was speaking with the Air Ministry with a view to getting a set of six Lion engines with integral electric starters. Subsequent dealings with Napier's and the Air Ministry proved fruitless however, as the Napier starters were inadequate to the task.(113) The Liberty starter was examined, with the same outcome, so Tarrants proposed to adopt the Maybach system which involved a complicated process of introducing a petrol-ether mix into the cylinders via manually opened exhaust valves, before closing the valves and firing from a magneto on the engineer's console. Rawlings and Grosert agreed that this was 'a troublesome business,' (105) presumably due to its complexity. For this RAE would fit a small header tank containing a petrol-ether mix, together with one vaporiser for each top engine and one for each bottom engine pair, to fire up the engines. In the event, for first flight at Farnborough, the mechanical Hicks starter was employed.

As was by now well established, there were significant issues relating to the size of all control surfaces. All were only half or two thirds of those found by experience to be needed on such large machines, yet each would test the strength of a single pilot to operate in all but the calmest conditions. (The Handley Page V/1500 with modified control surfaces had not yet flown in adverse conditions for this reason.) Mechanical or electrical servo assistance would be needed.

Sperry electrically operated servo-assisted power controls had been employed recently on the Felixstowe Fury, although these had proven problematical and were subsequently removed to reduce weight. Major Arthur Quilton Cooper of the Technical Department, who flew the Fury on its first flight, developed an electrical servo system for Sperry. On 19th February the Technical Department informed Tarrants that they had obtained a Sperry system for the Tabor.(114) RAE were disconcerted to find that no installation guidance was provided. Tarrants announced at the first flight safety conference that power controls would be considered, prompting Ogilvie to opine that it would be much safer not to have electrically powered controls but to have the pilots control it, presumably using a system of gears and pulleys. Bristow asked for confirmation that the whole machine was being designed on the assumption of manual controls only – it was.

On 21st March RAE admitted defeat, and Tarrants asked the Technical Department whether they could get Cooper down to advise.(115) The feasibility of using power controls was discussed again briefly at the second flight safety conference, three days later. It was decided to wait until all loadings had been recalculated and compared with the Handley Page V type for similar conditions before deciding how to progress.

On 14th April, replying to Sempill's letter confirming Cooper's willingness to help, Tarrants promised to submit drawings once they had decided on the manner of fitting.(116) However, at the third flight safety conference on 4th April, Ogilvie suggested it would be 'rather unwise to interfere with the machine now, as control will be quite sufficient for the time being.' (111) Analysis had shown that maximum loading on the control stick, as the Tabor was currently configured, was only 60 lbs, about half that on the V/1500 and well within the physical abilities of the pilot. No further discussion of servo assistance appears in the record, and it is likely that Tarrants decided to postpone a decision on it until such time as the Tabor's control surfaces were enlarged.

There were also last-minute concerns about the propellers, with Wilson writing to Buchanan on 6th May for relevant data. (117) Napiers were now confident that their engines could produce 500 hp, not the 400-450 hp previously thought available. If so, Dunn might need to keep the throttle down initially, to prevent damage to the pusher propellers.

6.5 Financial Liability

By April, an internal investigation within the Ministry ended. At issue was financial liability for the Tabor's first flight. Following a meeting with Rawlings on 2nd April, Sempill wanted to know the contractual position of each party. Buchanan reported

> I have looked into the question of the testing of the above machine and cannot find any suggestion of a special arrangement. It is certain that the usual procedure holds in the case of this contract.
>
> Normally, all experimental firms are required to fly their machines before they are taken into the air by Air Ministry pilots. In a few special cases, exceptions have been made to this rule but such exemptions have only been made in the case of very special difficulties.
>
> The Tarrant machine presents further difficulty as regards price. Normally the cost of testing is an extra and as these machines are being built on the system of limited expenditure, it is submitted that this be considered as necessary expenditure above the specified limit.(118)

Armed with this information, Sempill wrote to Rawlings on 4th April, informing him that "[t]he usual procedure in experimental work is that the Contractor demonstrates the machine in the air before it is taken over by Air Ministry pilots. During such trials the responsibility for the safety of the machine rests with you." (119)

The Ministry would not, therefore, accept financial liability for the Tabor before its own acceptance tests. Tarrants were evidently not comfortable to leave the matter there, calling a follow-up meeting with Sempill. On 28th April, Sempill wrote to confirm the outcome of this meeting.

> With reference to the conference held in my office a short time ago, at which Captain Rawlings, together with Lieut. Colonel Ogilvie and Major Mayo were present, the position with regards to the tests of the Tarrant machine was fully discussed.

> I have been in close contact with the Contracts Department and I can now definitely confirm that, subject to this department being in every way satisfied with the pilot employed for the test flights of the machine, the responsibility will be taken for the trials. This implies that the machine will be taken over from you prior to flight trials.
>
> There will therefore be no necessity for you to further consider the question of insurance.(120)

Acceptance of Tarrants' pilot for test flights, and advising no need to consider insurance further, seemed to imply that the Ministry now accepted responsibility from first flight. Tarrant replied on 30th April.

> We have to thank you for your communication of the 28th inst. and note the ruling which has been laid down by yourselves and the Contracts Department with regard to the financial responsibility for the trials of the 'Tabor' machine.
>
> We should esteem it a favour if you could arrange at your convenience for your representative to view the machine and give his definite approval, and we should further be pleased to forward you any details with regard to the experience and qualifications of the pilot, Captain F.G. Dunn, RAF.(121)

On 5th May Sempill wrote to Tarrants again, this time stating that 'the department will of course keep in close touch with you and approval for taking the machine preparatory to flight trials will be given of course. I shall be glad, however, to receive a resumé of the previous experience of your Captain F.G. Dunn.' (122) The company replied two days later, noting Sempill's commitment and providing the requested resumé. This elicited an apologetic reply from Sempill. 'I regret that I did not notice your pilot's initials in your last communication, otherwise of course this question need not have arisen as his abilities are well known.' (123) Was Tarrants liable for the demonstration flight or not? Moreover, while Dunn's abilities were well known, were they adequate for taking up the Tabor?

6.6 Wind Tunnel Tests

By 3rd May, RAE completed tests in their 5 ft wind tunnel on a 1/50th scale wooden model of the Tabor that Tarrants supplied. This determined whether the ailerons or elevators were over-balanced, and established a suitable tailplane setting and wing loading for the first flight. Although the model was not wholly accurate – the wings were too narrow, for example – allowance could be made for this. The range of measurements taken covered all of Tarrants' own calculations and were in broad agreement.(124) The control surfaces were found to be balanced.

The Tabor was determined to be stable and the elevator control was considered 'ample provided the tail was set suitably'. The machine was, however, tail heavy, requiring a balancing compensation on the bottom tailplane. The setting for a lightly loaded aeroplane was established to be +2º but because this tailplane could not be set above -2.5º, the desired effect could be obtained instead by adding 1,200 lbs of nose ballast. RAE's recommended settings for first flight were given as 5º upper and 0º lower tail plane incidence with 1,200 lbs of ballast in the nose, all petrol in the forward tanks, all engines running, and trimming (top) wing set at 20º down. RAE cautioned that these figures might need revision once the machine's true CG had been established.

The CG of the empty aeroplane was taken on the 4th May 1919.(125) The weighing scales, one set of which were used on either side of the aircraft, were not large enough so levers were employed. The body was supported near the tail by a rope attached to a Denison weigher. The wing was secured in position with cables to prevent forward movement when the tail was raised. Measurements were taken at four positions and the CG was determined graphically. Distances were measured from plumb lines suspended to touch the leading edge of the bottom wing and the tail sling.

The CG was established as 6.57 ft behind and 10.12 ft above the leading edge of the bottom wing, i.e. behind the wheels, roughly central to the bottom wing.(126) The CG of a fully loaded plane was calculated to be 6 in further back. Consequently, a lightly loaded machine would overbalance should it rotate forward by much more than 11°. On 6th May Tarrants forwarded to Ogilvie's the RAE's CG results, wind tunnel findings and elevator settings, and proposed a meeting to review them.(127)

By 11th May RAE had run all engines satisfactorily *in situ*. Writing in 1966, Grosert recalled that 'I sat in the pilot's cabin and opened up the top engines, bottom not running, to get the feel of the tail. Under these conditions, it did not show any desire to lift.' (128)

Bristow and Pippard met with Rawlings and Wilson on the same day to look at RAE's figures. The results conflicted sharply with Tarrants' proposed settings, derived empirically by Wilson and agreed by Ogilvie's. The next day, Ogilvie wrote to Tarrants, warning that

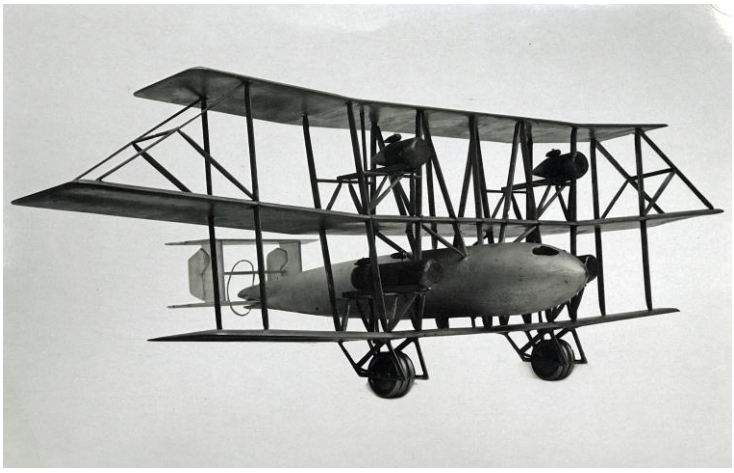

Figure 30. 1/50th scale model of the Tabor, used in the wind tunnel tests

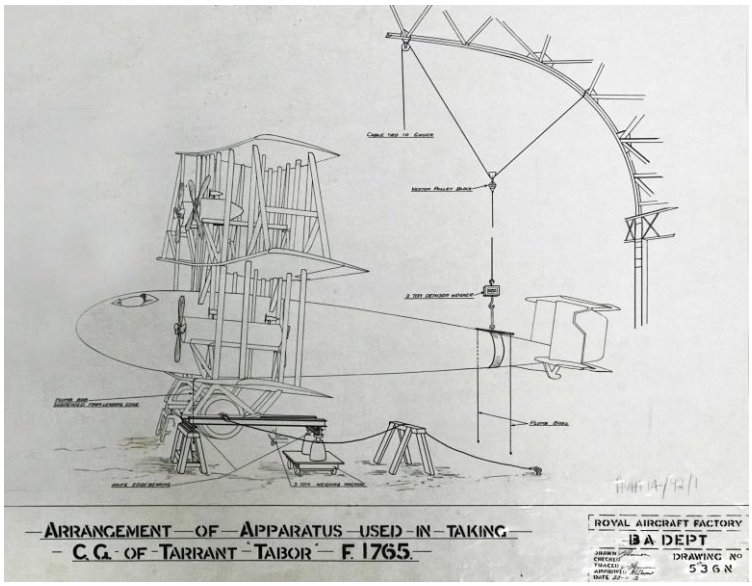

Figure 31. RAE's CG test arrangements for the Tabor

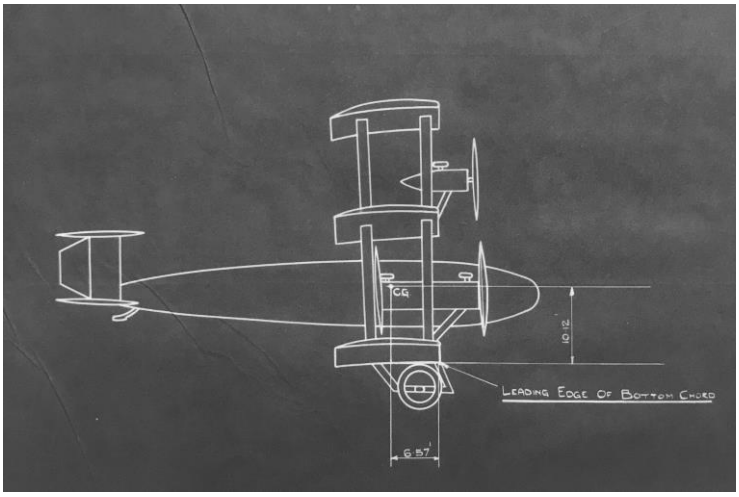

Figure 32. Position of the CG as measured by RAE

'[w]e have studied this very carefully and beg to inform you that, in our opinion, the big machine is not safe to fly if the figures of the test are accepted as they stand.' Ogilvie elaborated that the RAE wind tunnel tests indicated a 20º down setting was necessary on the trimming plane, requiring a compensating +20º (down at the trailing edge) set on the elevator. However, since the maximum available elevator setting was only +22º, this would leave the pilot insufficient margin of control. Ogilvie suggested further model tests to throw some more light on this.(127) This message surely caused considerable consternation both at Tarrants and RAE. Tarrant approached the NPL to validate the RAE results, although it seems there was no immediate response. RAE set about re-confirming their own findings.(127)

On 13th May Tarrants wrote to Ogilvie's, confirming the discussions with Pippard and Bristow on the 11th and advising that RAE had arranged to check and, if necessary, do further experiments. Tarrants took the opportunity to suggest that, in view of the CG and tail setting of the Felixstowe Fury, which Pippard knew of and which was broadly comparable to the Tabor in size and weight, it seemed likely the Farnborough wind tunnel tests were not accurate. Tarrants promised to let Ogilvie's know of any decision come to, in a day or so.(127)

6.7 The Tabor is Revealed

The next day, ending several months of occasional press speculation, Tarrant presented his aeroplane to the world. He invited the press to inspect the Tabor and afterwards gave them lunch at the Queen's hotel, Farnborough. In a brief speech Tarrant thanked Sydney Smith, RAE's Superintendent, his managers, and all the men who had been employed in the building of the machine at Farnborough. In reply, Smith said he was sure that everybody in the RAE who had had anything to do with the machine – and there were some hundreds engaged in the work – had done their best, from the head of the staff to the lowest unskilled labourer. They took great pride in the machine then and would again when it soared through the skies. There were many cries of 'hear, hear'.(5)

On seeing the Tabor, the *Evening News*' special representative gushed.

> I have just descended from the cockpit of the marvellous Tarrant triplane, which Major-General Seely recently foreshadowed in the House of Commons as the greatest development in aviation …. The first impression one gets is that of one of the great liners on the Clyde, and something of the feeling of standing in the presence of the *Olympic* ... Here before one stands a vast erection which to the uninitiated seems as impossible to fly as the Crystal Palace, yet not a single one of the well-recognised laws of aviation have been violated it its construction.
>
> There is not a man among the splendid mechanics working on the dizzy platforms of this aerial liner who today was not absolutely convinced that he was assisting in the biggest thing ever done in the air.(129)

Winston Churchill, never one to miss a headline, had come down to inspect the Tabor a few days earlier and left word to 'Call me any hour of the day or night when she makes her first trip.' (129)

The *Evening News* continued:

> General Seely is taking the keenest interest in this wonder. General Sykes (Chief of the Air Staff) is due on Saturday before the first serious trial.
>
> Already, half the side of the great balloon shed has been taken out to allow for the tremendous movement of the air when the six engines – 3,000 horsepower – with a noise of six Albert Hall organs full out – are at full tilt.

