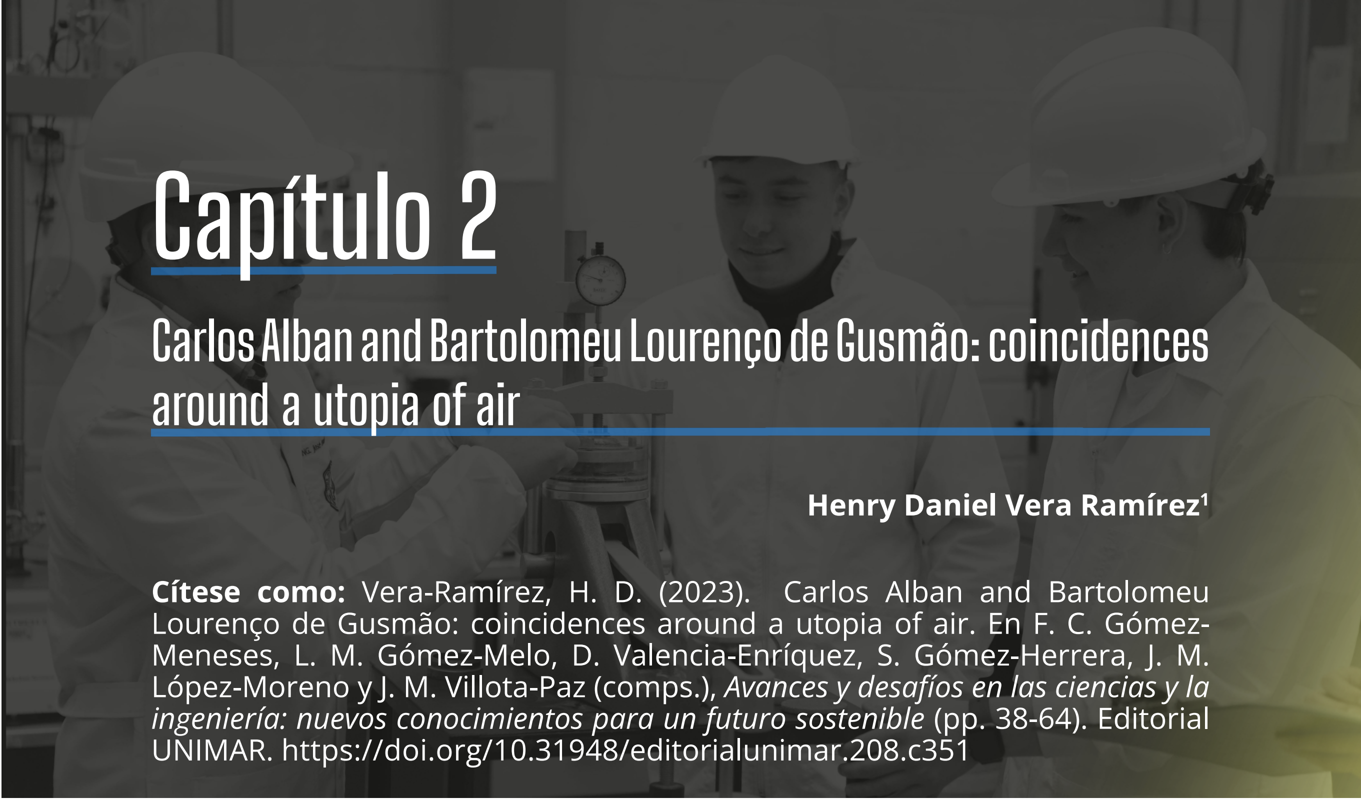

Capítulo 2

Carlos Alban and Bartolomeu Lourenço de Gusmão: coincidences around a utopia of air

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Abstract

This paper attempts to reflect on the relationship between two pioneers in the development of flying artifacts -later known as airships- from Brazil/Portugal and Colombia. The present research is framed in a documentary study of different archival collections of Francisco José Carlos Alban Estupiñán (1844-1902) and Bartolomeu Lourenço de Gusmão (1685-1724) who developed ideas and artifacts that pioneered the later developments of Ferdinand von Zeppelin (1830-1917). Some conclusions propose that the design of the «*passarola*» had a mythical scope that transcended its time and that Alban's patent #588 could be an important antecedent for the development of these artifacts in the case of the Colombian.

Keywords: aerostat; Alban; Gusmão; Zeppelin; patent.

Carlos Albán y Bartolomeu Lourenço de Gusmão: coincidencias en torno a una utopía de aire

Resumen

El presente documento intenta realizar una reflexión sobre la relación existente entre dos pioneros en el desarrollo de artefactos voladores, conocidos posteriormente como dirigibles, provenientes de Brasil/Portugal y de Colombia. La investigación se enmarca en un estudio documental de diferentes fondos de archivos de Francisco José Carlos Albán Estupiñán (1844-1902) y Bartolomeu Lourenço de Gusmão (1685-1724), quienes desarrollaron ideas sobre artefactos que fueron pioneros de los desarrollos posteriores de Ferdinand Von Zeppelin (1830-1917). Algunas conclusiones proponen que

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el diseño de la «*passarola*», tuvo un ámbito mítico que fue trascendiendo su época y, que la patente #588 de Albán podría constituirse en un antecedente importante del desarrollo de estos artefactos en el caso del colombiano.

Palabras clave: aerostato; Albán; Gusmão; Zeppelin; patente.

**Carlos Albán e Bartolomeu Lourenço de Gusmão:
Coincidências em torno de uma utopia do ar**

Resumo

Este artigo procura refletir sobre a relação entre dois pioneiros no desenvolvimento de artefatos voadores -mais tarde conhecidos como dirigíveis- do Brasil/Portugal e da Colômbia. A presente pesquisa está enquadrada em um estudo documental de diferentes coleções de arquivos de Francisco José Carlos Alban Estupiñán (1844-1902) e Bartolomeu Lourenço de Gusmão (1685-1724), que desenvolveram ideias e artefatos que foram pioneiros nos desenvolvimentos posteriores de Ferdinand von Zeppelin (1830-1917). Algumas conclusões propõem que o projeto da «*passarola*» tinha um escopo mítico que transcendia seu tempo e que a patente nº 588 de Alban poderia ser um antecedente importante para o desenvolvimento desses artefatos no caso do colombiano.

Palavras-chave: aeróstato; Alban; Gusmão; Zeppelin; patente.

Introduction

There is an insufficient approach to the scientific and technological advances that have been carried out in the historical development of the Colombian context. Although there are currently some scientists and inventors of national and international recognition, our country has been the cradle of some important figures in the scientific field, both in the post-independence period and throughout the twentieth century. Many of them were influenced by a *spirit of knowledge*, which made them -if the term is still allowed- integral intellectuals, due to their capacity for analysis of different problems arising from the reality of the country and its context. Regardless of their political stance, many of them generated scientific instruments that even made them pioneers in the development of certain areas of knowledge.

One of these characters, who has been valued much more in his political aspect is Francisco José Carlos Alban Estupiñán, a lawyer, mathematician, inventor, doctor, military, and civil engineer. His importance as a politician stood out in the *Thousand Days War* and the consolidation of conservative ideas, but the aspect that we seek to deepen is his aspect as an inventor and science disseminator.

On the other hand, Bartolomeu Lourenço de Gusmão, known as the «voador», was a priest of Portuguese-Brazilian origin, who was interested in the construction of machines and especially in a machine that could fly and that finally resulted in a flying machine design called the *Passarola* (1709). This approach seeks to make a rapprochement between two scientific profiles from different places or areas that intend to make visible advances in a *creole science* that has been relatively unknown for the benefit of figures of greater recognition and coming from the global north.

