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The Reichswehr, the Rocket, and the Versailles Treaty: A Popular Myth Reexamined

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This article seeks to demonstrate that, contrary to a well-entrenched myth, the failure of the Versailles Treaty to ban military uses of the rocket had little or no importance to the decision of the German Reichswehr to start work in the technology in 1929/30.

1. Introduction

One of the clichés of popular historical writing about the German rocket programme, which led to the revolutionary V-2 ballistic missile, is that the Reichswehr's Army Ordnance Office (*Heereswaffenamt*) began to investigate the rocket in 1929/30 because it was not banned by the Versailles Treaty [1]. This assertion has a clear origin: the memoirs and statements of the later military commander of the programme, Gen. Walter Dornberger [2]. Yet Dornberger certainly knew from personal experience that the Reichswehr (which included both the Army and the Navy) was far from obsessed with obeying the Treaty—it was violating Versailles as much as was feasible. Although the Treaty certainly set severe limits in German military power, that did not stop the Reichswehr from secretly experimenting with banned weapons such as tanks, aircraft and poison gas, in part through cooperative programmes with the Soviet Red Army [3].

The spaceflight historian Frank Winter was the first to point out that the traditional explanation was problematic—why would the legality of the rocket matter under these circumstances? But given the dearth of original documents from the earliest history of the German rocket programme, he had to fall back on a watered-down version of Dornberger's explanation. My own book, *The Rocket and the Reich*, emphasized other factors, especially the restrictions on heavy artillery in the Treaty, but lack of evidence made it difficult to dispense with the rocket's legality entirely [4].

Now the rediscovery of the minutes of two early Army Ordnance meetings provide strong evidence that *the legality of the rocket had little or no importance in the rocket decision.* These minutes from 17 December 1930 and 30 January 1932 also give much insight into the origins of the decision to pursue this rather exotic technology, and reveal little known aspects of the Reichwehr's early rocket activities, including the active participation of the Navy and the central importance of the pre-World War I experiments of the Swede Wilhelm Unge in the formulation of Army Ordnance's solid-rocket programme [5].

2. The 17 December 1930 Meeting

Army Ordnance Testing Division (*Prüfwesen*) and especially its Ballistics and Munitions Section (acronym *Wa Prw 1*), headed by Lt. Col. Dr. Karl Emil Becker (fig. 1), first took an interest in the rocket in 1929. Becker's attention was drawn in part to the exploitation of powder rockets in various public stunts, a by-product of the rocketry and spaceflight fad of the late Weimar Republic. The firm of Friedrich Sander in Wesermünde, on the North Sea coast near Bremerhaven, used new high-pressure hydraulic presses to manufacture the propellant charge of these black-powder rockets, which were designed as line-throwing, life-saving rockets for use in ship sinkings. The spaceflight fad also generated a certain amount of discussion of the possible military value of solid-fuel and liquid-fuel rockets, which might further have piqued Becker's interest [6].

A second, heretofore neglected context of Becker's decision was the emergence of systematic, secret rearmament planning in the Reichswehr after 1928. Following the Locarno Pact of 1925, relations with the West eased, Germany was admitted into the League of Nations in 1926, and the

Fig. 1 Dr. Karl Emil Becker (1879-1940) in 1937, when he was a General der Artillerie and chief of Army Ordnance Testing Division. Within a year he would become Chief of Army Ordnance. (Courtesy of the Smithsonian Institution)

Inter-Allied Control Commission was withdrawn in early 1927. Oversight of German armament became noticeably less stringent. Under the leadership of a new Reichswehr Minister, retired Gen. Wilhelm Groener, the Army began the "1st Armament Program" in fall 1928, with an end date of 31 March 1933. Its objective was to systematically build up a minimal industrial base and arms stockpile for an enlarged (and therefore illegal) Army. Planning for a "2nd Armament Program" to run from 1933 to 1938 began in mid-1930, with the aim of creating arms stockpiles and manufacturing capacity to equip a field force of twenty-one infantry divisions, triple the Versailles limit. These programmes, combined with the increasing turn of Reich governments to the far right during the Great Depression, created a stable funding basis for the Reichswehr at a level considerably higher than had been the case in the mid-1920s, even as civil budgets were harshly cut after 1929 in the face of astronomically rising unemployment [7].

While secret rearmament planning doubtlessly formed an important context for Army Ordnance's interest in the rocket, when Becker opened his December 1930 presentation to a group that included Gen. Alfred von Vollard-Bockelberg, the Chief of Army Ordnance, and Col. Erich Karlewski, Chief of Testing Division, it was the rocket's dubious associations that were first on his mind:

> Before dealing with the details of the rocket problem, I would like to expressly emphasize that we must approach these questions with the greatest seriousness. Therefore we must fully leave aside for the moment all the well-known plans of recent years, given in numerous propagandistic publications, for space travel with rocket-powered vehicles. By that no value judgement is implied on the ultimate development possibilities for space travel in the distant future. Our first task is, based on theoretical investigations and practical, systematically constructed experiments, to show *to what degree the rocket might serve as a supplement to our weak artillery armament* [8].

