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Chapter 12

The Correspondence between the Rocket Pioneers Johannes Winkler and Hugo Hückel*

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Abstract

In longstanding work all letters between rocket pioneer Johannes Winkler and businessman Hugo Hückel were transcribed and digitally preserved for further research. The file contains 240 letters and postcards. Johannes Winkler launched the first European liquid propellant rocket in March 1931, Hugo Hückel was for about two years more than his sponsor. Their correspondence is the only document giving an insight to the development and modifications of the Hückel-Winkler-No. 1 rocket (HW1), the problems and solutions for design, mechanical and chemical problems of "Modell No. 2" rocket, and the first ideas of the (not realized) "Modell No. 3." Several aspects of their technical and commercial correspondence will be enlightened to take a look back to the beginnings of astronautics.

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I. Johannes Winkler (1897–1947)

Figure 12–1: Johannes Winkler.

Johannes Winkler was the sixth of eight children of independent carpenter Robert Winkler and his wife Rosina (maiden name Dude), born on 29 May 1897 in Bad Carlsruhe / Upper Silesia. His education was determined by the Old Lutheran faith, which was firmly rooted in his family. Already in his childhood technical devices and tools fascinated him. His inclination to astronomy resulted in the observation of Halley's comet in 1910. The novels of Jules Verne and later by Otto Willi Gail laid the foundation for his interest in space travel. His musical talent was enhanced by teaching in guitar, piano, and harmonica. Guitar and piano played a major role in the family circle and church work. After attending the Volksschule and the Realschule, Johannes Winkler attended the Royal Gymnasium in Liegnitz. In 1915, he received the testimony of maturity for the Prima as a volunteer. Already in March 1916, he was so badly wounded that his leg was shortened in time. His father fell victim to war in 1917. Despite his technical interests, he began a theological study at the request of his mother, and in 1922 he gave his first theological examination. In October 1922, Johannes Winkler was sent by his church authority as a candidate of theology to Witten an der Ruhr. After the study of Hermann Oberth's book *Die Rakete zu den Planetenräumen* (1923), Johannes Winkler turned his attention to rocket science, but he remained until 1929 rendant (financial administrator) of the Evangelical Lutheran Church in Prussia. In 1924, as rendant, he came to the idea of the issue of "Arbeitsgutscheinen" (work vouchers). They should be acquired by the General Council of Churches from unemployed community members and serve as a basis for the reconstruction of ecclesiastical finances. On 23 April 1926, he married Elisabeth Frobös, the daughter of the director of the Breslau College. Their daughters Dietlinde (*1927) and Elisabeth (*1929) emerged from the marriage.

From January 1927, Johannes Winkler published a *German Youth Newspaper.* It became the journal of the "Verein für Raumschifffahrt—VfR," founded on 5 July 1927, under the name from July 1927 of *Die Rakete.* He was the first chairman of the VfR. Basic articles of Winkler in his journal *Die Rakete* were contributions to the theory of the "jet engine," as he also called his rocket engines, also on economic and medical questions of space travel. They founded his reputation as a rocket pioneer of the first hour. Little is known that Johannes Winkler, in collaboration with the Breslauer Modell-und Segelflug-Verein e. V., built models equipped with powder rockets. Based on these experiences, he submitted a usage pattern for a high-speed aircraft at the Reichspatentamt Berlin on 15 September 1927. Parallel to the theoretical considerations, the practical experiments on liquid propellant engines began at the Technical University Breslau in 1928, which he reported in his magazine *Die Rakete.*

The magazine *Die Rakete* had to be discontinued due to financial problems at the end of 1929. Hermann Oberth succeeded him, in November 1930, in the club presidency.

His priority work already had originated from the beginning of his work at the Junkers works from September 1929 onward. These were theoretical considerations on the heat transfer of liquids into gases, first calculations on the gas dissociation, and the bundling of liquid propellants. Johannes Winkler developed the theory of bundling engines into four stages and published the mathematical foundations in the book "Men of the Rocket" by Werner Brügel (1933). Both areas of the theory of liquid propellant engines accompanied him through his life.

The family Winkler lived in the Brunnenstr. 70 in Dessau and moved, in 1939, to Braunschweig-Querum. The work on the first European liquid rocket took place parallel to his work in the research institute "Prof. Junkers" in Dessau. There, from the beginning of September 1929 to the end of July 1931, Johannes Winkler worked on various fluid powerplants with petrol, coal gas, liquid oxygen, and nitric oxide. The largest measured thrust was 250 kp.

The launch of the "HW 1" rocket took place one week after the completion of the work at the Junkers works on 14 March 1931. It was the first European liquid propellant rocket. Then Winkler worked temporarily on the Berlin rocket airdrome. One of his assistants was Rolf Engel. Previously, the ideas of Johannes Winkler and Hugo A. Hückel had begun to create a model 2. The launch of the rocket "HW 2" on the Frischen Nehrung (Baltic Sea) in East Prussia failed for various reasons on 6 October 1932. Despite some attempts to continue the work, Johannes Winkler followed a short period of unemployment. From the summer of 1933, a second employment relationship began in the Junkers works, which lasted until 1939. Until 1935, he continued the experiments with liquid oxygen

and liquid methane. After that, he devoted himself to the bundling of engines up to a total output of 1,000 kp. With the support of the Junkers company, Winkler worked for the Luftfahrtforschungsanstalt in Braunschweig in 1939. He rose there to the head of the department. In 1943, he had a first heart attack. After the end of the war, he worked for the British allied authorities. Johannes Winkler died on 27 December 1947 from another stroke in Braunschweig.

II. Hugo A. Hückel (1899–1947)

Figure 12–2: Hugo Hückel.

Hugo Augustin Theodor Hückel was born on 9 August 1899 in Neutitschein. His father, Johann Hugo Ferdinand Hückel, was one of the heirs of the hat factory "Johann Hückel & Söhne," whose main production facility was in Neutitschein since 1805. They had achieved the status of purveyor to the imperial court in Vienna. The company processed hides from all over the world, delivered globally, and had up to 4,000 employees in three factories at peak times. Hugo, his brother Herbert (*1901), and his sister Christine (*1903) grew up in a wealthy and guarded environment. The family owned a large mansion with servants and was one of the city's dignitaries. During the first years of their youth, the children were home-schooled. From the fifth grade onward, Hugo attended the Realschule Neutitschein and finished the Gymnasium prematurely in the spring of 1917, with his conscription order immediately following. Thus, the 17-year-old high school graduate entered the military service in the St. Pölten telegraphic regiment. After one year of training, he was dispatched to Feltre in South Tyrol, but he fell ill with appendicitis. Since this was not diagnosed promptly, he had to stay in the hospital for a period of six months. Due to a resulting incisional hernia, he was declared irrevocably unfit for military service. At the same time, however,

World War I ended with the collapse of the empires in Germany and Austria. Neutitschein was now located in the just then founded Czech Republic.

