

# **History of Rocketry and Astronautics**

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## **Chapter 5**

# **Le Prieur and the First Air Launched Rockets\***

**Hervé Moulin<sup>†</sup> and Philippe Jung<sup>‡</sup>**

After the first rockets were launched by the Chinese in the 10th century, only slow progress was made. Then the Englishman Congreve, and later the Frenchman Susanne made the black powder rocket, a mass-produced mobile weapon system during the 19th century. But the parallel progress of the cannon, with breach loading and with rifling of the barrel sounded the death knell for the rocket. France concluded its heavy use all around the world in 1872, seemingly the last country to do so [1] [2].

Thus it is no surprise that the rocket reappeared during the First World War in France, eventually associated with a brand new vehicle, for which this country had been the very cradle, the airplane.

Many suggestions were made during WWI, including one by the engineer Henri Guerre of Lyon, who proposed to Marshal Foch on March 31st, 1915, the use of anti-aircraft and anti-Zeppelin rockets, to protect Paris. Tests seem to have been performed on the previous March 24th, six incendiary rockets being launched to altitudes of 1,000 to 2,000 meters. Service de l'Aéronautique apparently did not follow up on this proposal.

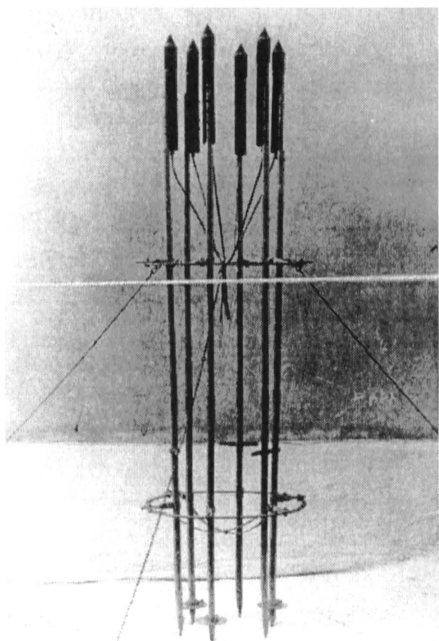
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However, this WWI use of the rocket was to be achieved, thanks to the will of a remarkable inventor, with an astonishing range of talents, Yves Le Prieur.



The Guerre System.



The Fernex-Le Prieur self-contained system, probably with Le Prieur himself.

### **Yves Le Prieur, Genius Inventor**

Born in the French city of Lorient on March 23rd, 1885, Le Prieur graduated from Ecole Navale in 1905. He left Toulon in April 1908 for a mission to Japan, where he built a glider based on drawings made by Voisin, the first company in history to have started series production of airplanes. Thus Le Prieur, although a Marine officer, performed the first towed flight in Japan of a heavier than air vehicle on December 9th, 1909. He later obtained an aircraft license on June 13th, 1917, accumulating 124 flight hours by the end of the war [3].

Back in France in 1911, he developed several aiming and navigation devices, both for marine and air applications. In parallel, he had the advanced idea for its time of mounting incendiary rockets on aircraft, the first air-to-air missiles in history, decades before they became established.

But before switching to the history of the so-called aerial torpedoes, it should be mentioned that Le Prieur, furthered the development of many additional pieces of navigation equipment (and even experiments with cinema). In addition he made two major contributions, in two widely different areas:

- in 1918 he created with Bonneau and Derrien the world's first instrument-flying device, to allow "cloud flying."
- on August 26th, 1926 he tested the very first scuba diving system he had developed with Fernez, staying 10 minutes under water without any outside connection, paving the way for the more practical aqua-lung device of Gagnan-Cousteau in 1943 [4]. He had been diving, using surface air, since 1907.

Having also worked since October 1919 as technical director of the Bréguet company (which flew the first helicopter in 1907), and after such an extraordinary career, Le Prieur died in Nice on June 2nd, 1963. The aviation community generally does not know that the same man made such significant contributions in the marine field, and vice versa.



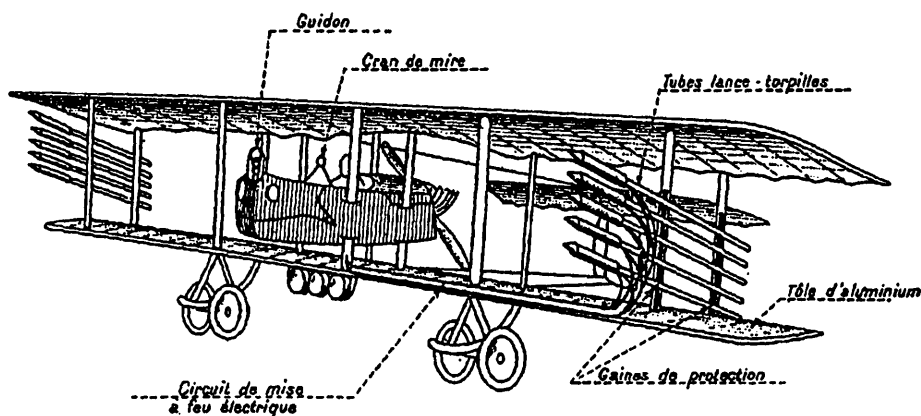
Le Prieur to the left presents his system on Nieuport fighters to French President Poincaré.

## Development of the “Le Prieur System”

Le Prieur initially proposed air-launched incendiary rockets around 1915, but the Director of Artillery rejected the idea, as “the incendiary rockets already had been studied and abandoned, due to the risks they put on the aircraft. In addition their efficacy seems uncertain” [5].

But he persisted, and succeeded. The Zeppelin raid on Paris on January 30th, 1916 must have helped, as it created some panic. He was received by Colonel Régnier, the director of Aéronautique Militaire. The latter also had been the director of Ecole de Pyrotechnie in Bourges, which had inherited the advanced rocket activities of Ecole de Pyrotechnie de Metz. Le Prieur thus was given full authority to develop what was called “torpedo-aircraft, using torpedoes of rocket type”.

No time was lost, and the first tests were made in Le Bourget and Cazaux. As early as February 24th, a demonstration was staged with a Farman MF.30, in front of President Poincard, the War Minister and the Military Governor of Paris.