The Tabor's reception was mixed, however. One observer thought the two top engines were placed too high. With all six engines running, any discrepancy between the centre of thrust and the centre of resistance would not be too great, but if one of the top engines cut out it would be necessary to cut one of those on the opposite bottom plane to equalise it. Further, should the top engines be idle in flight or when taxiing, any sudden surge of power from them would have to be compensated with some rapid and drastic tail trimming. Rawlings acknowledged this but remarked, 'Any such tendency to bring the tail up would be counterbalanced by the down draught from the top plane.' (130)

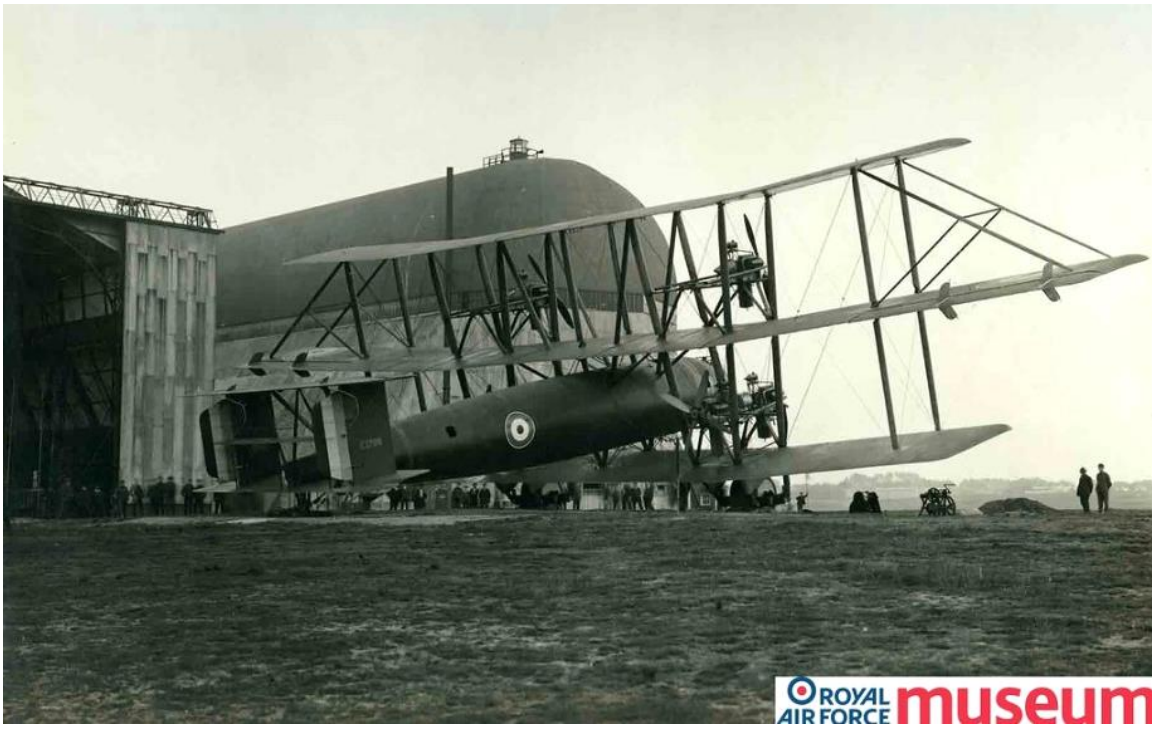

Figure 33. The Tabor on its withdrawal track, outside 'C' Shed with a good view of the 4-blade 'pushers' RAF Museum, X003-2602/16778

Elsewhere, concerns were again raised about the strength and clearance of the undercarriage. In an internal memo that same day, Buchanan warned Sempill

> With reference to the [Tabor] and the visit paid by Mr Hamlin to the RAE on the 13th inst. it is desired to draw your attention to the strength of the chassis of this machine. In Mr Hamlin's opinion, this chassis is likely to give trouble and I think it advisable that it should be looked into further before the machine goes into the air. There has been considerable discussion in the past on the question of this chassis and all the modifications suggested by Mr Hamlin have not been adopted. As the trials of this machine will be carried out on the financial responsibility of the Air Ministry it is especially desired that no accident will happen … (131)

Sempill acknowledged Buchanan's concerns and sought to calm his fears. In a handwritten note on the memo, he replied, 'I quite agree. The ground clearance is only adequate with a light load. All is in order for a test flight.'

The next day Sempill wrote to the Director of AID emphasising the importance of adhering to the usual procedure regarding experimental machines in that a complete inspection should be made before flight test. AID responded accordingly.(132)

The engines were run again on the 17th, when the AID inspector informed Grosert that all the engines would have to be removed for new gudgeon pins that link the piston to the connecting rod. It was later agreed this modification could be postponed for six flying hours and the engines were all run again for the inspector.(128)

On 21st May, Major Francis Bramwell of AID reported to Sempill on the results of his inspection. Like Hamlin, his chief concern related to the limited ground clearance.

> The undercarriage was still not satisfactory. I am prepared to pass it from a strength point of view for preliminary trials, provided these are carried out with as light a load as possible. There is one other point, however, on the undercarriage which does not appear to be very satisfactory. As far as can be judged the ground clearance is likely to be small, but this cannot be determined very satisfactorily until the weight of the machine comes on the complete undercarriage. Special attention should be paid by members of this department before the machine makes its first flight.(133)

The issue concerned the horizontal cross-bars ('I-beams') at front of each wheel assembly, securing the two sides of the truss to form a supporting frame. The wheel axle was secured to this frame front and back by a shock-absorbing system of wooden slats tightly bound with gutta-percha tape, the stretching of which on such a heavy machine had been calculated but not yet demonstrated. If the slats were too flexible, the wheel axle could move vertically more than intended. The clearance between the ground and I-beams was 7 in. Check-cables prevented the wheel assembly moving by more than 4 in, but calculations by Lieutenant C. H. Vickers of AID showed that the wheels would cause the Tabor to over-rotate catastrophically if they sank into the ground by more than 3 in.(134) Clearly, this was a very narrow margin of safety. This issue was recognised by all parties and work was under way on a redesign of the undercarriage but this would not be available for the first Tabor. With their habitual pragmatism all agreed that the plane could fly for test purposes, provided its weight was minimised.

Following up Tarrant's earlier request, Sempill wrote to NPL to ask that they perform a wind tunnel test urgently to validate the RAE results.(135) This was followed the same morning by a second letter informing NPL that the model would be brought round by hand later that day.

On 23rd May, having completed his inspection of the Tabor, Bramwell gave Grosert the Tabor's Aircraft Approval for Flight certificate.(128) That afternoon, Buchanan informed Rawlings and Wilson that the NPL tests had been completed.

Tarrants also received a letter from Sempill, advising of changes proposed to engine systems, following the final inspection.(136) This letter is typical of the level of detail considered by the Technical Department.

With reference to a recent inspection of the engine installation of the above machine by an Officer of this department. The following items are brought to your notice:-

1. It is noted that the altitude control is not connected with the throttle as is customary on modern aircraft. This will necessitate a proper understanding between the pilot and the engineer officer.
2. It is thought that the ¾" outside diameter pipes on the lubricating system are too small. In cold weather this may lead to trouble. It is not necessary to make any modifications of this, pending the results of trials.
3. The vent on the filler cap of the oil tank is considered too small and it is recommended that a short ½" outside diameter pipe should be taken out through the filler cap… (136)

While Sempill was content to leave these alterations until after first flight, the Ministry's experts would surely have been more usefully occupied addressing the Tabor's aerodynamics. One other expert was prepared to do so. Bristow of Ogilvie's had already made his point at the second flight safety conference. He again visited Farnborough on 23rd May for a long discussion with Tarrant, Turner, Rawlings, Wilson and Dunn.

Figure 34. The Tabor outside 'C' Shed on 14th May, off its tracks and standing on solid ground. RAF Museum, X003-2602/16776

6.8 Opposition to the First Flight

Bristow was adamant that the Tabor should not fly until further confirmatory wind tunnel tests had been carried out on the tail setting. He emphasised that the tests made at RAE did not agree with his previous experience with big machines and that the tail setting was extremely important

in view of the doubt about the strength of the undercarriage, as any trouble would mean a complete wreck of the machine. He also wanted further wind tunnel tests at both RAE and at NPL to be done on a second model of the Tarrant being constructed by RAE so that there might be no doubt about the tail setting. Dunn, it seems, also held this view, although we do not know whether he expressed it at the time.

Seeking support, Bristow asked Turner whether he shared his concerns. Turner replied

> As officially representing RAE, the date on which the Tabor was to fly and the question of safety did not affect him. But his personal view was that if there were any doubt about the safety of the machine, the date of flight ought to be held over until he (Bristow) was quite certain.(137)

Eventually, all present agreed that the Tabor would not fly unless NPL's wind tunnel tests more nearly bore out the calculations and experience of the experts from Tarrants and the Ministry than did the RAE's tests. They concluded by discussing how to approach announcing a delay of a few weeks, should the need arise. As Turner reported to Sydney Smith,

> Owing to the large amount of publicity in the Press, it was thought desirable for Mr Tarrant to write to the Press stating that, owing to certain modifications which he desired to incorporate, the machine would not fly for a few weeks but otherwise it was quite ready for flight.(137)

Tarrant accepted that before anything definite was decided it would be desirable for him to talk with Brooke-Popham (now on secondment to the Ministry of Munitions as Director of Aircraft Research). Tarrant drafted a letter to Ogilvie, amended in conference with Bristow, Rawlings and Wilson, listing the decisions come to. Bristow then left to go to NPL to expedite the additional proposed tests and to brief Sempill at the Ministry. He also intended to brief Brooke-Popham on his side of the discussion, although this did not happen.

Turner prepared a summary of the meeting for his superior, which a concerned Smith decided to forward to Brooke-Popham.(137) A call was made to the general, and in his absence his superior, Major-General Edward Ellington, Director-General of Supply and Research, who agreed to intercept the document and 'go into it with Brooke-Popham that afternoon.' Smith confirmed these arrangements in a letter to Brooke-Popham, sent up the same day.(138) Whether the two generals met that afternoon, we do not know.

7. THE FLIGHT

7.1 The Fateful Decision

One day later, (Saturday 24th May), Rawlings and Wilson met with Brooke-Popham. Hearing of this, Tarrant decided to join them. Rawlings and Wilson first had a long meeting with Buchanan and other Ministry experts to review the NPL test results (Tarrant may also have been present). These broadly confirmed RAE's wind tunnel tests, at odds with Wilson's empirical results and calculations by the Ministry's own experts. Those present could not reconcile the wind tunnel results with the tail settings and proven performance of comparable machines and could only surmise that either wind tunnel tests were not always scalable, or that known inaccuracies in the

model itself were generating spurious results. In either case, they concluded that the wind tunnel results should be set aside as unreliable.(127)

Following a briefing from his experts, Brooke-Popham then sent for Tarrant, summarised his experts' conclusions and advised him 'to wash out the model tests and abide by the calculations only, as it was pretty certain that the model was not accurately made.' (139) He asked Tarrant if he was satisfied with his [Tarrant's] experts' decision. Tarrant expressed full confidence and Brooke-Popham, confirming his confidence in his own experts, assented to a trial flight. With the wind tunnel tests set aside, Tarrant believed Bristow's objections were resolved and thus Ogilvie's would concur with a flight decision. He was remiss, however, not to warn Brooke-Popham that Ogilvie's had considerable doubts about the plane's longitudinal stability. But the general should have known this anyway, as he had a copy of Major Turner's report relaying Bristow's serious concerns.

While still at the Ministry, Tarrant wrote a letter to Bristow advising him of the decision that all agreed the Tabor was safe to fly. Bristow's conditions had been met and therefore the test flight would take place on Monday morning, 26th May. (127) As no one had Bristow's address the letter was posted to Ogilvie's office, which by time was closed for the day. Before the letter was opened, the Tabor was matchwood.

Tarrant, Brooke-Popham, Rawlings and Wilson all seem to have discounted Bristow's emphatic advice that further wind tunnel tests should be conducted by both RAE and NPL on the second model before a first flight. What was the tearing hurry? Clearly, every day cost Tarrants money, but the additional cost of a few days' delay would have been insignificant in relation to overall expenditures. Perhaps it was group-think, that everyone's keen desire to see the Tabor fly distorted their objectivity, leaving them unable adequately to assess the potential risks of a flight. Or perhaps the decision to fly was made under pressure of publicity?

The *Daily Mail* had established a prize in 1913 for the first successful transatlantic flight and it was known that Handley Page, Vickers and others, including some American companies, were shortly to attempt it. The contest had caught the public's imagination and it would have been tempting for Tarrants to participate. Tarrant possibly held this view. The *Globe* reported on 14th February a 'super triplane for Atlantic', and on 2nd March the *Sunday Mirror* highlighted 'an attempt to cross the Atlantic' in relation to the Tabor. This information would likely only have come from Tarrant. Irish author and close friend of Tabor pilot Dunn's family Desmond Houston-Chapman Mountjoy later wrote that 'At that time everyone was talking about flying the Atlantic. It was generally supposed that the Tarrant Triplane would be entered for the event.' (140)

Tarrant had given a preliminary interview to *Flight* for its 8th May edition, and followed this with an invitation to other newspapers to inspect the Tabor the following week. Consequently, a crowd of excited and apprehensive reporters, photographers, and cinematographers gathered outside 'C' Shed at RAE Farnborough early on the following Monday morning, 26th May.