By this introduction Col. Becker (as now he was), distanced himself from the spaceflight fad while indicating that he was open-minded enough not to dismiss the topic out-of-hand. For the Army, of course, the only thing that mattered was the rocket's value as an artillery weapon in the context of Germany's extreme military weakness.

After quickly alluding to the eclipse of black-powder rockets in the later nineteenth century by rifled, breech-loading artillery, Becker went on to present a very detailed account of the testing of Unge's "rocket torpedoes" by the Krupp company at its Meppen range in 1909/10. By that time Wilhelm Theodor Unge (fig. 2), a Swedish inventor and Army officer with a German name, had been patenting various solid-fuel rockets for almost fifteen years, but had had little luck selling them to any government, including his own. Becker nonetheless believed that Unge's rockets represented something close to the state-of-the-art even two decades later, in large part because no one took much interest in the technology during the World War. Particularly noteworthy were Unge's various systems, such as a turbine-like nozzle, for spin-stabilizing the projectile like an artillery shell, which allowed one to dispense with fins or the traditional bulky pole. Accuracy was improved, but not enough to convince Krupp in 1910 of the rocket's value. According to Becker and Karlewski, the then Prussian Army knew little or nothing of these tests; Krupp turned its attention to developing mine-throwing mortars as a superior alternative [9].

Becker noted that for the purposes of poison-gas warfare (initiated by the Germans in 1915), the greater dispersion of the rocket was tolerable, and the method was certainly safer than "the frequently used primitive lobbing of gas bottles" during the war. Additional advantages of the Unge-type solid-

fuel rocket included the lightness of the firing tubes or framework, the economical use of materials, and the ease of transportation in difficult terrain. The emphasis he placed on frugality of the rocket, in comparison to conventional artillery pieces, undoubtedly reflected the cash-strapped condition of the Reichswehr, however much the situation had improved in the late 1920s. On the negative side of the ledger was the black-powder rocket's heavy smoke trail, which gave away the launch site, the less efficient use of propulsive energy than was the case with shells, the need for new types of fuses, and problems manufacturing the powder charges. New nitrocellulose "smokeless" powders might remedy some of these problems [10].

Nowhere in the transcript of the 17 December 1930 meeting, which reads as if it was the first formal rocket presentation to the Chief of Ordnance, does Becker mention its legality under the Versailles Treaty as one of its advantages, even though he listed those advantages at length. Nor, for that matter, did anyone else bring the matter up. On the contrary, Army Ordnance's artillery expert definitely saw the solid rocket's greatest potential in chemical warfare, which it bears repeating, was forbidden to Germany under Versailles [11].

In the second part of Becker's presentation on the rocket, he summarized the existing state of development in Germany. He noted the lifesaving rocket work of Friedrich Sander and made the interesting remark that: "We already have had earlier contact with Sander, who delivered to us some rockets for meteorological purposes." A certain Professor Wiegand at the University of Hamburg was also working with Sander on weather rockets, and claimed that Sander had launched one to an altitude of 4000 m (13,000 ft). Another solid-fuel rocket experimenter was "former flying officer" Reinhard Tiling, who had launched rockets with unfolding wings [12].

But for space historians, Becker's most interesting remarks were about the Society for Space Travel (*Verein für Raumschiffahrt* or *VfR*) and Rudolf Nebel, whose liquid-fuel development group, the *Raketenflugplatz Berlin*, was a spin-off of the VfR (fig. 3). Becker saw the VfR primarily as a primarily a propaganda organization under Prof. Hermann Oberth, the man whose seminal 1923 book, *The Rocket into Interplanetary Space* (*Die Rakete zu den Planetenräumen*) had done so much to legitimize the topic. As for Nebel, Becker outlined the secret contribution of 5000 marks to Nebel in spring 1930 for the launching of Oberth's ill-fated rocket built in

Fig. 2. Wilhelm Theodor Unge (1845-1915), a Swedish officer and rocket inventor, tried unsuccessfully to sell his spin-stabilized, black-powder artillery rocket system to the Krupp company in Germany in 1909-10. Twenty years later, his innovations would influence the early solid-rocket designs of the Reichswehr. (Courtesy of the Smithsonian Institution)

connection with the movie *The Woman in the Moon* (*Frau im Mond*), and Nebel's subsequent creation of the Raketenflugplatz on an unused military ammunition dump in Berlin. However, "we have ourselves recently pulled back from Nebel, above all because secrecy does not seem to us to be adequately guaranteed." Equally recently, The Emergency Community of German Science (*Notgemeinschaft der deutschen Wissenschaft*), an influential scientific foundation, had decided that it might finance Nebel, based on a deceased member's interest in upper-atmosphere research. But Ordnance had received permission to give its opinion before the final decision. It is apparent that Becker intended to sabotage Nebel, who he viewed (not without reason) as a loudmouth and threat to military secrecy. Since the Raketenflugplatz did not receive the grant, Becker's intervention must have worked [13].