Hugo Hückel studied electrical engineering at the Technical University of Vienna since 1919 and successfully graduated in 1923. Immediately afterward, he entered his father's business and practiced at the departments for production and administration to prepare for a future position as managing director. As a young engineer, he was interested in all state-of-the-art developments in technology. At the same time, the topic of spaceflight must have come to his attention. He procured Max Valier's new booklet *Vorstoss in den Weltenraum* (1924) and contacted him at the end of the year. From August 1926 to April 1927, Hückel deepened his knowledge on operating procedures, technology, and design at Stetson, Crofut & Knopps, as well as with Max Lachlau in the United States. Back in Neutitschein, he married Edith Felkel (*1906), born in Troppau. At first, they wanted to marry in autumn 1927, but due to a serious illness, the ceremony was postponed to 14 January 1928. The convalescence was only apparent, however, and an odyssey through medical practices and sanatoriums began. The first diagnosis of rheumatism finally emerged as bone tuberculosis.

As early as 1927, Hückel had learned of the formation of the Association for Space Travel (VfR) in Breslau. The concept of spaceflight fascinated him so that he not only joined the club, but also conducted first experiments himself. The paternal factory provided materials and equipment, which enabled him to build his own laboratory and carry out first experiments. He designed a simple rocket engine made of NTC3 Krupp steel, and he used oxygen and gasoline as fuel. Some experiments also were carried out with hydrogen peroxide. Regrettably, his illness put an end to these practical efforts. Therefore, he decided to support other rocket pioneers by providing funds and expertise. Particularly with Johannes Winkler, he established a close cooperation, which went far beyond financial support. Already in 1928, he had donated to Valier 1,000 Marks for his rocket car. In the summer of 1930, he paid a monthly amount of 500 marks for development and experiments to the VfR (Hückel Foundation to VfR). He was also elected to the association's board of directors. In the spring of 1931, the contract with Winkler was signed, so that the latter received 500 marks each month. A further 250 marks were given to the VfR. As the correspondence between the two men shows, not only financial but also many scientific and technical questions were discussed. In May 1932, Hückel came to Berlin for the final medical treatment. This resulted in personal meetings with Winkler, Engel, Nebel, and Willy Ley.

After the launch failure of the Winkler rocket Model 2 in October 1932, Hückel withdrew from the topic of rocket development and returned to his fa-

ther's company in 1934. He became a co-owner and had senior functions in the company. He was responsible for the management of the plant in Ratibor. The family grew; in September 1937, son Manfred came into the world. He was followed by Dietrich (*1941) and Gottfried (*1943). The beginning of World War II slowly but steadily affected the production within the company. On the one hand, sales to Western European and Eastern European countries declined. Foreign customers were still found in Luxembourg, Switzerland, and Sweden. On the other hand, the company had to gradually switch to war production. From 1941 onward, underwear, gloves, and face protection were added to the company's product range, to equip the German Wehrmacht. In 1943, some parts of the factory were converted to allow metal processing. New products were fuses for grenades and cartridges. When the front line approached Ukraine and Poland in 1945, most of the family members moved westward for security reasons. In January 1945, his wife with their children and his parents left Neutitschein by train in the direction of Starnberg, Bavaria, where Hückel's sister Christine lived. Shortly before the arrival of the Red Army, Hückel set off to Bavaria on 3 May 1945. He was interned in Prague, but was then able to leave for Vienna, where he arrived in June 1945, starving and without any money. Hugo Hückel tried to build up a new business in Vienna, surviving the winter in the sample storage of the Vienna branch. In cooperation with the long-established company P. & C. Habig, the hat production was to be revived in 1946. The cooperation was a lot of work, but little time was on hand. Hugo Hückel fell ill with cancer and died in Vienna on 3 March 1947.

III. The First European Liquid Propellant Rocket HW-1

Figure 12–3: Winkler with HW1 rocket.

The basic idea of a close cooperation between the two rocket pioneers was already born in November 1929 by Johannes Winkler. Winkler wrote: *Since I am very much interested in Junkers, for example, while I am not allowed to make any patent applications during my affiliation to the company, which for me is often a too great a sacrifice, I am concerned with the idea of founding a factory for repulse construction on a pure business basis, from which, however, the first space shipyard is likely to emerge* (Winkler on 21 November 1929).

Hugo A. Hückel initially refused such an idea. Because of his illness, he had only limited financial resources, and he felt the rocket research at the Junkers Airplane Factory to be correct. Both rocket pioneers had legitimate doubts at the time when the Junkers Factory had economic problems, and the working-law basis of Winkler's employment in the Research Center became uncertain. On the other hand, Winkler's self-confidence grew through his success in the development for waterplanes of a recoil as a starting aid. Hückel's intellectual change apparently occurred in the middle of May 1930. In a letter, he wrote: *For a construction, according to your scientific direction, I would already give a few thousand marks if you can also guarantee the use of the funds for this purpose. To you I have full confidence but to me unknown people of course not* (Hückel, 20 May 1930). Already in the middle of June 1930, Winkler had concrete ideas for cooperation with Hückel. Despite the patents of Prof. Junkers, there would still be scope for Hückel's own research since the basic principles are free. He would like to deal with the problem of rebounding outside his professional career. This work would have to remain secret. He could devote 50 hours per month for 3 Marks per hour to a project outside the Junkers Factory. All auxiliary devices, measuring instruments, and so forth would remain the property of Hückel, while the right of ownership would remain with the rebel Winkler. A test bench would be essential, because *I can not simply take over selected designs from Junkers, but must first test the parallel constructions on the model* (Winkler, 18 June 1930). Hückel, in his answer on 27 June 1930, informed Winkler that he would devote part of his income to rocket building under his control. He shared Winkler's concerns about the necessary secrecy. The financial conditions form a debatable basis. With the work plan, the goal of rocket development should be clearly formulated. Hückel did not believe a spacecraft could be developed from a rocket aircraft. On 7 July 1930, Hückel took a position on a work plan, which is not preserved. First, a rocket with an empty weight of 1 kg should be used. After a successful launch, one could go to the construction of an apparatus ten-times larger, which should return with a parachute. The "Egg of Columbus" would be if Winkler could replace the fuel pumps of Oberth by heating the fuel containers by means of nozzle exhaust gases. On 15 July 1930, the transfer of 1,000 RM to

Winkler took place. It can be assumed that this work was tacitly endorsed by the Junkers Research Institute. It is also possible that Winkler was financially supported by Prof. Junkers, too. At the same time, Johannes Winkler continued his work at the research institute of Prof. Junkers.

III.1. Results of the Research Financed by Hückel Parallel to the Employment of Johannes Winkler at the Junkers Factory

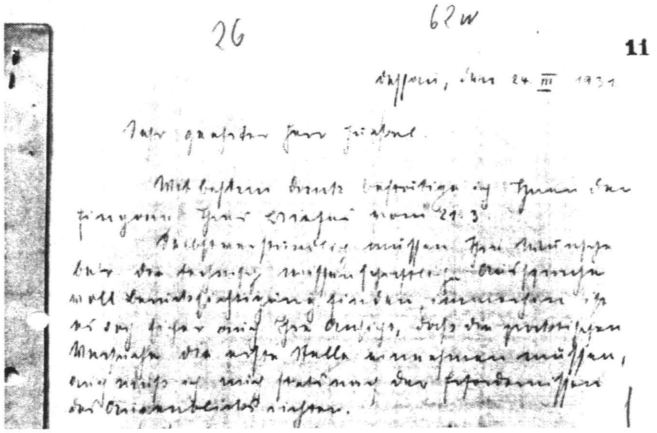

Figure 12–4: Original letter from Winkler to Hückel after launch of HW1.

