REPORT ON A PIECE OF FABRIC ATTRIBUTABLE TO PFALZ D.III 4020/17 AND A PIECE OF PLYWOOD ATTRIBUTABLE TO FOKKER DR.I 425/17 OWNED BY [redacted] AND ON LOAN TO THE GENERAL HAL MOORE MILITARY MUSEUM

Charles S. Gosse
August 31, 2018

Introduction

This is a report about two objects believed by their owner to be from a German aircraft of the First World War, specifically a Fokker Dr.I triplane, Dr.I 425/$_{17}$, which was being flown by Rittmeister Manfred Freiherr von Richthofen, when it crashed on April 21, 1918, at Vaux-sur-Somme, France, as a result of wounds suffered by its pilot.

Background

The owner of these objects is [redacted] who explains that she has inherited these objects from her ancestor who was a soldier in the German Army of the Second World War. [redacted] is interested in loaning these objects to The General Hal Moore Military Museum which is located in Bardstown, Kentucky, and is a 501(c) Nonprofit Corporation. The museum is interested in receiving them but would like to gain a better sense of their authenticity before accepting and displaying them to the public. To that end, the museum's Curator and Board Member, Lt Cdr. Robert Llewellyn, USCGR (ret) contacted Alan Toelle to ask for his opinion about their authenticity. Mr. Toelle referred Mr. Llewellyn to Charles Gosse, who is the author of this report.

I received these objects by mail from Mr. Llewellyn on July 5, 2018, and returned them to him by mail on August 24, 2018.

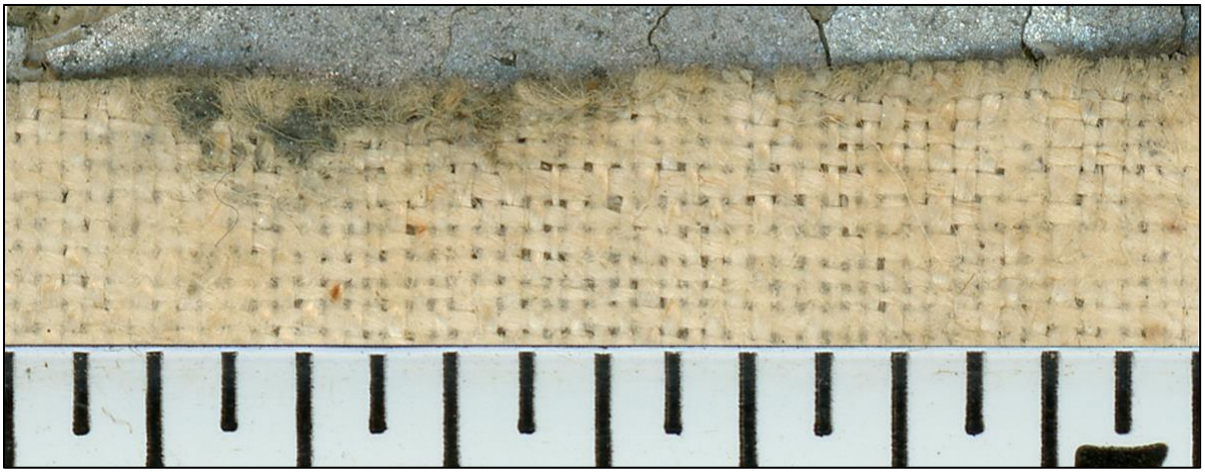
When received by me, these objects were adhered to a piece of paper along with an article titled “Richthofen’s Last Flight.” by Percival Phillips writing in the London newspaper “Daily Express” and a backing board from the frame which they had been housed in.

I asked Mr. Llewellyn for permission to remove the two objects from the paper in order to examine their reverse sides. Mr. Llewellyn conferred with [redacted] who gave me permission to do this in a telephone call on July 6, 2018. My analysis of each object follows.

Object No. 1 – Historical Research

Object No. 1 is a piece of linen fabric made from the fibers of the flax plant. It measures 11.5 cm by 10 cm, one face of which has been covered in a dull, silver-like material. This material has flaked-off in some areas, especially along fold lines.

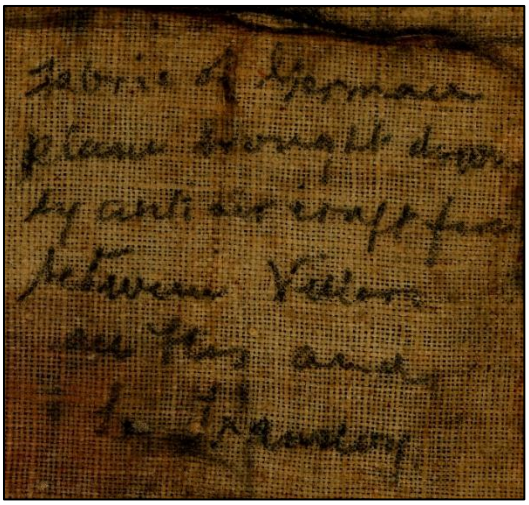
I examined the fabric under a magnifying glass, counted the number of threads and determined that there were 52 to 54 threads to the inch, consistent with the type of fabric used by the German Air Service during the First World War. One example placed next to a ruler is shown below.



