History of Rocketry and Astronautics

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Chapter 7

An Overview of French Astronautical Activities in the 1930s*

Christophe Rothmund†

Foreword

Today, very little is known about the French space pioneers of the 1930s, but even though they left modest legacies, in comparison with their contemporaries in the United States, Great Britain, Germany or the Soviet Union, these great pioneers have nevertheless a lasting influence. The purpose of this paper is to summarize this little-known story.

Introduction: French Rocketry 1428-1920: Military Rockets

Military rockets have been used in France on and off since the 15th century. Their first documented use was in 1428, when Joan of Arc used them during the siege of Orleans. They were then quite widely used during the wars that took place in France in the 15th Century. However, they rather quickly were forgotten in the ensuing centuries: it was only in 1793 that the French revolutionaries openly encouraged rocketry. Unfortunately, no operational uses followed.

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Then, in 1810, Emperor Napoléon called for the development of military rockets. This attempt was quite successful and closed the then-existing "rocket gap" between France and Great Britain. The rockets thus developed were used for the first time in 1811 and continued to be used until Napoléon's defeat at Waterloo in 1815. This also meant the end of French rocketry.

However, a few years later, in 1824, rockets were reborn with the establishment of the Ecole Centrale de Pyrotechnie de Metz. This Central School enabled France to become the leading military rocket power in the mid-19th century. These successes unfortunately came to an untimely end on February 28, 1864, when the last French military rocket was fired during the battle of Guadalajara, in Mexico. Finally, on July 27, 1872, the French war minister deleted rockets from his inventory. For the next 40 years, military rockets were nonexistent in France.

In February 1915, German Zeppelin dirigibles began bombing Paris. This led Ensign Yves le Prieur to design anti-balloon rockets, fired from fighter planes: he had created the air-to-air missile. Following initial tests, the French Military Governor of Paris, General Maunoury, decided to equip 20 planes with such rockets. The Royal Flying Corps did likewise. These "Le Prieur" rockets were used against Zeppelin bombers and also against "Drachens" observation balloons. In 1916, British General Trenchard, in charge of British military aviation, awarded Yves le Prieur the Military Cross.

However, large caliber machine guns had overcome rockets by 1917. Two French officers, Andreau and Bory, developed longer range rockets. A range of 1000 meters having been demonstrated, French Marshall Foch ordered 20,000 such rockets. The end of the war led to the cancellation of this order that remained shrouded in secrecy. This cancellation also meant the end of French military rockets until 1939.

Civilian Rockets

Until the end of the 19th Century, the only civilian rockets were fireworks. The first documented non-firework use of such rockets was by Amédée Denis who, in 1888, published a study on aerial photography by means of rockets. None, however, were ever built.

Two years later, Just Buisson built a rocket-powered boat. He published a patent on his propellant (based on petroleum and ammonium nitrate) and very successfully operated his boat. He, unfortunately, died when it exploded.

In 1887, the Romanian-born inventor Simcu built a rocket-train that ran in Sevran near Paris. He also proposed a rocket plane, but his lack of means prevented him from building such a vehicle. (see References 1, 2, 3, 6, 7)

Solid-Propellant Rockets in the 1930s: Introduction

The main field of solid propulsion was fireworks, the well-known firm of Ruggierri, being already established in this field. But other civilian and more practical applications emerged in the early 20th century. Among them we can distinguish: anti-hailstorm rockets and rope-carrying rockets, used for recovering wrecked ships and their crews. However, these rockets were often of rudimentary design and were not much different from 19th Century products.

The Work of Louis Damblanc

Born in 1889, Louis Damblanc was a real inventor who, after first dealing with aeronautics and car engines, became interested in rocketry and devoted many years to the study of solid propellant rockets.

He initially studied the actual performance of the then-available solid propellant (i.e. black powder) rockets. This followed the design of a test bench able to measure pressures, kinetic energies and also the exhaust speed of combustion gases. This device was built with the support of the French Office National des Inventions et Recherches Scientifiques and of his director, J. L. Breton.

Damblanc studied three types of rockets:

- a "fusée lance-amarres," used for sending ropes to wrecked ships. These were the most powerful rockets then available.
- two "fusées paragrêle" used by peasants against hailstorms. These were built by Ruggieri.
- a rocket designed and built by the Ecole Centrale de Pyrotechnie de Bourges.