Regarding developments elsewhere, Ordnance's artillery expert noted that Oberth's 1929 book, *Wege zur Raumschiffahrt* (*Ways to Spaceflight*), "which had been variously received," had been awarded a French spaceflight prize, which he rather suspiciously and erroneously attributed to French interest in military rocketry. The only foreign rocket experimenter about which Becker had information was

the American Robert Goddard, who was he thought was launching Unge-type rotating solid rockets—misinformation that reflected inaccurate press coverage and Goddard's obsession with secrecy [14].

Turning to German military rocket projects, early in 1930, Becker stated, his Army Ordnance Ballistics and Munitions section had held a "extensive meeting" with Navy Ordnance in order to promote collaboration and prevent duplication of effort. The resulting agreement was cleared all the way up to the levels of the Army and Navy Chiefs of Staff. The Navy, through the Torpedo Research Establishment at Eckernförde, had begun a programme to develop smokescreen-laying rockets with Sander. Results had not yet been satisfactory, since some rockets went wild, and maximum range was as yet only 1700 m (about a mile). The Army took an interest in eventually developing the same rocket "for gas and smoke" at ranges up to 20 km, "which is necessary for many situations in border defence" and exceeded the range of much of the artillery. The Navy would also take the lead in developing the Flak (anti-aircraft) rocket, based on unguided solid rockets by Sander. The Chief of Army Ordnance intervened, expressing his desire that the Army take over anti-aircraft rocket development, but engineer Nikolaus of the Aviation section (*Wa Prw 8*) was skeptical that such rockets would be of much effectiveness unless guided, which Becker admitted was impossible in the near future [15].

Under the agreements, Becker continued, the Army would take the lead in the "precision long-range rocket (*Präzisionsfernrakete*)"—in other words, the ballistic missile, an idea that would eventually develop into the V-2 programme. Such a missile would be "gyro-stabilized and eventually remotely guided by wireless... for heavy and super-heavy area bombardment." The Navy might contribute monetarily but was happy to leave this idea to the Army. But Becker quickly left this crucial and fascinating topic behind, noting that the Navy would continue work on meteorological data-gathering by rocket, which the Army felt could be done better in other ways; the Navy would also support Reinhard Tiling's winged rockets, which Army Ordnance equally viewed with skepticism as "too unnatural" in motion [16].

In the short run, Army rocket work would concentrate on the questions of propulsion and stabilization. Privy Councillor (*Geheimrat*) Walter Nernst, physical chemist, winner of the Nobel Prize for Chemistry in 1920, and professor at the Physical Institute of the University of Berlin, was actively engaging his doctoral students in research on propellant and nozzle questions for the Army, in conjunction with the Reich Establishment for Chemical Technology. A "pendular" test stand was to be built at the Kummersdorf weapons range, near Berlin, to experimentally examine nozzle design. As for stabilization and guidance, Becker believed that the large firm Siemens, with which he had already had discussions, might be the best collaborator. But shortage of funds had meant that all this "highly important work" in rocketry research could not be carried out with "the necessary urgency" [17].

A discussion ensued, led by Ordnance Chief Gen. von Vollard-Bockelberg. The representative of the Signals section of Testing Division (*Wa Prw 7*) expressed an interest in signal and line-throwing rockets, while the representatives of the Motor Vehicles and Aviation divisions (*Wa Prw 6* and *8*) rejected rocket propulsion as inefficient and dangerous for their purposes—an opinion not shared by Becker, who thought it might have supplementary value to the internal combustion engine. For the rocket in general, however, Becker had an enthusiastic supporter in his immediate boss, Testing Division head Col. Karlewski:

> After the clear and convincing explanations of Col. Becker, I believe it is our duty to pursue the rocket question with all possible means. Along with remote guidance, infrared and ultraviolet rays, etc., it belongs to the areas from which one day the revolutionary new invention may emerge that Germany has been waiting for in order to achieve rapid liberation. We must stick to our oars in these questions in order to possibly overtake the other powers. If we do not do something in this regard, or do not do it quickly enough, someone else may one day surprise us with the new weapon [18].

Karlewski's statement neatly captures the combination of open-mindedness, desperation and ultranationalist politics so typical of the Weimar officer corps.