7.2 The First (and Only) Flight

On Monday 26th May 1919 at 2:15 am the Tabor was winched out sideways on the railway track laid down for it. Problems with a staple pulling out of the ground meant that the machine could

not be moved into its proper position, delaying the start by nearly two hours. A 35 ft high Hucks starter was used on each tractor engine in turn, a process that took over an hour.* The pushers were started by the slipstream from the tractors. The lower tractors were run up to 1,775 rpm and the pushers to 1,475 rpm. In view of the uncertainty surrounding longitudinal balance and the pitching effect of opening up the upper engines so far above the centre of gravity, the upper engines were specifically set to a slow idle.(128)

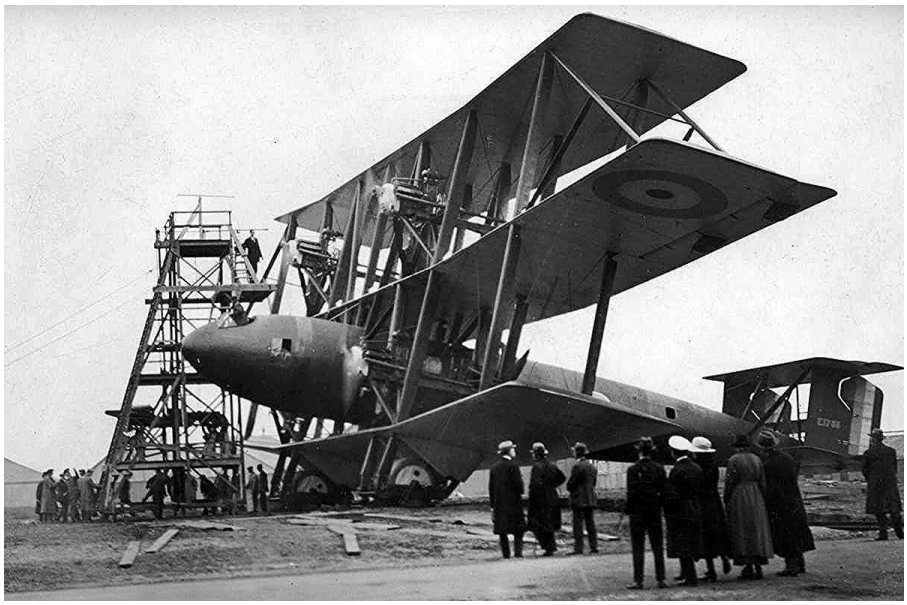

Figure 35. The Tabor with the Hucks in position to fire up the starboard engines. RAF Museum, X003-2602/16783

Earlier that morning, Rawlings, Wilson and Dunn, in discussion with RAE officials, agreed that the Tabor should taxi about the aerodrome for an extended period before attempting a high-speed run, including a stop to allow Wilson and Grosert to examine the undercarriage and skid. Grosert was only permitted in the machine under express orders from Smith that the plane was not to fly with him on board.(127) We do not know what conditions were attached to the test although Tarrant, giving evidence at the Coroner's Inquest, stated that 'we expected the machine to taxi over the ground before it started to fly.' (141)

7.3 'Dusty' Dunn

In 1913 Frederick George "Dusty" Dunn learned to fly at the Bleriot School at Hendon. He was from a family of modest means, in service, and only 17 years of age. Apprenticed to the school as a draughtsman, it is likely his employer provided the means for Dunn to obtain his pilot's licence. In August 1914 he was accepted for immediate active service as an aerial scout and, some seven weeks after war was declared, posted to A Flight, No. 3 Squadron, in France. Here

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* The Hucks-Ford system was a common starter used until the mid-1930s. An ordinary Ford car was mounted on a moveable platform and its engine was used to rotate a chain, connected via a clutch to a shaft attached with a 'dog' to the aircraft's propeller shaft. A longer chain was used to drive the shaft to start the top engine, and the staging and car could then be easily shifted to the other side of the plane to start the other set of engines. This was probably the largest Hucks starter ever built. Were the Hucks starter not available, the exhaust valves could be opened manually and petrol-ether injected into the cylinders from the vapouriser. With the valves closed and cylinders primed, the engine would then be fired from a magneto in the engineer's compartment.

he came into contact with the 'military wing' of the RFC, officers originally commissioned into army regiments, among them his squadron leader, then-Major Brooke-Popham.(140)

In April 1915 he returned to England, with 290 hours' flying time since his first flight on every available make of fighter in every condition and state of repair. By this time the RFC had identified an urgent need to send to France large numbers of machines that had been carefully tried and thoroughly tested at home. Dunn's cool, calculating manner, competent judgement, and passionate and innate love for engineering machinery were exactly suited to this work, on which he spent the next two years.

Figure 36. F G "Dusty" Dunn at Flight School

He returned to France for the last 18 months of the war, testing captured German machines, spending over 3,000 hours in the air on some 150 different machine types. It is not clear why Tarrant selected him as the Tabor's test pilot after war's end, but the authorities hastened his demobilisation and transfer into the RAF Reserve, so that he was free to devote himself entirely to this role as Tarrants employee.(140)

Figure 37. "Dusty" Dunn, RFC in 1916

Dunn took his work seriously, appraising the aeroplane and its assembly over the next four months with an expert's eye. He might have been a little too free with his observations and suggestions, however. Lieutenant Geoffrey Adams RN, who had been with Rawlings on the *Goeben* flight, was seconded to Tarrants in late April to be second engineer and observer on the Tabor's first flight. Rawlings wrote to Dunn on 25th April to explain their responsibilities.

> You will appreciate that the position as a whole, since we are working in a Government Factory, is one which requires considerable tact and I therefore rely on you to use every endeavour to maintain the feeling of friendship and goodwill between the Farnborough employees which, as far as I know, in the past has existed. I do know that the Farnborough people who are working on the machine have our interests very much at heart and it is this reason that makes me desire both you and Adams to maintain as diplomatic a position with regard to them as you can, consistent, of course, with my obtaining what I desire in big issues.(142)

Dunn also wrote to Tarrant a few weeks after the third flight safety conference to recommend a longer fuselage (doubtless on subsequent machines) and reiterate his concerns regarding size of the tailplane and ailerons and the understrength undercarriage. Wilson replied for Tarrant on 28th April, agreeing with Dunn on all matters but reminding him they had all been discussed at length and it was agreed to postpone any changes 'at present.' Presumably Dunn recommended a longer fuselage to ensure the tail received adequate 'wash' from the wings and engines, suggesting he saw longitudinal stability as an issue even before the RAE wind tunnel tests. Wilson sought to reassure him.

> It would certainly improve the machine if the fuselage had been made longer, but I do not consider that it is unsafe to fly the machine as at present, although undoubtedly it will be uncomfortable. I am getting particulars of the Braemar and the Fury from the Air Board so that we can make comparisons and thus give you greater confidence on the trial flights.

Wilson also assured him the control column was being moved forward 6 in on the second machine and noted that Dunn had already sent instructions to the Drawing Office to modify the engine throttle levers, 'using as many of the existing parts as possible.' (143)

We know from Mountjoy that Dunn remained concerned throughout the last few weeks before the flight following the RAE wind tunnel tests and CG findings. In more than one conversation with Mountjoy he asked rhetorically, 'Will it fly?' His regular letters and cards home also hinted at his concerns, if light-heartedly. However, he was ever the professional pilot, accustomed to obeying orders and prepared to make a go of any task he was given. According to Brooke-Popham, in a letter to Dunn's father after the fatal crash, 'He was probably the best all-round pilot I have ever seen.' (144) On 26th May, with Rawlings in the co-pilot's seat, he flew into history.

Figure 38. A prophetic postcard Dunn sent to his aunt in April 1919. The nacelles on the wheels were an artistic embellishment

7.4 Grosert Recalls

In a 1966 letter, John Grosert – the last survivor of the Tabor project – summarised the events surrounding the fateful morning, and is worth quoting at length.(128)

> The crew consisted of Captain Dunn in the port pilot seat and Captain Rawlings in the starboard pilot seat, with myself in between. I had one leg anchored to the ladder by which entry was made to the pilots' cabin from the walkway. My head was slightly higher than the pilots and I could see all the cabin instruments, the tail and the undercarriage. A fitter named See was in charge of the petrol system, which had alternative supply systems. The foreman Edney was in charge of the engineer's compartment and I could speak to him. At

the extreme rear of the fuselage there was an observation window where Captain Wilson, Tarrants designer, located himself. Somewhere between Wilson's position and Edney's cabin an engineer officer Adams was stationed.

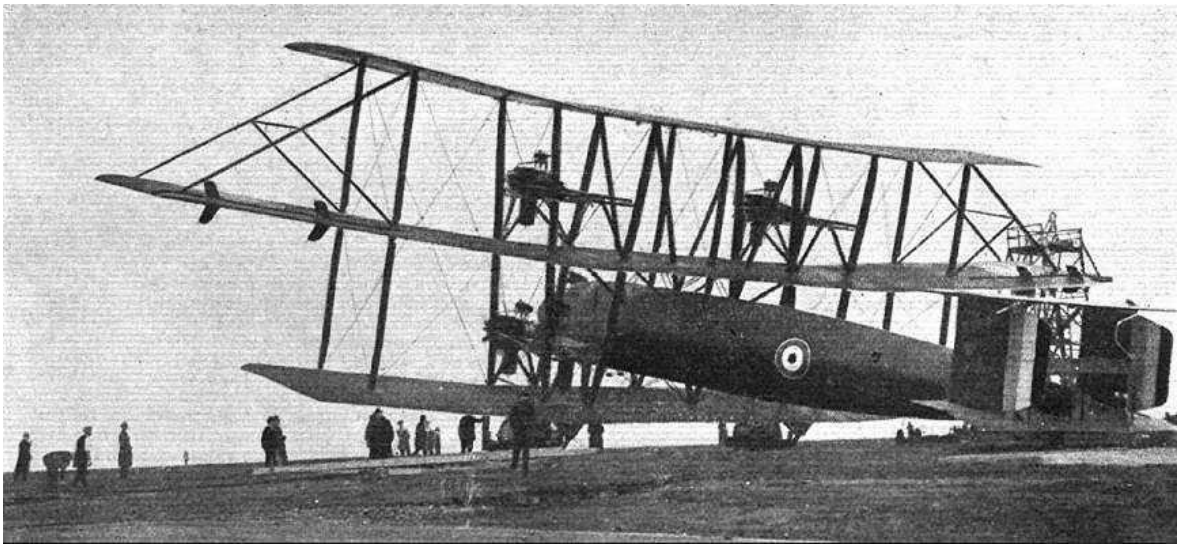

Figure 39. At 6.10am on 26th May ‘Dusty’ Dunn commenced his taxi run, leading into the fatal attempt. RAF Museum, X003-2602/16785

Dunn stated he would not use the top engines on the test flight. The start was made at 6:10 am with the weather fine and calm. The machine went straight for 90 yards with all bottom throttles in a similar half-open position, top engines just turning over. It was intended to turn to the left but at this spot, Dunn momentarily stopped the Tabor and said: ‘The damn thing won’t turn.’ He was told that he could not turn it on rudder only, but that he would have to throttle down port engines and throttle up the starboard. He tried to do this but got mixed up with the levers and opened up the port front and rear engines. He then said: ‘It does not matter now, she turns very easy’ [*sic*] and the Tabor turned a complete starboard circle.

Rawlings at this point drew up his legs and sat on them, facing Dunn, saying: ‘I feel very miserable.’ The tail of the aircraft came near to colliding with the end of the airship shed ‘A’, and the Tabor went on to circle the compass course for about 100 yards. At this point, it made a star turn, swaying badly; the speed on this


THE GRAPHIC

AN ILLUSTRATED WEEKLY NEWSPAPER

SATURDAY, MAY 31, 1919

The Wreck of the World's Largest 'Plane

The triplane Tarrant, built by Mr. W. G. Tarrant, of Byfleet, at the Royal Aircraft Factory at Farnborough, which was originally intended for the bombing of Berlin, and was regarded as the largest aeroplane in the world, came to grief during its trial trip on Monday, when Captain P. T. Rawlings, one of the pilots, was killed outright, and the other occupants were injured.

Figure 40. The Graphic, 31st May 1919. The figure in the left foreground graphically illustrates the Tabor’s scale.

turn was not reduced. It was heading for the centre of the airfield. At this moment, the tail commenced to rise and at the next turn it rose still higher and was very near the flying angle. The speed before this last turn was about 40 mph with all engines at half throttle except the top pair, which were idle.

He now opened up all the bottom engines full out and I noticed the tail climbing higher. Dunn never looked astern at the engines or aside. Rawlings was still sitting sideways on his legs.

Realizing we were about to attempt flight, I settled back down the ladder and hooked one foot around a bomb rack girder. The Tabor was bumping and bouncing very badly and I looked back along the fuselage at the tail and was alarmed at its height. After this I heard the roar of the top engines and looked at their revs–they were already at 1,800, a very sudden increase.

Then on looking at the landing gear, I saw the wheels were well clear of the long grass, which I knew was 18 inches long. The elastic cordage was not strong enough and that allowed the solid undercarriage to sink near to ground level.

I next saw a shower of earth thrown from the landing gear on the starboard side. Very shortly after this, I actually saw Dunn and Rawlings thrown from the aircraft when it hit.

The Tabor had come to rest with its nose section collapsed and its tail in a near vertical position. Grosert was trapped in the remains.

Figure 41. The Tabor from the starboard side, showing total destruction of the nose and top wing.

RAF Museum, X003-2602/16791

I crawled about the wreckage under the petrol tanks, saw daylight and crept clear, followed by Edney. See and Adams were lying face down towards my exit. Dunn and Rawlings seemed to be lying near each other and about 25 yards ahead of the wreckage. Wilson had a long drop from the tail onto the wreckage below, for he had been hanging onto the rear portal with no means of descent. When he let go, he fell about thirty or forty feet. I saw Dunn and Rawlings into the ambulance and began to feel faint. A test pilot, Captain Edward Gribben [of the Technical Department], was with me, and together we walked along the track the machine had travelled, to try to trace the bumping period. There was evidence of the wheels having left the ground.(128)

The *Daily News* reported the next day that ‘Mr Tarrant was naturally much distressed but he still has faith in the design. It is hoped that another machine of the same type, which is already well

advanced, will be more successful.' [145] In his distress, Tarrant probably went further than he should have at that early time, telling the press that 'two top engines were opened up too fast and that brought the tail up.' This was unfortunate as some aviators saw this as prejudging the cause of the accident.

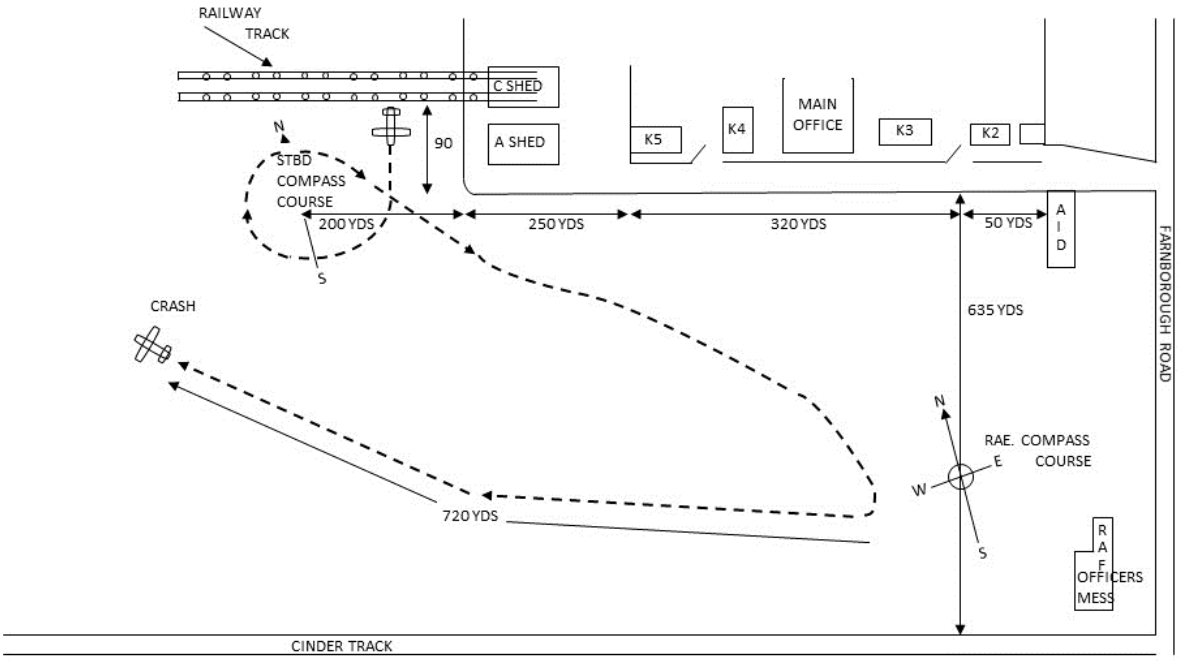

Figure 42. Reproduction of a map of the path taken by the Tabor, drawn by J Grosert at the time. Grosert was confused over the final leg which was to port, in the direction of Pyestock and not starboard as drawn.

In its 29th May 1919 edition, *Flight* delicately summarised the accident.