The correspondence reflects very impressively the complex activity of Johannes Winkler on the construction of the engine and the HW 1 apparatus. The share of Hugo A. Hückel consisted above all in the financing Winkler's work. The fundamental approach of Winkler to the question of rockets can be seen in the letter section of 7 September 1930. It distinguishes three types of recoilers under the boiling temperature criterion. Oxygen and hydrogen belong to type 1. *I chose oxygen surplus because it is cheaper than methane excess. The performance goes back by the lowering of the temperature, but without cooling it is hardly possible, otherwise the nozzle melts in a fraction of a second, as we sometimes experienced in the beginning.* From the letter of 17 September 1930, it becomes clear that Hückel had little knowledge at this time about the concrete construction of the apparatus. Winkler explained to Hückel, on 3 October 1930, that now the development financed by him was in full swing. Because of the expected collision with Prof. Junkers, it would not have been possible for him to replicate the Junkers-Factory design. He would have chosen methane to get closer to the hydrogen surplus. Winkler wrote: *There are only tricks in the principal, but very much depend on them, for example, the principle of allowing the cooling fluids to flow in the closed manner inside the wall. Since the liquid can only assume the*

boiling temperature corresponding to the pressure so that the wall remains relatively cool. On 7 October 1930, he informed Hückel that he had decided in principle against counter-injection because of the high explosiveness. Subsequently, he explained the operation of the engine based on a drawing (which is not preserved). The description, however, includes the statements that it operates with a ring gap and an internal ignition. The main ignition would, therefore, be an external ignition. Winkler reported, on 30 November 1930, about the first burning trials. *The nozzle burned very evenly almost without a bang. However, the pressure in the combustion chamber and the recoil have hardly been measurable.* In contrast to the experiments at the Junkers plants, the liquids were now in the boiling state, so that a part evaporated. Methane appeared to be an excellent fuel. If enough liquid oxygen flowed along the wall, Winkler thought the cooling should be sufficient. On 18 December 1930, Winkler described his working week, which showed his extraordinary strain. The letter of 7 January 1931 showed that the engines used not just an excess of oxygen, but the intake nozzles were tilted to produce a centrifugal force. To this, he gave the following sketches to Hückel (Figure 12-5).

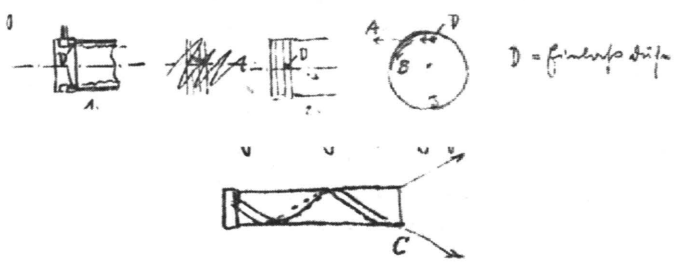

Figure 12–5: Winkler's drawings to illustrate the fuel injection.

These sketches and the drawings for the engine of HW 2 prove that HW 1 and the future HW 2 had the same cooling systems. In the letter of 7 January 1931, Winkler also informed Hückel about the formal denunciation by the Junkers-Factory, which had hurt him very much and revived his thoughts about an exit. He would also be very burdened that his current debt from living was 400 RM and asked for in advance, which could be offset against the income from the rise of the HW 1. In his reply of 7 January 1931, Hückel emphasized that Winkler was the one who *penetrated deeply into the theory and practice of the liquid rocket in Germany.* On 17 January 1931, Winkler thanked him not only for sending 400 RM, but also enclosed a thrust diagram showing that the model had become more stable. The return would be 8 kg, and the combustion chamber pressure would be 4 atmospheres. The apparatus, on the other hand, would weigh

only 2.7 kg. On 20 January 1931, Hückel congratulated Winkler on his success and told him that without air resistance the climb height would have amounted to approximately 1.5 km. He planned to pay 8,000 RM annually for future cooperation, so that Winkler could devote himself entirely to his own rocket. In a 25 January 1931 letter, Winkler described the remote control of the model 1. With the letter, he also sent Hückel an image of the apparatus. He calculated the height of vertex about 400 m, which would be too much for the parade ground at Dessau when the rocket was being driven off. His aim would be to establish a company to produce registration rockets for the German Aerospace Center (DVL) or a meteorological institute. In the letter of 29 January 1931, Hückel expressed astonishment about the design of HW 1 and wrote: *Thank you very much for the photos. They leave the apparatus quite different from the one shown on your first sketch. Six vessels were visible on the latter, while in the photograph only three long and one short appeared. This asymmetry is probably the reason why you fear the occurrence of a torque. With perfect symmetry no torque is possible.*

Hückel could provide Winkler 6,000 Marks in 1931, whereby Winkler could also use a part for personal purposes. On 7 February 1931, Winkler described the failed start up attempt because of a leaky methane valve. About the height, Winkler calculated 640 m. Winkler also described his experiment with dinitrogen tetroxide, which he himself produced. The HW 1 reached a height of 2 m on 21 February 1931. No press information appeared because Winkler had no permission from the Junkers Factory. According to the letter dated 14 February 1931, the plant management of the Junkers-Factory Johannes Winkler generally refused to publish the model's rise. On 28 February 1931, Winkler decided the first attempt would be made when he was no longer bound by the Junkers Factory. After Hückel had also declared the takeover of the bank debt against Philipp von Doepp, Winkler finalized his employment at the Junkers Factory on 7 March 1931. He received a supplementary certificate from the Junkers Factory on his assessment of 20 March 1930.

III.2. On the Cooperation of the Hückel / Winkler Working Group— HW 1 and Its Versions

Hugo A. Hückel informed Johannes Winkler, on 12 March 1931, about the dispatch of Deutsche Bank's commitment letter and the transfer of the 600 RM to the Anhaltische-Dessauische Landesbank to replace his commitment to Philipp von Doepp. This was the basis for his cooperation with Hugo A. Hückel. One week after the end of his work with the research institute Prof. Junkers, the first European liquid rocket HW 1 (which according to today's standards was more of a measuring device) was demonstrably launched near Dessau on 14 March 1931.

It lacked a rocket's shell, a control mechanism, and a payload. The launch of the HW 1 nevertheless represented a milestone in rocket technology, because it demonstrated for the first time in Europe that a future rocket design, with the help of a fluid propulsion system, was possible. Without Johannes Winkler's systematic research at the Junkers-Factory, this would not have been possible. In his letter of 14 March 1931, Winkler described the successful launch of model 1, during which a Paramount News cameraman and two other gentlemen participated. The model would have been 20 m high, then would have flown 200 m distance. The apparatus was destroyed, but the individual parts would have been well preserved. *I have deliberately refrained from using the spin effect this time.* Winkler deeply regretted that Hückel was not present and hoped very much for a good impression in the press. After a shortcut in the *Anhalter Anzeiger* from 16 March 1931, Winkler gave a detailed description of the HW1 design in the same newspaper on 18 March 1931. The rocket would be a three-sided open column whose edges were formed by the three oxygen bottles. The apparatus would be about 70 cm high. At the upper end was a small bottle with a specially prepared fuel. Two manometers were used for reading. The spark plug was located on one of the upper connecting struts. *On the apex of the upper part, which is like a three-sided pyramid, is the combustion chamber, a downwardly open tube.* In the following days, further publications appeared in the German and international press. Notable in the press reports was the lack of reference to the concrete fuel methane. In his autobiography of 1933, Winkler mentioned this fuel in *Men of the Rocket*, Werner Brügel's book: *The apparatus had a take-off weight of 4-5 kg at about 1.7 kg, which consisted of liquid oxygen (-182 degree) and liquid methane (-164 degree).* On 19 March 1931, Winkler continued his reporting to Hückel on the start of model 1 and described the extensive reaction of the press, including a representative of the German-friendly Hearst press in America. However, it was not possible to generate significant amounts of money. For the public, Winkler thought of an intermediate model 3–6 meters high to impress both the public and media. He then switched to problems of the future model 2. Hückel's response, on 21 March 1931, must have been like a cold shower for the euphoric Winkler. The rise of 14 March 1931 and the reaction of the press would have been pleasant, but the contact between Hückel and Winkler would not have become more intimate. He would have reported only three pages in the last 14 days. The construction of an intermediate model would only delay the material development work, and the prospect of profit would become very vague. Furthermore, the actual work would be a failure because the actual height did not meet expectations. On the other hand, the combustion and the recoil were a complete success. The straightforward rise had not yet been solved. Hückel expected