The Chief of Testing Division also strongly endorsed the rocket as a battlefield artillery weapon, whether it could be made more accurate or not. Area bombardment was useful, either with gas or shrapnel-producing warheads, and the light launching stands saved money compared to conventional artillery guns, something that would allow faster rearmament. Since the Ordnance Chief had stated that there was no hope that the Reichswehr Ministry would provide a budget supplement of 200,000 marks ($47,600 US), a figure Becker had given before the meeting, Karlewski promised to reprogramme the funds from Testing Division's budget as far as possible [19].

In conclusion, Karlewski stated that: "I would like to ask in addition that these extremely important questions be kept strictly secret, especially in foreign countries and also in Russia" [20]. In the 1930s, the Red Army was the only other military service to invest heavily in rocketry, but this comment helps to explain why there is no evidence of an exchange of rocket technology with Germany before secret military cooperation was cut off by Hitler in mid-1933. There was Soviet espionage activity around the private German rocket groups before their suppression by the Army and the Gestapo in 1933-34, but that is another matter [21].

3. The Meeting of 30 January 1932

Whereas the December 1930 transcript mentions nothing about a previous gathering at that level in Army Ordnance, indicating that it was indeed a meeting of fundamental importance to the history of the German rocket programme, the Chief of Ordnance opened the meeting thirteen months later with an explicit agenda of reviewing the progress in the preceding year and deciding on objectives for 1932 and following years. Becker began by noting that, since the 1930 meeting:

> Through the good offices of the Krupp firm, we held repeated negotiations with the son of the late rocket inventor Unge; the younger Unge was even once personally present for an exhaustive meeting in our section. But in the end he made such far-reaching pecuniary demands with multi-year obligations that we had to break off negotiations. This could be allowed to happen, however, because through the tenacious and intelligent work of the responsible officer [*Referent*], Capt. Dr. Ing. von Horstig, we have succeeded in bringing our own development to the stage at which [the elder] Unge broke off his work [22].

To carry out this research, von Horstig had designed and built a test stand at Kummersdorf which was used for the economical testing of propellants and nozzle forms, presumably the test stand alluded to a year earlier. Black powder remained the programme's primary propellant, but Sander's attempted redesign of his powder charge had been a complete failure. Becker expected that Sander's latest redesign would bring a marked improvement. Experiments with a highly concentrated nitrocellulose (i.e., "smokeless") powder manufactured by the explosives firm Wasag, however, made only limited progress [23].

As for liquid fuels, "numerous doctoral students of the Physics Institute of the University of Berlin" continued their sharply defined dissertation

Fig. 3. Rudolf Nebel, at left, is shown at the Raketenflugplatz in April 1931, along with space popularizer Willy Ley and engineer Klaus Riedel. The engine test stand in the background was made out of the launch rail for the ill-fated Oberth Frau im Mond rocket of 1929.
(Courtesy of the Smithsonian Institution)

projects, while Ordnance had struck up a relationship with the firm of Dr. Paul Heylandt, a manufacturer of industrial gases and related equipment in Berlin. Heylandt had supported Max Valier in 1929-30 before Valier's accidental death, and then resumed rocket work in the winter of 1930-31 with a rocket car that was a technical success but a financial failure. The extremely inefficient propellant usage in the Heylandt rocket car engine (which Becker estimated to be seventy-five times poorer by propellant weight than black powder) had led his Ballistics and Munitions section to give Heylandt a research contract to use compressed air to improve its nozzle design. This fact provides a clearer explanation for why Becker and von Horstig rejected Heylandt's engine and financed compressed-air experiments instead than Frank Winter and I were able to provide in our study of Heylandt, but still leaves unexplained why the Ordnance experts were convinced that the problem lay in nozzle design rather than poor combustion. For the time being, Becker concluded, black powder remained the only

practicable rocket propellant, given the difficulties with liquid fuels and smokeless powders [24].

In the area of stabilization and guidance, Ordnance had made progress as well, primarily through the development of the "so-called finger nozzle." When multiple nozzles were canted at an angle of twenty to twenty-five degrees to the axis of the rocket, they produced the desired spin. (Von Horstig passed around a heat-damaged aluminum "finger nozzle" at this point.) Unfortunately, in test launches the rockets reached 300-500 revolutions per second at burn-out, resulting in the mechanical failure of the rocket casings at the point where the charge and the warhead were joined or in some cases along the casing itself, leading to explosions. "A small consolation" was the fact that the Navy's Torpedo Research Establishment was having the same problem with its short-range smoke rocket. Becker asserted, however, that an interim solution had been found; the rocket now performed better (in accuracy?) than the Unge 10 cm rocket, and twice as well as a field mortar [25].