The general objective of the paper is to analyze a comparative study of the advances in aerostat issues carried out by the Colombian scientist Carlos Alban through the impact of the assignment of patent #588 and the advances carried out by Bartolomeu Lourenço de Gusmão. The specific objectives are: to describe the set of scientific contributions and especially the one to the development of hot air balloons in the studies conducted by Carlos Alban; to describe the relationship between science and politics in Colombia in the late nineteenth and early twentieth centuries, to contribute to the analysis of the context in which the political event of the patent assignment took place. Finally, analyze the historical importance of the contribution of Bartolomeu Lourenço de Gusmão to the later development of airships.

The work focuses on the need to recover historically different figures who have contributed in different ways to the advancement of science in our country. In this sense, it does not promote a political vindication of the figure of Carlos Alban, but an analysis that focuses mainly on understanding and valuing his scientific contributions and especially his aid to the development of aeronautical science and the development of airships. "The Zeppelin evolved into an emotional symbol of science, national pride, peace, war, gigantism, and even disaster, beyond the control of any man or political power" (Mosher, 2002, p. 64).

This, without leaving out an analysis of the political and social context of our country, where the assignment of the patent took place, and the meaning, from the political point of view of the act and the consequences in terms of the advancement of science and technology in the country.

The work can contribute to the disciplinary formation of those interested in the social studies of science since it allows them to analyze the political context that developed during the work of Carlos Alban and its comparison with the advances of Bartolomeu Lourenço de Gusmão, through the *Creole science* device, as the way in which certain figures who had made important advances in the development of different disciplinary fields were undervalued and how some political acts can, in a certain way, vindicate the scientific work. An example of this is the work of Kühne (2012), on Zeppelin's contributions to technical and social development in Germany, without even naming the initial support of the Colombian with whom he met in Hamburg when Alban was part of the diplomatic corps.

Figure 1

Francisco José Carlos Alban Estupiñán January 1st, 1899, and Bartolomeu Lourenço de Gusmão in a painting by Benedito Calixto de Jesus. Oil painting, 1902

Source: Paulista Museum.

Some physical fundamentals of aerostats

The airship is an aerostat that, by the effect of motor-propellant groups and stability and maneuvering surfaces with which it is promoted, moves through a medium. The apparatus is generally subject to the laws of subordinate horizontal flight aerostat, as well as aerodynamics. The lower coefficient of drag in the air and a better relation between power and speed (taking into account the own volume and the density of the environment), and the performance of the propeller generally favor designs of fusiform aspect and elongated backward (Maluquer, 1942; Mortane, 1938; Davy, 1950).

However, this definition can be extended to any device that can be kept in equilibrium in the atmosphere by simple applications of Archimedes' principle; this one is a general principle of the mechanics of incompressible or non-compressible fluids, by which a *hydrostatic impulse* is calculated, as enunciated by Archimedes: Anybody immersed in a liquid is subjected to a vertical impulse, directed upwards, equal to the weight of the volume of the displaced liquid. It can be demonstrated by the theorem: *Calculate the sum of the pressure forces on all surfaces of the immersed body.* The impulse is given by $A = \oint_{s} P d\vec{\sigma}$. (See: Bruhat, 1940; Giqueaux-Oudart, 1957).

Once it is made up of solid elements with a density higher than that of air, it is necessary to have a volume occupied with a body less dense than air to ensure its equilibrium in the atmosphere. Static equilibrium at a certain altitude will be obtained when the weight of the volume of air displaced by the aerostat is equal to the weight of the aerostat with its gas.

An aerostat behaves suspended in the air thanks to two vertical elastics acting in opposition. One of them represents the lift force and the other the weight, which is also related to the force of gravity. The practice has shown that the upward force of gas, the difference between the weight of 1 m^3 of air and the gas under consideration, is related to a total upward force, which is the difference between the weight of the air displaced by the gas and the weight of the gas. If it is assumed that the volume of the gas is constant and that the lift force varies according to the air density and the inclusion of variables such as temperature and pressure, data related to its possible altitude and hygrometric state can be obtained.

It is worth mentioning that, a hygrometric state refers to the ratio of the actual amount of water vapor contained in the air to that which it would have if it were saturated, the temperature being identical in both cases.

A 1000 m^3 balloon filled with industrial hydrogen -lift force of 1100 kg-, has a total lift force of 1100 kg, and if it were to pass with all its components, passengers, and ballast of 1080 kg, the lift force would be 20 kg. As long as there is a total lift force greater than the weight, the aerostat would rise to the equilibrium altitude, where the total lift force equals the weight of the solid components. The gas is contained and subject to a differential pressure of the gases. The apparent differential pressure is proportional to the gas lift force.

Zeppelin and the advance of aerostats

The history of aeronautics goes back to a time of which the most distant vestige is an engraved record on *Atlantean* pottery in Central America, with important events such as the first public ascension of a hot air balloon on June 5, 1783 (Duhem, 1943). Most of the means of flight imagined by the precursors endured or coexisted for centuries and it often happened that several of them were associated with a single project and in a single machine.

If one follows a deeper historical process of the development of aerostats to zeppelins, according to Tissander (1890), Blakemore and Watters-Pagon (1927), and Burgess (1927), the following background can be found:

- A series of models and projects that were initially presented by Meusnier (1783), followed by other prototypes such as those of Giffard (1852), using steam engines.
- The Tissander brothers and Renard (1884) with the use of an electric motor.
- Santos-Dumont (1901), who obtained it by using the application of the gasoline explosion engine at a speed of 1 m/sec together with the possibility of maneuvering on the airship.
- A. Severo in 1902, who died in the explosion of PAX, the first semi-rigid airship, while Major *Cipriano Jardim* in Portugal, presented a report on his airship to the *Academia das Ciencias* in 1885, a model that managed to fly.
- Airships also played a vital role in the successes and failures of polar explorations such as those of Amundsen (1926) and Nobile (1928).

But undoubtedly one of the most important breakthroughs is due to Count Ferdinand Count von Zeppelin; he was born on July 8, 1830, in Constance (Prussia) and died on March 8, 1917, in Berlin. He studied Mechanical engineering, Chemistry, and Politics at the Stuttgart Polytechnic, the War College in Ludwigsburg, and the University of Tübingen. Having joined the Wurttemberg Army, he became a cavalry officer in 1858, subsequently undertaking military studies in Austria, Italy, France, Belgium, and England (Kirshner, 1957).

Ferdinand von Zeppelin's ancestors were distinguished by very different characteristics. On his mother's side, he descended from The *Macaires* who were Huguenot refugees who were found there, after the violent expulsion, settling mainly in Geneva-Switzerland. Among them, we find some representatives who had an exceptionally fine sense for progress, who possessed above-average manual skills, who learned to think economically at an early age, who possessed excellent organizational gifts, and who often possessed a conspicuous artistic streak. Many of them were sensitive and very close to nature (Bélafi, 1990).

> During the American Civil War, von Zeppelin served as a military observer with the union troops and there he saw how balloons were used for reconnaissance purposes. About his participation, it is stated that although, Zeppelin did not express himself about airship travel before. His experience in America served him as a connection for the later development of airships (Bélafi, 1990, p. 64).

Zeppelin served in the Austro-Prussian wars in 1866, in the Franco-Prussian war in 1870-71, and at home. In 1887 he became commander and in 1890 brigadier commander in Saarburg. He was also at that time in command of a dragoon regiment in Ulm and "understood the far-sighted concerns about the importance of generating ways to improve information and the use of devices for warfare: the problem of the airship must have preoccupied him long before even the year 1874" (Bélafi, 1990, p. 65). After his retirement, together with Theodor Kober (1865-1930), he concentrated on the construction of an airship, which he accomplished around 1873.