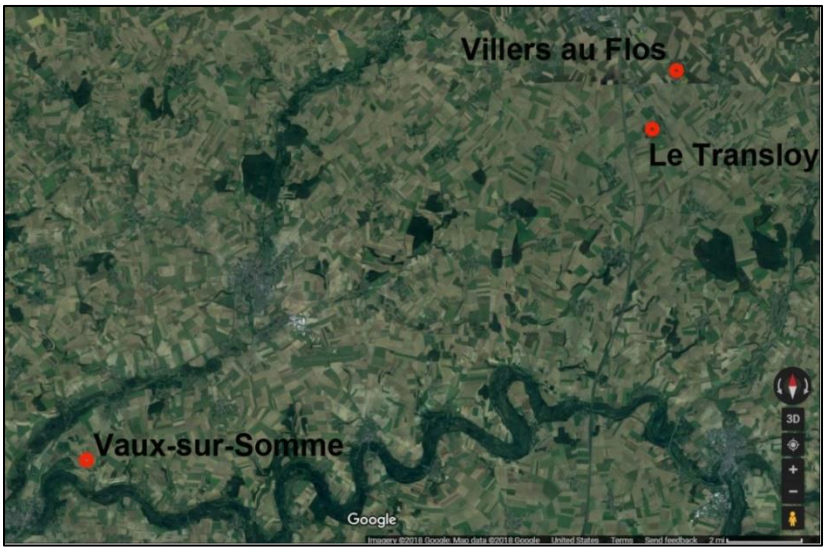
In addition, the fabric appears to be calendered, the result of being pressed between heavy rollers in order to flatten the threads and prepare them to better receive the dope which would be applied to tighten the fabric over the frame of an aircraft.

The fabric on the triplane flown by von Richthofen was known from various historical accounts as well as artifacts salvaged from its wreckage to be painted red (specifically, vermilion red) and that the undersurfaces of the wings were painted vermilion red over a light blue. Silver is not known to have been found on any fabric from this specific aircraft. The color silver is know to have been used on several other German aircraft, especially aircraft manufactured by the Pfalz Flugzeugwerke G.m.b.H.

The writing on the back of the fabric is in pencil and reads "Fabric of German plane brought down by anti aircraft fire between Villers au Flos and Le Transloy." The contrast of the image below has been increased to make the writing easier to read; the fabric is not actually this dark.



Villers au Flos and Le Transloy are next to each other and the point between them is about 17 miles or 27 kilometers northeast of where Richthofen came down at Vaux-sur-Somme as can be seen in this present-day aerial photograph from Google Maps.



I researched combat records[1] to try and identify one or more German aircraft which were

1. brought down by anti-aircraft fire
2. between Villers au Flos and Le Transloy
3. and of the type of aircraft known to have been at least partially silver in coloring.

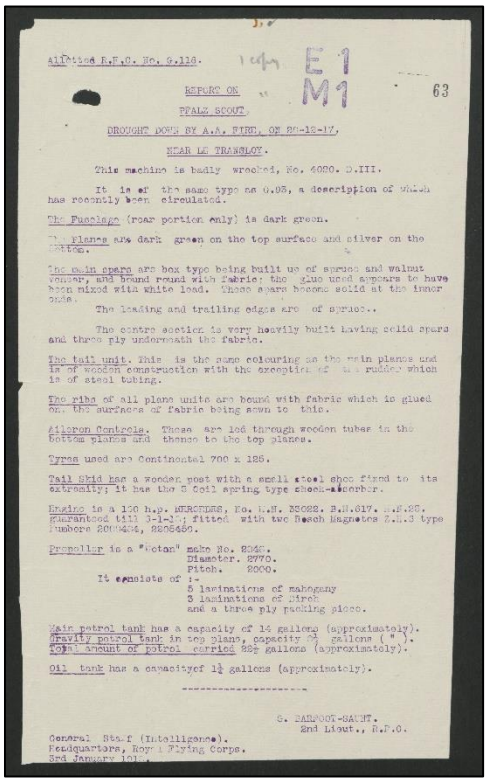
I found only one aircraft that met all three criteria and that was a Pfalz D.III single-seater scout with the serial number D.4020/17 which belonged to Jagdstaffel or hunting squadron 29. It was brought-down by British anti-aircraft fire on 28-December-1917. Richthofen was brought down about four months later.

The pilot of D.4020/17 was Vizefeldwebel or Sergeant Max Albert Gustav Brandenburg who was 23 years old and had just joined Jasta 29 on 8-December-1917 from Jastaschule II.[2] He was injured and taken prisoner, his injuries listed variously as "contusion r. side"[3] and "Contusion of back and shoulder"[4] and his capture as one day earlier, 27-December-1917.[5]

Most aircraft that did not return to the airfields from which they had taken off either had run out of fuel, encountered mechanical problems in the air, were damaged by enemy aircraft or ground fire or became out-of-control due to the death or injury of their pilot. As such, these aircraft would impact the ground at such a high rate of speed that little or nothing of the aircraft would remain to be identified.

In cases where an enemy aircraft was not totally destroyed but was either captured intact or, if wrecked, was on the allied side of the front line and could still provide useful intelligence, the Royal Flying Corps (later Royal Air Force) assigned the enemy aircraft a specific number to keep track of its components and then compiled a report about it. D.4020/17 was one such aircraft; it was given identification number G.116 and a report was written about it six days later by 2nd Lieutenant G. Barfoot-Saunt, a staff officer in the Intelligence Section of the General Staff of the R.F.C., who was the author of many of these kinds of reports.

The actual report on G.116 is stored in the UK National Archives. I obtained a copy from the archives and it is shown below along side a photo of Barfoot-Saunt. A full-size copy of the report is attached to the end of this report.



Attached R.F.C. No. G.116.

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REPORT ON

PFALZ SCOUT.

BROUGHT DOWN BY A.A. FIRE, ON 28-12-17,

NEAR LE TRANSLOY.