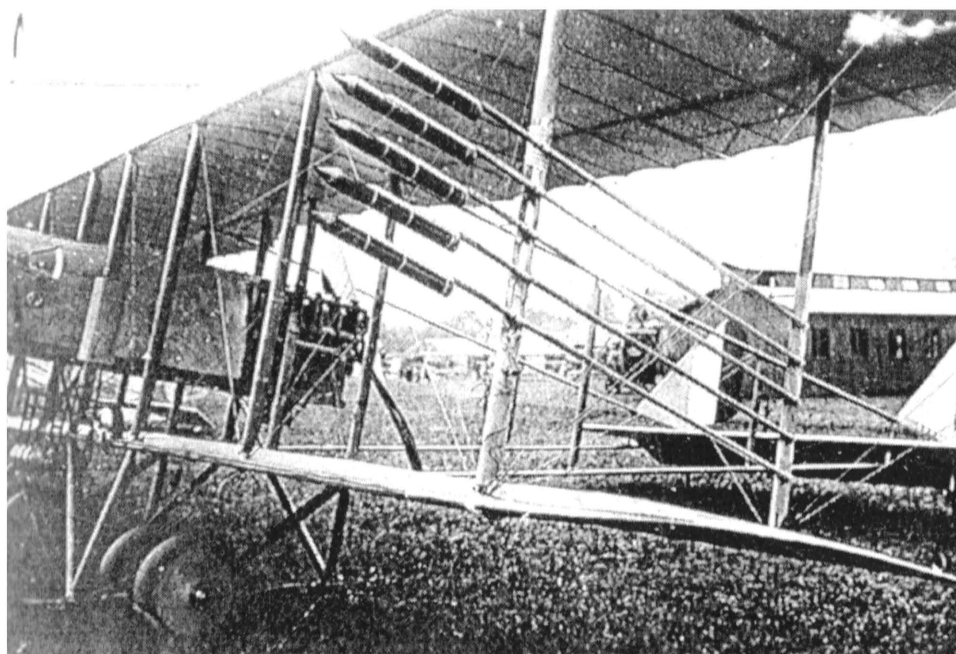


Torpedo aircraft against Zeppelin (Farman type).

Two types of rockets were used.

- Z torpedoes, against Zeppelins, launched from night-capable fighters (such as French FBA seaplanes, Caudron, the Farman MF.11 and F.40; and the British Sopwith Baby seaplanes and BE 2c).
- D torpedoes, against battlefield observation balloons (Drachen), launched from fast fighters (such as the Nieuport 11 and 16, and the SPAD 7).

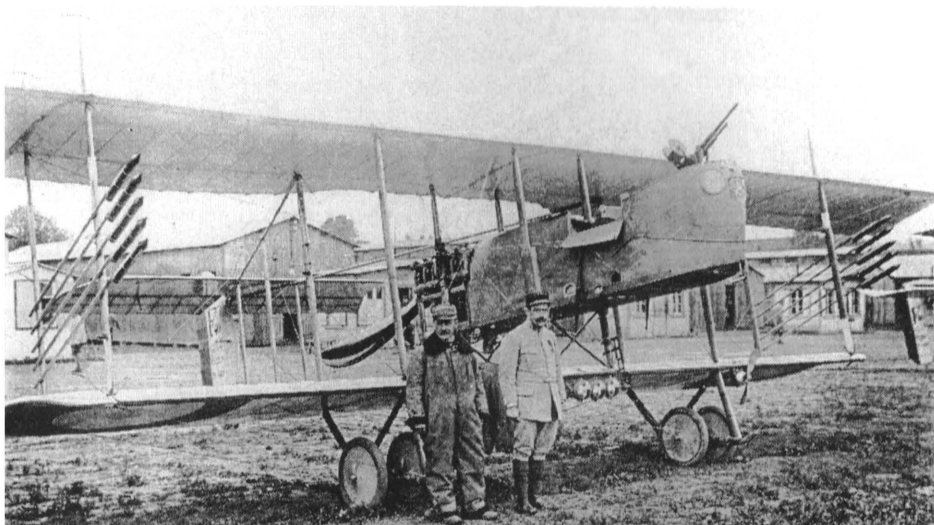
Other aircraft used were the French Nieuport 17 and 25, and the British Sopwith 1-1/2 Strutter and Pup, BE 2e, BE 12, and De Havilland DH 2.



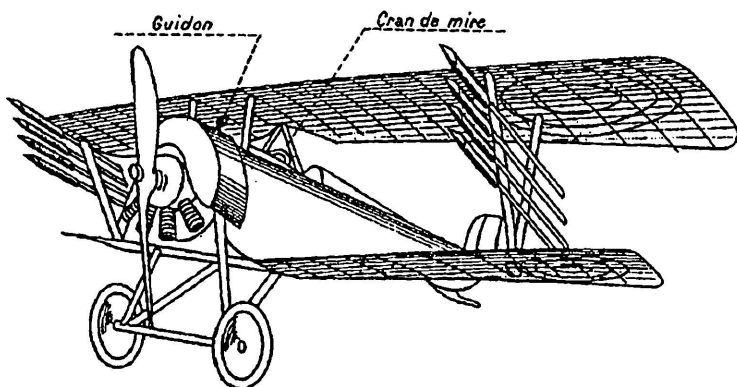
An early Farman MF.11.



Farman F.40 N° F3171 with 10 rockets.



Farman F.40 with 10 rockets.