In the years 1892-1893 he designed a rigid airship, which was rejected by a military commission that saw no specific military application for it. In 1892, the Count began detailed work on the design of his airship. Working for him in his Stuttgart office was engineer Theodor Gross (who had come from Daimler), but he soon left again. With Kober (formerly of *Ballorifabrik Riedinger*), he got a capable employee. In two years of construction work, his project took shape - a task for which there was hardly any technical foundation. In 1895 the count sent another project to Chief of Staff Karl von Einem (1853-1934), which was also rejected. As early as July 1894, a commission issued a verdict, based on the opinions of a certain Captain Michaelis and the Berlin professor Heinrich Müller-Breslau (1851-1925), who condemned the design for lack of strength and then for insufficient speed. Count Zeppelin reacted stubbornly and despite a new meeting of the commission and an immediate response from His Imperial Majesty, little changed (Anmerkungen, 2005).

In 1898, he founded the 'Society for the Promotion of Airship Navigation' with a capital of 800,000 marks, to which he contributed more than half of the funds. In cooperation with Kober and Ludwig Dürr (1878-1956), he built the first rigid Airship LZ1 (z for Zeppelin), which was launched in 1900 on July 2. Later the LZ4, which had been destroyed by an explosion and appealing for donations in 1908, got the foundation of the 'Zeppelin Airship Navigation Company' in Friedrichshafen. Between 1910 and 1914 many flights were carried out over Germany, including the civil Airship service called *Schwaben* with an average speed of 76 km/h and with a payload of 6.5 tons.

Zeppelin built other airships and large aircraft in Staaken (now part of Berlin), mainly for the army. His closest co-worker was later Hugo-Eckener from 1905. In turn, the airships were used in World War I and to undertake trips across the Atlantic and the world. In August 1929, the Graf-Zeppelin made its first round-the-world trip. After its commercial exploration, its construction declined and the Hindenburg disaster in May 1937, after 63 flights, put an end to production.

The Hindenburg catastrophe is studied as a case study of tissue flammability by Dilisi (2017). The objective was to examine the outer skin of the ship and decide whether or not it was the fuel source that caused the catastrophe. To do this, they performed a basic vertical flame test with students from an introductory-level university laboratory. The test was based on the protocol established by the American Society for Testing and Materials (ASTM) for determining the flammability of textiles. The 80th anniversary of the Hindenburg disaster presents a compelling case study that provides great opportunities for teaching the physics of flammability, as only careful measurements of time, distance, and weight are needed.

However, these new aerostats failed and could not have had a better impact. In 1909, 119 airships were built and named in his honor Zeppelins. During World War I they were used to bomb Brussels, Paris, London, and Bucharest. Below, are the airships manufactured as of 1913:

Table 1

Number of airships in different countries in 1913

Countries	Civil	Military	Total
Germany	15	9	24
France	14	3	17
Russia	14	-	14
Italy	10	1	11
England	5	2	7
Austria	3	1	4

Source: Karataev et al. (2018, p. 1163).

"This development was countered by lightweight zeppelins, called height climbers, which were able to reach altitudes of 20,000 feet. The height climbers represented special perils for their crews, however, because parachutes were banned as excess weight" (Irons-Georges, 2002, p. 796).

Social Impact of Zeppelins

In historical discourse, the word ingenuity has been associated almost exclusively with the concept of '*weapon*' and has been related to military science since ancient times. For example, in Herodotus as in Thucydides, the referents vary from more generic meanings such as means of warfare to more specific objects related to artillery elements. This quasi-absolute association of mechanics with the universe of war is not justified by a codification of historical discourse. Rather, its reason is based on an economic-military matrix that was imposed even from the 5th century B. C. In this context, the most important phase of a warlike confrontation was the encirclement of fortified cities, since the existence of means to penetrate spaces of this type was nonexistent and armies maintained indefinitely the same positions on the ground without significant advances without being able to advance, due to the resources involved in their maintenance (Aristotle, 1936; Garlan, 1974).

Technology has a great influence on strategy, since what can be done technically determines the options open to the strategist. Early aviation theorists may have dreamed of defeating an enemy using air power alone. Speculation that bombing would destroy the morale of the enemy civilian population had captured the popular imagination and, in 1908, H. G Wells published his book *War in the Air*. In this book, he imagined fleets of dirigibles and free planes to roam and bomb and described a German Zeppelin raid over New York, which brought the United States to the brink of collapse. The description of aircraft and weapons technology in the period from 1914 to 1918 clearly shows that such ideas were, at that time if not outlandish, at least had an impact on the imagination that could be summarized in two aspects: fear and progress (Grattan, 2009, p. 61).

The sociology of expectations had a broad impact on the imaginary and possibilities of zeppelins in Germany and their possibilities in the military field. Zeppelins contribute as an imaginary phenomenon to the motivation for a positive expectation for change to improve people's conditions. One of these aspects was sought by the zeppelins not only at the military level but also for civilian use. Kühne (2012) states that the use of zeppelins served as a tool to strengthen a historical discourse, about the union of *Germaneness* and progress.

For example, as Kay (2014) states, the girls studied war maps, daily troop positions, and the latest battleships and submarines. They were also encouraged to write essays and diaries about the war experience. Is it surprising, then, that the girls expressed an intense desire for revenge against the enemy? As one thirteen-year-old writer put it: "Everyone hopes that a Zeppelin will fly over

England as soon as possible because the hatred for our cousins across the Channel is at its worst. When our brave troops kill them, the shouts of victory are doubly noisy" (p. 9).

What actions triggered these conceptions and for what reason? These and others are questions that could be answered in more detail by integrating the scientific literature on futures and expectations into research on this topic. Regarding the use of zeppelins for civil transport, the following account by Hiam (2014) expresses these expectations:

> Margaret G. Mather, an American who was in Europe and wanted to return home, thinking of buying a ticket to New York. Although an experienced air traveler, she remembered her **strange reluctance** to make the purchase but then considered the alternative, which was to cross the Atlantic on increasingly luxurious steamers, whose sumptuous comfort and entertainment meant little to a sea-sick wretch. (p. 1)

As Higham et al. (2014, as cited by Faulkner, 2012) point out, the emergence of aviation divided the world into rich and poor. Few nations could maintain significant civil and military aviation institutions. Aviation played a key role in Hitler's foreign policy, aided by skillful disinformation campaigns that increased the French perception of their technological and numerical inferiority. Such was Zeppelin's success and recognition that one of the *Kriegsmarine*'s most important aircraft carriers, the Graf Zeppelin, attracted considerable interest over the decades. "Such recognition of its importance in the development of military technology is expressed in this aspect, even taking into account its already limited range" (p. 492).

Methodological approach

Concerning the methodological approach, it is expected that this research will be carried out based on a qualitative paradigm with a historical and explanatory type of research, taking into account that the research intends to be supported by the interpretation of key documents of the development of the subject that allows sustaining as a fundamental idea, the ignorance of the scientific and inventor activities of Carlos Alban and Lourenço de Gusmão (1685-1724) who, from the work, got a partial recognition of their contributions, especially on the field of aeronautics; and on the other hand, to analyze how the political decisions directly affect the scientific development of our country, in a specific context. In terms of Colombian patents, the performance is not the most adequate either, as will be seen below.

Through the analysis of patents (between 1968 and September 2007), it will be possible to assess patenting activity, either by Colombian inventors or by Colombian organizations, as recorded in the database of the Colombian Patent Office and Trademark Office, Colombian organizations, as registered in the database of the United States Patent and Trademark Office (USPTO), in the European Patent Database (ESPACENET), and the Intellectual Property Office (WIPO). "In the United States 59 percent, in Europe 16 percent, and internationally 26 percent" (Sánchez et al., 2007, pp. 254-255).

The archives sources were: archive National Library of Portugal Lisbon; archive Municipal Library of Evora; archive Library Coimbra University; archive Library Porto University. About Francisco José Carlos Albán Estupiñan. Fund General Carlos Albán, Universidad del Cauca.