This machine is badly wrecked, No. 4020. D.III.

It is of the same type as G.98, a description of which has recently been circulated.

The Fuselage (rear portion only) is dark green.

The planes are dark green on the top surface and silver on the bottom.

The main spars are box type being built up of spruce and walnut veneer, and bound round with fabric; the glue used appears to have been mixed with white lead. These spars become solid at the inner ends.

The leading and trailing edges are of spruce.

The centre section is very heavily built having solid spars and three ply underneath the fabric.

The tail unit. This is the same colouring as the main planes and is of wooden construction with the exception of the rudder which is of steel tubing.

The ribs of all plane units are bound with fabric which is glued on, the surface of fabric being sewn to this.

Aileron Controls. These are led through wooden tubes in the bottom planes and thence to the top planes.

Tyres used are Continental 700 x 125.

Tail Skid has a wooden post with a small steel shoe fixed to its extremity; it has the S Coil spring type shock-absorber.

Engine is a 160 h.p. MERCEDES, No. D.W. 35022. D.III.017. D.F.C. Guaranteed till 9-1-18; fitted with two Bosch Magnetos Z.H.3 type numbers 200404, 200480.

Propeller is a "Botan" make No. 8045.
Diameter. 2770.
Pitch. 2000.
It consists of :-
5 laminations of mahogany
3 laminations of Birch
and a three ply packing piece.

Main petrol tank has a capacity of 14 gallons (approximately).
Gravity petrol tank in top plane, capacity 6½ gallons (").
Total Amount of petrol carried 22½ gallons (approximately).

Oil tank has a capacityef 1½ gallons (approximately).

G. BARFOOT-SAUNT.
2nd Lieut., R.F.C.

General Staff (Intelligence).
Headquarters, Royal Flying Corps.
3rd January 1918.

Barfoot-Saunt begins his report “This machine is badly wrecked…” The rear portion of the fuselage is described as “dark green” and the wings “are dark green on the top surface and silver on the bottom…” and the tail of the airplane “is the same colouring as the main planes."

I consulted with the aviation historian Greg VanWyngarden about the description of this aircraft as given in G.116 and he commented that its coloring was consistent with the known coloring used by Jasta 29. To explain further, when new Pfalz D.III and the later D.IIIa aircraft arrived from the factory, they were completely silver in color and the Jadgdstaffel or ‘Jasta’ to which they were delivered added its own, additional coloring so that its pilots could differentiate their squadron’s aircraft from those of other squadrons during combat.

Based on the report of G.116, we can conclude that [redacted] silver fabric is from either the bottom surface of one of the two wings or the bottom surface of the elevator or stabilizer on the tail of the aircraft. The bottom surface is the surface which faces towards the ground when the aircraft is in flight. Observers looking upwards from the ground would have difficulty seeing D.4020/$_{17}$ because of its silver bottom surface, which was the intent of giving it a silver color; this color acted as a type of camouflage. It also repelled UV radiation, reflecting sunlight away from the aircraft and therefore preserving it.

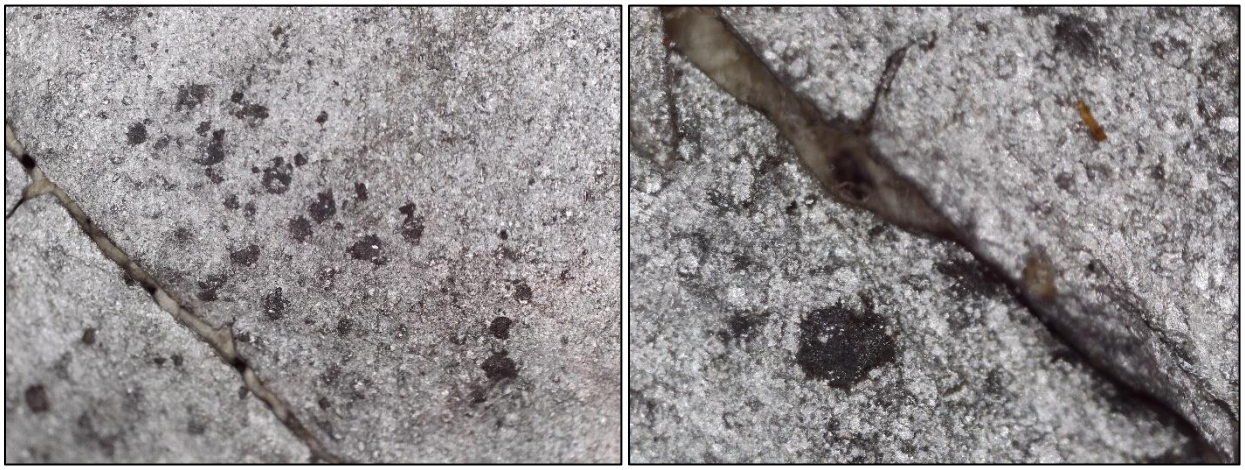
No photos of Pfalz D. 4020/$_{17}$ with its Jasta or after it crashed on 27 or 28-December-1917 are known to exist. A photo of D.4011/$_{17}$ of Jasta 21 with it’s pilot Fritz Höhn is shown below.

This photo of Pfalz D.III 1411/$_{17}$ shows the factory-applied silver finish to great affect.

The pilot, Max Brandenburg, was born 1 May 1894 in Clausthal-Zellerfeld,[6] a town in Lower Saxony located in the southwestern part of the Harz mountain. He returned there after the war and was listed as the head of the Bund Deutscher Flieger e.V. or League of German Airmen e.V. at Altenauerstr. 15.[7] The building, seen here in present day, is used by the Verein Deutscher Studenten, an association of 38 German fraternities.