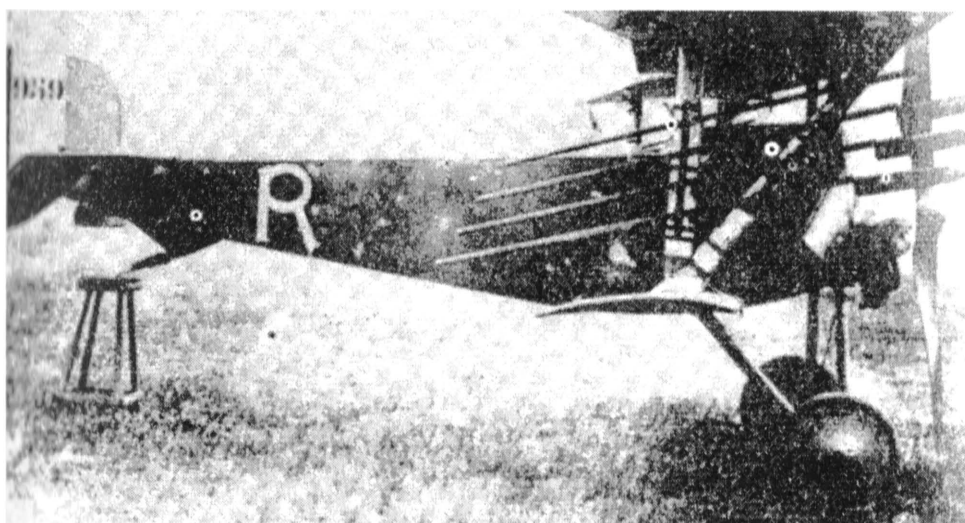
Torpedo aircraft against battlefield observation balloons (Drachen) (Nieuport type).



Le Prieur, probably with a Nieuport 11 of 80 hp.



Nieuport fighter with 8 rockets.



Nieuport 16 N°959 of 110 hp and of 13 m<sup>2</sup> wing area.

The rockets were simply inserted into tubes attached on the biplane struts by bolted straps. The tubes were about 1.5 m long, with a diameter of about 25 mm. The struts themselves were covered with protection plates made of 24 gauge steel, with 1.5 m asbestos in between. These tubes were inclined upward at an angle of 17.5.° Another 26 gauge aluminum plate was added on the lower

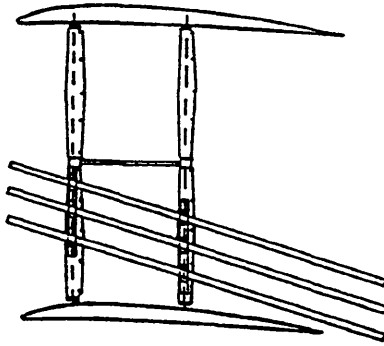
wing outer edge, to prevent the latter from being set on fire at the departure of the rocket. In the case of the Z torpedoes, 2 sets of 5 were mounted, with sometimes an additional 2 sets of 4 if intermediary struts were available. They could be fired in two salvos of 6 and 4, or 10 and 8. The D torpedoes, with 2 sets of 4, were fired in a single volley.



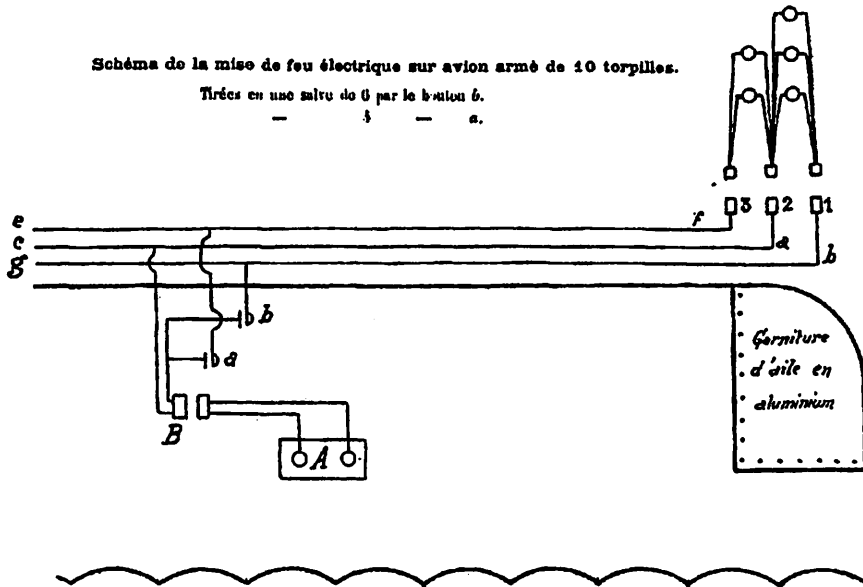
Nieuport 17 of 110 hp and 15 m<sup>2</sup> with 8 rockets.



Ensigne de Vaisseau, Georges Marie Frot, French Navy, commandant of the "Pas-de-Calais" airplane squadron, resting on the wheel of a Nieuport 17 fitted with Le Prieur rockets, possibly in Flanders, 1916 (Photo: MA 1407, Musée de l'Air, Paris).



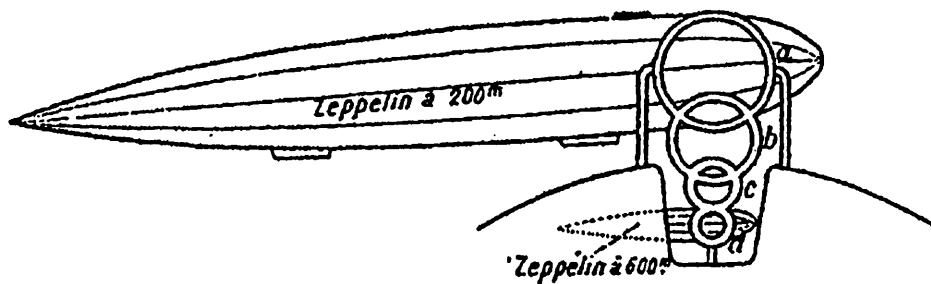
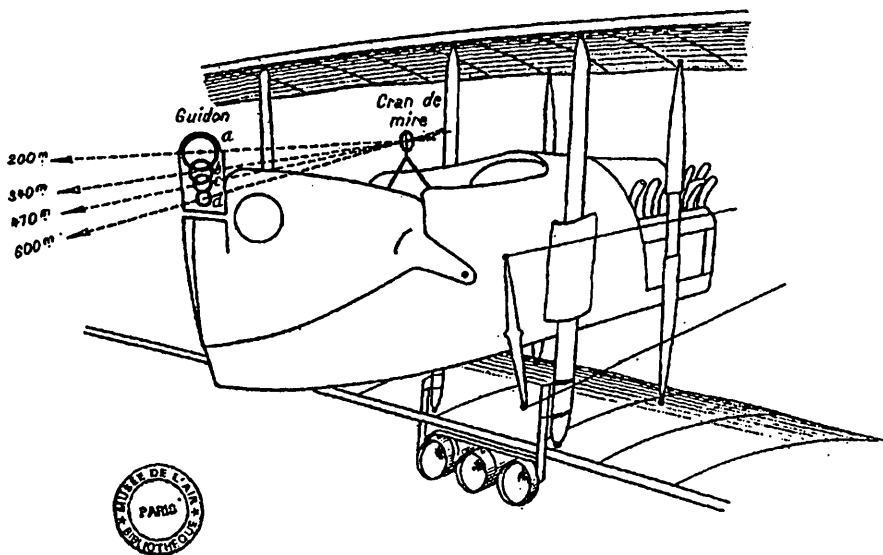
Spad 7 tube mounting, of 12 kg mass,  
as specified on October 20th, 1916 by STAé.