Table 2

References about Carlos Alban and his aerostat - Fund Carlos Alban Universidad del Cauca

Charles Claudel. A handwritten letter in French sent by the student of pharmacy Charles Claudel in which he communicates to Mr. Carlos Alban that he has known by an article published in a French newspaper that Mr. Alban is a balloon manufacturer for which Mr. Claudel offers his help in France since he has worked in the office of aerostats could be useful to him. The document also has a horizontal manuscript in one of its folios of very difficult reading. Folio: 2. Provenance: Paris. Date: February 20, 1891. Remarks: Original manuscript in French.	Francisco José Carlos. Letter sent by Carlos Alban to the editors of the newspaper Cosmos in Paris; in this letter he responds to an article published in the number 180 in which it is affirmed that it is not possible to create a steel balloon that can float because it will be crushed by the pressure of the atmosphere. In the paper, Carlos Alban states his theory; "without the blister of the pre-pneumatic machine, by placing an auxiliary casing provided with a small valve that closes when released without leaving the aisle after the vacuum has been performed: the casing will not be crushed. Similarly, place the barometric vacuum	Letter sent by Carlos Alban to Gen. Rafael Reyes in which he congratulates him for having recently arrived at the ministry of development, and tells him about the matter of the metallic balloons that have already been dealt with. He comments that in the newspaper 'Anunciador' of New York last December 12 has been published the news that the scientific engineer Mr. Bossuet has gone there to give a lecture on the construction of such balloons. Alban says that he has already written to the newspaper rectifying that judgment and sending papers dealing with his invention. He asks Reyes to help him with a question that more than personal, is ofpatriotic honor.	Letter sent by Carlos Alban to Julio R Delgado in which he thanks him for sending Cerrito's notebook, that it is evident that this rascal has obtained a favorable ruling from Spain, but that this does not suppose that the terms are very burdensome for Colombia. He also thanks him for sending the Italian newspapers relative to the jubilee of Leon XIII for all this he sees that he has not forgotten his overseas friend and for this reason, he is encouraged to importune with his question of the metallic balloons. He encloses a paragraph clipped from the newspaper	Document in which Carlos Alban, before Vicente Mosque, notary public of the circuit of Popayan confers and grants special broad and sufficient power to Mr. Don Felipe del Castillo, a native of the State of Cauca and resident in Paris, so that in the form in which it is necessary and representing, with the legal obligations the person and rights of the grantor request and obtain from the French government and any other government of Europe, privilege of property or those that there are used to grant to exploit some new	The package contains documents related to the invention of hot air balloons made of metals by Carlos Alban. There is a copy of an engraving of the airship in which some conventions can be read. Also found are 3 copies of a memoir on the use of metal envelopes for hot air balloons, the document contains an explanation made by Carlos Alban on how a structure made from metal plates can be made to fly; "knowing that one cubic meter of air at 0° weighs 1. 3 K, the 125 cubic meters of hydrogen can lift a weight of 125 x 1.3 K = 162.5 K of which, subtracting 150 kilograms of envelope weight, leaves twelve and a	Letter sent by Carlos Alban to Pedro del Castillo who is in Paris. In it, Carlos Alban talks about the matter of the discovered balloons, of which he has already spoken in other letters, and warns that these ideas can be very useful to the progress and reputation of our country. In the document, Carlos Alban tells Pedro del Castillo that Mr. Diego Caicedo travels to Paris and with him sends him a power of attorney to do him the favor of applying for the privilege, both in France and in other nearby nations. Alban adds that the balloons with metallic covers and

	cleaner in a thin-walled tube and it will not break either. The pressure is balanced in all directions and at all points". He further adds that the idea of metallic balloons has belonged to him since 1883 and that he has just obtained a patent which he encloses and begs to publish. Folio: 1. Provenance: Popayan. Date: January 1, 1889. Remarks: Original manuscript in French.	Alban says that it seems to him pitiful in that office they have not given him a course to the request that he made on the privilege of these balloons, which was published in the official newspaper N° 6958 of February 18, 1887, and it has not been published again. He asks him to do what is necessary to obtain the privilege and to carry it as a matter of his own. In another matter, he tells him that until when the government will see with indifference the matters with Ecuador, which are not good to neglect for what he recommends naming a general consul in Quito, for which he recommends Mr. José Ignacio Delgado. Finally, he speaks to him about the exportation of the conspirators and that it is suspended by the lifting of the banishment. Folio: 2. Provenance: Popayan. Date: February 29, 1888. Remarks: Original manuscript.	the New York Advertiser of December 12 last in which he says that the Yankees will shape the invention as his own, which is a lie, and adds that he has not been able to get the patent even in Colombia. Alban has already written to the newspaper claiming his rights but begs him not to forget the question of the privilege there. Alban encloses the application for the privilege published in the official newspaper and an article from the Noveau Monde in which the matter is discussed. He reminds him that as long as he does not have the privilege granted in Europe, he will have many problems and asks him not to forget the matter. Finally, he speaks to him of the political questions that continue has raised	applications and scientific grantor. Especially first: the privilege to manufacture and sell hot-air balloons with a metallic cover whose envelope is formed, not of cloth, as is used today, but of thin sheets of steel, copper, or other suitable metal, and second; the privilege to manufacture and sell an optical instrument which he has called a polymeter, because it will serve to measure heights, densities, and distances, having as its basis an elastic lens formed by a liquid enclosed between two transparent and dilatable partitions. The grantor declares that he approves and considers well done what Mr. Castillo does in use of this power of attorney,	half kilograms of lift force for a the lower price, its great resistance, safety against fire, facility to take various forms and greater means of direction in the air. Finally, there is a power of attorney granted before the notary public, Vicente Mosque by Carlos Alban using which he confers the special broad and sufficient power to Don Pedro Felipe del Castillo, resident in Paris, to represent him in requesting and obtaining from the French government and any other European government the privilege of ownership or what it is customary to grant for the exploitation of some new industrial applications and scientific discoveries of Carlos Alban: first a privilege to manufacture and sell hot air balloons of metallic cover whose envelope. And second to	not of cloth are a fact and can be a good business, finally, he speaks to him about a polymeter that he lacks to build his apparatus and that Mr. Caicedo must obtain in France. Folio: 2. Provenance: Popayan. Date: June 25, 1884. Observations: Original manuscript.

	by the perhaps inopportune beneficence of General Payan, which has begun to agitate with violence, but with the return of Mr. Núñez, calm has returned. Folio: 2. Provenance: Popayan. Date: March 4, 1888. Provenance: Original manuscript. Remarks: Original manuscript.	authorizing him to substitute it for Mr. José María Torres Caicedo or any other person of his confidence. The registration fee was paid, etc. Page: 3. Provenance: Popayan. Date: August 14, 1888-August 28, 1888. Remarks: Original manuscript.	and advantages of a metallic envelope for balloons are; its sell an optical instrument called a 'polymeter' that will serve to measure the height, densities, and distances, having as its basis an elastic formed by a liquid enclosed between two transparent and dilatable partitions. Folio: 5. Provenance: Popayan, Date: October 1884 - August 11, 1883. Remarks: Original manuscript.

Source: Own construction based on the Archive of Universidad del Cauca, Fund Carlos Alban.