These tests were conducted over three years and produced very valuable results. They enabled Damblanc to establish practical formulas on combustion speeds and the variation of powder mass as a function of time. He then deduced a law on combustion pressures and established equations governing the trajectories of rockets.

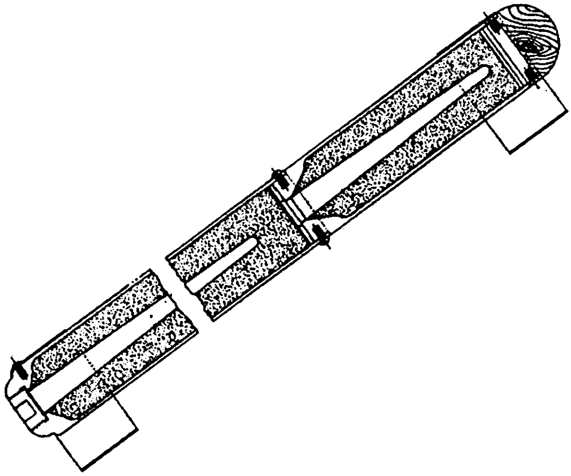


Figure 1: The fusée lance-amarres (from ref. 9).

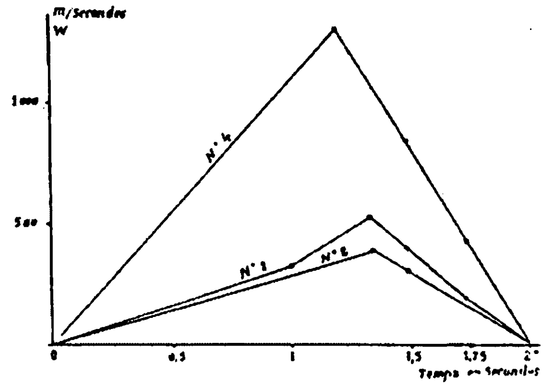
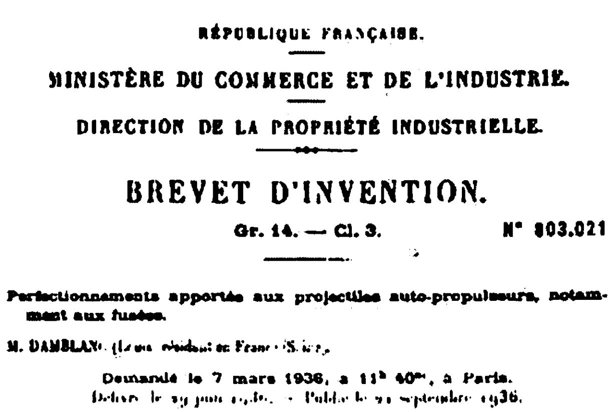


Fig. 36. — *Diagrammes des vitesses des gaz brûlés en fonction du temps.*

Figure 2

Later, Damblanc built his own rockets in order to measure the temperature of their casings. These temperatures were initially measured during ground tests, but he also flew his two-stage rockets. In his last trials, the rockets reached altitudes of around 1,000 meters. He also built the biggest pre-war French rocket: a three stage design with a diameter of 133 mm. A total of 360 firings of his own rockets were performed.

Among Damblanc's many patents was one for multi-stage rockets. This patent was recognized by the American government in the 1950s and it is said that he received royalties on it!



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MINISTÈRE DU COMMERCE ET DE L'INDUSTRIE.

DIRECTION DE LA PROPRIÉTÉ INDUSTRIELLE.

BREVET D'INVENTION.

Gr. 14. — Cl. 3. N° 803.021

Perfectionnements apportés aux projectiles auto-propulseurs, notamment aux fusées.

M. DAMBLANC [illegible]

Demandé le 7 mars 1936, à 11h 40m, à Paris.

[illegible] 1936.

Figure 3: One of Damblanc's patents.

Other Pioneers

On May 23, 1923, the War Ministry had ordered rockets for lighting battlefields (in weights ranging from 3 to 14 kg), while in 1925, the aircraft designer Makhonine performed rocket tests.

In the mid-1930s, Bory (who already worked in this field in WWI) fired about 1,000 75 mm caliber projectiles. French military officers witnessed these trials, accompanied by British Army, Royal Navy and Royal Air Force officers. The rockets were launched in salvoes of 8, 16 or even 32 projectiles and could be launch either from the ground or from airplanes. All these trials were filmed.