> After months of painstaking work, and having solved an endless succession of constructional problems, those responsible for the large Tarrant "Tabor" triplane, have suddenly seen the results of their labours annihilated in the course of a few minutes by the accident which occurred on Monday last. Not only is the beautiful structure, for beautiful it was from a constructional point of view, whatever may have been one's opinion of the design, reduced to matchwood, but at least one of the men who had worked on the machine from the time of its inception has succumbed to the injuries sustained in the accident, while a second man, the pilot, is lying in a critical condition.
>
> With regard to the accident itself, it is difficult to be certain of the exact cause, but it would appear that the machine was travelling along the ground at high speed with the four lower engines running, and that, in order to get sufficient speed to rise, the pilot opened out the two top engines, which had up till then been throttled down, with the result that the extra thrust, applied so far above the centre of resistance of the machine, brought the tail up.
>
> The result was that the machine turned on to her nose. It is quite conceivable that had the machine been in the air the momentary pitching could have been corrected by trimming the tail, but on the ground there was no time in which to do this before the machine was over.
>
> By keeping cool to the last, the horror of a fire was avoided by someone - probably one of the pilots, as there was a master switch in their cockpit - switching off the engines, otherwise the disaster might have been far greater than was the case.

> In addition to the two pilots, there were on board at the time of the accident the following: Capt. T. M. Wilson, who, as the machine turned over, was flung into the rear part of the fuselage and sustained a broken leg; Lieut. Adams, engineer-in-charge, who accompanied Capt. Rawlings on the famous flight to Constantinople in a Handley-Page; Mr. Grosert, of the RAE; two mechanics. The injuries to the crew, with the exceptions of those sustained by the pilots, are not thought to be serious.*

7.5 Ogilvie's Withdraw

The day after the crash Ogilvie wrote to Tarrant, informing him that 'in view of the fact that the trial flight was in direct opposition to our advice, Ogilvie & Partners are terminating our

contractual arrangement with you.' (127) Tarrant was not impressed. He had been working with Ogilvie for well over 18 months and must have seen this as an act of betrayal. In a detailed rebuttal the following day, all the more potent for its formality, he averred.

> It looks to me as if the principal anxiety of your firm has been to obtain kudos in the event of the machine being a success, but to avoid risks in the event of mishap. … I beg to say that I am not at all sorry that you have withdrawn from the consulting position … I must say that your attitude in connexion with the accident is quite inexplicable to me… (146)

This marked the end of Ogilvie's relationship with Tarrant. His firm's only involvement in the subsequent investigation, aside from providing written statements, was that of Pippard who was invited to review the draft Accident Investigation report and commented on it at length.

King George V commiserated, sending Tarrant the following telegram, reported in the press.

> The King has just learnt, with much regret, of the terrible accident to the latest type of triplane on her trial flight, resulting in the death of your managing director (Captain P. T. Rawlings, DFC).
>
> His Majesty hopes that you will convey to the relatives the expression of his sincere sympathy.
>
> The King trusts that the injured may be speedily restored to health.(147)

But for Dunn it was not to be; he had suffered a fractured skull, never regained consciousness and died in hospital on 29th May.

7.6 A Fitting Farewell

The two pilots were interred within days. Rawlings' funeral, reported nationally, took place in Aldershot on 30th May. His brother was chief mourner and the pall-bearers were captains of the RAF. Full military honours were paid by the Black Watch (Royal Highlanders) as Rawlings was interred at Highgate Cemetery.(148)

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* *Flight*, 29 May 1919, pp 702-3

Dusty Dunn's funeral took place at Farnborough on 1st June, recorded by local and national newspapers, including the *Pall Mall Gazette*.[149] Fallen heroes normally received a three-volley salute from between three and seven rifles over their open grave. That Dunn was honoured with 100 rifles was the surest indication of the regard in which he was held within the services and may well have required the King's consent. His grave in the Victoria Road Cemetery, Farnborough, now sadly neglected, records the desperate words of his parents: "To the memory, ever dear and beautiful, of our beloved and only son." It concludes with the line: "God touched him with his finger and he slept." He was only 24 years of age.

On 30th May, Brooke-Popham, eyewitness to the disaster, wrote to his superior, General Ellington. He first described the accident in detail, then recommended no further work be done on the Tabor because – with the war ended – the military had no use for it. Brooke-Popham said he believed that at the eastern end of the airfield Dunn determined to fly (as opposed to making another high-speed run).

> My reasons for believing this are that the pilot had stated that when he took off, he would start from near the officers' mess, Southern Area Repair Depot (Eastern end) and head in the direction of Pyestock chimney. Before he turned 30 degrees to the left, he was heading considerably to the right of Pyestock chimney. The sharpness of the turn was no doubt due to the turning effect of throttling down the engines on one side being underestimated.

Brooke-Popham also made an extraordinary statement. He had only on the afternoon of the accident discovered his department's responsibility for the flight. 'As a matter of fact, I was not aware of this till Monday afternoon but should have made myself acquainted with what the conditions actually were.' What did he think he was giving permission to? Interestingly, Brooke-Popham also noted that

> Colonel Bristow did not see me either on the 23rd or subsequently, although I was in my office all the afternoon of the 23rd, the whole of the 24th and all the morning of the 25th.

Evidently, he anticipated questions as to why he had agreed to a flight in light of Bristow's emphatic advice to Tarrants to the contrary. [139]

Ellington responded with a hand-written note on the memo, saying,

> I agree with your proposals and have instructed the Liquidation Commission to close the contract on the best terms they can make. If the sum we have to pay can be reduced by handing over the parts of the second machine to Tarrants I have told the committee that I will agree to this …. [139]

Copied in on Brooke-Popham's note to Ellington, Sempill objected, asking,

> 'Wouldn't it be best to continue with the second machine, at least until the findings of the accident investigation were available? That way, much additional useful data on large machines we have under development would be obtained.' [150]

This indeed made sense but the Ministry was preoccupied with many other types of heavy military aeroplane. With Weir and Ogilvie gone, there was no senior level advocate for an experimental machine that clearly had major design issues. Brooke-Popham replied in a hand-written note on Sempill's memo that Tarrant was free to continue with the project at his own expense and if he did so, he would be given every facility.[150]

On 2nd June Seely stood in the House of Commons to announce that, since the Tabor was a service aircraft, 'It would not be in the interest of the public service for the results of a technical investigation into the causes of the accident to be published.' (151) On Brooke-Popham's order, all Ministry and RAE files relating to the Tabor were then embargoed (released only in 1969 and 1970). Preliminary results of the accident investigation were not made available to the Coroner's Inquest, and government officials called as witnesses, including Brooke-Popham himself, declined to answer certain questions, claiming Crown privilege.

8. AFTERMATH

Ten days after the accident, (5th June), Brooke-Popham wrote to Smith at RAE:

> Please note that instructions have been given to the Liquidation Committee to close the Tarrant machine contract, and (if specially requested) it is intended to hand over the existing parts of the second machine to Messrs. Tarrants.
>
> It is requested that all work upon the second machine is to cease forthwith please. (152)

Tarrant tried to maintain momentum. He had two meetings with ministry officials, one unwelcome and the other more positive. In the first he was informed of the Ministry's intention to discontinue the second machine – for purely military reasons, he was assured. Tarrant took it on the chin, suggesting, 'I would give the matter my very careful attention and see if I could submit a proposal.' (153)

He met with Buchanan on 16th June to review suggestions that Hill put forward regarding the tail and to look at alternative arrangements for the engines. The meeting concluded in agreement, and Tarrant wrote next day to Sempill, perhaps a touch desperately:

> There is little doubt, I think, that the little test that the machine has had has enabled us to see how to eliminate the risk of failure in the future.
>
> A suggestion was made by Colonel Buchanan which is, I think, of very considerable importance. It is that we do away with the top engines and place them in between the two bottom engines, where we have plenty of space and connect these by means of gearings through a main shaft to carry a 16 or 18 foot propeller. There is no doubt by this means we should get the utmost efficiency from the engines and propeller.(153)

By this means the centre of thrust would also align approximately with the centre of resistance and the propeller would be long enough to send the whole of the slipstream onto the tail unit. Sempill replied on 20th June, saying he was glad to hear of agreed modifications to the second machine while acknowledging that 'mechanical problems involved are fairly large.' (154)

Tarrants design team pursued this line for the time being, continuing to look at how to resolve the inherent weakness in the design of undercarriage. On 9th July, Tarrant wrote to Brooke-Popham.

> I have sent you drawings showing the alterations which we propose making in the Tarrant Triplane which I trust will meet with your approval in every way.
>
> Unfortunately, at the present stage, I am unable to lay before you any financial proposals, as I am still awaiting the promised visit of the government auditors to check and pass my

> accounts in connexion with the contract. As soon as this has been done and the financial position of the Aeronautical Department made clear to me, I hope to lay before you certain proposals which I trust will meet with your approval.(155)

The same day, Seely gave a wide-ranging interview to the Manchester *Guardian* on Government aviation policy.(156) Asked about rumours of an aircraft even bigger than the Tarrant Tabor, he demurred.

> The Tarrant machine has been unfortunate, but it has a future. Improvements in aeroplanes usually result from improvements in engines [and] there are five new types being made [with horsepowers] varying from 320 hp to 650.

Seely explained that the Air Council had 11 different types of aeroplanes and seaplanes under development with 20 different designs. Whilst being made primarily for military purposes, he had no doubt that 'many of them contain features that would be of considerable value to civil aviation and [some] can be adapted to carry passengers, mails, or other goods suitable for aerial transport.' Later, turning to a large wall map, showing curving lines radiating from England all over the world, he said, 'I hope that an aeroplane will fly from Cairo to the Cape by the end of the year. The preparations for the India-Australia route will probably take longer but it is anticipated that a machine should reach Australia early in 1920.' (156)

The Tabor was not an outlier, a wild experiment before its time. Seely appeared to have confidence in its future, and if he was correct, there was considerable potential demand for heavy transport machines. Perhaps things weren't so dark for Tarrant after all. But first, he had to contend with the fall-out from the Coroner's Inquest into the deaths of Rawlings and Dunn.

8.1 The Coroner's Court

Rawlings' Inquest was opened on 28th May 1919 by the Deputy Coroner for Aldershot, but was suspended at the request of the military authorities to allow time for initial investigations.(157) Tarrant took this opportunity to

> … express his very greatest sorrow and sympathy to the relatives, and to say how very much he appreciated the efforts of Captain Rawlings to assist in the construction of the machine. He was quite as keen on the machine as he [Tarrant] was. Nothing he could say would sufficiently express how much he appreciated all that he did.(157)

Ogilvie and William Brooks Sayers, a consulting engineer who had worked with Tarrant on the original Tabor plans, both attending as observers, also expressed their sympathy. Sidney Smith said he would like, on behalf of the Royal Aircraft Establishment, to express their deepest sympathy with the loss the relatives had sustained.

Resuming on 27th June, this time also covering Dunn's death, Inquest witnesses included Tarrant, Brooke-Popham, Sempill and George B M Cockburn, head of the Air Ministry's Accident Investigation branch. Ogilvie's retained their own counsel to ensure certain questions were aired.(158)

As first witness, Tarrant gave a short description of the aeroplane and the proposed test run, stated that Dunn appeared confident and confirmed that the experts were satisfied the plane was

safe to fly. In answer to questions from Counsel to the Inquest he stated that Brooke-Popham had given his approval for a test flight. Dunn had been away with him for a week's holiday in order to get quite fit for the trial flight and he was not cautioned by officials as to the machine not being safe.

Called to testify, Brooke-Popham said the trial flight took place on the Monday and the decision to do so was made on the previous Saturday morning. Responding to Ogilvie's counsel, he said he was not aware at the time that Ogilvie & Partners did not know of the flight, and he did not see any of them on the Monday. As far as he remembered, Tarrant did not tell him that his consultants had reported that based on the RAE wind tunnel test the machine was not safe to fly. Nor did Tarrant tell him that he had drafted a letter stating the flight must be postponed. These statements did not impress the jury. However, Brooke-Popham clearly knew of Bristow's very strongly stated views through Turner's report and RAE's telephone call to Ellington on 23rd May, so his careful responses appear somewhat self-serving.

Brooke-Popham added that during a conversation with Tarrant on the Saturday morning, it was decided by the experts to set aside the conclusions drawn from the model tests and to make their arrangements for flight based on the calculations, and – to the best of his knowledge – the calculations were all in substantial agreement. This was true but again Brooke-Popham was being economical with the truth. In his note to Ellington, he had stated that he recommended Tarrant to 'wash' the wind tunnel tests. Understandably, Tarrant believed that he had '… received instructions from General Brooke-Popham to fly the machine.' (146)

Counsel then asked Brooke-Popham if, 'From your own observations, are you satisfied the actual performance of the machine negatived [*sic*] the air tests, and that she was not tail heavy? To which he replied tersely, 'Yes, that is so.' Brooke-Popham acknowledged the plane had not proved tail heavy but he was not about to concede that it was nose heavy. He declined to answer that question, claiming Crown privilege.(158)

Sempill said he inspected the machine after the accident. For the purpose intended, he thought the undercarriage was perfectly satisfactory. He had reported the state of progress to Brooke-Popham who had subsequently come to the final decision that the machine was fit to fly.

Vickers said the final inspection of the machine on the material and workmanship was commenced on Sunday, May the 8th and completed on Saturday the 24th, when it was approved for trials. In his opinion, the machine was fit to fly.

One question consistently arose which all government witnesses declined to answer.
As regards whether the tail plane was too heavy, you cannot give an opinion? – No.
Those are your instructions? – Yes.

In summation the coroner said

> Without being unkind or offensive in any way to any department, when they examined it all, it came to nothing. They had had the evidence of experts, but the evidence given before the Board of Inquiry was not allowed to be produced, and Major General Seely, in the House of Commons, said that it would not be in the interests of the public service that the results of the technical investigations into the cause of the accident should be published.

> Possibly it *was* in the interests of the public that the facts and the reason should not be given, but that was a matter of opinion.

After a consultation of five minutes, the jury returned a verdict of accidental death, to which the foreman added this rider.

> But we all of us feel unanimously of opinion that something has not come out which should come out. We have not had the evidence of anyone in the machine and we feel that something has been kept in the background which we should know.(158)

8.2 Court of Public Opinion

Others shared the jury's view. In fact, dissatisfaction with the Government's lack of transparency appeared widely held among the aviation community.

On 4th July, Hugo Massac Buist, an aviation and motoring pioneer, editor of *The Autocar* magazine and author of *Aircraft in the German War*, wrote to the *Morning Post*.(159) He observed that manned flight was still in an experimental, dangerous stage and that lessons learned from accidents would benefit all aircraft designers. With the war over, there was no longer a need for secrecy, yet in conversation with a senior Ministry official, Buist was 'astonished to discover that the authorities provided no means by which such information could be shared with designers – and apparently saw no need to do so.'