Testimonies of the demonstrations and claims of the priority of the invention of the hot air balloon by the father of Gusmão can be found at:

Table 3

Sources of possible observations of the apparatus of Bartolomeu Lourenço de Gusmão

Salvador Antonio Ferreira, Portuguese Chronicler of the XVIII century (Códice Ms. da Biblioteca Municipal Porto, No. 15 from the collection of the Conde Azevedo).	Francisco Leitão Ferreira, member of the Royal Academy of Portugal, in the text of *Ephemeride historial, chronologica luzitana, na qual por dias e annos se referem varios sucessos historicos, e memoraveis acontecidos em Portugal, e nas suas conquistas com outras memorias notaveis a este gloriozo dominio pertencentes*. - [S.l.] **:** [s.n.], [16--] . - 2 vol.; 12º (22 cm). Enc. em pergaminho com atilhos. Rivara, tomo III, p. 82º vol.: [419] f. (Ms. From the Biblioteca Municipal de Évora.	Cardenal Conti (Nuncio in Lisbon from 1694 to 1710, elected Pope in 1721, under the name of Innocent XIII.). Letter to the Cardinal Secretary of State (Foglietta di avvisi, t. 67 *da Nunziatura di Portogallo, dos Arquivos do Vaticano).*	José Soares da Silva, member of the Royal Academy of Portugal, Gazeta em Forma de Diario (ms. From the *Biblioteca Nacional de Lisboa*)	Anónimo-Do. *From Códice 537*, *Biblioteca Universidad de Coimbra*, the author being a detractor of Gusmão.	Marquês de Fontes, Ambassador of Portugal to the Vatican. *Relato acerca do Memorial e da Estampa da Pasarola,* de 1709, which is included in the work of Pier Jacopo Martellol. Versi e Prosa, 1720, pp. 375-377 del Vol. V.	F. Freire De Carvalho. *Memoria que tem por ojecto revindicar para a nacão Portuguesa a Gloria da Invencão das Machinas aerostaticas.* Lisboa, 1843.	A. Filipe Simões. *A invençao dos Aerostatos Reivindicada,* Evora, 1868.	Gustavo T. Correia Neves. *As experiencias Aerostáticas de Bartholomeu Lourenço de Gusmão*. Lisboa, 1911.	Jaime Cortesão, *Alexandre de Gusmão e o Tratado de Madrid (1750), 1ª parte, t. I, e 2ª parte, t. II. Río, 1950-1952.*	Abrangem tres sermoes, breves memórias cientificas, relativas aos aparelhos que inventou, e dissertacoes, que podem ver-se na integra *em Obras diversas de B. L. G. (with critical study of A. de Tauney). SP., s/d (1934).*	Barbosa Machado, 455-456; Inocencio I, 332-334, VIII, 362-363.	Faria, Visconde. *Reproduction fac-similé d'un dessin à la plume de sa description et de la pétition adressée au jean v. (de Portugal) en langue latine et en écriture contemporaine (1709) retrouvés récemment dans les archives du Vatican*. - [s.l. : s.n.], 1917 (Lausanne : impr. réunies s. a.. - 17 p. : il. ; 29 cm).

Source: Own construction on based archive National Library of Portugal Lisbon; archive Municipal Library of Evora; archive Library Coimbra University; archive Library Porto University.

Bartolomeu Lourenço de Gusmão, o 'voador'

Bartolomeu Lourenço de Gusmão o 'voador': inventor of the hot air aerostat was born in Santos, Brazil, baptized on December 19, 1685, and died in Toledo, Spain on November 19, 1724. He was educated in the seminary of Belem (Baía), where the Jesuit Alexandre de Gusmão was *rector*, from whom he took his surname (in the same way as his brother, who later became a diplomat). According to Serrão (2011)

> Son of Francisco Lourenço and D. María Álvarez, he was born in Santos (Brazil), probably at the end of 1685, and was baptized on December 19, 1685. He studied at the seminary of Belém (Baía) of the Society of Jesus under the guidance of Father Alexandre de Gusmão, whose surname, as it turned out, he had adopted. (p. 184)

He became a novice in the Society of Jesus, which he left in 1701, and traveled to Portugal where he became known for his ingenuity and prodigious memory. Returning to Brazil, "he invented a process to *«make the water rise to any desired height»*, which was put into practice in the seminary of Belém before 1706" (Serrão, 2011, p. 184). He was ordained a priest and is then listed as enrolled in the Faculty of Cânones of Coimbra on December 1708. However, he interrupted his studies, probably because of the «Passarola»**.** "In early 1709, he presented to D. João V a claim of privilege for your «máquina de andar pelo ar»" (Serrão, 2011, p. 184). The official experiments were held between August 5 and 8, 1709, at the House of India, with the presidency of the sovereigns, two infants, and the *Nuncio Conti* (later Pope Innocent XIII). With respect to the tests:

i. The first test failed when the device burned out before it moved. On August 5, 1709, in the *Sala de Paso*, and the presence of D. João V, he tried to raise a paper balloon that had on it an opening with a small boat with an igneous focus, but the balloon burned.
ii. The second was successful with a rise of the balloon to about 4.5 meters which ended the intervention of the servants wary of the possible spread of a fire.
iii. The third was successfully held outdoors (October 1709), in the courtyard adjacent to the same facilities. However, the ball ended up catching fire when it crashed into a *cimacio*. It probably occurred at the India House on October 3; the device was launched from the bridge of the house.

Regarding the balloon: "Tratar-seria de modelos de aerostáto com a configuração de uma calote esférica ou em concha alongada, constituida por material leve -papel armado- sobreposto a um recipiente com combustivel a arder" (OLX, Portugal, s.d., p. 1400).

The king certainly granted the requested privilege on April 19, 1709. At this same moment, Gusmão redirected the «Manifesto sumário para os que ignoram poder-se navegar pelo elemento do Ar», trying to show with many arguments the possibility of this aeronautical development. The father counted on Marquês de Fontes for the development of his machine. The development of the machine became known and the father created an expectation around it with engravings and drawings of his flying machine. Today it is already known that these engravings are a mystification of the apparatus to divert the attention of the curious. The known sources do not give a clear idea of what the airship would look like; simply a hot air balloon, judging by the experiments carried out shortly after. Gusmão: *«pos por obra nao logo principal invento, mas uma amostra»* (as quoted in Serrão, 2011, p. 184).

The lack of enthusiasm of the public caused a lack of follow-up to these experiences. An atmosphere of discredit was generated, which, however, was not enough to prevent the unleashing of a mythologizing image of the machine that was originally composed for camouflage purposes, which became known as the «Passarola».

The priest continued to enjoy the confidence of the court, presenting in fact, in 1810, another invention designed to prevent the escape of water from ships. He was also in northern Europe from 1713 to 1716, the year he re-enrolled in the Faculty of Cânones of Coimbra, doctorate on June 16, 1720. Presented to the court, he was sent to Rome to negotiate and was appointed academician of the *Academia Real da História* on December 22, 1720, an institution that was recently founded.

The young Brazilian priest had invented an aerostat in a rudimentary form. In the second half of the 18th century, the idea spread - later accepted by several authors - that Father Gusmão himself would manage to make an ascent in the machine he built for this purpose. This is a legend since the sources of his time seem to support the fact that the experiences have not been fully demonstrated continuously and that some of them, in part, have been considered a failure are key facts for the assessment of his work.

However, he was not disinterested in technical and scientific matters and in 1710 he published a booklet on «varios modos de esgotar sim gente as naus que fazem aguas». In 1713, he left for Holland with the hope of realizing some projects, clinging to his dream of flying. He returned to Portugal in 1716 and continued with his studies, which he finished in 1720 with the degrees of bachelor, *licenciado* and doctor, enjoying great prestige as a preacher and man of letters in front of the *Academia Real de Historia de Portugal*. He was then nominated academic and D. João V, continued giving other possibilities in his court, as proof of his esteem, "colocou-o na Secretaria de Estado, fé-lo Fidalgo-capelão da casa real e concedou-lhe importantes rendimientos no Brasil" (Serrão, 2011, p. 185).