Based on Unge's launch-stand design, the Reichswehr workshop at Spandau (near Berlin) had built various launch racks which were lighter than Unge's. Test firings had produced ranges from 2700 to 4300 m, with an average dispersion of 150 m at 3 km distance. Becker discussed the implications of this dispersion for the saturation of a battlefield region with mustard gas. His conclusion was that rockets could cover a 2.25 hectare area with mustard for about half the net cost of "1.Sprg.M.18" artillery shells, while the lightweight launch stand was much cheaper than the gun. Even the current "interim solution" would be useful, Becker stated, "in certain cases on the Oder [river]"—a war with Poland being one of the constant preoccupations of the Weimar Reichswehr. To the surprise of the Ballistics and Munitions section, however, the rockets drove themselves so deeply into the ground that live warheads would need more sensitive fuses if the gas was to be dispersed properly [26].

In other developments, the anti-aircraft rocket had been postponed until better fuses and rocket charges could be developed. Similarly, the "gyro-stabilized *long-range rocket* had to be completely put off, as the creation of long-burning and efficient [liquid-fuel] propellants is a fundamental condition for its development." Wa Prw. 5 (Fortifications) was developing a "rocket grenade launcher" and had experimented with "line-throwing rockets." Wa Prw. 7 (Signals) continued to work on a signal rocket, but 6 and 8 (Motor Vehicles and Aviation) remained uninterested in rocketry. Personnel shortages had slowed the work so that not all objectives could be met, but overall Becker assessed 1931 as a successful year in that Unge's rockets had been exceeded in performance. By pressing onward with the same energy, further success was to be expected in 1932. "The approval of the requested extension of the appointment of Capt. Dornberger will be an important condition for that success" [27].

In the minutes of the two meetings, this is the first explicit reference to Walter Dornberger, who completed his engineering diploma (Dipl.Ing.), equivalent to a Master's degree, at the Technical University of Berlin-Charlottenburg in spring 1931 as a part of a technical officer training programme. On 17 December 1930, the Ordnance Chief had asked whether "it is possible and useful for one or the other university-trained officer to be employed in this matter?" [28] --at that time Dornberger clearly had not yet been chosen. The many claims in the latter's (sometimes willfully inaccurate) memoirs and memoir articles notwithstanding, it is apparent that Dornberger did not join the rocket programme in 1930 and did not yet head it [29]. Nonetheless, since joining the Ordnance group, Dornberger's contribution had been valuable, and within a year he indeed would become the "*Referent*" for rockets in Wa Prw. 1, when von Horstig moved up to section chief and Becker to head of Testing Division.

In the concluding discussion, the Chief of Ordnance inevitably asked about money; Becker replied that a further 200,000 marks was needed for 1932, although that was not completely adequate. Much discussion centered around the rocket's inaccuracy, but once again Karlewski (now a Brigadier General) weighed in at the end with an enthusiastic endorsement:

> I see in the rocket already a valuable substitute for the artillery piece over short ranges.... The fear that rockets would fly completely unpredictably, even come back in a boomerang effect, has not come to pass. The dispersion is great, but useful in war. With the question of the propellant charge we are still in trouble. It appears to me as always problematic that the long smoke trail of the rocket betrays the launch position; we will continue to pursue the solution however. Perhaps it would be possible to launch the rocket mechanically with a catapult or something similar, then start the rocket charge after a delay...
>
> In the case of the long-range rocket I see a good supplement to air bombardment.

Wrapping up, Gen. von Vollard-Bockelberg backed Karlewski's statement, but warned of the

Fig. 4 Adolf Hitler in front of the Kummersdorf officers club in early 1934. Second from the right in the front row is Karl Becker and on the far right is the Reichswehr Minister, Gen. Werner von Blomberg. Behind Hitler are Rudolf Hess and Martin Bormann. Wernher von Braun is the civilian in the second row from the top standing in front of the doorway.
(Courtesy of Wolfgang Fleischer)

dangers of undue optimism—in other words, he was not as enthusiastic as Karlewski and Becker. Becker noted that they believed that foreign powers were developing rockets too, but had no information [30].

4. Conclusions

Just as with the meeting minutes of 17 December 1930, those of 30 January 1932 never once mention the Versailles Treaty, nor the fact that rockets were omitted from the treaty's list of banned weapons. Clearly, the state of military weakness that Versailles imposed on Germany, however much the Reichswehr secretly violated the treaty, did play a crucial role in the decision to pursue rocket technology. But it appears that the issue of legality had little or no importance, otherwise Becker would have made a point of listing it among the advantages of the rocket at the first meeting. The treaty's ban on heavy artillery was apparently of equally little import. In the absence of evidence, we cannot even prove that leading officers in Army Ordnance were

aware of the rocket's legal status; if they did know, they probably saw it as a minor point in its favour. The rocket's real importance lay in its value for chemical warfare, which was denied to Germany under Versailles.