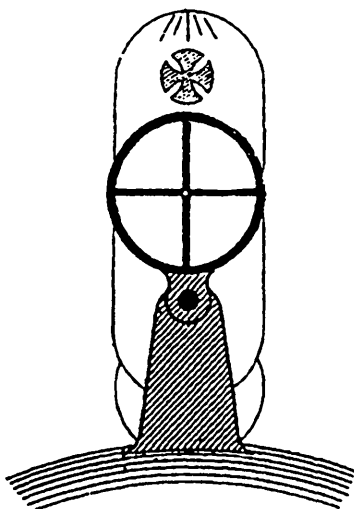
Electrical wiring for 10 rockets.

Ignition was electrical, thanks to a 2-volt Tudor BR 2 battery located in the fuselage. One or two push buttons allowed the pilot to fire an equal number of salvoes. There also was a safety pin to prevent accidental firing.

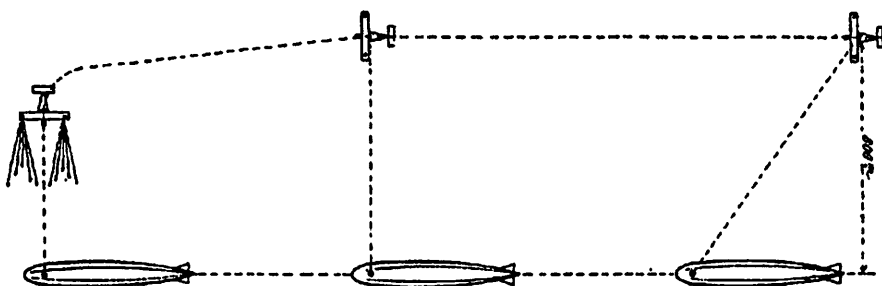
Le Prieur devised simple but ingenious aiming devices, combining a sight at the level of the pilot's eye, with a forward plate incorporating four holes corresponding to the view of a Zeppelin at varying distances (200, 340, 470 and 600 meters). The angle between the biggest (and highest) hole was  $22^\circ$  with respect to the rocket axis. For the Drachens, the device was even simpler, with a mark on the windshield and a sight on the engine cowl, corresponding to a firing distance of 120 meters. The angle with the rocket axis then was  $14^\circ$ .



The aiming system of a Farman for use against Zeppelins.



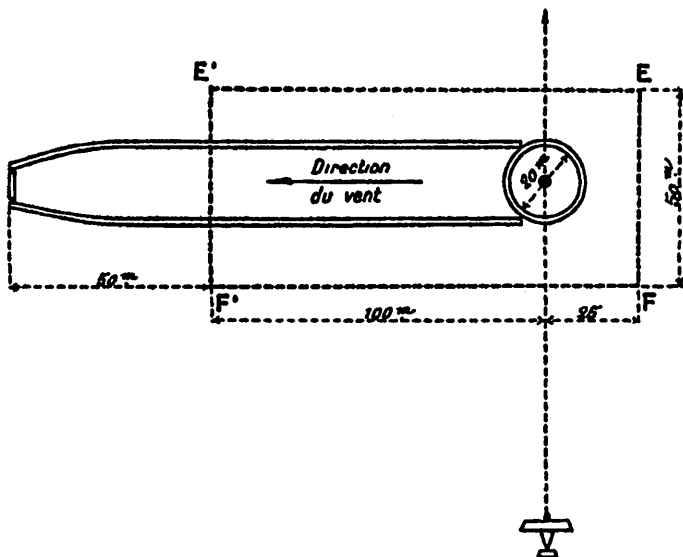
The aiming system for attacks against Drachens.



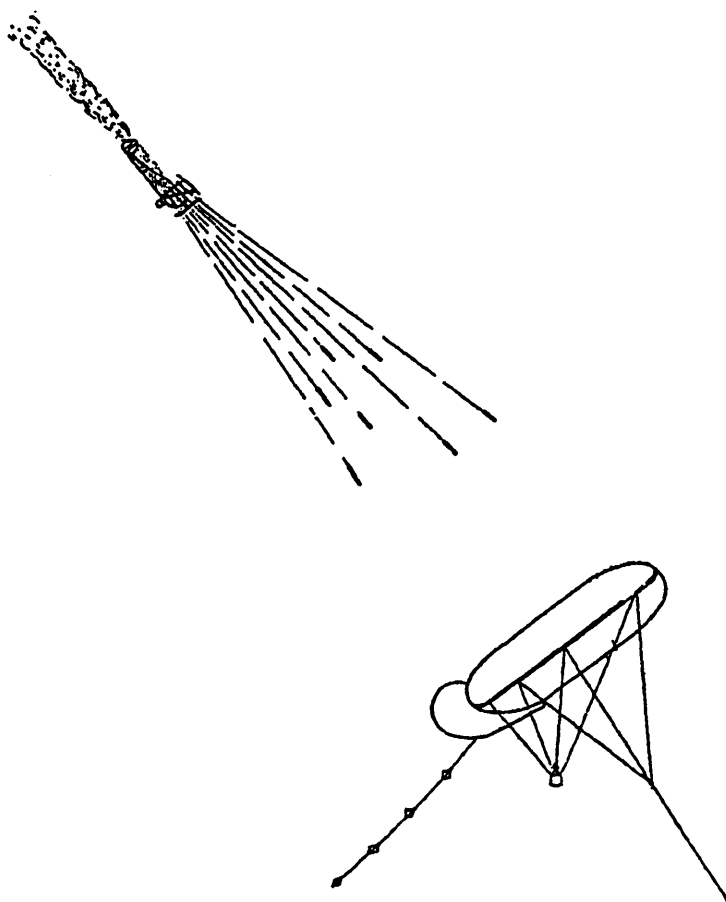
Scheme for attacks against Zeppelins.