extensive information on technical and scientific work. That was not be an unreasonable desire for 11,000 RM a year. For further work with the M 1, he required prior information on the intended trials.

III.3. Versions of the HW 1 (March to July 1931)

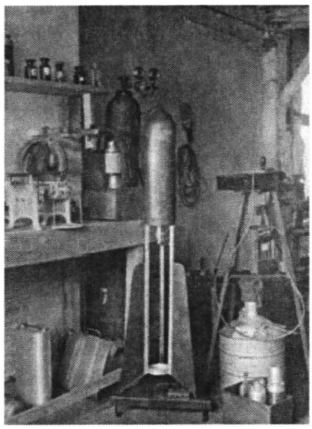

Figure 12–6: New Version of HW1 with fins.

From the end of March to the beginning of May 1931, the transition from the measuring apparatus HW 1 to a vertical rocket HW 1c was carried out by means of intensive experiments. While Hückel previously had been the learner, he now had a decisive share in the road to HW 1 c. It became the basis for the HW 2. Regarding the HW 1 version, Winkler wrote on 24 March 1931 without reference to Hückel's objections: *The model now has 3 fins that are inclined to the direction of flight, so that a rotation of the model is caused by the air forces.* It was only after these specific statements that Winkler went to Hückel's conclusion that the attempt of 14 March 1931 had been a failure. *One can not reproach a model in which one wanted to gain experience only if it does not yet do what a new constructed apparatus would do on the basis of the accumulated experience.* All subsequent letters between the two were largely oriented on model 2. The comments on the versions of the HW 1, thereafter, were rather scattered in the correspondence. Hückel wrote, on 31 March 1931, that he was not sympathetic to the idea of making the whole rocket model rotate. Considerable rotation was needed to achieve stabilization. Hückel also referred to Oberth's book *Wege zur Raumschifffahrt* and its reference to tail fins. Nevertheless, on 8 April 1931, Winkler made an attempt with slanting fins, but it did not bring any breakthrough. However, the tightness of the new valves could now be ensured. Furthermore, Winkler wrote: *I will therefore choose for the next ascent a form in*

which the tanks lie above the combustion chamber, as generally chosen (also by me), and which is close to your letter of April 3, but without an additional nozzle and without a rotor.

Therefore, for this new intermediate form, the fuel tank was only half as large in volume. Hückel wrote, on 9 April 1931, that he would advocate the attachment of tail fins in another attempt with an HW 1 version. *If they are not likely to prevent the twisting of the propulsion during the drive, they will do so by ceasing, in the case of free flight. ... I would like to ask you to carry out the following as soon as you have completed the climbing tests with the present M 1: a small model M1b to be built exactly according to your design form b but with a maximum of 2-3 liters content so that the parts of the current M1 with exception of the tanks. It would be extremely instructive to know whether a vertical ascent takes place with this form.* The start if an expensive model 2 could only happen if a vertical ascent were secured.

The breakthrough in the vertical rise of an HW 1 version was achieved on 27 April, and Winkler wrote: *I will send you a picture of the rise of Mod 1 on the 25th of April ... The apparatus rose completely vertically. After exhausting the fuel, he turned and went down with the tip down. The apparatus tilted rather sharply at the highest point, the effect of a torque is not seen in it, which happened much too suddenly, but this is clearly the effect of the fins, the tilting was like an arrow.* Now, however, these tests should be interrupted, otherwise he could not work on the larger model 2. On 2 May 1931, Winkler added: *I am adding a slightly better photograph of the model 1c, it has a height of 1.30 m ... The model had been rebuilt, with enlarged containers, O_2 normally about 1.6 l of methane spherical 100 mm in diameter. ... This time I added the additional nozzle, which occupied the entire space between the three fin strips* (Winkler, 27 April 1931). On 26 May 1931, Winkler informed Hückel that he would bring model 1 into the intended 2c shape and make some climbing attempts to study the effectiveness of the fins in the non-drifting state. Hückel confirmed the procedure to make preliminary tests in the form of the future M 2. Winkler later devoted himself to this and confirmed, among other things, the identity of the cooling system for HW 1 and HW 2: *The inlet nozzles for O_2 are arranged obliquely to generate a spin, as in Mod. 1 ...* (Winkler, 9 July 1931).

IV. "Modell 2"—10 Times Rocket No. 1

Already before the successful launch of the development platform Hückel-Winkler-1 (HW1) on 14 March 1931, both men began to think about a larger rocket. In his letter from 16 July 1930, Winkler told Hückel that after testing all

the materials and components, he would proceed with developing a *10x bigger type.*

IV.1. Revolutionary Idea: Rocket Cladding = Tank Wall

During further discussions about the new type, Hückel had the revolutionary idea to use the outer skin of the rocket as a container wall for the fuel. Thus, on 14 November 1930, he wrote to Winkler: *We have already observed earlier that the performance of the model now under construction must be considerably increased. Apart from the fuel consumption, the mass ratio still needs improvement. When looking at the current model, a fundamental error immediately arises: the container walls just fulfil this very purpose. While the rocket coat has only one meaning, to give the whole the favourable shape for air resistance. [...] All of the above-mentioned causes of a rather favourable mass ratio would be eliminated by an arrangement which I have set out in the attached sketch. The rocket jacket is at the same time a container wall, there is only one container for O_2 and CH_4 and the volume utilization is almost 100%. This construction must result in a very significant improvement in the mass ratio.*

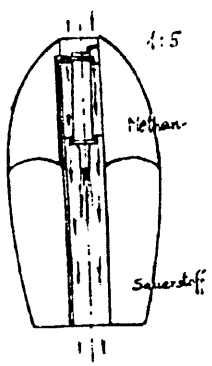

Figure 12–7: Hückel's drawing for model 2.

At the beginning of 1931, the project materialized. In Winkler's letter dated 25 January 1931, the term "Modell 2" emerged for the first time: *In this respect, I am in favour of starting with Model II as soon as possible, and to realize a successful liftoff. Construction of a combustion chamber and a general structure seems to me to be adequately clarified. [...] It is to be considered whether the new model should not already have a ten times greater weight.* And he estimated that due to the experience gained with the HW1 development, he could complete the new model in 26 weeks until take-off.

