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Chapter 5

France and the Peenemünde Legacy*

Jacques Villain†

Paris, the Prime V-2 Target

Beginning 6 June 1944 with the Allied landings in Normandy, the liberation of France was progressing. Paris was liberated on 25 August by General Leclerc's Second Armored Division, and on 6 September the Allied advance was located along a line stretching from the Somme to Champagne. The German army was withdrawing inexorably, but without yet having acknowledged defeat. It would continue to fight on for several more months, until 8 May 1945. On 6 September, it counter-attacked by putting into service a new weapon, which it called the "Vergeltungswaffe zwei" (retaliation weapon No. two), in other words, the V-2, the name that, on 18 July 1944, Hitler had bestowed on the A4 rocket developed at Peenemünde.

The southern V-2 group, deployed a few miles from Vielsam in the Belgian part of the Ardennes, included the 836th motorized artillery battalion and the 444th experimental battery; the group was under the command of Major Schulz, and it had been ready since 5 September to begin launching its first missiles. On 29 August, London had been designated as the only target by the

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† Société Européenne de Propulsion, Suresnes, France.

OKW ("Ober-Kommando der Wehrmacht"); however, the next day, Paris had also been singled out.

- 6 September 1944, at dawn. Two V-2s were installed on their launching pads.
- 6 September 1944, 10:30 a.m. The firing order was given for V-2 No. 18589.

The target was Paris. The engine ignited and swiftly achieved its maximum 25-ton thrust. Amid an ear-splitting din, the rocket lifted ever so slightly and almost instantly dropped back down onto the pad, its engine dead. It vacillated, but eventually it settled into a standing position in which it remained.

- 6 September 1944, 11:40 a.m. A second V-2, No. 18593, was triggered, with Paris as its target, and with the same result.
- 6 September 1944, afternoon. The Allied advance obliged the battery to retreat to near Sterpigny, southwest of Bochholz.
- 8 September 1944, in the morning shortly before 11:00 a.m., two V-2s were aimed at Paris.

The point of impact of the first one was never found. The device was not yet very reliable, and it had doubtlessly disintegrated as it entered the atmosphere. The second one was the first operational ballistic missile in history to strike its target. The impact occurred four and a half minutes after the launching, at 11:00 a.m., at Charentonneau, a district of Maisons-Alfort, in the suburbs southeast of Paris, after a flight of 320 kilometers. It caused a score of casualties in addition to extensive property damage.

- 8 September 1944, late afternoon. First firing of the V-2 rockets aimed at London. At 6:43 p.m., the first missile, fired by the 485th artillery battalion from somewhere around The Hague, Holland, fell on Chiswick, followed by another one 16 seconds later, which fell on Epping in Essex.

Throughout the month of September, no more V-2s were fired on Paris or on France, whereas England sustained at least two hits daily. However, this relative peace and quiet ended on 2 October, when four V-2s exploded in small towns around Paris—Saint-Germain-sur-Doué in the department of Seine-et-Oise, Bouillancy, Silly-le-Long and Brégy in the department of Oise. The following day, six more rockets fell on Tremblay-lès-Gonesse and Vaujours in Seine-et-Oise, on Bouillancy, once again, on Courchamp in Aisne, and on Nanteuil-lès-Meaux and Neufmoutiers-lès-Meaux in Seine-et-Marne. On 4 October,

seven more missiles exploded at Lizy-sur-Ourq, Dammartin, and Beaumarchais in Seine-et-Marne, and at Deuil-la-Barre and Puiseux-lès-Louvres in Seine-et-Oise. Two impacts also occurred in two small towns near Paris—Pantin and Noisy-le-Sec. On 5 October, four V-2s struck Plailly and Mortefontaine in Oise, and Louvres and Châtillon, located, respectively, in the departments of Seine-et-Oise and Seine. This made a total of twenty-one impacts that occurred in the Paris area.

During the first few days of October 1944, the Wehrmacht also launched V-2s against cities in northern France, i.e. 25 on Lille, 19 on Tourcoing, 6 on Arras, 4 on Cambrai and one on Saint-Quentin. The grand total was therefore 78 V-2s fired on France from 8 September to 5 October. This latter date marked the end of the V-2 offensive on French soil.