Commissioned by the Academy to write in Portuguese a history of the *ovispado* of Porto, he carried out research showing a critical spirit. However, technical inventions continued to attract his attention and he focused on making charcoal from clay and bushes in 1724 he obtained from the king a privilege related to "máquina ou modo de moer" (Serrão, 2011, p. 185), which was intended to increase the performance of hydraulic mills and sugar mills. He had never been so favored by the monarch to the point that it was said that: "tinha em palácio porta franca e mesa pronto" (p. 185) (he had a free door in the palace and a table ready).

On September 26, 1724, he fled quickly from Lisbon to Spain in the company of his brother Fr. João Álvarez de Santa Maria. He became ill during the trip and died in the Hospital de la Misericordia in Toledo, on November 18 or 19, 1724.

His flight is apparently due to fear of the Inquisition since his name appears shortly before involved in a complicated story of witchcraft. After this, it is known by the testimony of his brother that Gusmão will adhere to Judaism since 1722. In 1724, after leaving Lisbon, it seems that he revealed ideas of a megalomaniac and attributed frightening ideas to his flying machine. During his escape, he seems to have gone through a religious crisis amid delusions provoked by his illness.

Francisco José Carlos Albán Estupiñán 'El Loco'

According to Piñeros (1936), one of the first demonstrations of balloon ascension in our country took place in Colombia, thanks to José María Flórez (1820-1848), on June 12, 1893. The city: Popayan (Cauca). About seven o'clock in the morning the aeronaut appeared on the patio of the Local Seminary, where there was already a multitude waiting and where the religious body and the civil population stood out and crowded around the apparatus that was anchored to a trapeze of the plank. After a blessing, the Argentinian entered the basket and then the balloon slowly detached until it reached a height of 400 meters where it stopped. Observers followed the event and during the test saw how the navigator threw ballast without restraint and made enormous efforts to reach a higher elevation. The balloon had been broken by the wind and had diverted the fuel towards one of the fabric walls which produced a fire that finally could not be drowned. "The descent was therefore complex and the flames almost destroyed the ropes holding the upper part of the basket" (p. 11).

This story, which in space coincides with the region in which the Colombian inventor developed his work, highlights the search for steerable devices in the air and also existing experiences in the development of hot air balloons in our context. Nevertheless, it is the work of Francisco José Carlos Alban Estupiñán that will have a major influence, although unknown in the development of the same. References to him have had a greater emphasis on his history as a politician. Son of Rafael Alban and Mercedes Estupiñán, he studied at the seminary in the city of Popayan (Cauca) and later at the Universidad del Cauca, where he obtained two degrees in 1869 and 1871: the first as a doctor and the second as Doctor in Law and Political Sciences, when he presented a thesis on the Constitution of 1863, which he pointed out was excessively liberal (Velásquez-Rivera, 2002; Valencia, 2022).

Although, at first he seems to have participated in the battle of Santa Barbara in 1865, in which he served the defense of the liberal government against the conservatives, soon after he showed his sympathy for conservative ideas and founded a newspaper called *Los Principios*, which advocated the defense of conservative ideas against an excessive dominance of liberal ideas in the Constitution of Rionegro, accusing it of allowing an exacerbation in acts against life by the liberal *gamonales* to the detriment of the conservatives, a party that in practice had disappeared and which he was in charge of promoting (Velásquez-Rivera, 2002; Valencia, 2022).

The newspaper had to be closed in 1871, but later another one called *Principios Políticos-religiosos* was founded, which the help of characters associated with the possession of large portions of land in Cauca, such as Sergio Arboleda (1822-1888). Together with this and other leaders, the conservative party was reorganized, which generated a reaction in the liberal party that again forced the closure of the newspaper (Velásquez-Rivera, 2002; Valencia, 2022).

However, Alban's perspective, from the political point of view, was going to be very influenced by Catholicism and a manifest desire for the creation of a *Catholic* party, for which he had the support of the bishops of Popayan and Pasto, a task on which he focused in the years of 1875 and 1876, taking advantage of the internal struggle between radical liberals and independentists and which later served to launch the conservative party in 1876 into a war that it would eventually lose. This war, despite its misfortune, allowed an exaltation of the Catholic influence in the partisan ideology that would be taken advantage of in an alliance against the liberal party in 1885 that would end with the so-called period of *Regeneration* and *Conservative Hegemony*.

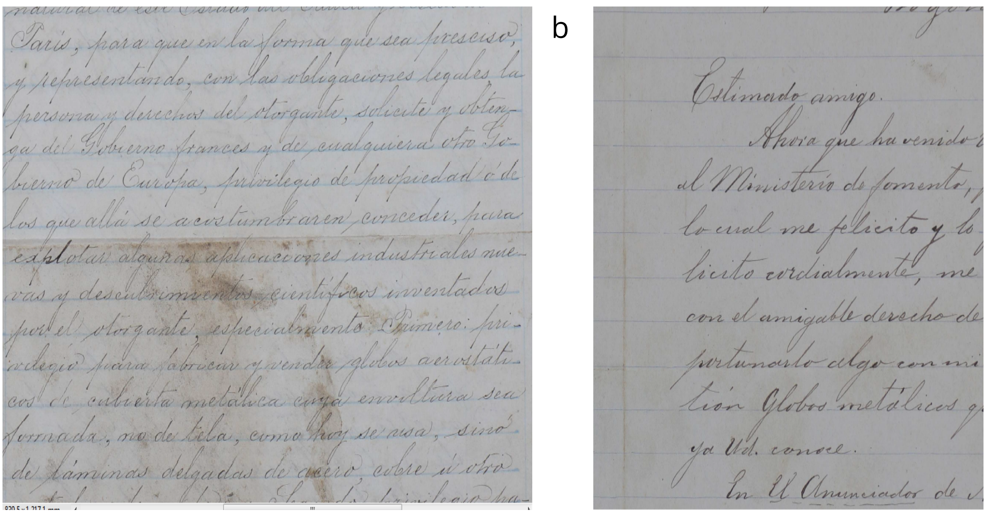
Since 1886, he served as Magistrate of the Tribunal del Centro, Attorney General of the State, joining the conservative party in one of its groups called the historical ones that opposed governments such as Miguel Antonio Caro (1845-1909) and Carlos Holguín Mallarino (1832-1894), which led Alban to be confined in the Cauca region through the Law of Horses in 1891. These traces of his political life are intertwined with his scientific gifts and hobbies, which he developed through several devices he designed and patented, such as a universal clock, a pneumobarometric pump, and an adjustable clock, the latter patented in Hamburg, which may give us an indication of its possible relationship with Zeppelin (Velásquez-Rivera, 2002). It should be noted that, for the development of the latter, he would likely have known the work of Fleming Sandford (1827-1915), published in French *Temps terrestre - Memóires,* which is located in the Carlos Alban Fund.

Figure 2 allows us to observe a document that Carlos Albán presents to Vicente Mezquita, notary of the Popayán circuit, who confers and grants broad and sufficient special power to Mr. Felipe del Castillo, a native of the State of Cauca and resident in Paris, so that in the manner in which it is necessary, given the legal obligations of the person and rights of the grantor, request and obtains from the French government and from any other government in Europe, property privileges or those that are customarily granted there, to exploit some new applications and scientific discoveries invented by the grantor. Especially first: the privilege to manufacture and sell hot-air balloons with a metallic cover whose envelope is formed, not of cloth, as is used today, but of thin sheets of steel, copper, or other suitable metal (August 11, 1883).