Hückel immediately confirmed (29 January 1931) this goal and corrected that it had to have about a ten times bigger tank. Also, *a parachute should be considered.* And he is willing to invest a considerable amount of money for this: *I believe I can offer you about 500 marks a month—6000 marks for 1931.*

Winkler immediately started work and compiled the most important parameters of the new rocket for Hückel on a data sheet (7 February 1931). However, he doubted how this increase in size, weight, and thrust could be achieved. In the letter of 19 March 1931, immediately after the first launch of HW1, he proposed an *intermediate model* to proceed step by step. Hückel quickly rejected that approach on 21 March 1931 and asked Winkler to focus on the new goal: *Right now, where the first take-off has been achieved for Germany, we don't need to show anymore consideration for the media, and, on the other hand, we must fear that a foreign competition will surpass us.*

Eventually, it was not a foreign competitor, especially since Dr. Lyon's success messages soon proved fake. But on the Berlin rocket airdrome Berlin, Klaus Riedel managed to successfully launch a liquid rocket only two months later. These two teams were now in competition. This was a difficult situation for Hückel. He was also financially invested in the VfR, and he had been admitted to the board of the association for space travel. Unilateral preferences for Winkler would have been regarded as biased, especially since Winkler had remained a member of the management board after his resignation as VfR chairman at the end of 1930. Therefore, Hückel decided to conceal his cooperation with Winkler for the time being.

Although Winkler also developed and tested various modifications of the HW1, he now focused on development of Model 2. He reported to Hückel, on 24 March 1931, that he *now turned towards the initially planned model 2.* He calculated the repulsion power of the larger model should be 100 kg. And he continued: *I am currently working on two options, which differ only in the container construction.* Impatiently, on 1 April 1931, Hückel asked when the first combustion tests with model 2 were to be expected. From Winkler's data, he calculated a vertical ceiling of 100 km with a payload of 36 kg. On 8 April 1931, however, Winkler replied that the situation was not quite as favorable as Hückel assumed. He only anticipated an exit velocity of c = 1000 m/s, which would result in a maximum altitude of only 12 km. Prior to this, he had stated in the letter of 4 April 1931 that *the construction of Mod. 2 must be started immediately, in order to test the combustion process.* On 2 May 1931, Hückel agreed with the plan for an immediate start of construction. As early as 12 May 1931, Winkler announced that the combustion chamber for model 2 had been completed, *the work on mod 2 is going well.* A month later, on 20 June 1931, inlet nozzles, pipe connections,

valves for methane, and oxygen as well as the manometers were ready for use. The tanks, which were to be formed from a magnesium alloy (electron plate), were still missing. The outer hull was supposed to be made from this very light metal as well. The company in Bitterfeld experienced delays while providing the desired material thickness. In addition to shaping the metal on the lathe, one had to first learn about its welding, since magnesium is highly flammable.

IV.2. Move to the Berlin-Tegel

The enormous noise emission of the combustion tests of Winkler's small rocket models HW1b and HW1c in a workshop in Dessau fueled the anger of the neighbors. Winkler was forced to look for a new test ground. At first, he still hoped for the support of the city by providing a suitable workshop. Then he went on trips to the surrounding area of the city to find a suitable location. Besides being a mostly deserted area, the location nonetheless required access for transport of equipment and fuels. In the middle of March 1931, Rudolf Nebel had already offered him the cooperation on the Berlin rocket airdrome. But Winkler was reserved and wanted to know Hückel's opinion on the matter. On 21 March 1931, Hückel replied immediately and encouraged him: *Secretly (before the close of our close working group), I have always wished that you would again receive the offer to work within the framework of the VfR again. [...] My ideal conception would have been if you could have worked, with my support, at the Berlin rocket testing range, but I have never dared to approach them with this proposal because of the earlier differences.*

Winkler immediately headed to Berlin and, the next day, visited its missile launching area. *For the first test it seems to be quite ideal*, he told his sponsor on 24 March 1931. Hückel asked him to list his conditions for a move to Berlin: Did he want to move with his family? Number of rooms required? Cost-related issues? Could the Berliners provide support? Hückel, from his hospital bed, did not know the living and working conditions on the rocket field. Over the winter of 1930–1931, the team had cleared old ammunition bunkers, set up a building as an office, and established their presence. Several young men (Engel, Heinisch, Riedel) lived there under poor conditions. In November 1930, Klaus Riedel thanked his grandmother for a package of sausages and apples. *The stockings and underpants were also greeted with joy.* Willy Ley described, in a letter of 14 June 1931 to Hermann Oberth, the conditions as follows: *Nebel, Riedel and our workers outside have lived on love alone and sometimes literally starved. It happened that important letters could not be sent out, because the money for stamps was not sufficient, that the whole rocket test range was left without lighting, because the electricity bills could not be paid, that during the last winter, at minus 15 de-*

grees, not a single bucket of coal was available. [...] In winter, they slept in ice-cold concrete houses on large piles of floor mats. In the forenoon (in the morning they could not get up because there was no light) they tried to cook a poor meal on a spirit stove. When I got out there in the afternoon, I bought a few cigarettes from my last money, which I had in addition to a ticket, so I could at least offer them a little bit of pleasure.

Winkler, too, recognized the extremely harsh conditions and summed them up, on 26 May 1931, to Hückel as follows: *What it really looked like, the apartment consisted of barracks on the parade ground, excellent for scouts and hikers, but I am married and have two children.*

While he was skeptical about living conditions in Berlin, he was able to report further progress on the construction of model 2: *The apparatus is now near completion, the piping has been finished. [...] Even the outer cladding is almost finished, I have started the centring process*, he told Hückel on August 8. The melee in Berlin went on. Hückel continued to promote cooperation on the rocket test range: *If, in the course of the work, you come to the conclusion that your permanent activity would be desirable there and that it would give you certain advantages, then it would be time to discuss the conditions for a permanent appointment. Should we achieve no adequate settlement then you will be free to leave Berlin again*, he wrote Winkler on 17 August 1931. Winkler returned to Berlin at the beginning of September to discuss the conditions for the emigration of the new test equipment for model 2. The conclusion was disillusioning: *From the first moment on, I had the feeling that a joint use of the missile testing range was not wanted*, he wrote to Hückel on 12 September 1931. Hückel acknowledged Winkler's opinion and answered, on 14 September 1931, that the question of rocket launching was therefore answered negatively, *and we will not spend any more time on this issue.* In the following weeks, Winkler revised his opinion. He told Hückel, on 30 September, that he had already written to Nebel and that he would move to the rocket test range in the following days. This happened on 5 October 1931. He also found a furnished room close by at Frau Jury in Scharnweberstr. 108. His wife with the two daughters remained in Dessau, but they corresponded regularly. In her correspondence, too, the working conditions on the rocket field and cooperation with the Nebel group were often discussed. Occasionally she visited him in Berlin.

The first weeks focused on installation and furnishing. Staff members Rolf Engel and Hans Bermüller from the Nebel Group joined the Winkler team. In the laboratory building, he found better conditions than in Dessau. In the first days, a shelf was built, the power supply connected, and the control panel was gradually installed. The test rig, which could be observed via mirrors, was built outside.