Why then did Dornberger later lay such emphasis on the legality of the rocket? Ultimately this is a mystery, but Dornberger's explanation, which first turns up in print in a 1943 defence of the Army rocket programme against attacks from Rakenflugplatz veteran and SS Major Rolf Engel, was probably rooted in what historian Manfred Zeidler has called the Nazi "myth" that the Third Reich alone deserved credit for the rearmament of Germany—the pre-1933 accomplishments of the Reichswehr were discounted. To what extent Dornberger had come to accept this distortion of history we do not know, but he certainly proclaimed his enthusiasm for Nazism and Hitler in the middle of the war [31]. After the war, he continued to fervently believe in a history of the German Army rocket programme that he had already formulated during the Third Reich—with certain politically convenient omissions. Thus he continued to assert or imply that the legality of the rocket under Versailles was a crucial factor in the origins of the programme, although it had begun at least a year before he joined it. In so doing, he launched a myth.

If the meeting minutes of December 1930 and January 1932 provide new evidence undermining long-held views about the origins of Peenemünde and the rocket programme, they also provide insights into many poorly understood aspects of its early history. The brief discussions of liquid-fuel rocketry and the occasional comments about the "long-range rocket" are particularly tantalizing. Despite the natural orientation toward short-range, solid-fuel battlefield weapons, it is clear that Karlewski and Becker in particular were intrigued by the radical concept of a large, liquid-fuel ballistic missile—a concept that every other military in the world at that time, except the Red Army, would have dismissed as a futuristic fantasy. Given the orientation of the Reichswehr rocket programme to chemical warfare, and the expectation among interwar strategic-bombing advocates that gas attacks against cities by manned bombers were inevitable, Karlewski and Becker no doubt imagined the ballistic missile being used in a similar fashion. Even the pioneer theoretician of the German spaceflight movement, Hermann Oberth, had discussed the idea of intercontinental gas attacks on enemy cities in his 1929 book, *Ways to Spaceflight* (*Wege zur Raumschiffahrt*) [32].

Unfortunately, the two minutes do not discuss the long-range missile further, in part because the immediate prospects for liquid-fuel rocketry looked rather bleak—especially from the perspective of January 1932. Unbeknown to those in the latter meeting, however, the events of the next year would lead to a distinct change in fortune. In April, for reasons that are still unclear, Becker and company renewed contact with Rudolf Nebel and the Raketenflugplatz. Even though the ensuing demonstration launch was a failure, it ultimately resulted in the enticement of the one of Nebel's assistants, the twenty-year-old engineering student, Wernher von Braun, to begin a physics dissertation at the University of Berlin under Army sponsorship. Exactly one year after the 30 January 1932 meeting, Adolf Hitler became Chancellor of Germany. Soon the Nazis gave greatly increased resources to the military in the name of rearmament. Hitler's money and von Braun's talent were the essential ingredients that made progress in liquid-fuel technology rapid in the 1930s (fig. 4).

But in the early thirties it was still the battlefield solid-rocket programme that was paramount, and in the minutes of the two meetings one can clearly see technological roots of that programme. The later Army solid-fuel rockets, code-named *Nebelwerfer* (smoke mortars or smoke launchers) as a result of their origins in chemical warfare, were all spin-stabilized through the use of canted nozzles in the rocket exhaust, a method adapted from Wilhelm Unge. The second fundamental influence was Friedrich Sander, whose black-powder rockets provided the starting point for propulsion development. Black powder remained the dominant propellant in the early models of *Nebelwerfer*; it was not until 1940 that the problems of smokeless powders were resolved sufficiently to stop production of the older types [33].

The Reichswehr's fascination with the rocket was clearly not confined only to Becker's Ordnance Ballistics and Munitions section. There was enthusiasm too in the Fortifications and Signals sections, plus there was significant activity at the University of Berlin and in the Navy, about which little or nothing is known. This research-and-development work mostly led nowhere, or produced routine military tools like signal rockets, but it certainly shows the fascination of the German military with the technology at that time, and afterward. As a result, it is easier to understand why the ballistic missile emerged in Germany first - an historical event that apparently has little to do with the specific provisions of the Versailles treaty.