Figure 2

a) Francisco José Carlos Alban Estupiñán document to Mr. Don Felipe del Castillo – August 11, 1883); b) Letter sent by Carlos Alban to General Rafael Reyes

a b


París, para que en la forma que sea preciso, y representando, con las obligaciones legales la persona y derechos del otorgante, solicite y obtenga del Gobierno frances y de cualquiera otro Gobierno de Europa, privilegio de propiedad ó de los que allá se acostumbraren conceder, para explotar algunas aplicaciones industriales nuevas y descubrimientos científicos inventados por el otorgante, especialmente: Primero: privilegio para fabricar y vender globos aerostaticos de cubierta metálica cuya envoltura sea formada, no de tela, como hoy se usa, sino de láminas delgadas de acero, cobre ú otro

Estimado amigo.
Ahora que ha venido
al Ministerio de fomento,
lo cual me felicito y lo
licito cordialmente, me
con el amigable derecho de
portunarlo algo con mi
tión Globos metálicos q
ya Ud. conoce.
En El Anunciador de

Source: Fund Carlos Alban, Universidad del Cauca.

But the main object that draws attention is the development of the aerostat described in his memoirs on the use of metal envelopes for hot air balloons, on which the following evidence is found. In this second point, in the development of the memoirs carried out in 1884 in October in principle states that from one m^3 a malleable metal such as iron or aluminum, can generate a metal surface of one (1) m^2, then you can build a cube of five (5) m^2, with a total area of 25 m^2, with a weight of 150 kg and a volume of 125 m^3. If it is known that one (1) m^3 of air at a temperature of *0 degrees Celsius* weighs 1.2 kg, then 125 m^3 of hydrogen can lift 125*1.3 kg= 162.5 kg, and subtracting from the 150 kg of the cover can have a free load of 12.5 kg.

Below, a letter sent by Carlos Alban to General Rafael Reyes in which he congratulates him for having recently arrived at the Ministry of Development, and tells him about the matter of the metallic balloons that have already been dealt with (February 29th, 1888, figure 2b). A son of the General, Daniel Bonilla Alban, a retired teacher who resided in Cali, claims that his aunt Agustina (Alban's sister), knew about the relationship between his father and von Zeppelin and that Alban had shown her the letters he received from the Prussian inventor in Popayan.

She also affirms that the design of the airship was started in Popayan and finished in Hamburg when Alban was the Colombian consul in that city. It is also supposed a friendship between both inventors that would even lead to a partnership to make the airship, which would imply a contribution in money by von Zeppelin and design by Alban. Bonilla Alban states:

> When Father returned from Colombia to intervene in the Thousand Days War, he left the designs for the airship in the hands of the Count. After he died in the ship 'El Lautaro', in a naval combat fought in Panama, my aunt Agustina received a letter in which Zeppelin announced that the invention had been a happy reality.

On the other hand, the grandson of General Alban, Jesus Bonilla Cabrera, who was a representative to the House of Representatives for Valle del Cauca, corroborates the information. Alegre Levy affirms that the crossed correspondence between von Zeppelin and Alban would be found in the hands of Eladio Valdenebro, husband of Elisa Alban, another daughter of the General, who was in Popayan.

The patent was recovered by an employee of the Ministry of Development and Industry, Abel Mazuera. Invention Patent #588. Concerning the development of patents, it is important to note that the development of patents worldwide began in the year 1474, being the first modern patent system; secondly, the British experience with patents that led to the Statute of Monopolies of 1624; and finally, the adoption by the Founders of the United States of Article I, Section 8, Clause 8 of the Constitution, together with the approval by the First Congress of the Patent Act of 1790. (See Nard and Morris, 2006, p. 225). The patent was registered as follows:

Invention Patent No. 588

Carlos Holguin,

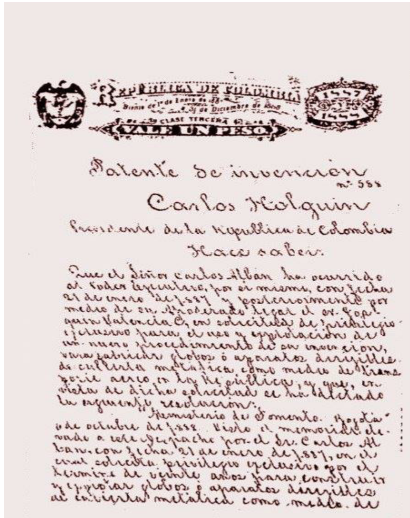
President of the Republic of Colombia hereby informs that Mr. Carlos Alban has applied to the executive power by himself, dated January 21, 1887, and subsequently through his legal representative, Mr. Joaquin Valencia C., for the exclusive privilege for the invention and exploitation of a new process of his invention to manufacture balloons or dirigible devices with metallic envelopes as a means of transportation...in the Republic and that by said application the following resolution has been issued: *"Ministry of Development. Bogota, October 6, 1888. Given the memorial presented to this office by Mr. Carlos Alban, dated January 21, 1887, in which he requests an exclusive privilege for...*"[2]

Below is a copy of the first page of the patent:

Figure 3

[2] The patent even had much longer terms than those established; for example, for the United States, where in 1790 the first U.S. Patent Act established a term of no more than 14 years, with a seven-year extension for the U.S. Patent Act of 1836 and changing to 17 years for the year 1861. (See Lester and Zhu, 2019, p. 786).

Facsimile of the invention patent granted to General Francisco José Carlos Alban Estupiñán for his invention of the dirigible in 1888. Fund Carlos Alban, Universidad del Cauca



República de Colombia
Clase tercera
Vale un peso

Patente de invención
nº 588
Carlos Holguín
Presidente de la República de Colombia
Hace saber.

Que el Señor Carlos Albán ha ocurrido al Poder Ejecutivo, por sí mismo, con fecha 21 de enero de 1887 y posteriormente por medio de su apoderado legal el Sr. [illegible] Valencia C., en solicitud de privilegio exclusivo para el uso y explotación de un nuevo procedimiento de su invención, para fabricar globos ó aparatos dirigibles de cubierta metálica, como medio de transporte aéreo en la República, y que, en vista de dicha solicitud se ha dictado la siguiente resolución:

Ministerio de Fomento. Bogotá 6 de octubre de 1888. Visto el memorial elevado a este Despacho por el Sr. Carlos Albán, con fecha 21 de enero de 1887, en el cual solicita privilegio exclusivo por el término de veinte años para construir y explotar globos ó aparatos dirigibles de cubierta metálica como medio de

One of the fundamental elements that would allow to establishment of a relationship between Zeppelin, would be given by the knowledge of the supposed letters that would give an account of this closeness, from the inquiry with the descendants of the Alban family. Even though an oral memory persists in which this possible relationship is established and there are contexts of way and place that indicate it, it is important to continue in the investigation of these elements in the family archives, both of Alban and Zeppelin, if in their archives there should be any reference or correspondence with the Colombian inventor.

Conclusions and Limitations

In the case of Alban, several of his scientific interests were focused on aspects of physics, chemistry, and the development of aeronautics. For example, he attempted the manufacture of lead chambers to obtain sulfuric acid, as well as studies on the classification of metals, and the reflection of light, which allowed him to invent a trifocal light mirror, as well as the importance of lighting from acetylene gas and the importance of the power generated by the Cauca River and its use. Many of his inventions were even patented inside and outside the country (Velásquez-Rivera, 2002; Valencia, 2022).

But one of the most important advances was generated precisely in the development of a system of metal-encased hot air balloons, which can be considered a significant advance and antecedent to the development of hot air balloons later developed by Ferdinand von Zeppelin in Europe. On the other hand, the Portuguese-Brazilian inventor developed advances in subjects such as a hydraulic pump and especially aerostatic balloons of which he made a set of tests. Unfortunately, all these experiences, although assisted by distinguished personalities of the Portuguese society of the time, were not enough for the popularization of the invention. The exaggerated capacities of the flying machine, the fire of three of the tested prototypes, the small dimensions given to the airplanes of the tested prototypes, the reduced dimensions given to the aerostats, and the little control of the same caused disappointment and bad public impression, making evident the precarious of the invention. These factors discouraged the construction of large and manned models.