His wife was very relieved that he could conduct the planned tests with sufficient protective devices. And she already asked curiously when he would execute the first tests (12 October 1931). Hückel also began to inquire about this matter. On 14 October 1931, Winkler was optimistic, expecting *to come to the first combustion test next week*. At the end of October, however, he had to admit he had been unable to make an attempt due to lack of transport containers for the liquid oxygen. Hückel gave free rein to his disappointment on 1 November 1931, writing that "*he was gutted*" about this message.

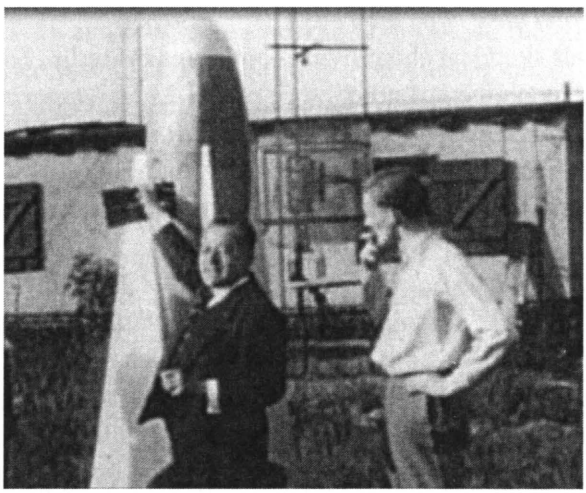

Figure 12–8: Winkler and Rolf Engel with Model 2 on the Berlin rocket airdrome.

IV.3. Combustion Tests

Winkler answered him on 4 November 1931: *After all, what is the advantage of a hasty combustion test without knowing the measurement categories? Repetition waste of the precious methane and waiting time for a new delivery. However, personally, I would now like to begin testing next week and I also believe in the possibility of success with the right instruments*. This topic led to a serious controversy between Hückel and Winkler. The former asked about testing regularly in the following weeks. Thus, he opined on 13 November 1931: *It would be extremely desirable from a tactical point of view if we could already look back on successful tests in the negotiation phase because it is to be assumed that on the other side more emphasis on your presence at the rocket field, the more they are convinced that you are valuable work because competitors do not like to come up.*

This requirement was modified in the following days: *I ask you to prepone the combustion tests at all costs. You can hardly imagine how much I am looking forward to receiving results. As of now there is a lack of judgement as to how far we have progressed, as long as the rocket engine has not been started* (Hückel on 19 November 1931).

I would like to begin by discussing the point which has always been the most important to me, namely, the combustion tests. I have now realized that the completion of the registration device cannot be predicted in any way, and I believe the path you have chosen is not the correct one. I base my opinion on the fact that we do not know yet about the new engine that it is in a stage which makes registering most of the planned sizes probably at present needless, because the registration of most values is necessary only at an advanced development stage (Hückel on 2 December 1931).

However, I would like to ask you again to carry out all further work on the recording mechanism not before the start of the combustion tests, but in parallel with them (Hückel, 3 December 1931).

Winkler, somewhat irritated, replied to this permanent demand for burning tests on 4 December 1931: *In the fundamental differences in the views on the working method, however, I believe that our working community is scarcely to be sustained, it must necessarily lead to disgust, and it must be considered whether it is not preferable not to let it come first, the victims are large on both sides and it would be very unfortunate if the work ended with a disagreement.*

Hückel verbally soft-pedaled in his next letter but was correct with his demand. Winkler did the same, on 4 January 1932, when he replied that he intended to start the trials without regard for completion of the measuring apparatus. Not until 5 March 1932 did Winkler carry out a single successful combustion test with model 2. But since the measuring apparatus still did not work to his full satisfaction, the diagram gave only a rough impression. After all, 100 kg of thrust was detected.

IV.4. Prestressing Wires

Tests in January and February had shown that the opening of the valves was not reliable and, therefore, the supply of methane and oxygen did not work. Winkler used valves opened with a spiral spring. In the closed state, the spring was wound, and the tension was held by a prestressing wire. Through current flow it should have been heated, melted quickly, and released the spring. As a result of icing, this did not always work. Therefore, both men tried to get to the bottom of the problem. Winkler realized that Joule's law would not work. Was it the additional cooling on the ice-cold valve, which required a higher heat output?

Hückel then made some theoretical assumptions, comparing the electrical properties of steel, copper, and aluminum. He considered the wire cross section, its length, its resistance, and determined the amount of heat required to reduce the strength to a third, then made specifications for the required current. He asked directly on 11 February 1932: *On this occasion, I wanted to ask whether you had switched an amperemeter during the attempts to glow into the circuit to set the maximum current? I would very much like to endorse the question of glowing through the most thorough study. It has already spoiled this problem for us.*

Winkler confirmed Hückel's analysis in his reply of 15 February 1932: *Thank you for your letter of Febr 11. Your comments on the prestressing wires are quite close to the actual conditions. [...] I am glad that you have taken the trouble to get to the bottom of the matter theoretically.*

According to Hückel, Winkler was able to carry out a series of experiments and reproduce the results in a diagram, which confirmed Hückel's theoretical view.

IV.5. Flight Stability

Already, shortly after the successful start of the HW1, Hückel spoke of the flight stability problem. Winkler had told him about the trajectory and drifting of the platform. In the following months, Winkler modified the HW1 design. On 17 April 1931, Hückel remarked: *On the new model, I noticed the one thing that made the tail fins so short. In weight this can not play any role. I would have made them twice as long as sketch b, or even as long as c. I would put a cover over the whole apparatus, similar to that of the projectile. I am thinking not only of the reduction of the air resistance, but rather also to prevent the air forces from producing on the irregular surface torques by one-sided action. I think you too have thought of such a cover. Everything should be done, which somehow hope to improve the flight stability.*

Winkler only came to the point of asking this question in his reply of 20 April. In the following months, however, the mentioned modifications of HW1b and HW1c were carried out.

It was only in September 1931 that Winkler came back to this question. He told Hückel about a conversation with Dr. Martin Schrenk (1896–1934) from the German Institute for Aviation (DVL) in Berlin-Adlershof, which also concerned the flight stability of rocket bodies. In the letter of 17 October 1931 he became more detailed: *Flight stability: The ascent is not quite accurate when using the center of gravity be perpendicular, but start obliquely and then become steeper, which hardly hurts. At the purely vertical flight can easily occur in the case of a deflection rocket axis is not steeper than the trajectory, resulting in a discontinui-*

ty. This consideration also gives why Tiling with the forward center of gravity a fairly vertical flight. If the rocket initially has a certain vertical upward directional velocity, the fins act in the direction of the body for a very long time. However, the latter method should fail. The low center of emphasis during the driving period is probably the safest method. This must now be tested.

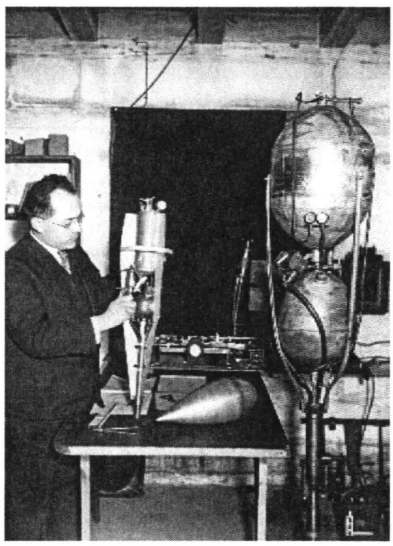

Figure 12–9: Winkler in the Berlin laboratory, in the foreground right the open model 2.