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2. See his *V-2* (German edition, 1952; New York: Viking, 1954), p. 19; "European Rocketry after World War I," *JBIS*, **13**, Sept. 1954, pp. 245-262, here 246; and conference remarks in Theodor Benecke and A.W. Quick, eds., *History of German Guided Missiles Development*, Braunschweig: E. Appelhaus, 1957, p. 294. Dornberger's formulation in *V-2* is less clear about the importance of the legality of the rocket than has often been construed, and indeed less emphatic than the formulation in his "Denkschrift: Die Eigenentwicklung des Heeres-Waffenamtes auf dem Raketengebiet in den Jahren 1930-1943," c. late 1943, Deutsches Museum Archives, Munich, from which his words in *V-2* are drawn.
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4. Frank Winter, "Birth of the VfR: The Start of Modern Astronautics," *Spaceflight*, **19**, July-August 1977, pp. 243-56, here 251, and *Prelude to the Space Age: The Rocket Societies: 1924-1940*, Washington, DC: Smithsonian Institution Press, 1984, p. 51; Michael J. Neufeld, *The Rocket and the Reich*, New York: Free Press, 1995; Cambridge, Mass.: Harvard University Press, 1996, p. 6. Of the two more scholarly earlier histories, David Irving's *The Mare's Nest*, Boston/Toronto: Little, Brown, 1965, does not mention Versailles at all, and Heinz Dieter Hölsken's *Die V-Waffen*, Stuttgart: Deutsche Verlags-Anstalt, 1984, p. 15, is ambiguous, but close to the traditional formulation emphasizing Versailles' restrictions.
5. The two documents exist in microfilm at the Imperial War Museum (hereinafter IWM) as file M.I.14/820(V). (The originals may well be in the Bundesarchiv/Militärarchiv Freiburg.) Two summary versions were done by M.I.14, the German order-of-battle section of British Military Intelligence, in August 1945 and are in file WO 208/3121 at the Public Record Office, Kew. For the early history of M.I.14 see Noel Annan, *Changing Enemies: The Defeat and Regeneration of Germany*, New York: Norton, 1996, pp. 1-43. As revealed by WO 208/3121, one of M.I.14's projects in summer 1945 was reconstructing the operational deployment of the V-2 after 1943. Only cursory attempts were made to look at the early history, but there are a couple of interesting notes of interrogations of Dornberger and others in the file.
6. The first major article on rocketry appeared in the *Militär-Wochenblatt*, an important periodical for the Army officer corps, on 4 Jan. 1929: Robert W. E. Lademann, "Die militärische Bedeutung des Rückstoßers," **113**, pp. 991-994. See also the articles in the 11 Jan. and 11 Apr. 1930 issues. On the rocketry fad see Winter, *Prelude*, and Michael J. Neufeld, "Weimar Culture and Futuristic Technology: The Rocketry and Spaceflight Fad in Germany, 1923-1933," *Technology and Culture*, **31**, Oct. 1990, pp. 725-52. On the importance of Sander, see Dornberger's speech reprinted in Hans Rielau, *Geschichte der Nebeltruppe*, Cologne: ABC- und Selbstschutzschule, 1965, p. 142.
7. Michael Geyer, "Das Zweite Rüstungsprogramm (1930-1934)," *Militärgeschichtliche Mitteilungen*, 1975, pp. 125-172; Edward W. Bennett, *German Rearmament and the West, 1932-1933*, Princeton: Princeton University Press, 1979, pp. 36-38; Wilhelm Deist, "Die Aufrüstung der Wehrmacht," in *Das Deutsche Reich und der Zweite Weltkrieg*, ed. Militärgeschichtliches Forschungsamt, Stuttgart: Deutsche Verlags-Anstalt, 1979, 1:379-92; Hans W. Gatzke, *Stresemann and the Rearmament of Germany*, 1954; New York: W.W. Norton, 1969. After Hitler came to power, the 2nd Rearmament Program was accelerated so that it was finished by the end of 1934.
8. "Sitzungsbericht vom 17.12.1930 über die Raketenfrage," IWM, M.I.14/820(V), p. 1. Emphasis in the original. All translations from the minutes are my own.
9. Ibid., pp. 1-13. On Unge, see Ley, *Rockets*, pp. 163-166, and A. Ingemar Skoog, "Wilhelm Theodor Unge: An Evaluation of His Contributions," in *First Steps Toward Space*, ed. by Frederick C. Durant, III, and George S. James (AAS History Series, vol. 6; IAA History Series, 1) (San Diego: Univelt, Inc., for the AAS, 1985), pp. 259-267.
10. "Sitzungsbericht," 17 Dec. 1930, IWM, M.I.14/820(V), pp. 8-13.
11. It is noteworthy that Dornberger omitted the chemical warfare orientation of the early rocket program altogether from his memoirs, just as he did all mention of the murderous exploitation of concentration-camp labor in World War II. But recent literature has unveiled the gas warfare connection; see Rolf-Dieter Müller, "World Power Status through the Use of Poison Gas? German Preparations for Chemical Warfare, 1919-1945," in *The German Military in the Age of Total War*, ed. Wilhelm Deist, Leamington Spa: Berg, 1985, pp. 171-209; Hölsken, *Die V-Waffen*, pp. 15-16; Neufeld, *Rocket*, p. 6.
12. "Sitzungsbericht," 17 Dec. 1930, IWM, M.I.14/820(V), pp. 14-15.
13. Ibid, pp. 14-16. For further information on Nebel and the Raketenflugplatz, see Winter, *Prelude*, chap. 4; and Neufeld, *The Rocket and the Reich*, chap. 1. The secret contribution to Nebel and Ordnance's role in the founding of the rocket testing ground was first discussed in the latter.
14. Ibid., 16-17.
15. "Sitzungsbericht," 17 Dec. 1930, IWM, M.I.14/820(V), pp. 17-21.