Object No. 1 – Analytical Research

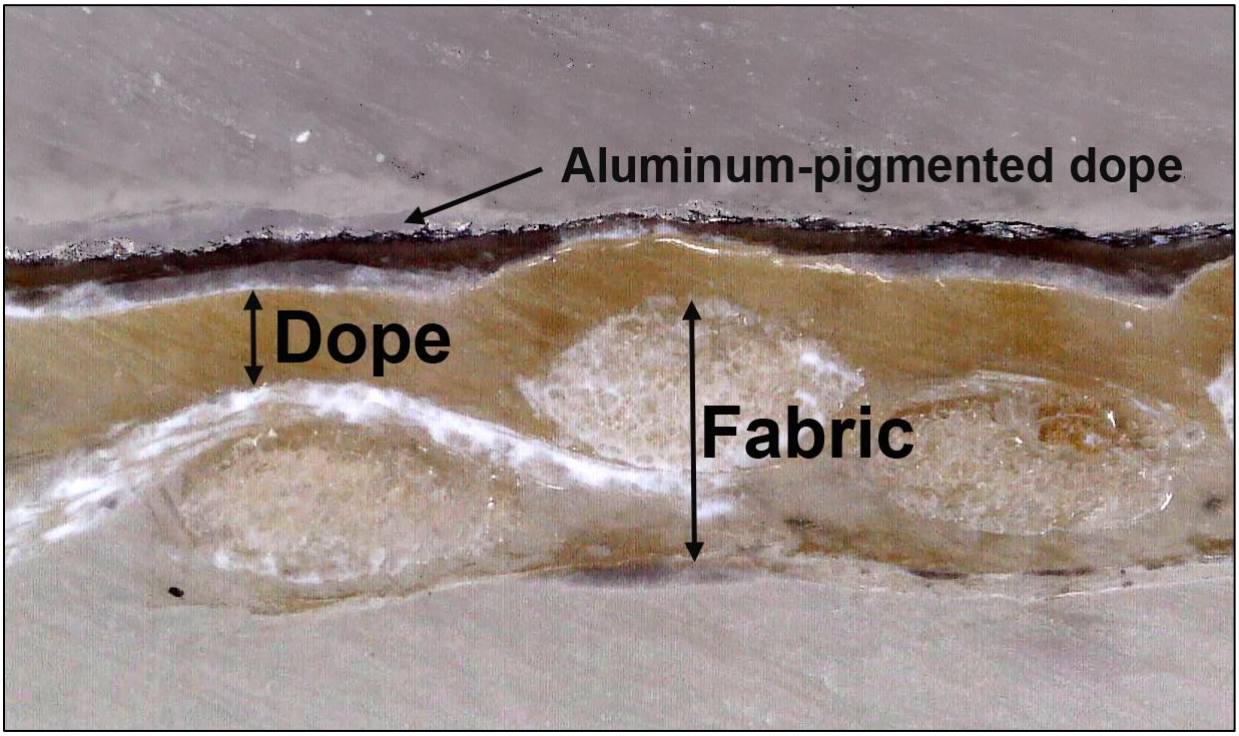
The human eye alone is not a good instrument for analyzing fabric – it simply can not see enough detail – and therefore a microscope is necessary. Under magnification, the silver material of Object No. 1, the fabric from Pfalz D.4020/$_{17}$, is seen to be predominantly silver flake with some black flake, as shown below. These are color photographs taken through the microscope that appear reflective to the naked eye but, when printed, appear grayer than they actually are.



A microscope looks down on its subject which typically is perpendicular to the lens of the microscope. Fabric analysis is most useful when the fabric and its coating can be seen from the side; in affect, the fabric needs to be turned ninety degrees towards the microscope lens. This poses some difficulty for the microscopist because the fabric does not want to remain in position exactly at ninety degrees towards the lens, it wants to "flop" to one side or the other. Further problems arise because, even though the sample may have been cut from a larger piece with a very fine cutting edge, the ends of the fabric threads still may not all line up at exactly the same place and thus some may be out-of-focus while others are in-focus.

To make analysis possible, a small piece of fabric is suspended in a clear casting resin and, when the resin has hardened, it is then polished so that the fibers of the fabric and the edge of its coatings are all at the same exact distance from the lens of the microscope. This technique was pioneered by Alan Toelle and used in this analysis.

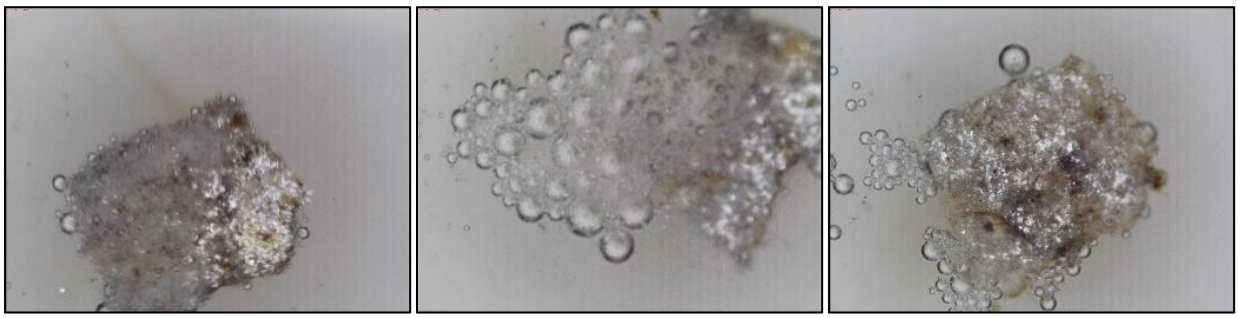
I removed a small, approximately 1mm x 2mm piece of fabric from Object No.1 and prepared it as discussed above.[8] In the photo on the next page the fabric and coating are seen at approximately 220x magnification. The ends of three fibers are seen facing the camera. Above the fabric is a thick coating of clear dope and above that is a thin layer of aluminum-pigmented dope. The bright white material is residual white polishing powder that is not part of the original object being studied.