He was already in the middle of the work on model 2 and had just set up his laboratory on the rocket launching area Berlin. In the letter of 17 November 1931, he even considered tackling the problem of air stability before the first combustion tests: *Perhaps it is to be considered whether we should not deal with the issue of air stability before the combustion tests. In spite of the stated principle, it still troubles me more than the efficiency of the engine, as long as there are not systematic tests. But it is conceivable that there are other influences which modify the thing. The experiments would be done first with powder rockets, then with the model 1, so that we then also let rise sufficiently.*

He then put this idea into practice by experimenting with powder rockets on the rocket field in mid-November. In the letter of 30 November 1931, he told Hückel: *I then let these rockets rise at some extreme loads. 1.) with a one-sided rod of 135 cm length and 90 gr weight, the center of emphasis was 32 cm from the top of the rocket. On a thread in the center of emphasis, the rocket and the stick turned up like a weather-beater against the wind. The rocket rose excellently and perfectly perpendicularly That is, even in the case of a longer driving time,*

nothing is to be feared and the arrow shape does not interfere during the driving period, which greatly simplifies the work.

Winkler also made these findings in his 1932 work "Der Strahlmotor." He devoted an entire chapter to the issue of air stability. Hückel, on the other hand, was skeptical about whether this gain in knowledge was really beneficial. He immediately noticed: *Experiments with the powder rockets for the investigation of flight stability are undoubtedly very instructive. But I cannot deal with this chapter in detail now, because these questions are not immediately clear. I am always only able to answer those questions with the interest which is a condition for a successful achievement, they are of immediate importance. I am in favour of the problem of flight stability. When the rise of the rocket is no more a technical obstacle than this* (3 December 1931) Winkler responded one day later: *Flight stability studies: The few attempts are of a rough orientation, now the thing may mature in the subconscious. The time expenditure was very low for these experiments, the burning test took about two working hours, the climbing attempts one quarter hour, the experience gain is considerable.*

Hückel resumed the question in January 1932 and remarked: *I did not really want to raise the question of air stability until later, but now that once I am cut off, I will just like to call my suggestion: I think it right and necessary to carry out experiments with "similar models." There is a "theory of models," for which I have not been interested. I only know so much that it is possible, the movement of the main execution with the help of a geometrically similar small body the experiment before. As is known, this method is used in marine hydrotechnics a lot. The big question mark in aerodynamic terms for M 2 are the fins. You have raised small powder rockets with a long burning time, which rose flawlessly. These rockets, however, had very long fins (rods), which were perhaps 6 times the rocket body length. Their shape was therefore very different from that of M 2, and I would not dare to close it from the ascent of the small rocket to that of the great. The fin length of the small rocket would correspond to a large one of perhaps eight to ten meters. I therefore consider it necessary to produce small models which are geometrically similar to the large rocket (in particular with respect to the fins)* (Letter of 14 January 1932).

In his reply of 18 January 1932, Winkler agreed with him: *Flight stability: I agree with you regarding the transmission of model values to the large body. The whole wind tunnel measurements have only made sense through this method. In the case of the rocket, things are more complicated in that the speed changes considerably and the importance of the missile rod has not yet been fully recognized in all parts; it lies not only in the air flow, but also in the gassing beam.*

In the letter of 26 January 1932, Winkler added: *Stability studies: The following applies to the transfer of model values to the actual conditions: speed (in m/s) times the length dimension (in mm) must be the same in both cases. This number is called the characteristic value. The wind tunnel only applies to the same characteristic value measured resistance coefficients, etc. In our case, this means that for the model the velocity must be greater.*

Wind tunnel tests would be required. "*Once the burning trials are tolerable results, I shall turn to the question of stability.*" In May 1932, the topic was taken up again briefly in connection with considerations on model 3. But as regards model 2, Winkler felt confirmed by experiments with powder rockets.

IV.6. Risk of Explosion

When Hückel studied Winkler's construction drawing, he recognized a possible problem. On 24 April 1932, he wrote to Winkler: *Obviously, you think that in the disguised rocket an explosive mixture is formed within the shell as a result of permeable points (e.g., CH_4-valve). I quite share your concern. As a countermeasure and protection measure, I propose to blow the air out of the interior with the help of CO_2 or N_2 and replace it with a carbonic acid or nitrogen atmosphere. CO_2 is perhaps preferable because it also has a cooling effect. However, this is not an unconditional protection, since CH_4 and O_2 escapes simultaneously within the same space. Can a horizontal separation slice be installed between the O_2 and CH_4 tanks? One could also think of carrying out the CO_2 aeration up to the launch.*

This hint was extremely farsighted. He repeated this recommendation soon after the first attempt to start on 30 September 1932. Winkler fatally, in his reply letter of 23 April 1932, only took a marginal approach to the proposal. And he wanted to stop further firing attempts to complete the rocket and to start until 7 June. He ignored Hückel's numerous requests to ensure the stable operation of his development by means of burning tests before a public launch.

IV.7. Launching Area

The correspondence of the following weeks and months was marked by the search for a suitable launching place. Winkler tried to implement the launch of model 2 within the contract period with Hückel. Hückel, on the other hand, could not contribute anything from his sick bed, Winkler and his colleagues were left with the initiative. Technical developments were no longer addressed; model 2 seemed perfect. On the other hand, the search for a suitable terrain was difficult. The missile launching area was much too small for the possible altitude of 12 to 40 km. In June 1932, Winkler asked the Reichswehrministerium in Berlin. Since

they were itself in the erection of their own area in Kummersdorf, none had interest in publicly effective rocket experiments. The Ministry's reply was unfavorable on 20 June 1932. However, Winkler would have learned of the (failed) demonstration of the Nebel group at the military firing range Kummersdorf that week. He had to tell Hückel, on 30 June, that he had also given a warning on the location question for the launch. He then tried in the surrounding area and asked the municipal authorities in Belzig, Luckenwalde, Baitz, and Fredersdorf. But here he was referred to the harvest season. Thus, he went to the island of Usedom on 1 July 1932, and he spoke to the heads for cures in the Baltic Sea baths from Bansin to Swinemünde. In Bansin, no one wanted to disturb the bathing season. In the second place, a deposit of 2,000 Reichsmark was demanded as a guarantee for damages. Ultimately, the Greifswalder Oie, a small island off Usedom (which was to serve as the launching point for Wernher von Braun's team five years later). The tenant had first agreed and had already informed the press. The rocket was packed into a transport crate, attached to the launching platform, and sent by train to Zinnowitz on 15 July. Winkler, Engel, and Bermüller traveled afterward. Engel still looked quickly at Hückel in the sanatorium Waldfriede in Berlin-Zehlendorf and received from him another 200 Marks in cash. But also, a start from the Oie smashed on licensing issues. Thus, Rolf Engel drove again, at the end of August 1932, to Berlin and spoke in the Reichsverkehrsministerium (ministry of travel). He was recommended to the Baltic Sea at Pillau (East Prussia). Thus, the Winkler group set off by ship for Pillau on 10 September 1932. Before that, they were still in Königsberg for a few days and introduced the rocket to the public. On 20 September 1932, he could tell Hückel: *Now these things have been settled, we went yesterday with a boat of the water engineering office to the Frische Nehrung, we were given a workshop space in a barrack, as well as an accommodation room. From the Kommandantur we are given a car, the permission to drive along the coast road is given. The forester of the water construction engineering office company Mr. Onasch has so far supported us with his vehicle.*