In 1939, Jacques and Grande designed a self-propelled projectile shot vertically from a tube. Tested in early 1940, this rocket was not very successful. Finally, in February 1940, General Dassault ordered anti-aircraft rockets to protect convoys from "Stuka" attacks. Four armored-cars and 20,000 rockets were ordered, but the defeat of the French army led to the non-fulfillment of this order. (see References 7, 8, 9, 10, 11)

The Liquid Propellant Pioneers: Esnault-Pelterie and Barré

Born in 1881, Robert Esnault-Pelterie initially devoted his gifts to aeronautics. Owner of the fourth pilot's license issued in France, he soon designed his own airplanes and was the inventor of the control stick and the radial engine. His plane, built in 1911, was the first to accomplish a circuit without changing the engine.

In 1908 he began thinking about space. In February 1912 he delivered a presentation on this subject in St. Petersburg (Russia). In December the same year, he delivered another lecture to the French Physics Society. Its rather unglamorous title "Considerations on the indefinite lightening of engines" masked its actual topic: the possibility of achieving space travel by means of multistage rockets. His vehicle was what is called today a "single stage to orbit," powered by a nuclear engine. This was, and still is, a visionary thought. In this paper, he discussed not only of flights to the Moon, but also to Mars and Venus. He computed flight times to these planets.

After the war, he had contacts with many of his colleagues: Goddard, Oberth and Hohmann. In 1925 Esnault-Pelterie met with Andre-Louis Hirsch and they decided to establish a prize, to be awarded yearly to outstanding researchers. This "Prix International d'Astronautique" was to be awarded to authors of scientific works, theoretical or practical, that represented significant progress in the astronautical sciences.

The first winner was Hermann Oberth in 1929. Among other early winners were Louis Damblanc in 1935, and the American Rocket Society in 1936.

In 1927, Esnault-Pelterie delivered a paper entitled "Exploration of the upper atmosphere by means of rockets and the possibility to achieve interplanetary travel," which was published a year later. The following year he contacted the French armed forces on the possibility of using rockets for military purposes.

In 1930 he published his major work *L'Astronautique*, followed by a "supplement" in 1935. These books "laid the groundwork for later French achievements in rocketry and spaceflight," writes Frank Winter.

In 1931 he experimented with a bipropellant rocket engine operating with tetranitromethane and petrol. An unfortunate explosion ripped four fingers of his left hand and he decided to replace the tetranitromethane with liquid oxygen. In the same year he was invited to deliver a paper in New York on "By rocket to the moon."

From 1932 onwards, Esnault-Pelterie commenced experimental work on thrust chambers. He began with the design of an injector and of pressurization systems for propellant tanks. A year later, he continued with studies on flow into pipes. After designing his thrust (combustion) chambers, he performed six ignitions, refining the ignition procedures as well as the stability of the combustion.

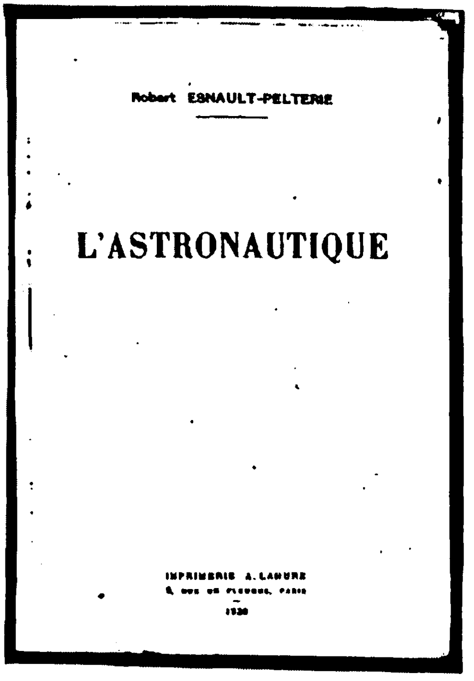

Figure 4: Cover of L'Astronautique.