The Tarrant triplane was a case in point. There was clearly a need to explain why the firm's consulting engineers had advised so strongly against flight in the machine as configured, yet this did not come out at the Inquest. Nor, it appeared, was it likely to emerge from the Government's own inquiry. The Technical Department's policy appeared to

> … camouflage the facts of the accident under the absurd but always usable excuse about secrets of military importance. It was common knowledge from end to end of the land in aeronautical circles, as well as abroad, that the machine was tail light, hence the fatal nose dive.
>
> It is amazing that Parliament should be so indifferent to the importance of the progress of aviation to this country, as to accept the mere opinion of a Government Department, that knowledge should be deliberately concealed in this manner.(159)

Opinion of the Air Board was not unscathed despite every bit of political machinery possible being used to prevent the truth becoming public. 'As long as it maintains this attitude it will rightly create distrust in the mind of the public, as well as in aeronautical circles.' (159)

8.3 A 'conspiracy of silence.'

Strong words – and there were more to come. In a long angry letter to the *Morning Post* on 12th July Desmond Mountjoy, writing as Chapman-Houston, lamented the loss of 'two of England's bravest sons. (144) He was only acquainted with Rawlings, but Dunn, known to 'hundreds of flying men' as 'Dusty', was his friend with whom he had often discussed the Tabor and its prospects of flying the Atlantic. He was with Dunn on May 24th from 4:30pm until 10:00pm and

the impression he formed from Dunn's demeanour then, as from previous conversations, led him to believe Dunn had doubts about the ability of the machine to fly. Nevertheless, he said that Dunn

> … got up early and in his usual, quiet, casual, cheery way, took on what he knew to be a big, difficult, and risky job. It was one of the bravest things in a career full of bravery. No advertisement or applause, no huge money prize, none of the excitement of competition or worldwide interest in a machine tested and retested and with every possible risk minimised, foreseen and provided for. Just the routine of a days' work carried out in cold blood and without applause or glory. For some reason, the splendour of the action of Dunn and Rawlings and their companions has gone almost without appreciation, and that portion of the press that goes in for booming 'stunts' has not noticed it by as much as a word! (144)

He blasted the 'conspiracy of silence in the Press and in Government' and asked five key questions, to which, of course, no official replies were forthcoming.(144)

> Now that the Coroner and jury have spoken, Captain Dunn's parents and friends can no longer keep silence. There is something behind it all; something that explains the almost universal 'hushing up' by the Press and the official decision towards secrecy, and the public have the right to know what it is.
>
> Now that the war is over, it cannot be maintained that there is any sound reason for secrecy. Two splendid men with war records unequalled have been lost to the country and we want to be assured that the sacrifice was unavoidable. 'Dusty' Dunn was the soul of loyalty, and, moreover, loved the old Triplane, but when I asked him will she cross the Atlantic? He always replied 'Yes, if she flies at all!'
>
> We are, I think, entitled to know:
>
> 1. Was there any considered collective opinion given on the fitness of the triplane for her trial flight? By all the experts separately consulted, or were the results of their views in any way coordinated?
> 2. Was the machine repeatedly altered and re-altered in parts and was the total effect of these alterations and adjustments taken into consideration before the trial flight?
> 3. Was the final decision to try her totally unconnected with the other efforts being made to cross the Atlantic?
> 4. Were definite orders issued beforehand that this huge, unwieldy machine with engines placed in a very unusual position and from which the pilots could see nothing of the ground, was to be taxied over the ground and thoroughly tried thereon before attempting to fly her, and was the ground suitable and large enough for the test?
> 5. If the machine was properly balanced and her design and construction correct, why was it necessary to adopt the unusual practice of putting lead into the nose?
>
> Two men have been rewarded, and properly so, for crossing the Atlantic, and two, for a gallant attempt; and a newspaper has secured an enormous advertisement at the very moderate rate; but the price has been paid by P T Rawlings, who bombed the *Goeben* at Constantinople, and by F G Dunn, the boy pilot of 1914, and a mother, who watched in prayer and anxiety for nearly five years, is now, on the eve of Peace, without her only son.(144)

Huston's letter elicited a response next day from 'MGK', a former RAF captain. He had been present when the Tabor was revealed to the Press, and had remarked to Rawlings that the top engines, if used at full power, would cause the machine to nose-over in taxiing or in flight. 'Rawlings laughed and replied that possibly it might be inadvisable to open the top engines while taxiing but he was certain they would have no bad effect if opened in flight. They had had a model tested by RAE with 'very satisfactory results.' (130)

Together with another press representative (also an ex-RAF officer), MGK observed that the undercarriage was structurally weak. With striking insight, he surmised that far too much attention had been paid to the wooden girder construction invented by Tarrant and far too little to the more important design of the machine as a whole. Just because a model had been tested it was taken for granted that the machine would fly. In his opinion this was misguided, to say the least.

Turning to Chapman-Huston's questions, MGK offered that as regards question 3, Rawlings had told him that, 'The Atlantic competition had nothing to do with the machine being tested at the time; it was even very doubtful that the Tabor would be entered in it.' This may have been true, but it is equally possible that Rawlings was dissembling.

With reference to question 4, MGK was 'pretty certain that Farnborough aerodrome was amply large enough for taxi tests', but not for a flight – at least, not on the run that Dunn took. The other questions were for the Air Ministry, which MGK suggested, was

> … keeping its inquiry into the affair very secret – it has been suggested in one of the best-known technical papers that the Technical Department of the Air Ministry is keeping back from civil aviation important knowledge which should be made public for the general benefit – a not unusual mistake for this Ministry to make. (130)

The 'technical paper' MGK referred to was *The Aeroplane* which, in its aeronautical engineering supplement of 9th July, had come out strongly in a whole page editorial against the Technical Department and the Air Ministry.(160) Observing first that Seely had withheld the initial findings of the Accident Investigation because of the need for secrecy surrounding a plane built for military service, the editorial writer lamented that if 'this is the case, it is distinctly unfortunate that the veil of secrecy was not drawn a little closer.' He added

> It is fairly obvious that [RAE's] model tests were erroneous and worthless ... It is difficult to avoid a suspicion that the public interest which is to be served by refusing to disclose the results of the official enquiry is that of maintaining some fragments of a reputation for the departments and officials implicated in the affair.

The editorial continued with a strongly worded indictment.

> On the strength of [the RAE wind tunnel] tests [Ogilvie & Partners] wrote to Mr. Tarrant, stating that the machine was not safe to fly if the figures of the test were to be accepted as they stood. Upon the strength of this report from his consultants Mr. Tarrant apparently drafted a letter to the Technical Department, on May 23rd, asking to be allowed to postpone the trials until confirmation by the National Physical Laboratory of the correctness, or otherwise, of the RAE tunnel tests.

> If the NPL tests confirmed the calculations and experience of his experts – presumably Ogilvie and Partners – he would like to make the tests as the machine stood; but if not – that is, apparently, if they agreed with the RAE tests – he was afraid that further model tests would be absolutely necessary, and whilst these were being made he would like to change the engines and also the undercarriage.(160)

Tarrant's draft letter was never sent because at a meeting at the Ministry the following day, Tarrant was advised that a flight could proceed, in direct contradiction of his consultants' advice:

> Tarrant would not have engaged Ogilvie's out of pure philanthropy. On the other hand, no sane man would employ a consultant in whom he had no confidence, nor act in a sense directly opposed to the last advice of his consultants without further consultation, unless there were a very urgent reason for that course.(160)

Was that reason, by any chance, the refusal of the Technical Department to allow important technical data to pass into the possession of civilian engineers? The implication was that Tarrant must have been induced to agree to the flight, possibly on the basis of incomplete or withheld information. This was the second time *The Aeroplane* had castigated the authorities over the Tabor. In its 28th May edition, the magazine had associated the crash with Wilson – incorrectly identifying him as the Tabor's designer, based at RAE. An alarmed Smith had written to Brooke-Popham, requesting an immediate retraction.(161) The general, professing never to have heard of the magazine, arranged for Tarrant himself to set the record straight in a letter to the editor.(162)

There is no evidence to suggest *The Aeroplane*'s 9th July assertions were correct, although it is notable that, unlike the earlier occasion, no one wrote to the magazine to refute them. Nevertheless, many senior aviators clearly felt a strong suspicion of and deep dissatisfaction with the authorities for their lack of transparency. In response, the authorities said nothing.

8.4 A Civil Action

Coming on the back of two valued employees' deaths, Tarrant must have found all this deeply distressing. It got worse before it got better. Shortly before the test flight, Tarrants arranged a £4,000 life insurance policy with the Aviation Insurance Association for the pilots and crew for up to 12 hours of test flying. Dunn's father, as his son's executor, submitted a claim – which was denied on the ground that no insured event had occurred. Dunn senior asked Tarrant to join him as co-plaintiff, suing the Lloyds syndicate for payment. The suit came before the Kings Bench Commercial division in early January 1920.(163)

Counsel for the defendants denied liability, contending that what happened before the accident did not constitute a flight. Furthermore, there had been a verbal agreement that no flight would take place without Ogilvie's prior warranty that the plane was safe to fly, there was a verbal understanding that the contract would not take effect until after the first flight made by the machine, and the contract did not cover flights in which the pilot was put in unusual or exceptional danger.

The defendant's main argument was that no flight occurred as the machine never left the ground. Bristow, serving as a witness for the defendants, said that in his opinion, from inspection of the ground following the crash, the Tabor had not taken off. However, the plaintiffs' expert

witnesses, Brooke-Popham, Sempill and Buchanan, were in agreement that it was not necessary for a plane to be off the ground for a flight to have commenced. In their view this happened when the pilot began his last taxiing for getting into the air.

Turning to whether the machine itself was insured, Counsel for the plaintiff caused a stir by announcing that the Tabor cost £60,000. Bristow confirmed that the matter of insurance had arisen in discussions before the accident. No insurance was taken on the aeroplane, so far as he knew, because it was largely experimental and the Government ultimately took responsibility. Bristow subsequently testified that Dunn had thanked him two days before the accident for the efforts he had made to prevent the Tabor being flown prematurely.

Giving judgment on 28th January, Mr Justice Roche found that a contract had been made, accepted the plaintiffs' expert witnesses' definition of flight for commercial purposes, and identified no conditions in the contract specifically excluding unusual or exceptional danger. There was no question of a formal warranty being given by Ogilvie before the machine was flown. He accordingly found for the executor plaintiff and awarded him costs. However, since this was the first ever aeronautical insurance case, Roche gave leave to appeal.(164) The case came before the Court of Appeal in late May 1920 and on 9th June the appeal was dismissed unanimously, with costs awarded to the plaintiff. (165)

8.5 The Air Accident Investigation

The previous June the Air Ministry had tasked the Accident Investigation Sub-Committee of the Aeronautical Research Committee to determine the ultimate cause(s) of the Tabor crash. The Sub-Committee took evidence and commissioned research over the following two years, delivering its final report in July 1921. G B M Cockburn, Inspector of Accidents at the Air Ministry, led the accident investigation. Most of the wind tunnel testing and theoretical analysis was led or undertaken by E F Relf, who had joined the scientific staff of NPL in 1912. After initial investigation Cockburn issued an interim summary report on 5th June 1919, for government eyes only. In his opinion the Tabor had crashed due to 'tail movements resulting from the setting of the tail plane in the trial being inadequate to balance the pitching movements induced in the aeroplane, and that as a result of this lack of balance the aeroplane over-turned.'

His report continued:

> Even if the tail setting approved by the Technical Department had been strictly adhered to, it is doubtful whether it would have been adequate … In view of the considerable divergence of opinion which existed as to the correct setting of the tail plane, the greatest caution should have been exercised in the carrying out of the trial. In effect this was not the case. […] the pilot did not adhere to the arrangements previously made either with regard to the rolling test or to the running of the top engines. No adequate reason for his action in either of these respects can be given.(166)

Examination of the crash site, and eye witness evidence, enabled the investigators to state that

> The point of opening up the engines and the rise of the tail planes coincided roughly with the undercarriage digging into the ground. This took place about 100 feet from the turnover. The marks on the ground at this point are well pronounced but not exaggerated. The skid then cleared the ground once more for a distance of 13 feet on the starboard side

> and 20 feet on the port. The second dig in is much more pronounced than the first, continues for a much greater distance and is finally very deep.
>
> On examination of the wheel tracks, it is found that the distance between the port and starboard centres is 34 ft 6 in before the undercarriage dug in and remains at this distance till about 20 feet from the wreckage, when the last clear indication of it is 34 ft 0 in. It can therefore be assumed that the undercarriage did not give way and cause the accident.
>
> The clearance of the undercarriage is 6 in to 7 in. The shock absorber is very stiff. The check cables remained tucked under the rudder. There is no suggestion that the axle was allowed to ride unduly. Indeed, it has more the appearance of remaining solid with the undercarriage.(167)

One of the reporters present at the crash noted that the ground dipped into a small depression shortly before the crash point and that the tail was righting itself before the top engines were powered up, moments later.(168) Sempill confirmed the Tabor was considered technically sound under prevailing conditions and the pilot was approved as a suitable test pilot.(169)

The Sub-Committee's investigations continued slowly through to mid-1920, delayed by Dunn and Tarrants legal case which it was felt might require the authorities to give testimony. No other findings were published during this period as the authorities preferred to wait until they had a full understanding of the cause(s) of the accident.(170) This required development of an understanding of the aeronautical evidence through further modelling and analysis. Professor George Bryan of Bangor University had submitted a paper to Sempill in June 1919 in which he identified a danger that was not sufficiently recognised when using a multi-engine aircraft with a propeller well above the centre of gravity. This danger was, of course, the pitching effect. Bryan's paper was passed to Relf at NPL. (171)

Figure 43. Close-up showing the final path of the Tabor and complete destruction of the forward section, up to the mating ring. RAF Museum, PC72/100/231

As is often the case in these circumstances, the investigation attracted unsolicited contributions. One such was from Sayers who wrote to the Ministry, saying

> As the expert who advised Mr Tarrant to undertake the design and building, under then EXISTING WAR CONDITIONS, of the giant bombing triplane, and who drew out the original trial plans on the basis of the late Capt. Rawlings' rough figures and calculated performance curves which were submitted by Mr Tarrant to the Air Ministry, I feel that it should be known that I advised against putting engines in the upper planes and recommended the use of two large propellers at the correct height relative to the centre of gravity, each propeller driven by gear from two or three engines.
>
> I further advised and urged that such a giant machine should *not* be run upon a single wheel axis but should be spring borne upon two four-wheel undercarriages. adjusted to give the correct angle of incidence to the planes for rising from the ground. I drew out an undercarriage on these lines and I am satisfied today that my recommendations were correct and that, had they been followed, the disastrous occurrence of 26th May would have been avoided and a successful flight assured.
>
> I write this more particularly because it is not merely Mr Tarrant's money and reputation that is involved, but public money and the lives of those entrusted with the trials. Also other men's reputations. Assuming that the second machine will be completed as stated by Mr Tarrant, I submit that my plans and recommendations, particularly as regards the two points referred to, should be given fresh consideration.(172)

The Ministry assured him, were another machine to be built, that 'your recommendations will receive the attention they deserve.' (173)

Later in June the Sub-Committee asked the Air Ministry to order from RAE a new, more accurate 1/40th scale model of the Tabor, constructed in metal, to be tested by NPL in order to gain further information on the accident and in particular the pitching effect of opening the upper engines.(174) RAE delivered the model in September and NPL conducted tests on RAE's advice to arrange the model so as to simulate near ground conditions.(175) (The original wind tunnel tests at both RAE and NPL had been for an aeroplane in the air with all engines running and did not simulate takeoff conditions.) Relf was asked to examine the effect of suddenly opening the top engines, as requested by Bryan. For this he needed a statement from Tarrants of the flight conditions pertaining at the moment of the accident – speed, aileron and tailplane settings, etc. – to aid in his calculations. Wilson replied by letter on 26th November, estimating that the plane was travelling at 60-70 mph and was horizontal at the moment that the top engines were opened up.(176)

Consideration turned to the matter of perceived tail-heaviness and the use of ballast in the nose. In January 1920 Bramwell submitted a statement to the Investigation Sub-Committee which was first reviewed and approved by Brooke-Popham.