Three months before launching the V-2, Germany had begun using another ground-to-ground missile system, the V-1. Impacts of the V-1 began occurring on 15 June 1944, in the department of Pas-de-Calais and, from June to September 1944, 79 V-1s hit the ground in this department. On 1, 3 and 4 July, three V-1s exploded at Arronville, Méry-sur-Oise, and La Celle-Saint-Cloud in the Paris area. On 2 September, two more of these missiles fell on Chatou and Le Bourget. The department of Le Nord was hit by some 30 V-1s during the period from September 1944 to January 1945.

Interestingly, the approximately one hundred V-1s that struck French soil were the result of the malfunctioning of these missiles, whose launching ramps were aimed at England.

France's Access to V-2 Data: The Role of Professor Moureu

The data that was available to France at this time, concerning the V-2 and the other new German weapons, was largely due to the initiative and efforts of one man, Professor Henri Moureu.

During the German occupation of France, Moureu headed the municipal laboratory of the city of Paris, concurrently with his duties as the technical advisor for passive defense. In this latter capacity, his role consisted of ensuring the protection of the population against aerial attacks. In the performance of these duties, he had investigated the V-1 explosions that had occurred on 1, 3 and 6 July 1944, around Paris. A few weeks later, specifically on 29 August, i.e. four days after the liberation of Pans, Moureu received a visit from two American scientific attaches, Professor Noyes and Dr. Hickmann, who were members of the ALSOS mission: the latter was responsible for collecting data on Germany's secret weapons. He then learned of the existence of a long-range rocket whose weight was estimated at ten tons.

Cooperation began between the Americans and Professor Moureu for the purpose of more accurately pinpointing the features and the performance capacities of the V-1s and V-2s. They even inspected a few manufacturing plants in the Paris area and, on the premises of a company called La Précision Mécanique, they discovered a V-2 servomotor in the process of being assembled.

A few days later, on 8 September, the police informed Moureu that an explosion had just occurred at Charentonneau, southeast of Paris. After inspecting the site, Moureu drafted the following report:

> On 8 September 1944 at 11:00 a.m., a sudden explosion occurred at Charentonneau (Maisons-Alfort). Having been immediately advised by the police, I made a number of on-site findings that pointed to the existence of a new device, one that was distinctly different from the V-1; the differences were apparent both in the conclusions drawn from the examination of the debris (ball bearings, sophisticated switchgear and control gear, precision-machined parts) and in the extent of the damage, plus the surprising fact that no noise had been heard prior to that explosion and that no aircraft had been detected. Since the debris collected by my staff do not enable the identification of a weapon that, clearly, was extremely complex, I delivered them to Dr. Woodruff and they were immediately sent to the United States for further examination.

A few days later, the parts were identified as being those of a V-2.

As the German army withdrew, various sites that had been utilized for the manufacturing or the launching of the V-1 and V-2 became accessible. Thus, on 16 September, at La Chaussée-Tirancourt, in the department of La Somme, Moureu discovered V-1 launching ramps. On 29 September, accompanied by Air Ministry technicians, he discovered the huge underground facilities in the Longwy region that were geared to turning out some 100 to 150 V-1s per day. On 2 October, with Frédéric Joliot-Curie, he traveled to Watten, in the department of Le Nord, where a huge concrete structure had been built to produce liquid oxygen and also to serve as a V-2 launching base.

The V-2s that were fired on Paris on 2, 3, 4, and 5 October, yielded access to a fairly large number of parts in relatively good condition, collected from the craters of the explosions. Examination of these parts revealed that the devices were similar to the one that had hit Charentonneau on 8 September.

In addition, new intelligence concerning this device had reached the Americans, and, at a meeting between them and Moureau on 19 October, conclusive evidence was established, proving that it was indeed the V-2 that the Germans were using for bombarding Paris. The fact also emerged that this missile utilized a combination of liquid oxygen and alcohol propellants; this finding

made it possible to show a connection between the V-2 and the facilities at Watten.

Professor Moureu, who realized the advantages implicit for France in the acquiring of more thorough knowledge of these new weapons systems, had voluntarily taken the initiative of studying them; he pursued further investigations in the plant facilities that had been left behind by the retreating Germans.