Dope is a clear liquid of cellulose acetate applied by brush to the fabric of fabric-covered aircraft after the fabric has been stretched and attached to the wings and, in some cases, the fuselage. The dope dries and, as it dries, it tightens and stiffens the fabric creating an airtight and weatherproof surface. Some aircraft are flown with no further coating other than dope, itself. Some times, after the dope has dried, a layer of paint is applied on top of the dope. Other times, instead of paint, a second coat of dope is applied to which a pigment has been added. In the case of D.4020/$_{17}$, the coating on top of the initial dope coating is aluminum-pigmented dope.

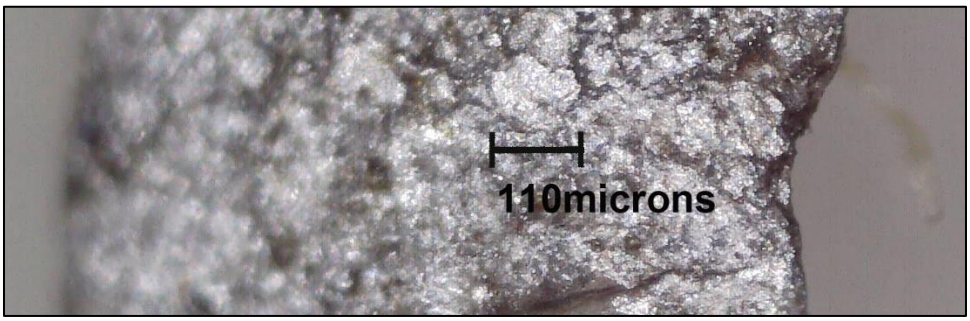
To confirm that the thin silver layer is aluminum-pigmented dope, two tests were performed.[9] *In the first test, acetone was seen to dissolve the cellulose acetate dope and disperse the aluminum pigment.* Below are three frames from the film of this test which was made through the microscope as the test occurred. These frames show in progression from the left frame to the right frame the affect of acetone on the silver flake.

In the second test, potassium hydroxide (KOH), a known reagent of aluminum, was seen to destroy the aluminum pigment. In progression from the left frame to the right frame, the affect of KOH is seen.



The results of these tests lead me to conclude that the silver layer on Object No. 1 is aluminum-pigmented dope; it is not paint. This supports the probability that the sample is from a Pfalz aircraft. Evidence of black pigment was also seen but it is not clear if this black pigment was being used to tint the aluminum.

To my knowledge and to that of Alan Toelle, with whom I have discussed this, the only other known and verified example of aluminum-pigmented dope on German aircraft of the First World War is from a Pfalz D.IIIa flown by Antoni Wroniecki of Jagdstaffel 64w that was brought down on 14-April-1918. Alan Toelle examined it in 1993. He concluded that it was aluminum-pigmented dope and that aluminum powder alone was used, with no evidence of any other pigment, such as the black pigment found in Object No. 1. Mr. Toelle estimated the size of the aluminum flake in the example he looked at to be from 2 to 40 microns with the majority smaller than 20 microns while the size of aluminum flake in Object No.1 that I measured was 10 to 110 microns with most less than 30 microns. A piece of aluminum-pigmented dope from object No. 1 is shown below with a large flake at 110 microns indicated.



These two examples indicate that the silver color of Pfalz aircraft was derived from finely-ground aluminum powder added to and suspended in liquid dope which was either brushed on or sprayed onto the fabric covering of the aircraft in a thin coat applied after a thicker coat of clear dope had already been applied and dried. In the sample examined by Mr. Toelle, no black pigment was observed, but it was observed in Object No. 1 so whether or not black pigment was a constituent part of the factory-applied finish is still not known.

Object No. 1 is only one of two known examples in either museums of private collections of the silver color on German aircraft of the First World War and, as such, it is quite rare and of much importance to historical research. It is not from von Richthofen's triplane but the world already has more than enough examples of the vermilion red fabric from that aircraft so Object No. 1 is much more unique and important.

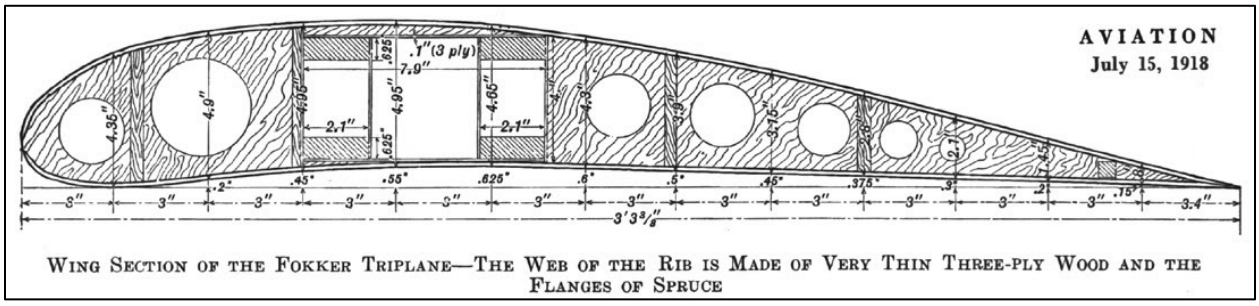
Object No. 2

Object No. 2 is the piece of plywood shown below. It measures 10 cm by 5 cm and is 1.3 to 1.73 mm thick and made up of three plies, the middle ply being substantially thicker than the two outer plies that sandwich it. The thin outer plies run in a different direction from the middle ply. One outer ply has a clear coating - possibly dope - that slightly stains it a darker color. The other outer ply does not have a coating or any writing.