Bramwell had been responsible for checking the structural strength of the Tabor and issued the structural strength clearance certificate to Buchanan, confirming the machine was satisfactory in this respect for trial flights. He had subsequently been present at a meeting on 24th May attended by Tarrant, Rawlings, Wilson, Buchanan and other ministry experts. He fully agreed that the tail setting calculations Wilson made and subsequently took with him to Tarrants were correct. Wilson's approach had been used with satisfactory results on many comparable

aeroplanes. He also knew that the model which had been tested was somewhat inaccurate and distorted in places and hence attached considerable suspicion to the results. In any case, the amount of tail heaviness indicated by the RAE model test would not make the machine dangerous for the purpose of trial flight. According to Bramwell, the actual flight of the machine confirmed this. Although the wind tunnel results indicated that the machine would be tail heavy, in practice it was nose heavy, acknowledging for the first time this condition for the Tabor.(177)

8.6 Theoretical Analysis

In March 1920 Relf circulated a research paper on an interim investigation of the Tabor's longitudinal motion. This was made available within government, in case such evidence might be called for in Dunn's and Tarrants legal action, but was not published. Relf found that

> The pitching moment results indicate sufficient longitudinal control. The effect of the proximity of the ground is considerable, especially on the pitching moments and should be taken into consideration in considering the equilibrium of the machine when taxiing. Special attention is drawn to the difference of tail setting which may be required to meet (a) 'getting off' and (b) free flight conditions.

In summary, he concluded that:

1. The machine was satisfactorily stable at all speeds except stalling speed.
2. Proximity to the ground improved stability.
3. When taxiing at observed speed and attitude, the aeroplane would turn over if the top engines were opened out.
4. There should have been ample control to prevent this happening, if actuated in time.(178)

In September, NPL published its full report on the analysis of pitching and longitudinal control. This confirmed that the machine would have flown satisfactorily had it left the ground. Their work showed that unless the controls were used, the turning effect of the upper engines would necessarily bring the nose to the ground. However, given use of controls, the turning effect should have been countered. They acknowledged that 'this did not agree with the witness evidence that the pilot had the stick fully pulled back, and they had no solution to this discrepancy.'

Nevertheless, NPL were able to conclude that:

1. Upward movement of the tail had already started when the stick was pulled back; it was possible that too much angular velocity was generated before the stick was used.
2. All engines should be opened full together, so as to avoid any sudden changes.
3. The centre of gravity must be as low as possible so that even at a negative angle of incidence, the CG is still behind the point of contact of the wheels and the ground.(179)

This was followed immediately by Air Publication 785, issued by the Directorate of Research on behalf of the Air Council. This repeated NPL's last two conclusions, also warning that the thrust lines of the propellors should pass as near as possible to the CG. With these conditions met, 'it is reasonable to suppose that a machine as large as the Tabor could be satisfactorily developed.' (180)

In a further report for the Accident Investigation Sub-Committee in January 1921, Relf provided the most plausible explanation for the crash.(181) He observed that Wilson's letter of 26th November stated the plane was horizontal and travelling at 60-70 mph when the top engines were opened out. However, Air Ministry Report W.13 (not found but circulating at some time in late 1920) indicated that the Tabor lifted off the ground for a short time before the crash, at an estimated speed of around 55-60 mph – close to the calculated stalling speed of 57 mph – and not the 60-70 mph that Wilson had estimated. This suggested another possible explanation for the accident.

> If the machine left the ground when very near the stalling speed, the pilot would naturally try to reach a flying attitude i.e. to gain speed and reduce the angle of incidence. To do the former, he switched on his upper engines; to do the latter, he may have eased his stick forward. One may, therefore, well imagine that the machine was just clear of the ground at stalling speed and attitude, and that at this moment a large negative pitching moment was applied by opening out the upper engines and possibly also by a movement of the elevators. Under these conditions, the machine would rapidly decrease its incidence and lose lift. It would therefore fall back to the ground, having meanwhile acquired a considerable angular velocity in pitch.
>
> It seems likely that this angular velocity, augmented by the couple due to the ground friction at the wheels as the machine bumped heavily, would suffice to turn the machine over until the undercarriage dug into the ground and caused the complete overturning.
>
> The latter explanation seems more likely than that of previous reports and agrees with the evidence of W.13 as to the speed of the machine and the position of the control stick. The previous evidence given in [Wilson's] letter, to the effect that the body was horizontal is not necessarily inaccurate, since if the present explanation of the accident is correct, the machine must have passed through the attitude when the body would be horizontal very soon after the upper engines were put on, and an observer, especially at a little distance away, might well have thought that the body was horizontal at the time he heard the upper engines opened out.(181)

Later that month Cockburn published an extract of witness statements including those from Sempill, Wilson, Grosert, Vickers and Edney. All agreed that the Tabor rotated *after* the top engines had been opened up.(167)

The following month, NPL reported on the latest wind tunnel tests on the new model, examining tail settings for longitudinal control.(182) They concluded that the rotating effect of the upper engines could have been compensated for with a trimming elevator setting of 17.5^{o}, a large but not unrealistic adjustment. They also confirmed RAE's recommended setting of the bottom elevator as $+2^{o}$.

In March 1921 the Sub-Committee published the results of a canvas of the principal aircraft manufacturers regarding the validity of the known methods for establishing tailplane settings by calculation/estimation, by wind tunnel modelling, and by trial and error in actual flight.(183) The feedback provided appeared to show that there was little difference in settings obtained by these three means, although the results were by no means conclusive. Nevertheless, the Sub-Committee felt confident that wind tunnel tests were an adequate means of obtaining relevant settings.

Also in March, a submission by M. A. Doyle (mirroring Hill's critique of February 1919) highlighted both the relatively low surface area of the tailplanes and that they were not 'washed' by the slipstream from the lower engines which were placed too far apart. The effect was to

> … entirely lack the slipstream forces which, in a properly designed aeroplane, provides the controllable moment which the pilot uses during the early stages of the launching run after the tail has lifted from contact with the ground. Thus with limited elevator control and in order to avoid overturning, the pilot would have to keep the tail down with the tail skid ploughing the ground, by throttling his engines until he had attained sufficient airspeed to achieve elevator control to balance the residual overturning moment when the tail lifted.
>
> With throttled engines and skid drag, a long run would be needed. It therefore seems likely that the pilot found himself running out of runway without attaining lift-off speed and opened his top throttles in an attempt to clear obstacles ahead. Having raised the tail the resultant overturning moment increased rapidly and the lack of slipstream over the tail meant the pilot had no adequate means of obtaining a compensating righting moment.(184)

Grosert, however, thought otherwise. Writing in 1966, he attributed the accident solely to inappropriate operation of the top engines.

> Dunn had been given to understand, after the centre of gravity discussions and alterations to the tail incidence, that the tail would be very difficult to raise in spite of the nose ballast. This may have been the influence that prompted him to open up the top engines. Another explanation is that during an engine run, he complained he found it very difficult to reach the top throttle levers and asked me to alter them to be forward to close. This was done, but on 23rd May I persuaded him to stick to standard practice of forward to open. He agreed, but I've often thought he may have overlooked the change-over. The second Tabor was stopped when about 60% of the work was completed. I still think the Tabor was a wonderful aircraft. If it had been handled by the type of test pilot we were later accustomed to, I believe it would have justified itself.(128)

It had been suggested that the Tabor's longitudinal stability might be particularly sensitive to the position of the CG, so any error in calculating the CG might necessitate a disproportionate adjustment of the tail setting in order to properly trim the aeroplane. To test this, Relf made a comparison of control settings used on the Tabor and five other large aircraft, including the V/1500 and Vimy, to determine whether the elevator angle necessary to correct for any error in CG position was outside norms. He found the Tabor very close to the mean, from which he judged that there was no evidence to suggest poor design.(185)

This concluded the main investigation, which was followed by the Accident Investigation Sub-Committee's first draft report in April 1921.

8.7 The Draft Report

In a first draft of its report the Sub-Committee stated:

> The plan agreed between the parties to the test was to taxi from the Balloon Shed towards the eastern end of the runway, by the officers' mess, then stop to permit inspection of the undercarriage by Captain Wilson and Mr Grosert. Only if all was satisfactory would a fast

run be made. In the event the pilot executed a fast turn at the eastern end, did not stop for the inspection and began a fast run back towards the Balloon Shed. Having made the fast turn the pilot struggled to control the plane as it veered first to starboard and then port before achieving a straight path.

About halfway back to the Balloon Shed the tail rose alarmingly, was seen to dip back slightly then continued rotating catastrophically as the top pair of engines was opened up. The plane crashed at 45-60 mph with fatal consequences, the undercarriage collapsing at this point. Analysis of the wheel marks on the ground indicated that the undercarriage held firm until the crash, however the wheels began to sink into the soft ground coincidentally with raising of the tail and the top engines being opened up. The top engines were fully opened, the rev. counter being found after the accident as recording 1,700 rpm.

Mr Grosert added that, 'Nothing was carried out as arranged. After taxiing out of the Balloon Shed the plane made a complete circle then taxied up the field and made a sharp turn and then an uncertain course. It appeared that the pilot had difficulty in controlling his machine and had his work cut out. The tail rose beyond level and the top engines were opened up fully.' Captain Wilson, although still in shock stated: 'Dunn did not follow any of the arrangements made prior to the start. He should have done a rolling test then stopped for undercarriage checks.'

Captain Dunn was a highly skilled pilot on almost all types of single engine plane with some experience of multi-engine types. Captain Rawlings, co-piloting, took no part in the trial. It was surmised that Dunn felt he was going too fast on the return run to pull up before getting into rough ground and decided to fly it; or wanted to impress the photographers present. At any rate, the test was not carried out with care and caution.

The top engines were always intended to be used only in stable flight to correct tail heaviness. One witness attested that all engines were started but special adjustments had been made to allow of the upper engines only just revolving. Another witness, Mr Edney of RAE, stated he could see Dunn throughout. The tail began to lift badly about halfway along the fast run. Dunn had the control column pulled hard back into his chest almost from start of the final run and opened up the top engines shortly before the crash. Dunn appeared to use all his energies with the column and didn't attempt to use the trim elevator control wheel.

Calculations of required static trim on the tail planes differed between NPL, RAE, Tarrants and the Air Ministry. However the differences between the various calculations were not major and would probably still have led to the aircraft being tail heavy. Scale model wind tunnel tests conducted by NPL on a tail section indicated a reasonable degree of agreement with the parties' calculations, so elevator trim settings were not attributed as a source of the accident.

It was not possible to explain why the tail rose as it did when, according to the evidence, the pilot was holding the stick well back almost from the start of the final run. The only explanation of what actually occurred would appear to be that at a certain stage of the run along the ground, the elevators were held down and the tail rose rapidly. This motion was checked by upward movement of the elevators, but at this moment the upper engines were opened out and the couple due to their thrust overturned the machine. The Sub-Committee does not, however, regard such an explanation either as complete or satisfactory.

In conclusion, the Sub-Committee determined that:

1. A completely satisfactory explanation for the accident had not been reached, in part due to the passage of time and thus distance from the accident.
2. Any error in static tail setting would be likely to have kept the tail down, if anything. Why the tail rose before the top engines were throttled up, with the pilot holding back fully on the control column, could not be explained.
3. The high thrust lines of the top airscrews relative to the ground and the fore and aft position of the centre of gravity relative to wheel base, coupled with neglect of the expedient of arranging for airscrew slipstreams to act on the tail, failed to provide longitudinal stability during launch.
4. The immediate cause of the accident, the additional moment caused by running up the top engines, must be attributed to an erroneous reasoning, or temporary confusion, in which the pilot was guided by no reasons at all but by the instinct to call for more engine power as an aid to getting off when the aeroplane appeared to be making an unduly long run and was approaching rough ground.
5. It did not seem possible to account for the fact that the tail rose during the run along the ground and before the top engines were opened up but it was possible to see that, once the tail had risen, the motion would be unstable in pitch and, without the exercise of a powerful longitudinal control, would go on increasing until the machine overturned. That the longitudinal control was not powerful enough to counteract this tendency to overturn was due partly, if not entirely, to the fact that it was not arranged that the slipstream of the aircrews should act on the tail.(186)

Responding to feedback on the draft report, and following discussions with the Accident Investigation Sub-Committee, Relf and H B Irving of NPL published a new paper on calculated elevator settings in an attempt to explain why these appeared to differ from those seen by eye-witnesses. They did this by applying a different coefficient of friction to the wheels at the point at which the plane grounded.(187) Whether this was justified was moot but indicative of the state of knowledge in aeronautics at the time.

Another amendment to the draft report addressed the by now well-known difficulty of an unaided pilot controlling large moveable surfaces, reflected in a second draft of the final report issued in June.(188) The authors appeared to imply that Wilson was unable to provide them with the basis of his empirical tailplane settings. (In his submission to the Sub-Committee, Wilson ruefully noted, 'I returned to my office following my recovery to find it had been cleared for another and all my books and papers piled outside; many of my notes had been lost... My contribution therefore must rely on memory.') (189) The report's authors also stated with confidence that scale-model wind tunnel tests provided acceptably accurate tail settings. Pippard, however, saw a bigger picture and challenged the second draft report on several fronts.

Invited to review the draft report, Pippard wrote on 28th June to the Sub-Committee. He first reminded the authors that Wilson's method was documented and had in fact been supplied to the Sub-Committee. While acknowledged to be empirical, his method had been used throughout the war and produced results consistent with those for other large aircraft.

Pippard also cautioned against stating as a certainty that Dunn must have failed to pull the stick back in time as they had no proof of that. He continued with more queries and corrections before finally warning:

> Our report is practically a statement that model tests may be relied on implicitly and, while admitting the success which has attended the use of these tests for tail setting determination, I feel that in this particular case something was wrong which requires clearing up. It may only be a question of percentage error as suggested by [an academic], but whatever it is, it requires discovering in the interests of future designs.
>
> If we honestly accept the opinion we are expressing in this report, we should be prepared to build another large aeroplane and send it on its trial flight with the tail set according to a 1/40th scale model. If the Committee feels that they are so satisfied that they would undertake that responsibility, well and good – personally, if the tail setting obtained by the scale model was directly contrary to all previous experience, I should very much hesitate before accepting the results without further serious enquiry.(190)

8.8 The Final Report

The Final Report (191), published within the Government in July 1921, omitted overtly negative references to Wilson and Dunn and qualified the strongly positive wording on wind tunnel tests. It also sought to explain the tail lift, noting that all proposed tail settings had been based on stable flight, rather than takeoff conditions. Accordingly, 'a tail setting suitable for getting off has been inquired into and from model data it appears that with a setting of -1.4^{o} and the elevator neutral, the tail would begin to lift at some 6 mph below stalling speed.' A possible explanation of the observed tail lift was thus presented.

As to the differences between tail settings proposed by the various parties, the authors asserted there were really only two views, a) those of the Technical Department, Tarrants and Ogilvie's (all based on Wilson's calculations using an empirical method devised during the war), and b) the wind tunnel results from RAE and NPL. Differences between RAE and NPL as regards trimming plane setting (+20^{o} vs +15.5^{o}) could be attributed to different test conditions. The differences between the empirical and model-based approaches when looking at takeoff were not that far apart. They concluded that:

> the methods adopted by the designers [of the Tabor are not] comparable in accuracy with modern methods. There need be no discrepancy of large magnitude between the estimates made on the basis of the general knowledge now existing and those from complete models.(191)

In other words, model test results and 'modern' calculations were in reasonable agreement and provided more accurate settings than Wilson's empirical method.