16. Ibid, pp. 21-22. The Navy connection to Tiling has earlier been noted, e.g. in my book, *The Rocket*, p. 25, but no one has ever attempted to research German Navy records in the Bundesarchiv/Militärarchiv Freiburg to see if any rocket material is included. Becker specifically mentions "point 10" of the agreement deals with anti-aircraft rockets, which indicates that a specific document might yet be found in Navy records.
17. "Sitzungsbericht," 17 Dec. 1930, IWM, M.I.14/820(V), pp. 22-24.
18. Ibid., pp. 26-27.
19. Ibid., pp. 28-29.
20. Ibid., p. 29.
21. In 1932 Soviet agents attempted to recruit Hermann Oberth, indirectly through an approach to the writer Willy Ley, who naively urged Oberth to take the Soviet offer. A Soviet agent later showed up at Oberth's home in Rumania. Ley to Oberth, 25 May 1932, in Oberth Papers, Hermann-Oberth-Raumfahrt-Museum, Feucht; Boris V. Rauschenbach, *Herman Oberth*, Clarence, NY: West-Art, 1995, pp. 80-83. For Soviet rocket activity in the 1930s, see Winter, *Prelude*, pp. 55-71; for the secret military cooperation, Zeidler, *Reichswehr und Rote Armee*.
22. "Sitzungsbericht vom 30.1.1932 (11 bis 13), Abschnitt A: Raketenfragen," IWM, M.I.14/820(V), p. 2.
23. Ibid., pp. 3-4. If the original of this document could be found, the diagrams, which are illegible on my copy from microfilm, would shed light on exactly what Sander's design changes were.
24. "Sitzungsbericht vom 30.1.1932," in IWM, M.I.14/820(V), pp. 4-5; Frank H. Winter and Michael J. Neufeld, "Heylandt's Rocket Cars and the V-2: A Little Known Chapter in the History of Rocket Technology," in *History of Rocketry and Astronautics: Proceedings of the Twenty-Sixth History Symposium of the International Academy of Astronautics*, (AAS History Series, 21; IAA History Symposia, 13), ed. Phillipe Jung, San Diego: Univelt, Inc., for the AAS, 1997, pp. 41-72; and Neufeld, *The Rocket*, pp. 10-11, 17-19, 31-33.
25. "Sitzungsbericht vom 30.1.1932," in IWM, M.I.14/820(V), pp. 5-7.
26. Ibid., pp. 7-9.
27. Ibid., pp. 10-11.
28. "Sitzungsbericht vom 17.12.1930," IWM, M.I.14/820(V), p. 24.
29. Dornberger, *V-2*, p. 20; "European Rocketry," p. 249; "The Lessons of Peenemünde," *Astronautics*, **3**, March 1958, 18-20, 58-60, here 18.
30. Sitzungsbericht vom 30.1.1932," in IWM, M.I.14/820(V), pp. 12-14.
31. Zeidler, *Reichswehr und Rote Armee*, pp. 295, 303; Michael J. Neufeld, "Rolf Engel vs. the German Army: A Nazi Career in Rocketry and Repression," *History and Technology*, **12**, 1996, pp. 53-72, here 65; for Dornberger's political views see the evidence cited in Neufeld, *The Rocket*, pp. 182-183. For the 1943 document and its relationship to Dornberger's memoirs, see note 2.
32. Hermann Oberth, *Wege zur Raumschiffahrt*, 1929; reprint, Bucharest: Kriterion, 1974, pp. 199-200. Why German Army Ordnance concluded by the mid-1930s that the liquid-fuel ballistic missile was a superweapon worth the expenditure of enormous research-and-development resources continues to be somewhat debatable because of a lack of key memoranda and meeting minutes from the period 1933-1936 paralleling the two discussed here. See Neufeld, *Rocket*, 16-18, 51-54 and 293n25 for my attempted explanation. It appears that the Army lost interest in long-range chemical warfare by ballistic missile later in the 1930s, which might correspond to the decline of Douhetism in the Luftwaffe at the same time, but might also have to do with the enormous technical challenge of fusing a chemical warhead that impacts at a high Mach number.
33. On the Nebelwerfer, see Rielau, *Geschichte der Nebeltruppe*, esp. p. 144, and for an illustrated history from the veterans' viewpoint, Joachim Emde, *Die Nebelwerfer*, Friedberg: Podzun-Pallas, 1979.

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