Thickness at various points is shown below. As some of the plywood is missing, it appears that the entire piece may have been at least 1.73 mm thick. The piece is bent or warped in several directions and absent of any moisture. It may be that the thickness of the piece as originally manufactured when it retained moisture and was not yet subject to compression during flight and the aircraft's impact with the earth was greater than 1.73mm.

Ross Walton advised that "The triplane did have a considerable amount of plywood. In addition to the turtle deck, there were two large plywood side fairings. The leading edges of the wings were plywood sheet and the wing between the landing was completely covered in plywood. All of the aforementioned wood was three ply, 1.5mm thickness. The double box spars were a combination of plywood, mostly 1.5 mm thickness and spruce stringers that ran the wingspan. On qualitative examination, this plywood appears to be in the 1.5 mm thickness range."

I also consulted Achim Sven Engels, who has also studied the design of this particular aircraft, and asked him if this plywood piece, Object No. 2, could have been the web – the vertical piece – of a wing rib or from the box spars that ran through the wings. A drawing of a Fokker triplane wing rib published in the magazine "Aviation" is shown below to illustrate.[10]

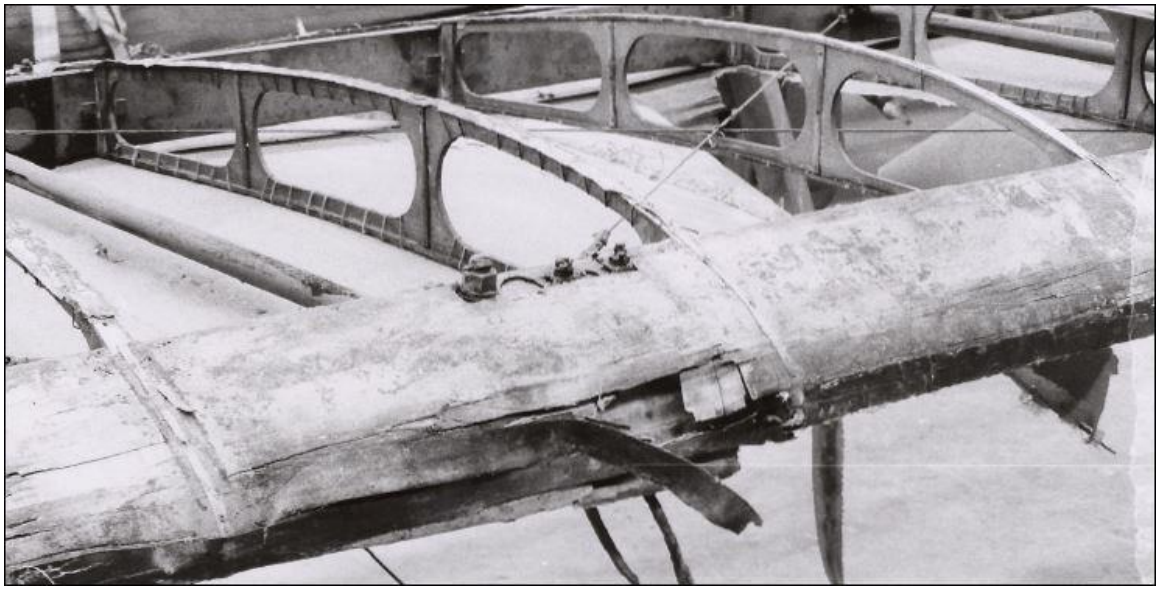


WING SECTION OF THE FOKKER TRIPLANE—THE WEB OF THE RIB IS MADE OF VERY THIN THREE-PLY WOOD AND THE FLANGES OF SPRUCE

He informed me that "early triplanes had 1,7mm plywood for wing ribs later ones (as 425/17) had it reduced to 1,5mm…" The thickness of Object no. 2 therefore is slightly more than the thickness one would expect from a wing rib from von Richthofen's later triplane, 425/17. Mr. Engels went on to say "What leaves me puzzled is why only one side is covered with varnish/dope. This rather indicates it is a outer surface with no fabric on top."