As in the second draft, the final report also highlighted the difficulty for a man of average strength to operate control surfaces on large aeroplanes, and the committee recommended that some form of relay be investigated before proceeding further with designs for heavy machines. The Sub-Committee was still not convinced that it had got fully to the heart of the problem, however, concluding that apart from 'general considerations to which attention has been drawn above and which may be of use to the Air Ministry in the case of the construction of other large

aircraft, the Sub-Committee are clear that at this distance of time it is impossible to get closer to the details of the primary cause of the accident.' (191)

9. A PLAUSIBLE SCENARIO

From the eye witness evidence, it is possible to reconstruct the fatal flight. Although apparently initially confused over operation of the lower engine controls, Dunn completed the taxi to the eastern end of the field – about half a mile – more or less according to plan. Instead of the agreed stop for undercarriage checks, however, he immediately executed a fast-turning start at an acute angle, heading roughly west and bisecting the airfield. Might he have intended a wider radius turn, aiming for a south-westerly takeoff but misjudged the turning power of using only the port engines? This was Brooke-Popham's conjecture.(139)

Almost immediately Dunn had the four lower engines on full power. Mindful of the need to avoid over-rotation, he held the stick fully back to hold the tail on the ground until the machine built up enough speed to become airborne. It is possible, however, that Dunn was prevented from applying full elevator control by his own body. The second flight safety conference noted that the stick was 6 in too close to the pilot but, as with so many design issues identified late in the day, resolution was postponed until after the test flight.

If Brooke-Popham's surmise was correct, on his fast run Dunn was initially off course, necessitating a turn of 30º to port to head in the direction of Pyestock chimney. Distracted by the need to correct the inevitable course wobbles occasioned by the extreme turns and bumpy ground, made particularly difficult due to the small size and position of the rudders (as Hill and others had forewarned), Dunn discovered that he was running out of ground.

At a critical speed just short of stalling speed the tail rose, initially beyond the horizontal, before beginning to return to the near horizontal. It is not known whether this was as a result of Dunn's action or the downdraft from the top wing acting on the tail but nevertheless, disaster was imminent.

The plane dropped into a small depression then rose up the other side whereupon it became airborne, 2-3 ft from the ground and at or just below stalling speed. Dunn's instinctive reaction as a light aircraft pilot was to apply more power to achieve lift, at the same time possibly pushing his stick forward to reduce the angle of incidence.

The four main engines were already at full power when Dunn threw open the difficult-to-reach throttles for the top engines (recorded as at maximum power of 1,700 rpm after the crash). At full power the turning force of these engines, mounted so high above the centre of gravity, caused rapid rotation which Dunn had no time to counteract. Within a couple of seconds, now airborne a mere 80-100 ft distance, the undercarriage struck the ground, bounced, and struck again. This drag combined with the high angular velocity and caused the nose to plummet 15 ft, the undercarriage ploughing along the ground at 45-50 mph, before the plane upended. The nose section broke up, throwing out and fatally wounding both pilots.

There can be no doubt that the accident resulted from over-rotation for which the tail plane could not compensate. NPL raised the possibility that the Tabor's centre of gravity was too far forward

with respect to the undercarriage, although this also was only lightly touched on in the final report and no firm conclusions were reached. Although RAE had calculated the CG as lying behind the bottom wing chord, it would only take a rotation of 11^{o} to bring the plane's high CG forward of the wheel axle, making a crash inevitable once the plane returned to the ground. Was there more to this CG issue? Did lead ballast inserted in the nose contribute to the crash as many in aeronautical circles believed?

Figure 44. View of the Tabor's undercarriage showing distortion of both front I-beams as they impacted and then ploughed the ground

RAF Museum

Following its wind tunnel tests in early May 1919, RAE recommended that for a lightly loaded aeroplane, balanced flight required all engines running with all fuel in the forward tanks and 1,200 lbs of ballast inserted in the nose. In the May 24th meeting, the experts concluded that the wind tunnel tests – which in their judgment erroneously indicated the machine was tail heavy – should be set aside, in which case there was no need for the ballast. Yet we know from at least three sources that ballast was indeed inserted. Why, and was it significant?

The first mention of ballast is in a 'List of Meetings held with Ogilvie and Partners' produced by Tarrants within days of the crash.(127) Referring to the May 24th meeting, this summary noted that 'in order to give the pilot sufficient scope to adjust the tail elevators as he might find necessary, it was decided to put no set on the tail elevators and to put instead 1,200 lbs of ballast in the nose.' (127) This was written by someone other than Wilson who was still in hospital. Was it a 'nod' to RAE's recommendation, or a response to the earlier finding which Wilson reported to the first flight safety conference, that the CG was marginally farther back than designed for?

The ballast is next mentioned in Sempill's evidence to the Coroner's Inquest. 'The fact of lead being put into the nose of the machine would point to the fact that it was tail heavy.' Unfortunately, neither Counsel for the Inquest, nor Ogilvie's counsel, appears to have probed this statement.

Lastly, according to Wilson's later evidence to the Accident Investigation Sub-Committee, the ballast was added to restore the CG to its designed-for position. This explanation was evidently accepted by the Sub-Committee and appears in a one-line statement – a mere 15 words – in the 3,000-word final report. (In his letter to the Sub-Committee, Pippard advised the authors to 'give

some further explanation as to why 1,200lbs of ballast were carried in the nose,' however this was not done.) (190)

These three subtly different reasons appear to be compatible and understandable in the context. Lead was indeed added to restore the Tabor's longitudinal balance. In which case, why was the decision to load it seemingly made only at the last minute?

Tarrants' 'List' placed the decision to load ballast at the meeting between Tarrants and Ministry of Munitions' experts on 24th May. However, Bramwell's later statement of evidence which covered this meeting made no mention of any such decision. Given the major controversy over longitudinal balance that arose following the accident, surely, he would have mentioned so relevant a decision.

In his long and detailed note to Ellington on 30th May, Brooke-Popham made no mention of the ballast nor any decision to install it.(139) So when and by whom was the decision made? We can only assume it was by Tarrants, either later on 24th May or some time on the following day. If Rawlings and Wilson decided this, they would likely have told Tarrant, who ultimately would have accepted his experts' recommendation. Was the decision Wilson's alone, as the Tarrant family myth has it? If so, this might explain why Wilson quit aeronautics altogether in January 1920, accepting junior roles in the chemical industry instead. The plain fact is, though, we simply do not know.

Whether or not Tarrant knew about the ballast, Dunn almost certainly would have. Such a material decision with the potential to affect the safety of the aeroplane and crew would not be withheld from the pilot. In any case, the ballast occupied nearly two cubic feet and was placed in bags under the pilots' cockpit, in an area directly visible to the pilots as they climbed up to their seats. Grosert, who stood on the cockpit access ladder during the taxiing, knew of it too.

Did the ballast in the nose contribute to the tail rising unduly? Grosert reported no tail elevation in a static test when he ran the top engines on full power with bottom engines idle and without ballast. Contrasted with the Tabor's overall weight, the ballast was not a major element – half a ton compared with the 6½ tons forward of the CG. (It matched that proposed by RAE to balance a perceived tail heaviness that Bramwell had stated was 'not dangerous for a trial flight.' *The Aeroplane* editorial concurred. 'One thousand pounds in the nose of the machine would be far from sufficient to counterbalance the degree of tail-heaviness indicated by Messrs. Ogilvie's report on the results of the RAE tests, so it may be assumed that only a minor degree of tail heaviness was expected.' (160) Although modest, the ballast would still have had an effect, however, for two reasons. The first was that it was placed far forward; the second was that Dunn knew of it.

With the ballast so far forward, even its relatively modest weight contributed to angular momentum once rotation started. Although this was minor compared to the turning force of the top engines at full throttle, the aeroplane only had to rotate 11^{o} for it to overbalance. Unfortunately, with detail of the Tabor's construction and dimensions now lost to us, we cannot calculate this effect definitively.

We know from Grosert that Dunn had participated in discussions on tail heaviness and he had concerns about it, but he was not party to the decision to set aside the wind tunnel tests. While he

doubtless accepted the decision handed down to him, it is reasonable to assume that he still harboured doubts. Seeing the ballast installed, he could well have concluded that others doubted too. This could explain why he altered the elevator settings at start up from those agreed on 24th May to be closer to those recommended by RAE and NPL.

The table below summarises the various proposed settings, with Dunn's actual settings, found from examination of the crash wreckage in the last row. To obtain the least possible negative elevator setting, Dunn moved the adjustable bottom tailplane so as to give the greatest angle of incidence, resulting in an equivalent elevator setting of -1.4° with respect to the mid-plane line instead of -2°. Any movement towards the RAE proposed settings only increased the likelihood of rotation.

Table 1. Control Surface Settings Proposed for the Tabor's First Flight

Source	Incidence	Trimming elevator	Bottom elevator	Ballast
Tarrants' settings (Wilson)	Upper plane: +5° Lower plane: 0°	0°	-2.5°	
Ministry Technical Dept.		0°	-2.5°	
RAE wind tunnel test		+20°	+2°	
NPL wind tunnel test		+15.5°	+1°	
24th May agreed settings		0°	-2.5°	1 extra man +1000 lbs in nose
Actual flight settings	Lower plane: -2.5°	+5°	-1.4° equiv.	1 extra man + 1000 lbs in nose

The Accident Investigation Sub-Committee concluded, rightly or wrongly, that the tail settings were probably not decisive at takeoff nor was the lead ballast. Notwithstanding the above, the accident surely arose from fundamental design issues and errors of judgment: the high placement of the top engines and the undercarriage's low ground clearance, and Dunn's actions regarding the top engines and the takeoff path.

9.1 Dunn's Actions

Grosert recollected in 1966 that Dunn found the Tabor unresponsive to the rudder and became confused over operation of the lower engine controls when first attempting to turn the aeroplane outside 'C' Shed.[128] This suggests that he had little, if any, experience before the fatal flight in manoeuvring the big machine, a quite extraordinary state of affairs. Why did he not at least perform basic ground operations in the days before flight to get a 'feel' for the aeroplane? Perhaps because there was no time. The Tabor was completed, signed off and away in a matter of three or four days. We must ask again, why the tearing hurry? We just do not know.

Likewise, we do not know why Dunn undertook the fatal run before the planned inspection of the undercarriage or why he took the shortest available 'straightaway'. Could the many pressures

bearing on him – a young man from a modest background, recently released from the safe cocoon of the RAF, working for a 'force of nature' who rarely took 'no' for an answer, worried that the big machine might not fly, acutely aware that he lacked any experience of flying this radically new type of aeroplane and yet with all eyes (including very senior government ministers') on him, and believing (as we know from Bristow he did) that everything was being rushed – engender a febrile state of mind?

Certainly attempting a high speed run from a fast turn in such a large machine with control surfaces known by all to be barely adequate suggests that 'the test was not carried out with care and caution.' (167) Would any test pilot attempt takeoff in a radically new type of machine whose flight characteristics were unknown while on a short run terminating in rough ground or obstructions?

We know from Grosert that Rawlings was unhappy with the test, even on the first taxiing run. He must have seen something, and he certainly wasn't anticipating a flight, as he was sitting on his folded legs. Grosert's 1966 passing reference to 'the type of test pilot we were later accustomed to' is surely revealing. Brooke-Popham told Ellington

> I have known Captain Dunn for some years and he was certainly the last pilot to suffer from any fault of nerves, but I feel certain that the presence of so many photographers and reporters was the chief reason for his deciding to fly the machine at once, instead of taxiing about as had been originally arranged.' (139)

This is uncharitable given that Dunn was not able to answer for his actions. We should not forget that he was a very experienced pilot with a reputation for level-headedness. He was not given to hubris or exuberant behaviour. It is all too easy to impute pilot error. Something else was wrong here.

9.2 Authorities at Fault

We could argue forever regarding the consequences of the Tabor's design and Dunn's actions, but as Mountjoy and others identified, there were other significant questions to be answered. These included:

1. What role did the Air Board's Technical Department play in the early design stages, when Tarrants could have been steered to alternative approaches?

As Tarrant noted to Ogilvie after the accident

> I think you must agree that from the first to last, I have so organised my business as to give you every possible scope, and had given my experts all the necessary freedom to enable your recommendations to be considered by them in conjunction with the Air Ministry officials, and to carry into effect any recommendations they arrived at.

Tarrant continued

> My one anxiety from first to last has been to spare no expense or trouble to allow the experts to give their unbiased opinion and to do my best to see that those in my direct employ submitted all phases of the situation to the final Authority, viz:- Air Ministry, and having received their decisions, to carry them out.(146)

So why did Bristow's 'extremely flagrant errors' pass unremarked until Hill commented in February 1919 that it 'seems that advantage has not been taken of much experience already gained on large aeroplanes.' How did Tarrants continually manage to discount concerns expressed by other experienced observers in the weeks before first flight? Ogilvie had recognised in early 1918 that the 'gaining of experience is all before [Tarrant]', so where was the timely expert guidance from the Air Board, Air Ministry or Ministry of Munitions?

2. Why was the Tabor given its Air Certificate if there were still real doubts about the undercarriage clearance and of the aeroplane's longitudinal balance?
3. How could Brooke-Popham sanction a flight when he must have known – from Turner, if not Tarrant – that some of the country's foremost aeronautical engineers strongly disagreed?
4. How could Dunn be permitted to take out the Tabor when he was unqualified for heavy aircraft? He may have been Tarrant's employee but the Ministry approved him and had overall responsibility for flight testing, even if Brooke-Popham claimed he did not know this.

And, most importantly,

5. How could a massive, six-engine aeroplane of a completely new type be given clearance to fly without completing a comprehensive and incremental programme of field trials, particularly as we understand from Mountjoy who regularly met Dunn at that time, changes were made to the Tabor almost up to the last day?

Grinsted ventured at the second flight safety conference that, 'the mistake was made in not having model tests carried out of the type of controls, etc. at the commencement of the design.' (105) The wind tunnel tests carried out by RAE and NPL on a 1/50th scale model less than a month before flight were far from consistent with calculations and experience with broadly comparable machines. They also covered only full flight with all engines running, a major flaw given the significant concerns about the operation of control surfaces, particularly at low speed. The whole approach to testing seems vague, late, and not thought through.

Tarrant's paternal granddaughter remembered her boss (later Professor Sir) Alfred Pugsley, head of the structural and mechanical engineering department at RAE in the 1940s, saying the Tabor disaster resulted from a 'disgraceful fight' between NPL and RAE over execution of the government's aircraft development strategy, with NPL dragging its feet over wind tunnel tests for the Tabor.(192) Ostensibly the Tabor was getting in the way of a programme to develop fighter trainer planes. This is hearsay, of course, but the large NPL wind tunnel only became operational in early 1919, and there must have been a significant backlog of demand for its services. In these circumstances NPL would tend to favour its own priorities over those of an outside organisation and we do not know what arm-twisting or high-level political clout was applied to get Tarrants even the small amount of testing time on the 22nd/23rd of May.

Perhaps RAE and NPL could have collaborated on a programme of further tests, necessarily delaying first flight. Perhaps NPL refused any further support for the time being, leaving Tarrants with no option but to continue as planned. We cannot say as the historical record is silent. Whatever the case, it cannot be denied that had more test time been made available at the outset or at any stage before final assembly, at least one of the major design issues might have been resolved.

This ‘disgraceful fight’ may be part of the reason behind Brooke-Popham’s embargo – but only part. Although only four months into his role, he bore ultimate responsibility for the flight. It must have deeply embarrassed the government that in authorising it he had, wittingly or not, gone against very strong advice given by former senior officers of his own department. The Technical Department also failed completely in its role as overseers of the testing programme, to which evidently no thought had been given. The Aeronautical Research Committee, concluding its final report, could only offer a tepid excuse.