The meeting points between the Colombian inventor and the Brazilian/ Portuguese inventor is based on scientific knowledge according to the time in which they developed their devices, especially about the behavior of hot gases. On the one hand, there has persisted a perspective that has mythologized the apparatus created by Bartolomeu, however, the greater presence of literature and references about his work, shows its importance as a considerable antecedent to the development of aerostatic apparatus. Proof of this is the fundamental difference that exists in the expression and pictorial production of Gusmão's apparatus, compared to its real appearance, as expressed by Fiolhais (2002), who differentiates between the *real machine* and the *mythical machine*.

In the case of the Colombian inventor, there is a generalized ignorance of his scientific works. On the other hand, it is important to recognize the knowledge he had of measurable aspects as seen in his *memoirs* based on sustained and experimentally proven physical knowledge. There is a trend if you will much more realistic, of his work, but much less disseminated because of its little or unknown influence in other contexts. The perspective that seeks to highlight his influence should be revitalized based on a complete study of the existing documentary fund and an adequate exhalation as a pioneer not only of Colombian aviation but also of the development of technology and science. This is justified in his constant search for patents that show the need for recognition of his findings not only to satisfy a personal ego but also to take advantage of them through production, as in the case of the aerostat.

In addition to this, Zeppelin himself, following the premises of one of the first aviation engineers, the Hungarian David Schwarz (1850-1897), on the use of aluminum in the construction of zeppelins, aluminum was presented as a good option to establish itself as a material of use and, the new material, highly developed for the nineteenth century, could represent the possibility of its expansive use in the aeronautical industry. Many scientists and engineers considered the use of aluminum as a much more plausible material than the use of, for example, wood, which made the structures very heavy. "Would Zeppelin be following Albán's premises in this aspect regarding the use of metals for the development of his project? At least there is a meeting point there" (De Syon, 2002, p. 21).

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Annex A

Table 4

Technical data of the Zeppelin airships (v = after enlarged conversion)

Value number	Name	Year of Construction	Sister ships	Length (m)	Max. Diameter (m)	Volume (m^3)	Number of gas cells	Number of motors	Power (Kw)	Number of propellers	Net weight (ton)	Payload (ton)	Max. Speed (Km/h)
LZ1	-	1900	-	128	12	11 300	17	2	26	4	10	1,4	28
LZ2	-	1905	LZ 3	126	12	11400	16	2	125	4	11	2,8	39
LZ3(v)	ZI	1908	-	136	12	12 500	17	2	170	4	11	2,9	44
LZ4	-	1908	LZ 5, LZ 6	136	13	15 100	17	2	160	4	13	4,7	49
LZ6(v)	*Deutschland*	1910	LZ 8 *Deutschland*	144	13	16 000	18	3	275	6	14	4,4	56
LZ7	*Deutschland*	1910	LZ 9, LZ 12	148	14	19 300	18	3	265	4	16	6,8	60
LZ10	*Schwaben*	1911	LZ 13 *Hansa*	140	14	17 800	17	3	320	4	14	6,5	75
LZ11	*Viktoria Luise*	1912	LZ 15, 16, 17 *Sachsen*, 19, 20	148	14	18 700	18	3	340	4	15	6,5	80
LZ14	LI	1912	-	158	15	22 500	18	3	370	4	14	9,4	76
LZ18	L2	1913	-	158	17	27 000	18	4	520	4	20	11,1	75
LZ21	ZVI	1913	LZ 23	148	15	20 900	17	3	400	4	16	8,8	73
LZ22	ZVII	1914	LZ 25, 27 bis 35, 37	156	15	22 100	18	3	400	4	17	9,0	74
LZ24	L3	1914	-	158	15	22 500	18	3	450	4	17	9,2	80
LZ26	ZXII	1914	LZ 39	161	16	25 000	15	3	465	3	17	12,2	82
LZ36	L9	1915	LZ 38, 41 bis 58, 60, 63	161	16	25 000	15	3	465	3	18	11,0	85

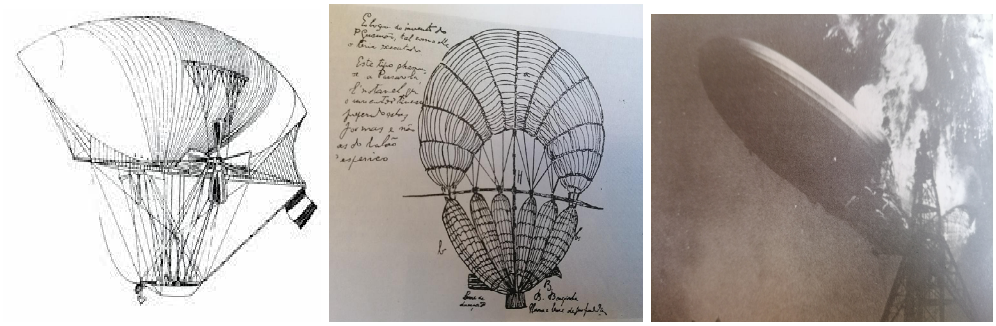
LZ40	LIO	1915	LZ61,64bis71,73, 77, 81	164	19	31900	16	4	620	4	21	16,2	96
LZ59	L20	1915	72, 74, 75, 76, 78, 79, 80, 82-90	179	19	35 800	18	4	705	4	22	17,9	95
LZ62	L30	1916	LZ 92	198	24	55 200	19	6	1060	6	34	32,5	103
LZ91	L42	1917	LZ 94	197	24	55 500	18	5	880	4	29	36	100
LZ93	L44	1917	LZ 96 bis 99	197	24	55 800	18	5	880	4	27	38	104
LZ95	L48	1917	LZ 101, 103, 105 bis 111	197	24	55 800	18	5	880	4	26	39	108
LZ100	L53	1917	LZ 104 = L 59 (Afrika-LS)	197	24	56 000	14	5	960	4	25	40	113
LZ102	L57	1917	LZ 113	226	24	68 500	16	5	880	4	28	52	103
LZ112	L70	1918	LZ *114 Dixmude*	211	24	62 200	15	7	1340	6	28	43	131
LZ113(v)	L71	1918	-	226	24	68 500	16	6	1150	6	28	51	118
LZ120	*Bodensee*	1919	LZ 121 *Nordstern*	121	19	20 000	12	4	710	3	14	9,6	133
LZ120(v)	*Bodensee*	1920	-	132	19	22 500	13	3	550	3	16	11,2	127
LZ126	ZR 3 *Los Angeles*	1924	-	201	28	70 000	14	5	1470	5	35	46	126
LZ127	*Graf Zeppelin*	1928	-	237	30	105 000	17	5	1950	5	59	60	130
LZ129	*Hindenburg*	1936	-	245	41	200 000	16	4	2650	4	119	96	137
LZ130	*Graf Zeppelin*	1938	-	245	41	200 000	16	4	2950	4	114	105	135

Source: Bücher von Kleinheins (1994, p. 265).

Contenido

Figure 4

a) Aerostatical balloon of Alban
b) Interpretative sketch of the invention of Gusmão. Longitudinal section according to the priest Himalaia
c) The Hindenburg's catastrophe



a) b) c)

Source: Fund General Carlos Alban, Universidad del Cauca. Grande Enciclopedia Portuguesa e Brasileira.

Figura 5

a) Monument to Carlos Alban. Carlos Alban Park. Popayan
b) Presentation by BLG to the "instrument for walking through the air", to the Portuguese court on August 8, 1709, in the Audience Hall of the Royal Palace (Seated, from left to right, are the Apostolic Nuncio Michelangelo Conti, King John V, and Queen Maria Ana of Austria). Painting by Bernardino de Souza Pereira, oil on canvas, 1940

Source: Paulista Museum.