THE AMERICAN INTERPLANETARY SOCIETY

cordially invites you to attend an address by

ROBERT ESNAULT-PELTERIE

the distinguished French scientist and engineer

"BY ROCKET TO THE MOON"

in the Main Auditorium

The American Museum of Natural History

77th Street and Central Park West

on the evening of January 27th, 1931, at 8:30 o'clock

A motion picture, prepared under the direction of Professor Hermann Oberth of Germany, showing the actual flight to the moon of an imaginary but scientifically possible rocket, will accompany the address.

There will be no charge for admission

DAVID LASSER,
President

Two seats will be reserved for you until 8:30
Please present this card at the door

Figure 5: Invitation to Esnault-Pelterie's New York presentation

Until the war, Robert Esnault-Pelterie continued his research, characterized by great care and a rigorous scientific approach. Some of the results he obtained in early 1935 are quite remarkable, even though they were behind those achieved by his colleagues abroad. For example:

Thrust	90 kg
Duration	60 to 120 s
Exhaust speed	2480 m/s

It must also be noted that, from 1932, he received yearly about 500,000 Francs from the War Ministry (Army: 200,000 F, Navy: 100,000 F, Air Force: 200,000 F). He had also moved his test facility, in October 1934, to the military camp of Satory, near Paris. There he performed a series of 16 tests on his improved thrust chambers.

In spite of pressures from the military, he continued his patient researches, and at the beginning of World War II had realized an engine with a thrust of 300 kg for a rocket weighing 100 kg. This rocket was expected to be able to reach an altitude of 100 km.

The outbreak of World War II caused his activities to cease. Following a retreat into Switzerland, he lost all interest in rocketry and died in 1957.

Robert Esnault-Pelterie can be considered the French counterpart of Goddard, and was equally secretive and individualistic. Had he been able to obtain the same sort of financial support that Goddard received from the Daniel Guggenheim Fund, he might have achieved much more tangible results and could even have been the first Frenchman to launch a liquid propellant rocket. (see References 3, 4, 5, 12, 13, 17)

Général Barré and EA41: the First French Liquid Propellant Rocket

Born in 1901, Jean-Jacques Barré had always been interested in astronomy. He studied at the famous Ecole Polytechnique and was posted to the Artillery School at Fontainebleau. He assisted at Robert Esnault-Pelterie's conference on astronautics on June 8, 1927, and was fascinated by what he then discovered. A couple of days later, he wrote a letter to Esnault-Pelterie and received an answer that started a six-year long correspondence between the two scientists. Nearly 300 letters were exchanged during these six years, dealing with very specific subjects such as exhaust speeds, propellant flows, pumps, etc.

From 1927 until 1931, he contributed to Robert Esnault-Pelterie's work and was, at Esnault-Pelterie's request, detached to his laboratory for one year, starting on September 25, 1931. Having had to leave Esnault-Pelterie in September 1932, he resumed his activities in 1935, being authorized to conduct research on the use of nitrogen peroxide for rocket-propelled gun shells, during his spare time of course! In a study dated December 8, 1935, he clearly established the superiority of rocket-propelled shells over classic ones. He also published a report on the combustion of liquid and solid propellants.

From January 1936 until May 1940, he tried to develop this projectile, whose main data were as follows:

Diameter	120 mm
Height	1.8 m
Weight	16 kg
Thrust	700 kg
Propellant	Benzotoluene/N_2O_4
Altitude	12 km

Four ground tests were performed in early 1937, but were disappointing. The final test, on April 6, 1938, ended in an explosion. All his activities ceased when the French army capitulated in May/June 1940.

Following the occupation of France by the Nazis, Jean-Jacques Barré was posted to Lyons, in the so-called "non-occupied zone" of France. There, he developed for the remaining armed forces a new missile. Funded officially by the Army, it had to be kept secret from the Germans (it was not clear whether this endeavor was, or was not, compliant with the armistice regulations) and for this reason, it was designated "studies for a new gas generator," named for the gas generators used to replace petrol for trucks and cars. This rocket, EA41, was built and ground tested for the first time on November 15, 1941, at the Larzac military camp. The circumstances delayed the development and although numerous tests of the engine were made, the first flight of France's first liquid-propellant rocket could only take place on March 15, 1945 from Toulon.