On 21, 22, and 23 December 1944, accompanied by Joliot-Curie and his assistant, a chief engineer named Chovin, he visited the installation at Wizernes, in the department of Pas-de-Calais, some 15 kilometers from Watten, which had been planned as a V-2 launching base for rockets intended for bombing England. During this visit, he had his first contact with the British in the shape of a fact-finding mission of the Royal Engineers Corps. Subsequent to this encounter, several data-exchange meetings were held with the British.

In the period preceding the German capitulation, that occurred on 8 May 1945, it had been possible to draft a score of reports concerning the V-1 and the V-2. On 9 May, Moureu headed a mission assigned to investigate the experimental station for V-2 inspection and reception at Ober-Raderach, near Lake Constance, in the French zone of occupation. Since this site was too near the Swiss frontier, the Germans had resigned themselves to abandoning it in January 1944. This plant had been started up in November 1943 under the code name of "Pozellan" factory, and it was used for testing V-2 engines. One complete V-2 out of every ten manufactured was also tested there. Moureu recommended the disassembling of this installation and its transfer to France. This mission, which lasted from 9 to 17 May 1945, was followed by a second one, from 7 to 29 June, in the American zone. One of the participants in both these missions was Major Jean-Jacques Barré, who had been a disciple of Robert Esnault-Pelterie since the late 1920s, and who, on 15 March 1945, had carried out the first launching of a French liquid-propelled rocket, the EA 1941, at the La Renardière testing site near Toulon.

In the American zone, the mission proceeded to Nordhausen in central Germany, the site of the V-2 underground assembly plant, where large numbers of deportees had labored under inhumane conditions and had paid with their lives in order to produce these first rockets. On 15 June, with the American authorities' permission, the mission members were able to inspect the premises. Moureu's basic aim was to bring items of equipment to France, for which he obtained the authorization of the American military command. Thus it was that nine freight cars loaded with miscellaneous hardware found their way to France, including four V-1s and a quadruple set of V-2 parts (nozzles, turbine-gas generators, servo-motors). On 18 June 1945, he also got a written commitment from the American Supreme Command to eventually supply France with ten complete

V-2s. However, on 27 February 1946, the United States War Department announced that it would not keep its commitment.

The third visit was to a V-2 nozzle calibration plant at Lehesten, in Thuringia, about 100 kilometers south of Nordhausen. This plant had been designed to take over from the one at Ober-Raderach. During this mission, the French representatives were able to witness engine trials and to interrogate German prisoners.

G.O.P.A.: Groupe Operationel Des Projectiles Autopropulses [The Operational Group of Self-Propelled Projectiles]

Until May 1945, Professor Moureu had been carrying on alone. In the light of the mass of V-1 and V-2 data that had been obtained, and with a view to gleaning all the information that would be useful for the future of French armaments, he decided, jointly with the various participating military authorities, to set up, in the same month, the G.O.P.A. (Groupe Opérationnel des Projectiles Autopropulses [operational group of self-propelled projectiles]), based on the pattern of similar organizations set up by the Allies.

Under the auspices of the D.E.F.A. (Direction des Etudes et Fabrications d'Armement [department of weaponry manufacturing and study]), and therefore of the army, the G.O.P.A. began establishing relations with the Air Ministry's central technical information department concerned with the quest for data on Germany's aeronautical weapons, and also with the Naval Ministry, which had appointed a Committee for German Secret Weapons in October 1944.

It was under G.O.P.A. that the various missions were carried on in Germany, including the ones noted above, and also the one in Kochel, south of Munich, in September 1945. This was where the Peenemünde supersonic wind tunnel had been moved following the Allied bombardments of 17 August 1943. When the French mission, consisting of Captain P. Carrière and Professor Demontvignier, reached the scene, this wind tunnel was being taken apart to be shipped to the United States. The American military authorities were cooperative, and they let the Frenchmen examine all the files. A few weeks later, there came the recruitment of 28 German aerodynamicists from among the ones that the Americans had not previously taken on.

Relations with the Allies thereupon proceeded amid a friendly and fruitful atmosphere. An example of these excellent relations was set by Major Harrison of the American intelligence service, who gave Moureu the German code for the manufacturing of the V-2 components.

Cooperation with the British also proceeded amid a climate of mutual trust, to such an extent that, in September 1945, Moureu obtained not only several tons of German documents, but also "certain information concerning the atomic bomb, which had only recently been utilized for the first time, with a rough sketch of the device."