On 28 September, the start-up test had to be interrupted, because the oxygen valve completely iced up in the damp sea air and did not open as planned. Bad weather prevented another attempt for a week. On 6 October 1932, the explosion of the rocket at a low altitude seconds after launch, with the outer skin blown off, occurred in front of the camera. A gas explosion in the interior was assumed to be the cause. That assumption was supported by some newspaper reports. On 7 October 1932, the *Berliner Volkszeitung* reported in its morning edition, independently of each other, that *the ignition failed, so that Winkler climbed out of his dugout again, and once again the manometers and apparatuses at the Rocket tested. Then the spectators watched as he hurriedly looked back*

at the protective cover. Again the electric ignition took place and after two minutes, the rocket leaped from the launch rack with a loud bang. Instead of climbing 7000 meters, the rocket surged towards the photographers' dugout. The metal sheath surrounding the rocket shattered and splintered the surrounding area. The many transports had apparently caused damages to the pipes, valves, or screw connections, and a leak had developed somewhere, so that in the time between the first and second ignition an explosive mixture occurred in the interior. That led to the destruction of the rocket during the renewed ignition.

V. Model 3—A Two-Stage Rocket

Although the work on a larger rocket model with the failure of model 2 was obsolete, at least the reflections of both rocket pioneers for a model 3 were to be reconstructed based on their correspondence. And it started very early. On 8 April 1931, shortly after the first launch of Winkler's test platform HW1, he wrote to Hückel: *An apparatus (3) with flowstreamlined tanks, otherwise, similar to model 2a would have an initial weight of a thousand kilograms when it exceeds the 30 km limit at M0 / M1 = 5 (without payload) and c = 1000 m/s. The apparatus would have—built according to model 2a—an altitude of 6–7 km. This would be, for example, the first apparatus to be taken seriously.*

Hückel reacted quite dismissively, saying it seemed to him to be too far into the future: *Now, as far as you are concerned, I must say that I am not going to agree with the construction of the M3, unless this rocket engine has experienced a substantial improvement (performance increase), or we have not done anything imaginable to achieve this* (17 April 1931).

Winkler soft-pedaled and wrote on 20 April 1931: *Mod. 3: I am, of course, of the same opinion that a series of tests must be switched on between mod. 2 and mod. 3 to improve the rocket motor, since this is already paid for larger models. If only to take the future, then right.*

Therefore, on 29 April 1931, Hückel presented a proposal on how model 2 should be surpassed: *Your suggestion with regard to M3, I would now oppose a counter-proposal. It sounds quite bold, but it can be practicable. M3 could already be a 2-stage rocket. Lower rocket 390 kg full, 90 kg empty without payload. Upper rocket. 50 kg + 10 kg starting device, together 60 kg. Both rockets together 390 + 60 = 450 kg take-off weight as a whole. These figures are only intended as guidelines. Thus, M2 is intended as a payload, and since it would reach only at about 15 km of altitude, it would be equipped with a nozzle for a high degree of expansion. I believe that in this way far more than 40 km of altitude could be reached. As soon as the design and size of M2 is fixed I would like*

to calculate the case. Well, M3 is still in a foggy distance, but it still attracts projects to make.

Hückel went so far as to propose a two-stage rocket model at that time. It was still *in a foggy distance*, but the idea aroused him. Certain considerations and calculations were a welcome change in his hospitalized existence. Winkler agreed with this proposal, writing on 2 May 1931: *Mod. 3 as a 2 stage rocket is probably arguable, especially because I would like to try such a design in practice, whether it is the undivided is preferable, I cannot judge yet, since the air resistance is still considerable and the small model may be more strongly stopped.*

And he went on: *With Mod. 3 we have the key to any performance in the hand. If the funds are flow in the same continuity as before, leaving the current line early would not be right,. B but as the funds are limited, I would almost advise them to throw them all to the decisive front. Since the test equipment and extensive experience of the construction of Mod. 2 are present, we should be able to move forward quickly and possibly still Mod. 3 to start, we would then with 30 kg of fuel possibly exceed the hitherto reached heights. I would be very happy if you could agree with. This suggestion is by no means a result of fatigue, but of the tendency to go a long way with the resources at its disposal. If we can start Mod. 3, the matter is so far advanced that it is suitable for manufacture and we are able to get orders, which will make it economically self-sustaining. Achieving this seems to me a worthwhile goal.*

After that, these first ideas were replaced by the work on model 2. Only a year later, model 3 reappeared in the correspondence. Winkler was not yet satisfied with the performance of the rocket engine and asked for a higher yield for a model 3: *I agree with the opinion that we have to try to reach the theoretical values close to 100%, in principle this should be the case, it would be possible because turbines of 98% efficiency are built, whether we are looking at the empty weight among others will not have to make concessions, I cannot yet overlook* (4 April 1932).

But Hückel was dissatisfied with the results for model 2. The two burn tests of March 1932 still did not prove the reliable working of the engine. He continued to plead for a successful completion and launch of Model 2 before further activities occurred: *There are a number of reasons that do not seem to me to be useful for M 3 to attack before M 2 is started.*

To open up the prospect, however, his letter of 5 May 1932 contained the following sentence: *P. S. Could you imagine an interim position from 7.6. until 31.12.? If the launch happens until 7.6. and I have nothing to pay from this date, I could probably sum up 7,000 RM by the end of the year. If work is then carried*

out for 5 months (1.1.33–31.5.33), you then spent 2000 RM on the wages, and 5000 RM on the work and material.

Despite all the financial problems, Hückel offered to support the development of a model 3 as well. Winkler was unsure whether he should accept the offer. He would have to launch Model 2. Thus, he replied on 8 May 1932: *In addition, your proposal for an interim work from 7.6. until 31.12.: It is difficult to say anything, the choice is not too big, you have to create a position for a time if you want to make a normal career, a frequent change is very unfavourable and so it would be better for me one this work would be completed before I began a new one.*

But he continued to pursue the idea of a two-stage rocket: *The construction of the individual elements of Mod. 3 should not be very expensive or cause any particular problems. Only the choice of the two parameters of rebound and empty weight would be made in other respects. The individual element would be small, i.e., be tested with little fuel consumption. A new feature would be the separating mechanics and the good timing of the separation. With the creation of such a single engine for the aggregate in the sense of my formula and a functioning aggregate which can be adapted to any desired performance (this simply depends on the number of individual rockets), the foundation for commercial exploitation would be created, whether Mod. 3 to rise or not; But it would come to the rise.*

VI. Conclusion

The correspondence between the rocket pioneers Johannes Winkler and Hugo Hückel gives a deep insight to the progress of rocket development in the early 1930s. Winkler launched the first European liquid propellant rocket. Ultimately, however, the failure to launch model 2, in October 1932, would end all his private experiments. In addition, Hückel financed supplies, travel, and accommodation, as of 7 June, to ensure a successful launch of Model 2. It is now obvious that he was more than a sponsor, but an engaged engineer. In this way, he has entered space history as an unselfish supporter and advisor to Winkler.

VI. Acknowledgment

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