After the war, Jean-Jacques Barré continued to refine his EA41, designing the EA46 "Eole" that flew twice in 1952, following ground tests performed in 1949 at the LRBA (Laboratoire de Recherches Balistiques et Aérodynamiques) in Vernon. These tests were only partially successful and led to the redesign of the vehicle. This was his final work on rockets until his death in 1978. (see Reference 15)

Ananoff: the Indefatigable Propagandist of Astronautics

Born in Russia in 1908, Alexandre Ananoff and his family arrived in Paris in 1918. He discovered Tsiolkovski's works at the age of 18 and this set the course of his life. He became an indefatigable propagandist for astronautics (i.e. space travel) and was the French expert on that subject.

His first activity in the field was a speech he delivered on September 3, 1929. The title was "Interplanetary Navigation." His goal was to awaken public interest for space, to encourage personalities to become interested in the subject and to create French astronautics.

In 1937, he took part in the Universal Exhibition by staging the "Astronautics Hall" at the exhibition's Palais de la Découverte and by writing dozens of papers and delivering a hundred lectures on the subject.

In the decade until 1940, he published a number of papers in the Bulletin of the Société Astronomique de France. As he was working with Editions Larousse, a famous publisher of dictionaries and encyclopedias, he managed to convey in their publications his enthusiasm for astronautics.

He was more interested in astronautics than rocketry, which he thought was more for the military than for the scientists, and was among the first to employ system-oriented thinking. He envisioned astronautics as a whole, covering not only propulsion, but also trajectories, life-support systems, navigation, design of spacecraft etc. This was his main difference with his fellow "astronauts," as they called themselves, and also the reason for his difficult relationships with them!

After the war, Ananoff established his real legacy: he published a huge book in 1950, *L'Astronautique*, organized the first International Astronautical Congress in Paris (also in 1950) and was among the founders of the IAF, the International Astronautical Federation. He also recognized the need for a better coordination between scientists. However, events did not permit him to bring this activity to fulfillment.

Perhaps Ananoff's most memorable achievement is the "Moon rocket" featured in the comic books "Objectif Lune" and "On a marché sur la Lune" by Hergé (Georges Rémi). Published in 1950 and based on Ananoff's own book, the internal arrangement of the crew compartments of Hergé's rocket were based closely on Ananoff's work. The author, Hergé, met personally with Ananoff at least twice to discuss the realism of his rocket.

In retrospect, Ananoff was the first to recognize the need to make spaceflight popular, in order to gain public support. His influence in this area was invaluable. (see References 4, 14, 16)

The Short-Lived French Rocket Society

Ananoff realized that an organized society could not only legitimate and federate all the activities undertaken by "scattered" individuals, but could also generate more public interest and support, as well as motivate financial sponsors. As he was a member of the Société Astronomique de France, and had written numerous papers on astronomy, the Secretary General of the Société, Madame Gabrielle Camille Flammarion, permitted him to create the Section d'Astronautique, within the astronomical society.

The Section d'Astronautique had its first meeting on May 9, 1938. This was a great success, but rapidly, things deteriorated. The meetings were irregular, or cancelled due to missing chairs in the room or for other reasons. Ananoff cannot explain the reasons for this, except to quote "jealousy." The final meeting of the Section d'Astronautique took place on February 20, 1939. (see References 4, 12)

Why So Little Activity?

The reasons why so little activity was undertaken in the field of rocketry are numerous. One may however distinguish three main reasons, the first of which is politics. The global situation of France in the 1930s did not encourage such "extravaganzas" as rocketry or space travel. The aftermath of World War I and the economic crisis of 1929/30 had left serious scars. The political situation was quite troubled: there were scandals and riots. Furthermore, the politicians and military leaders of the period were very conservative and not prone to such innovations as rockets. In addition, the Army, the only organization that could fund rockets, did <u>not</u> believe in them. Finally, worries about the situation in Germany did not encourage dreams.

The second reason lies in the personalities involved. They all were quite individualistic and not very prone to publish, except perhaps for Louis Damblanc. The only one who perceived the need for co-operation was Ananoff, but he did not get on well with Esnault-Pelterie and disliked Damblanc. As each scientist was very much like those described in popular novels by Gaston Leroux (i.e. lonely scientists, working in their own labs with one or two assistants), cooperation and publishing was not the rule: each of them stayed in his own little niche.

Finally, the lack of an organized rocket society that could have made publicity and gathered interest and funds, coupled with the lack of private sponsors (like the aforementioned Guggenheim funding for Goddard) rendered these activities more difficult.