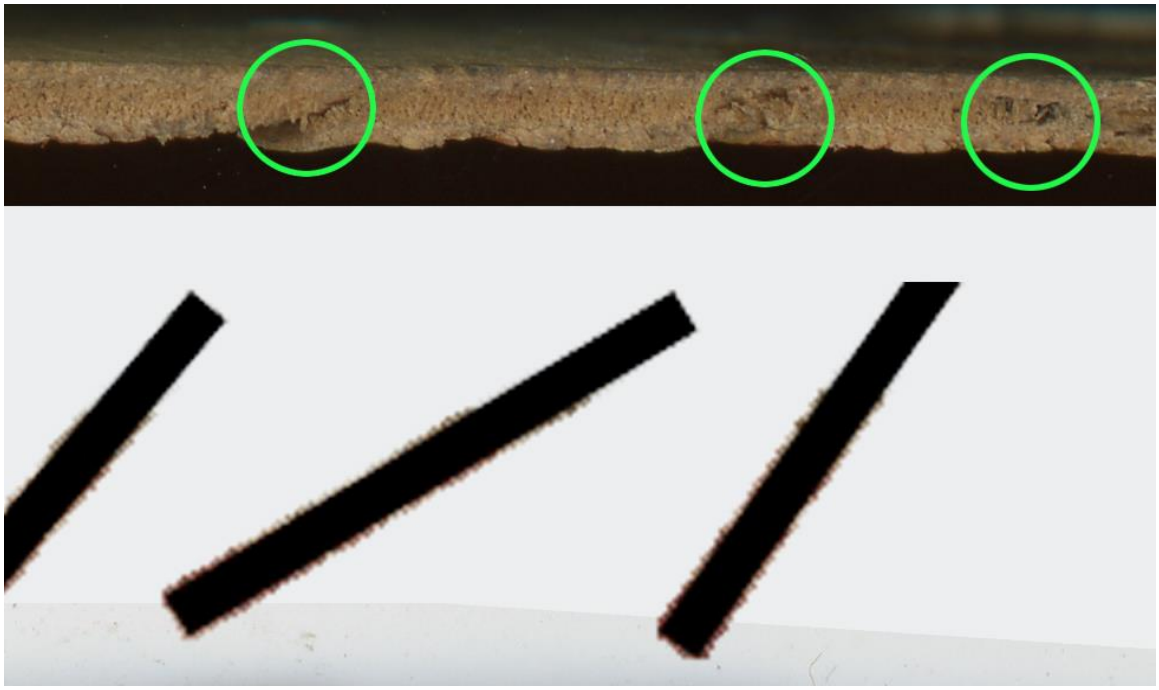
After further consideration, Mr. Engels added "If this is piece of a triplane, I assume it may be from a wing rib. I have marked the places where I think to see nails going through upright as if a cap strip would have been nailed to it." The image Mr. Engels returned to me is shown below with his marks overlapping the plywood.

The plywood wing ribs of early airplanes typically had a thin wood cap strip attached with very small nails over the top and bottom ends of the rib, as shown in the photo below of the wing of an Albatros aircraft. A thin piece of fabric would then be laid along the cap strip and be held in place with string.



When the wing was finally covered with fabric, a seamstress would stitch the outer fabric covering to the thin fabric running along the cap strip as shown in the photo below of the same Albatros aircraft during restoration.

I examined the edge of the plywood where Mr. Engels thought there were indications of very small nails having been driven into the plywood, evident of the attachment of a cap strip, and found examples of holes exactly where he thought they would be, as shown below.



If Object No. 2 is from a wing rib, it is difficult to identify a specific location on the Fokker Dr.I where it could have come from. All the ribs have lightening holes such that a piece of plywood measuring 10 cm by 5 cm is too large except for possibly the very last rib, as shown in the drawing below from the magazine 'Flugsport."[11]

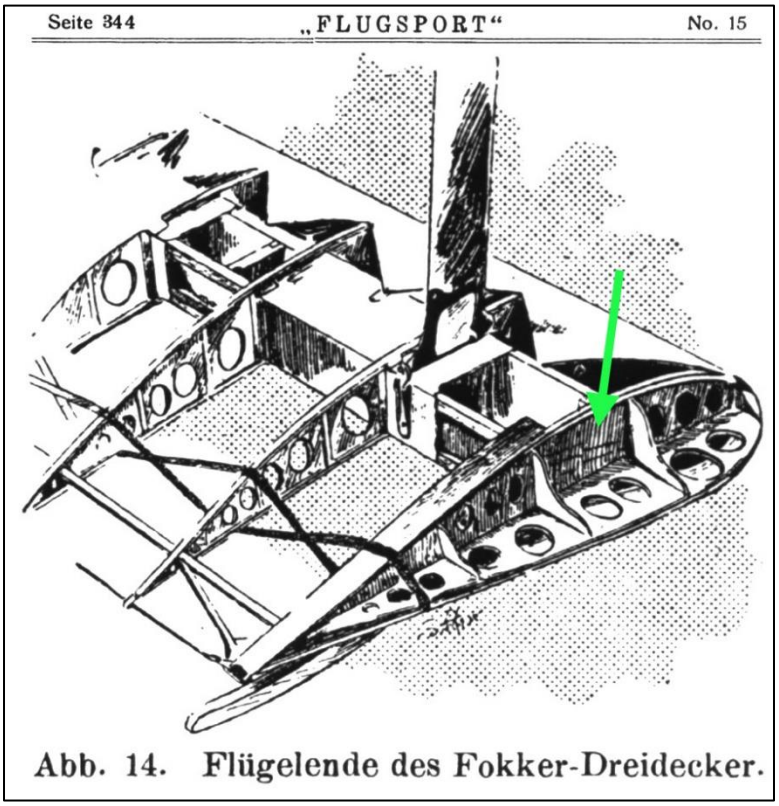
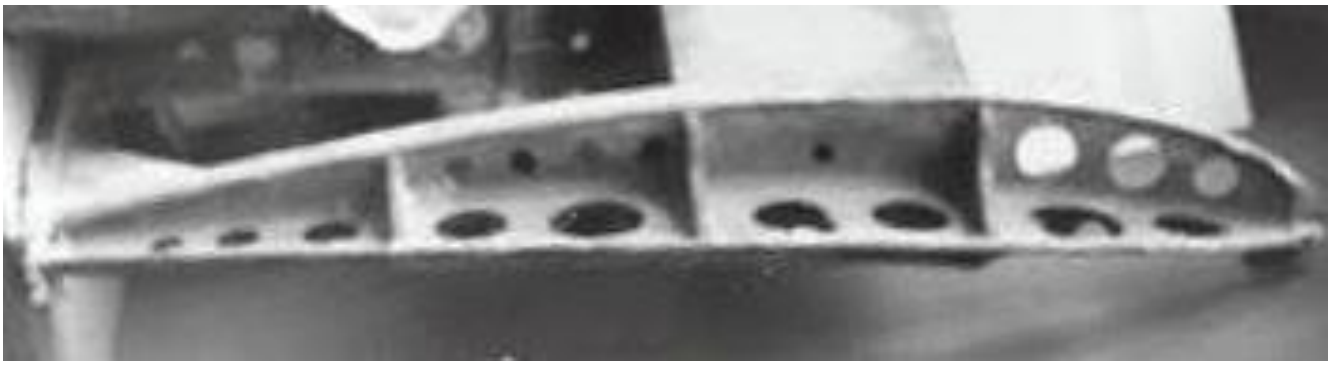