An attack on a Zeppelin was performed by initially flying parallel to it at a distance of 800 m, and at an altitude approximately 50 m higher than the target. Astern of the nose, the fighter started converging slowly until it was 600 m away, upon which it made a 90° turn and started the launches. Acting upon the stabilizer, the pilot kept his sight on the Zeppelin nose during the whole sequence, as the rockets left with a slight delay after ignition, and did not depart simultaneously (1 second dispersion).

An interesting system was devised for training pilots, by simulating a Zeppelin on the ground. A 20 m diameter circle was drawn with plaster, or with the covers of the rocket boxes! Two 150 m long linen bands, located tangentially to the circle and in the wind direction, then represented the fuselage of the Zeppelin. Flying at 50 m height, the fighter succeeded in its attack if the rockets fell on the ground within a rectangle of 50 x 125 m.



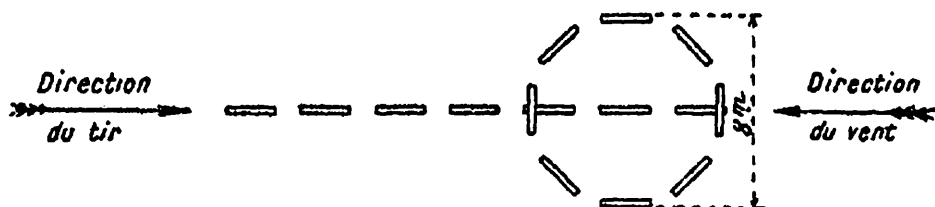
Ground training installation for Zeppelin attacks.



Scheme for attacks against Drachens.

For the Drachens, the attack was performed by diving from 500 m above, at a minimum angle of  $45^\circ$ , along the length of the balloon, and against the wind, until the sight coincided with the width of the target.

A simulation was performed by arranging covers from the rocket boxes in a 8 m diameter circle, at the end of a straight line in the wind direction. The pilot initiated his attack at 300 m; with success corresponding to ground impact within a 8 x 24 m rectangle.



Ground training installation for Drachen attacks.

## The Z Rocket

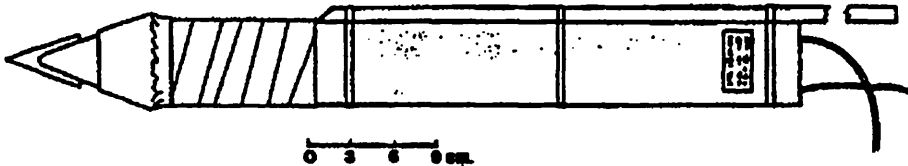
The Zeppelin rocket had a cartridge containing 200 g of Ruggieri propellant, on the side of which a 2 m stabilizing stick was mounted. The latter was made from pine and had a square section. It was attached to the rocket body by three white straps. It fitted snugly into the tubes, one part of the stick being thicker to allow a good fit. A so-called “framework”, attached at the front, housed a special aluminum-based pyrotechnic composition, and brought the body length to 50 cm. It was attached to the cartridge by paper or linen tape. To help penetration, a triangular blade was inserted into a slot of the wooden nose. The composition ignited at the end of propulsion, in case the rocket did not go through the various hydrogen bags of the Zeppelin. This started melting down the Zeppelin’s aluminum structure, thus ensuring a second ignition source. Two wires at the bottom allowed ignition. The average speed of the rocket was about 100 m/s.



The Z rocket.

## The D Rocket

The Drachen rockets were similar, except that the pyrotechnic composition was replaced by sand ballast, as the propellant was sufficient to ensure the balloon’s destruction by fire, in less than 30 seconds.



The D rocket. Color may have been red.

## The F and S Rockets

Other rockets also seem to have been developed, although they do not appear to have been put into service.

Type	Unit cost		
	July 1916	February 1917	July 1917
Exercise rocket	4.5 F		
Z rocket	)	5.6 to 6.1 F	6.8 F
D rocket	) 5.6 F	4.5 to 5.1 F	5.5 F

The S rocket, for which Section Technique de l'Aéronautique STAé issued instructions in August 1917, was tested the following October. According to a report by Captain Van den Vaero, commander of the GDE, they do not seem to be different from the other ones. They incorporated an explosive grenade between the nose and the cartridge. Two seconds after the latter had burnt out, the grenade exploded. A time fuse and its electrical contact had to be added, and the tubes modified with slits. Probably intended for attack against German twin-engined bombers, the S rockets were to be used by flying the fighter behind and lower than the target. Launch was when the full span of the wings filled the sight ring.

The F rocket was to be used against aircraft, according to a 1916 note of Lieutenant-Colonel Bares.

## Production

Le Prieur rockets were mass produced, to the total of more than 50,000, including 4,000 for exercise. In February 1917, 250 of them were being delivered daily. More than 450 launching devices were produced.

Several contracts were signed from June 1916 to July 1917, totaling 632,565 Francs. They show the cost of the launching device to be 117 F. A Farman aircraft then roughly cost 215 F.

Manufacturing by Ruggieri was not of a high standard: the firm was guilty of wrong labeling, defective packing, and a lack of inspection. Pyrotechnics officer Brichot noted damaged fuses, unreliable electrical ignitors, plus upper cones falling off when handling the rockets. The rockets were shipped in wooden or zinc boxes filled with hay. Captain Briey, Inspector of Aviation Armament, noted that, when opened, a box revealed that "the new and intact rocket, removed from a welded box, fell into pieces when taken by hand, losing its nose and ignition system. The packing hay was degraded to something similar to manure. In such conditions, it would be surprising that any pyrotechnics would be intact."