> The conduct of the trial was not such as should be adopted in the case of a highly experimental type, particularly when considerable divergence of technical opinion existed on several points. These circumstances have accordingly made it impossible for the Committee to deduce an entirely connected and reliable explanation save that the method of conducting the test appears to have been largely responsible for the accident.(191)

No wonder the government dissembled. Mountjoy held no doubt, writing in 1923

> It looked as if the Air Board, recognising that in sanctioning the flight one of its departments – presumably the Technical Department – had made a blunder, resolved to use every bit of political machinery possible to prevent the truth becoming public.
>
> To this day, no outsider knows why the accident happened. The matter might not be worth recalling in detail were it not at the expense of two of the bravest of the brave who were no longer able to speak for themselves.(140)

10. THE LACK OF CREDIBLE OVERSIGHT

Why did the Tabor accident happen? With the benefit of hindsight, we can see the lack of a ‘controlling mind’ with an objective view of the project and the design in the whole, informed by experience and with the authority to make decisions stick – across all relevant government departments, as well as with Tarrants. Had this been present, it is possible that a superior design and more balanced assessments of risk would have resulted. That the Ministry could not provide the necessary oversight is doubtless largely a consequence of its own inexperience in large aeronautical projects, compounded by the many organisational and staff changes being made throughout this period. Alexander Ogilvie was closest to fulfilling this role. The tragic irony is that, by aligning himself more closely with the Tabor as Tarrant’s retained consultant he lost authority both with Tarrants and the Ministry. Had Ogilvie remained in post, would not Rawlings or Tarrant have checked with him before making the fatal decision? Would not Brooke-Popham?

The number of experts involved in the Tabor project led to a focus on minutiae, not the bigger picture. As Brooke-Popham noted to Ellington, ‘There were too many people giving advice, the RAE, N.P.L., Technical Department, Messrs Ogilvie and Partners, besides Mr Tarrant’s own engineers.(139)

Rather than look for those to blame we should remember that all involved were operating at the very edge of aeronautical knowledge at the time, just 14 years after the Wright brothers’ first flight. All worked with the very best of intentions and immense ambition for a successful aeroplane. What brave men were Rawlings and Dunn, and what a giant was W G Tarrant!

The second prototype Tabor was already 60% complete, and Tarrant told *Flight* initially that he would progress, applying the lessons learned from the first test. The company was still investigating undercarriage designs as late as 26th September 1919.(193) Unknown to Tarrant, though, the various government departments were concurrently re-assessing their financial liability. A memorandum from the Assistant Controller to the Director of Aeronautical Supplies in January 1920 highlighted the problems associated with the rather vague original contract.

> So far as I can arrive at the details, contract specifies that delivery will be to Farnborough but does not specify by what means.
>
> No tests are called for in the contract other than what it may be possible to call for under '1. Aeroplanes Special Conditions' Page 3 'Delivery' and I fear that only calls for test flights which the contract may specify.
>
> The machine was at Farnborough and it seems to be entirely a matter whether the machine was specifically taken over by the D. of R. [Brooke-Popham] before the flight which was undertaken. If so taken over it was our machine and responsibility. If not, it would seem to be contractor's machine and responsibility.(194)

The tender form stated that test flights and trying out of the first machine might be required under this contract and Tarrants had added a clause to the tender that they agreed to carry out any special rules of procedure which the Controller, Technical Department might from time to time require. So, the question became: was the machine wrecked whilst the ordinary tests required by the Technical Department were being carried out? If so, it was the Ministry's responsibility.

The government's final position, established in a memorandum later that month, was that

> The aeroplane was not accepted by D of R [Brooke-Popham] and A.S.I. forms were not signed at the time that the accident took place. Mr Tarrant was required to demonstrate the machine in the air with his own pilot prior to acceptance. The machine was in the hands of Mr Tarrant at the time of the accident but was approved as being satisfactory for preliminary flight test by D of R.

However, the note concluded with a statement that rather undermined this position. 'This machine occupied a peculiar position and it was understood by this department that a definite contract had not been entered into.' (195)

It is arguable that the Government was 'trying it on'. Perhaps Tarrant was liable by default but Weir's original letter surely still stood, and senior government officers such as Ellington and Sempill had recognised the government's implicit financial responsibility. It is not known what loss Tarrant incurred, or whether the government shared financial liability. Not surprisingly, the records on this point have not been found. But one way or another, Tarrants will certainly have incurred a substantial loss, expressed in 2021 terms possibly £6 million.

11. FINAL DISPOSITION

For reasons unknown, although almost certainly commercial, early in 1920 Tarrant decided to abandon the Tabor. Closure of this project brought to an end the triplane design for heavy aeroplanes in the UK. Tarrants had been asked in mid-1919 whether they wanted the second Tabor back, Ellington hoping that this could be offset against any compensation due. Evidently

Tarrants declined, since the remains of the second Tabor were still at RAE. Eventually Brooke-Popham sought to dispose of the machine but did not know who owned it as the relevant file 'could not unfortunately be produced.' The Air Ministry was equally in the dark. 'It is regretted that we have no information as to Tarrant contract negotiations, as the matter was dealt with entirely by [Ministry of Munitions]. Perhaps D.A.S can help?' To which the Director of Aeronautical Supplies replied, somewhat primly, 'I have none of the documents relating to the Tarrant contract in the Department. The whole negotiation was settled without reference to me.' (196)

The final chapter in the Tabor story came to a close on 29th December 1921, when the Air Ministry wrote to the Liquidations Commission. While it was 'not clear from the records of this department whether the gear in question is Air Ministry property and as such can be thrown up for disposal in the usual manner,' the Commission was nevertheless instructed to ascertain ownership and dispose of 'a considerable number of parts and spares of the Tarrant machine, which was wrecked in May 1919, still lying at the Royal Aircraft Establishment, Farnborough.' (197)

W G Tarrant closed down his Tarrant Aircraft Company and returned to his original business, continuing land and property development in northwest Surrey. Tarrant's surviving Tabor team went their separate ways. Barling and Lobelle pursued successful aeronautical careers in the United States and the UK respectively. Wilson left Tarrants for a career outside the aviation industry. He took junior positions in chemical works while developing his skills as a mechanical engineer and was last heard of in 1930, working as an engineer in Stockton on Tees.

Ogilvie's firm won a few contracts, including investigation of the R.38 airship disaster, but was eclipsed by government departments and major private constructors and was dissolved in 1927. Ogilvie pursued a career in Australia before returning to the UK a few years later. Bristow, Sutton Pippard and Watts went on to distinguished careers in the aeronautical sector in the UK.

In February 1922 the Aeronautical Research Committee issued a fifth draft final note on the Tabor accident. It goes a long way to explaining why the government had, in Mountjoy's words, sought 'to prevent the truth becoming public.'

> The committee considered that the possibility of an accident occurring would have been reduced:
>
> a) had a pilot been employed who was fully experienced in first trials of experimental types of aeroplane. The pilot does not appear to have had such experience, though recognised as an experienced tester of standard types, nor had he wide experience of multi-engined machines. The latter is important in view of the fact that the "Tabor" was an extreme example of a multi-engined type. It is to be noted that during the previous three months the pilot had little or no opportunity of keeping himself in flying practices.
>
> b) had the machine been tested by an official pilot and not by the contractors': the former would have been less likely to respond to spectacular conditions.
>
> c) had a pilot when asked to undertake tests on a problematical type and especially one on whose design grave doubts have been cast, first gained the maximum of experience on existing types that approach it as nearly as possible and then proceeded in a careful and logical manner. The pilot should have been left perfect freedom to choose his conditions with no audience at all except his advisers. No public demonstration should ever have taken place until he had perfect confidence in the flying qualities of the new type.

d) had definite trials been discussed in advance and their systematic carrying out appreciated by the pilot insofar that he would have been in a position to curtail the test on observing any irregularity in the behaviour of the aeroplane.

e) had the portion of the aerodrome offering the longest "straight" been chosen for the flight and the trial not attempted unless this was possible.

f) had the test been postponed until the conflict in opinion concerning the setting of the tail plane had been reconciled or explained or, failing this, had a programme of rolling tests and short hops being mapped out in order to determine the setting that appeared most serviceable.

g) had the risks attendant on its testing out of a design highly divergent from current practice being sufficiently realised since it is felt that steps could have been taken to secure the services of a pilot of experimental experience and to have afforded him the opportunity to supplement that experience just previous to the trial by flying several types of the existing largest multi-engined machine. The conduct of what may be termed a most difficult flying feat in the presence of press representatives, photographers, cinema operators is to be deprecated, because this tends to unbalance the pilot and incline him rather to effect a spectacular flight than to conduct a technical trial.(198)

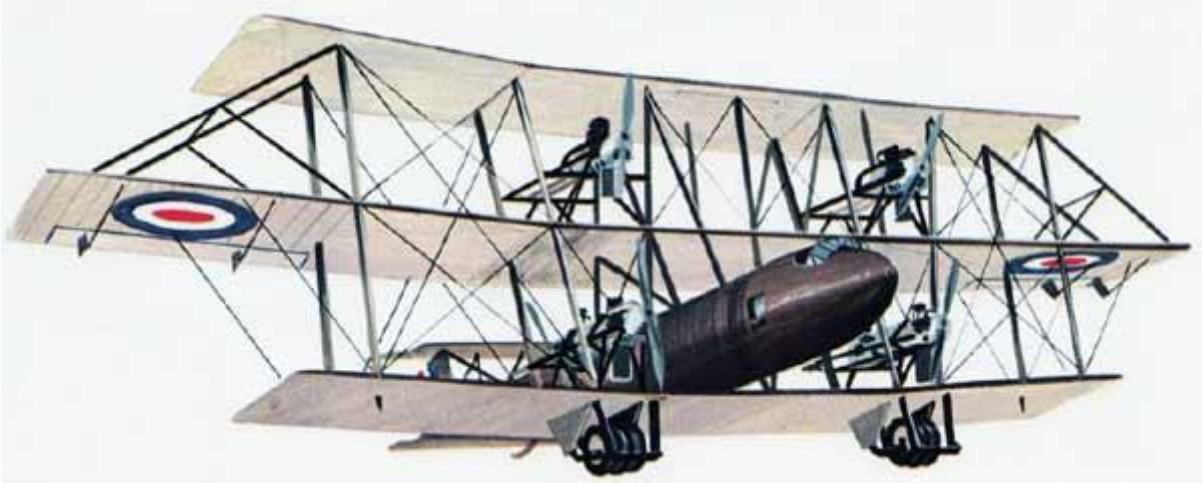

Figure 45. Artist's impression of the Tabor as a long-range RAF bomber

12. FINAL THOUGHTS

The Accident Investigation Committee found that the trial of the Tarrant Tabor was not conducted appropriately, while also noting that it had been 'impossible to deduce an entirely connected and reliable explanation for the accident.' We could speculate, for example, that if spruce had been available, the Tabor would not have been so heavy, eliminating the need for the top engines and third wing, thereby improving longitudinal stability and centre of gravity.

However, in truth, the accident was caused by many inter-related factors. These included deficient design of the Tabor's control surfaces and actuation, engine positioning, and undercarriage ground clearance. The design team was innovative but not competent for a machine of this radical new type and failed to consult other manufacturers and experienced pilots until far too late. The two Ministries' officers were similarly inexperienced and did not offer

serious challenges to the overall high-level design. Design validation through wind tunnel testing was also too late to affect the design process.

The pilot had no experience in testing prototypes or comparable heavy machines and was expected to attempt flight without the opportunity to 'get the feel' of the aeroplane. There was no estimation of the required runway length, and it is quite possible that Farnborough was unsuitable anyway. There was no planned approach to testing that would have included defined steps, expected outcomes, and fall-back arrangements, all while under media scrutiny.

AUTHOR'S NOTE

I began researching the Tabor story in its centenary year to resolve a long-standing question in my family regarding the loading of 1,000 lbs of ballast in the nose of the aeroplane, shortly before first flight. Did my maternal great-grandfather W. G. Tarrant know and approve of this action? By the end of my research, I understood that far bigger issues were involved, and in the process I shared in the excitement all involved with the Tabor must have felt, grappling with the 'known unknowns and unknown unknowns' of aeronautical design in the earliest days of heavy, multi-engine flying machines.

This work, which I hope is the definitive story of the Tarrant Tabor, is based largely on source material held at the National Archives, the RAF Museum, Imperial War Museum and the British Newspaper Archives. Special thanks to Evan Hadingham for his kind permission to quote at length the 1966 letter from John Grosert, courtesy of the Farnborough Air Sciences Trust (FAST) Museum.

I am particularly indebted to Vicky Taylor, great grandniece of Frederick Dunn AFC, Tarrant's test pilot, for permission to inspect Fred's family correspondence.

Simon Coles

West Wickham, May 2023

AUTHOR'S BIOGRAPHY

Simon Coles graduated from the University of Wales in 1972 with a degree in electronic engineering science, followed by a PhD in surface physics. He subsequently worked in IT and management consultancy, combining private sector work at home and abroad with extensive experience around central government and its 'arms-length' bodies. This has given him many insights into the bureaucratic mind. Simon has been married to Jane for 40 years and they have a son and a daughter. Since retiring, he spends his time exploring the world, enjoying their ever more demanding garden, and their delightful if exhausting grandchildren.

APPENDIX A – TABOR SPECIFICATION

Engines	Six 500-hp Napier "Lion."
Span	Middle wing, 131 ft 3 in; top and bottom wings, 98 ft 5 in
Total surface of wings	4,950 sq ft
Overall height	37 ft 3 in
Overall length	73 ft 2 in
Body	Round streamline, maximum diameter 11 ft
Gap	Top and middle planes, 14 ft 9 in; middle and bottom planes, 14 ft, 9 in
Chord	15 ft 2 in
Dihedral	4 deg on all planes.
Area of ailerons	On middle wing only, 105 sq ft each = 210 sq ft total
Area of fin	42 sq ft each, total 84 sq ft
Area of rudders	31 sq ft each, total 62 sq ft
Area of tailplanes	184 sq ft each, total 368 sq ft
Area of elevators	81 sq ft each, total 162 sq ft
Area of inter-elevator	54 sq ft
Span of tailplanes	30 ft
Gap of tailplanes	10 ft
Wings set at	3 deg to the body.
Top tailplane set at	-2 deg to the body.
Bottom tail plane set at	0 deg. to the body.
Weights (lbs):	Top wing 1,903; Bottom wing 2,691; Middle wing 1,833; Inter-wing struts 2,543 External bracing wires 608 (Total 9,578)
	Tail planes 334; Elevators 117; Fins 98; Rudders 40 (Total 589)
	Fuselage (including bomb girders) 3,590; Chassis 2,582; Tail skid 60; Controls 501 (Total 6,733)
	Engines, propellers, radiators and water, etc. 7,200; Engine accessories 650; Petrol and tanks (1,600 galls.) 12,662; Oil and tanks, etc. (92 galls.) 1,050; Crew (five) 1,080; WT 100; Guns and ammunition 380; Bombs and gears 4,650 (Total 44,672)
Maximum speed (est.)	Over 110 mph
Cruising speed (est.)	80 mph
Climb (est.)	To 5,000 feet: 10mins 30 secs To 10,000 feet: 33 mins 30 secs To 13,000 feet: over 60 mins

Ceiling (est.)	13,000 ft
Endurance (est.)	Normal 8 hrs Maximum 12 hrs
Range (est.)	At maximum speed: 900 miles; at cruising speed: 1200 miles

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