Abb. 14. Flügelende des Fokker-Dreidecker.

The Fokker triplane had three wings and, therefore, six end ribs from where Object No. 2 could have come from. One of these six is stored at the Royal Canadian Military Institute in Toronto, Ontario, Canada, and shown below.



Mr. Engels added that "If it is 2mm thick it could be a piece of the side fairing or turtle deck. These have been varnished prior to covering the plane so that the fabric would not stick to them." He also noted that the box spar would be 2mm plywood, as well.

The table below shows how the characteristics of Object No. 2, such as its thickness at 1.73 to 2.0 mm, evidence of nail holes and varnish on one side, fit with possible locations on the triplane.

	thickness	nails	varnish
Wing rib	✓	✓	
Box spar	✓		
Side fairing	✓		✓
Turtle deck	✓		✓
Leading edge	✓		
Spreader cover	✓		

I do not think it will be possible to conclude without any doubt exactly where this object was on the triplane but I believe that Object No. 2 could have come from a German Fokker Dr.I triplane of the First World War and could have come from Dr.I $425/_{17}$.

Acknowledgements and Notes

I would like to acknowledge and thank Alan Toelle for his pioneering work in the microscopic analysis of aviation fabrics and their coating and for sharing his methodology with me. I would also like to thank and acknowledge his advice on this specific project.

I also thank Achim Sven Engels and Ross Walton on their advice about the characteristics of plywood as used on early and later Fokker Dr.I triplanes and Greg VanWyngarden and Colin A. Owers for providing a partial transcript of the report on G.116 before the original copy became available and Greg VanWyngarden for his help in comparing G.116's reported color scheme to known color schemes for Jasta 29.

The photos of an uncovered wing and of a worker stitching a fabric cover onto a wing are courtesy of the National Air and Space Museum in Washington, DC. The photos of the two Pfalz D.III aircraft, D.4011/17 and D.1411/17, are courtesy of Greg VanWyngarden. The photo of the end of a wing from Dr.I 425/17 is from the book *The Red Baron: A History in Pictures* by Norman Franks. The photo of G. Barfoot-Saunt is from my private collection and the photos of Objects No.1 and No.2, the subjects of this report, were taken by me.

This report was sent to Robert Llewellyn and [redacted] as well as the five people with whom I consulted about this report, Alan Toelle, Achim Sven Engels, Ross Walton, Greg VanWyngarden, and Colin Owers.

Appended to this report is a copy of the entire, single-page report of G.116 as held at the UK National Archives and located within AIR 1/1965/204/264/2, "Reports and notes on captured German aeroplanes."

Charles S. Gosse
McLean, Virginia
August 31, 2018

Endnotes

[1] Rick Duiven, private files

Chaz Bowyer, editor, *Royal Flying Corps Communiques 1917-1918*, Grub Street, 1998;

Norman Franks, Frank Bailey and Rick Duiven, editors, *The Jasta Pilots*, Grub Street, 1996;

Norman Franks, Frank Bailey and Rick Duiven, editors, *Casualties of the German Air Service 1914-1920*, Grub Street, 1999

[2] *Cross & Cockade Journal*, Volume 21, 1980, page 188

[3] International Committee of the Red Cross, 1914-1918 Prisoners of the First World War ICRC Historical Archives, German Army Main File, List No. 176 of German Prisoners of War Europe Military Forces Main List, record A15841

[4] International Committee of the Red Cross, 1914-1918 Prisoners of the First World War ICRC Historical Archives, German Army Main File, List No. 178 of German Prisoners of War Europe Military Forces Appendix A, record A16363

[5] International Committee of the Red Cross, 1914-1918 Prisoners of the First World War ICRC Historical Archives, German Army Main File, Brandenburg, Max, 163836

[6] International Committee of the Red Cross, 1914-1918 Prisoners of the First World War ICRC Historical Archives, German Army Main File, List No. 176 of German Prisoners of War Europe Military Forces Main List, record A15841

[7] *Luftfahrt Deutsche Luftfahrer-Zeitschrift*, Klasing & Co., G.m.b.H., Berlin, 1921, page 154

[8] This fabric sample was 0.0174% of the total area of the object.

[9] Several small silver flakes measuring approximately 1mm x 2mm were loose and no longer attached to the fabric and were used to perform these two tests.

[10] *Aviation and Aeronautical Engineering*, The Gardener, Moffat Co., New York, July 15, 1918, page 870

[11] Oskar Ursinus, *Flugsport. Illustrierte Flugtechnische Zeitschrift für das Gesamte Flugwesen: Jahrgang 1918*, Frankfurt am Main, 1918, July, 1918