When Brichot visited Ruggieri to learn about documentation, he found that the controller, a junior officer, "simply asked the workshop manager whether there was anything new, and left two minutes later, after having declared the lot good, and accepted it without any examination."

In addition, Brichot found that storing was made in mushroom facilities, which led to an obvious deterioration of the propellant by humidity!

### Rocket Contracts

Date	Type	Quantity
28 June 1916	Exercise torpedo	1,500
4 July 1916	Exercise torpedo	2,590
	Combat rocket	480
16 February 1917	Torpedo D	23,660
	Torpedo Z	16,280
9 July 1917	Torpedo D	5,500
	Torpedo Z	1,000

### Launch System Contracts

Date	Company	Contract N°	Aircraft	Quantity
10 August 1916	Sohier et des Fontaines	-	Nieuport, Farman	79
March 1917	Sohier et des Fontaines		Torpedo aircraft	?
April 1917	Chennegros et Muller	499	Nieuport	71
8 May 1917	Chennegros et Muller	585	Spares	?
July 1917	Chauveau	1,149	Spad	147
7 July 1917	Chennegros et Muller	1,150	Sopwith	100
10 September 1917	Chennegros	1,650	Nieuport 17 & 25	50
9 November 1917	Farman	2,340	Torpedo aircraft	12

### Operational Use

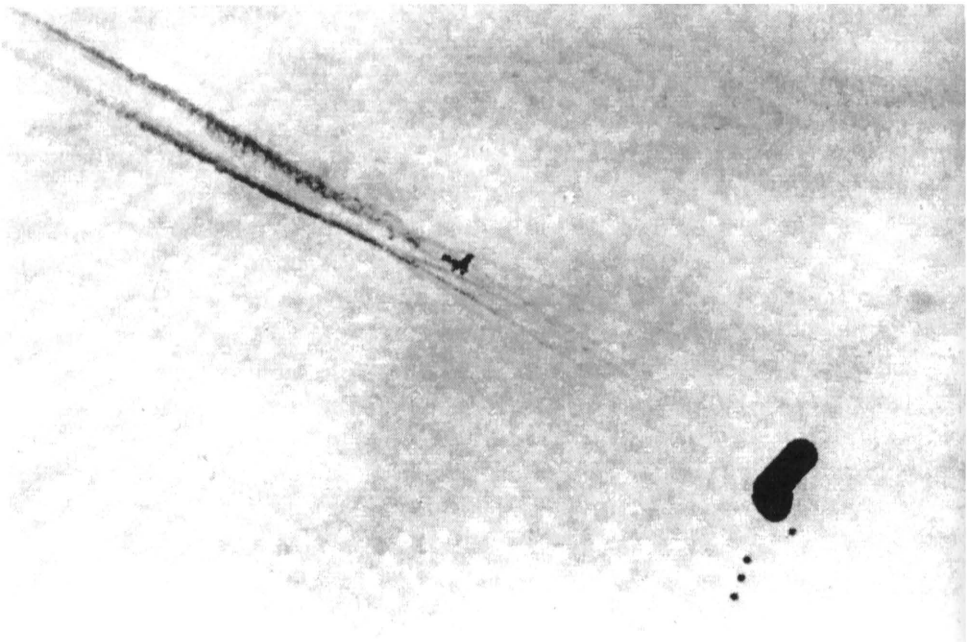
The use of Le Prieur rockets started even before contracts had been signed. Many tests were initially performed to allow tuning of the launches, before the authorization to create a special squadron was given. Equipped with Nieuport XI "Bébé" fighters, the latter performed its first test launches on May 18th, 1916 [6].

The battle of Verdun had started on February 21st, and General Nivelle was complaining about the high number of German observation balloons. He was planning an attack on Fort de Douaumont on May 22nd. So he asked for the Drachens to be destroyed before the attack. At 6 H 30, eight Bébé Nieuports took off from Verdun, under the command of Captain De Beauchamp. The others were flown by Lieutenants De Boutigny and De Gennes, with adjutants

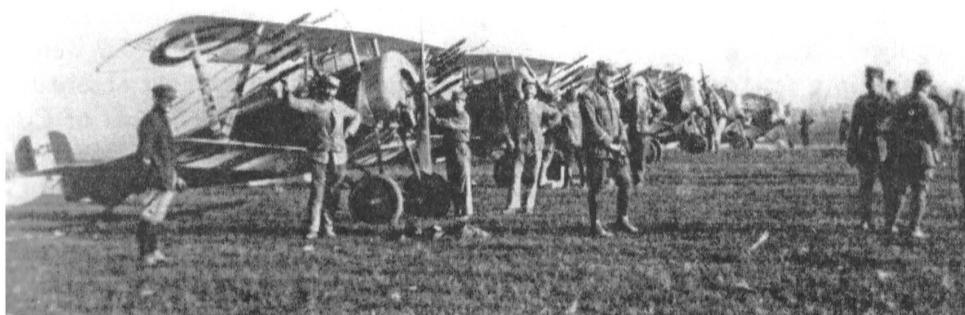
Barrault, Chaput, Guignet, Reservat and the famous ace Nungesser. At 2,500 m height, they spread over the 20 km long front between Etain and Sivry. Upon sighting the Drachens, the fighters dived down to 200 m, and fired their rockets. In less than 50 seconds, stupefied Germans had 6 balloons on fire, only De Boutigny and Barrault having missed their target. An attack by German Fokker and LVG fighters obliged Reservat to land within the enemy lines, where he was captured.



February 21st, 1916. Le Prieur briefs the pilots of the 8 fighters which are to record the first ever aerial missile kills.



A French fighter (Nieuport?) attacks a Drachen.



A row of Nieuport fighters.



8 rockets-Nieuport's 16.