Conclusion

Today, very little remains of these early years. Most of the pioneers are long forgotten by the public and their laboratories or hardware no longer exist. But their legacies remain.

Esnault-Pelterie and Barré pioneered the uses of propellants that are today used on Europe's Ariane vehicles: N_2O_4 and LOX. Ananoff created the International Astronautical Congresses and the IAF, both of which still exist today.

So, even if little was achieved, that precious little paved the way to the successes of French rocketry since the early 1950s.

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Appendix: The Prix d'Astronautique

PRIX INTERNATIONAL D'ASTRONAUTIQUE

REGLEMENT

TITRE PREMIER

Exposé.

ARTICLE PREMIER. — MM. ROBERT ESNAULT-PELTERIE et ANDRÉ HIRSCH offrent à la Société Astronomique de France une somme annuelle de 5000 fr. (cinq mille francs) pour chacune des années 1928, 1929 et 1930.

Cette somme est destinée à récompenser le meilleur ou les meilleurs travaux scientifiques originaux, théoriques ou expérimentaux, capables de faire progresser l'une des questions dont dépend la réalisation de la Navigation intersidérale ou d'augmenter les connaissances humaines dans l'une des branches touchant à la Science « astronautique ».

ARTICLE 2. — Selon la demande des donateurs, la Société Astronomique de France a constitué un « Comité d'Astronautique » chargé, en particulier et tout d'abord, d'établir et d'adopter le présent règlement et ensuite d'agir chaque année comme Comité d'attribution du Prix Rep-Hirsch.

Ce Comité peut prendre toutes dispositions lui paraissant désirables, tant pour la réception ou la centralisation des mémoires que pour leur répartition entre les différentes Commissions ou les différents Rapporteurs spécialisés qu'il aura choisis dans son sein.

TITRE II

Conditions d'attribution.

ARTICLE 3. — Les deux donateurs se refusent le droit de concourir pour le prix qu'ils fondent; par contre, ils désirent expressément que les autres Membres du Comité d'Astronautique aient ce droit.

Article 4. — Toute personne estimant avoir fait un travail scientifique théorique ou expérimental susceptible d'être récompensé, et désirant prendre part au concours, devra adresser un mémoire explicatif à la Société Astronomique de France.

Ce mémoire devra être *dactylographié ou imprimé*, clair et explicite, il ne devra contenir ni ambiguïté, ni réserve, *ni développements ou considérations autres que scientifiques*. S'il se réfère à des travaux antérieurs, il devra bien en préciser les dates, lieux et moyens de publication permettant de trancher le cas échéant toute question de priorité.

La Société Astronomique de France devra transmettre immédiatement les documents reçus au Secrétariat du Comité d'Astronautique.

Article 5. — Tout membre du Comité d'Astronautique a le droit de présenter au concours tout travail lui en paraissant digne.

Article 6. — Les mémoires doivent obligatoirement être rédigés dans l'une des langues suivantes : français, anglais, allemand, espagnol, italien ou esperanto.

Article 7. — Le Comité se réunit pour examiner les Rapports de ses Commissions ou Membres délégués, sur les travaux qui ont été reçus, jusqu'au 31 décembre précédent inclus. Il statuera à leur sujet à la majorité des voix des Membres présents et ceci en temps voulu pour que la proclamation des résultats puisse avoir lieu à l'Assemblée générale de la Société Astronomique de France au mois de juin qui suit l'année considérée.

Le Comité a toute liberté d'appliquer la somme annuelle de 5000 francs à un seul travail ou à plusieurs travaux, en un premier prix, un ou deux seconds prix, etc., ou de n'attribuer aucune récompense et, le cas échéant, la somme non affectée est reportée sur l'année suivante.

Article 8. — Dans le cas où un travail d'un des Membres du Comité est présenté au concours, ce Membre ne peut naturellement prendre part à aucun des scrutins d'attribution des prix de cette année-là.

Article 9. — Le Comité d'Astronautique se réserve le droit de publier *in extenso* ou en résumé tout travail récompensé par lui.

Article 10. — Tout auteur qui présente lui-même au concours un travail personnel doit signer un Bulletin d'engagement sur lequel un règlement du prix est imprimé, la signature de ce Bulletin emportant l'obligation de se plier au présent règlement.

Article 11: — **Le Comité est entièrement maître de ses décisions dont il ne doit justification à qui que ce soit.**