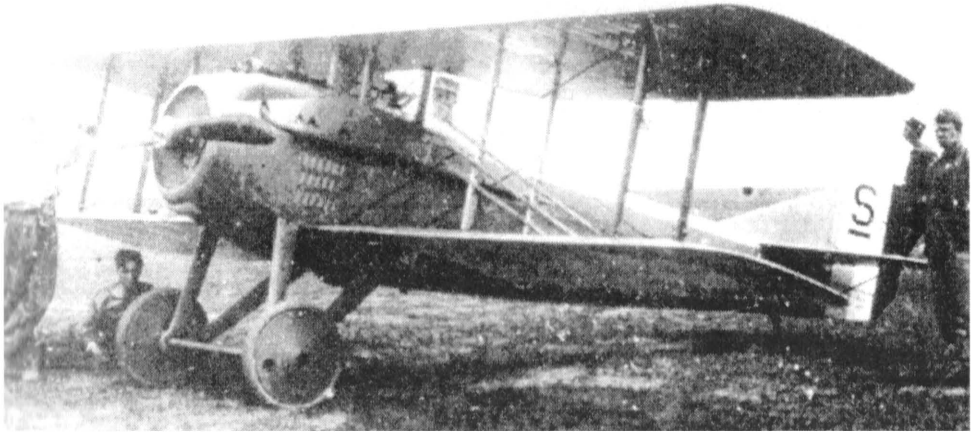
The impression upon the Germans was considerable. For the first time in history, rockets had been air-launched, the first air-to-air missiles, decades before their definitive adoption [7]. Use of the Le Prieur weapon continued: during the Battle of the Somme, starting on July 1st, 6 Drachens out of 9 were set on fire in a few days, depriving the Germans of good battlefield observation. Six squadrons of Bébé Nieuports were created, under the command of Commandant De Rose. The technique was incorporated into the training syllabus of Ecole de Combat Aérien in Pau. General Von Höppner admitted “enemy artillery aviation, working in full coordination with its guns, had succeeded in literally annihilating the German artillery” [8].



Nieuport 16 from N26 Squadron during the Summer 1916.  
Le Prieur may be in the background.

Rockets also were used on the Russian front, Lieutenant Georges Lachmann of N581 squadron based in Buchach downing a Drachen on June 26th, 1917 with his Spad 7 (with mountings for only 6 rockets). He scored again on September 1st and October 16th.

Many squadrons were equipped with the rockets such as Spa 81, Spa 124, Spa 193 with Spads, N 581 with Nieuport 17s, and Sop 582 with Strutters. But already by the Autumn of 1917, more practical incendiary ammunition had displaced the “aerial torpedo.”



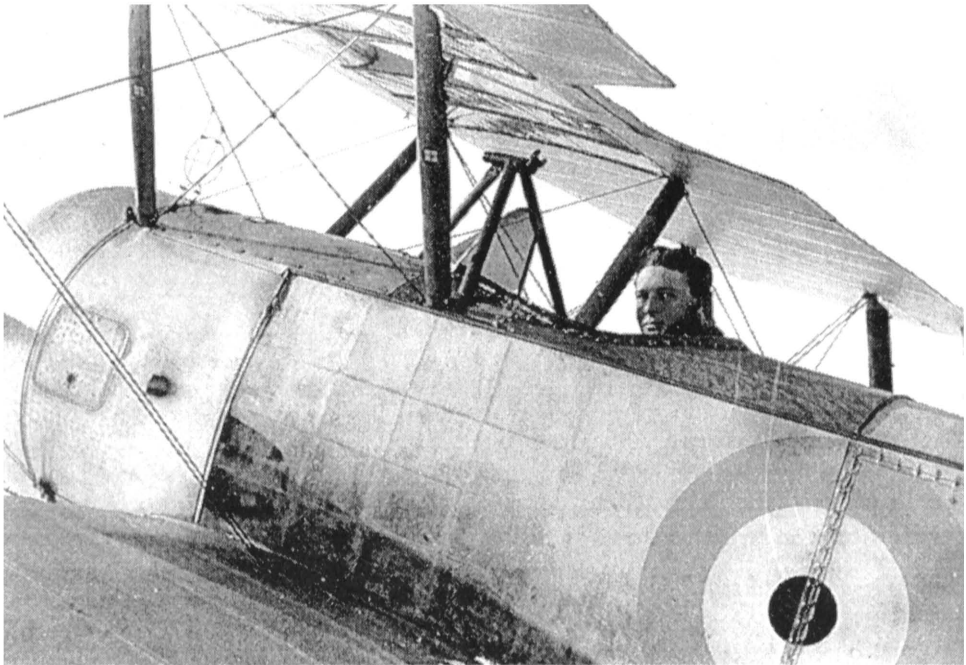
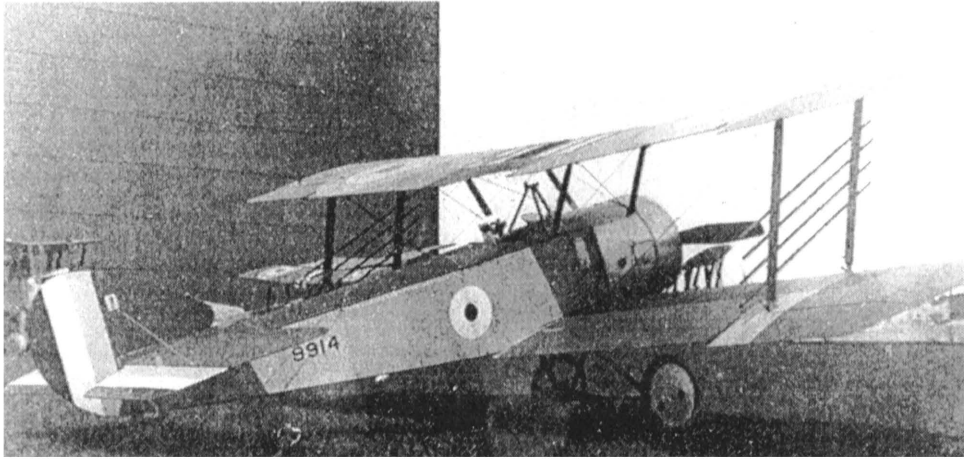
Lachmann's Spad 7 N° S3.

### Foreign Use of Le Prieur Rockets

The Royal Navy became interested in the system, with Admiral Vaughan-Lee interviewing Le Prieur in September. But the British had already used his rockets during the Battle of the Somme, downing 4 Drachens on June 25th. An officer was sent to Paris to study the technique. Tests showed the Baby to lose about 12 km/h of speed due to the assembly. Several squadrons were equipped, such as N°1 and 11 (Nieuport 16), and N°32 (DH 2). However, the flirtation was brief. Gunnery Memorandum N°92 of December 16th, 1916 [9] explains that the French rockets are too slow, and therefore should be reserved for practice. With the appearance of incendiary bullets, the rocket disappeared from the British arsenal in Spring 1917.



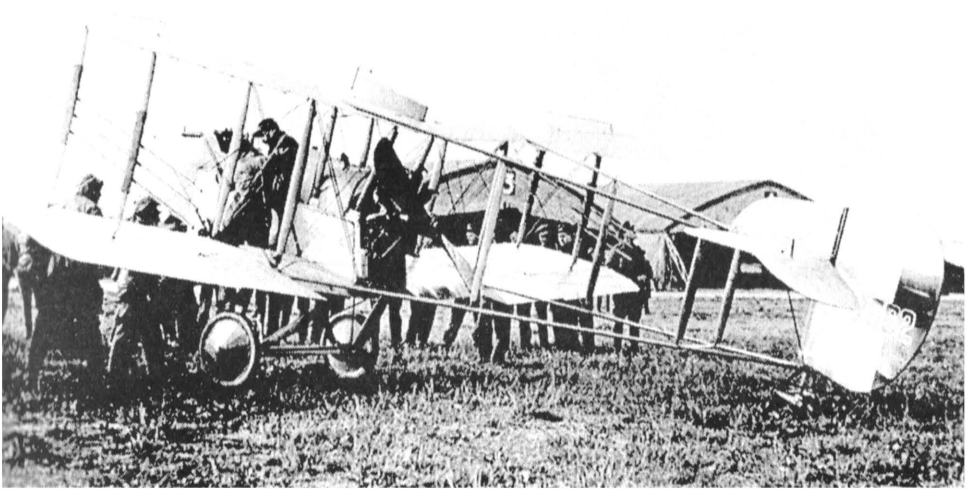
A Sopwith Baby fires a salvo of Le Prieur rockets  
at Isle of Grain in Summer 1916.



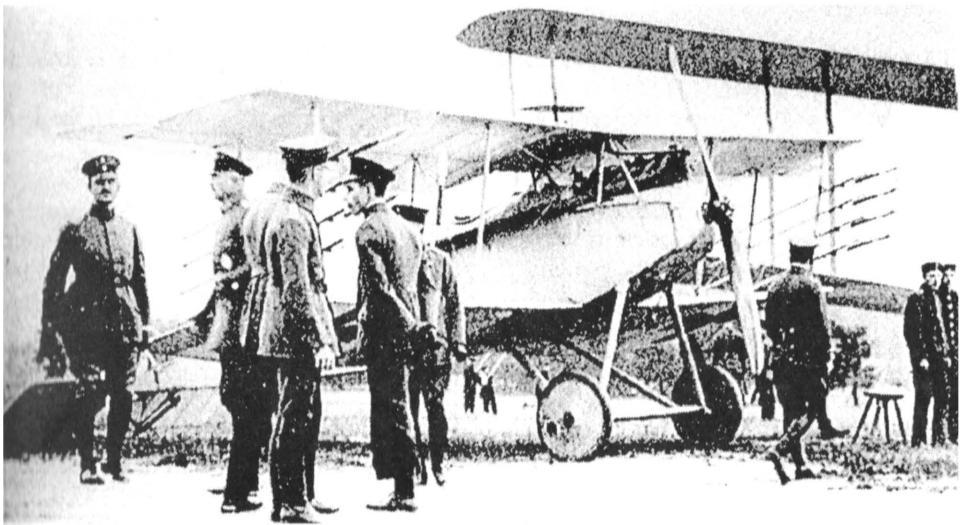
Beardmore built Sopwith Pup N° N9914 with 8 rockets  
(first tests took place in Eastchurch with N5186 in October 1916).

The Belgians also used Le Prieur rockets, while the Italians recorded their first success on October 18th, 1916, when an Austro-Hungarian balloon was destroyed near Selo.

A picture, probably from late 1916, shows a Russian Grigorovich M.11 flying boat equipped with a rocket gear on the struts. But due to the violent spraying of water during take-off, it is doubtful that it ever worked.



A 32 Squadron DH 2.



A D.II in Döberitz in Autumn 1916.

### Foreign Rockets

Memorandum N°92 also referred to the British Brock "Intermediate Rocket," of half the size and weight of the Le Prieur rockets. The Brock weapons thus were to be reserved for actual attack.

The capture of a rocket-equipped Nieuport led the Germans to create a Raketen-trupp in Berlin, equipped with Halberstadt D.II. On October 16th, 1916, one machine was sent for trials in the 1st Army area. After two weeks of trials, it came back because of difficulties with the system.

## Conclusion

A total of 50 balloons, and even 2 aircraft, are reported to have been downed by the Le Prieur rockets. The mention of its use as an air-to-ground weapon is not confirmed, but may correspond to the training of pilots with ground targets. Many pilots, such as the ace Georges Madon, used it successfully [10] [11].

Le Prieur was decades ahead of his time. So much so that, again the “black powder rocket” had to give way, this time to the incendiary bullet. But, as we know, with the later advent of guidance technology, the air-launched missile definitely carved its niche.

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- <sup>3</sup>Y. Le Prieur. “Premier de Plongée.” Ed. France Empire, 1957.
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- <sup>5</sup>Albert Vuillez. “Un inventeur de génie: le Commandant Le Prieur.” *Aviation Magazine* N°219, 17.1.57.
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- <sup>7</sup>Bulletin d’Informations, Ministère des Armées—Air. N°10/66, 25.5.66.
- <sup>8</sup>Revue Historique des Armées N°3, 1966.
- <sup>9</sup>Harry Woodman, “Avions-Torpilleurs: Le Prieur’s Rockets,” *Windsock* 5/6.94.
- <sup>10</sup>*Aviation Magazine* N°374, 1963, p. 19.
- <sup>11</sup>Georges H. Gallet. “A l’assaut de l’espace.” Ed. La Pensée Moderne, 1956, p. 34-37.