The following month, at the invitation of the English, Moureu and his assistant, Chovin, together with Captain Carrière, attended V-2 launchings at Cuxhaven, carried out as part of Operation Backfire. Likewise in attendance were the American and Russian delegations, the latter including V. P. Glushko and S. P. Korolev.

> The tests were wholly successful, and for the first time we witnessed the vertical lift-off and the shift into a stable trajectory of the enormous mass of the V-2, of which we knew practically all the mechanisms and operating details, but whose actual lift-off made a deep impression on us, and confirmed my opinion that it constituted a fundamental new contribution in both the scientific and the military realms.

Despite the dissensions that were already arising between the Soviet and the Anglo-American missions, Moureu took advantage of the circumstances to request the Russians for permission to visit Peenemünde, and also to request the English to transfer the equipment necessary for the launching of the ten V-2s that had been promised by the Americans. The Russians agreed but failed to carry out their agreement.

Creation of the C.E.P.A.: Centre d'Etudes Des Projectiles Autopropulses [Self-Propelled Projectiles Study Center]

Professor Moureu had grasped the potentialities of the rocket, and, in May 1945, had recommended the creation, in France, of a rocket institute. This idea, doubtless still premature, had nevertheless led to the setting up of the G.O.P.A., which was more specifically responsible for studying the rockets built by the Germans. On 12 June 1945, a new stage was achieved with the assigning to the War Ministry (army) of the study of self-propelled projectiles. On 13 August, the D.E.F.A. submitted, to the army general staff, an initial organizational project calling for the creation of a rocket study center assigned to do the following:

- To pursue the major research and reconstitutions undertaken, both on the V-2 and on various other German self-propelled projectiles.

- To undertake the scientific investigation of these devices, and to submit all suggestions designed to improve them, and to enhance their power and the methods of their utilization.

In addition, on 13 August 1945, the D.E.F.A. made it clear in a statement to the army general staff that "the V-2 is now viewed as something that is to be reproduced and tested, and the extremely large installations required for testing it in fixed position and in firing action will be built. . . ."

Thus, on 14 November 1945, The C.E.P.A. (Centre d'Etudes des Projectiles Auto-propulses [self-propelled projectiles study center]), attached to the D.E.F.A. was created, with Professor Moureu directing it.

The C.E.P.A.'s justification, its organization and its missions were, of course, placed "under the sign of the V-2," for, at the time, the military authorities considered this device as the very last word in strategic weaponry. It was also felt that the sheer fact of reproducing it, and of firing a sufficient number of the reproductions, would bring the French technicians up to the level of the German technicians who had designed and built it. Moreover, the fact that it was possible to bring into France a large number of V-2 subassemblies and related parts had militated in favor of undertaking the reconstitution of this device.

The Contribution of German Know-How to France's Post-War Missile Programs

The four major victorious countries of World War II—the United States, the U.S.S.R., Great Britain and France shared, to varying extents, the skills acquired by Germany in the realm of rockets. At the time, Germany undeniably boasted the greatest amount of know-how in this field. In addition to the V-1s and V-2s, this country had also successfully rendered operational many types of ground-to-ground, ground-to-air, air-to-air and air-to-ground missiles.*bï46bï

In this field France, like the other nations, had been lagging far behind. At the end of the war, the only French liquid-propelled rocket that had been fired was that of Major Jean-Jacques Barré. This rocket, the EA 1941, was of modest size compared to the V-2: weight 100 kilograms as against 12 tons, and one-ton engine thrust as against a 25-ton thrust.

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* Editor's note: Ground-to-air and air-to-air missiles were only at the experimental stage at the time.

To Moureu and to certain military authorities, it was clear that, before undertaking to produce the missile, France should first assimilate the German know-how. Obviously, although many items of equipment had been retrieved, it was also clear that it was necessary to obtain the services of certain of the German specialists who had designed this equipment. They could thus not only contribute their know-how to the building of the future French missiles but also transmit their knowledge to young French Engineers.

Setting Up the Means

The first means necessary for the building of the future French missiles were set up within the military administration, specifically in the D.E.F.A., which was responsible for the studies of ground-to-ground and ground-to-air missiles, and in the D.T.I.A. (Direction Technique et Industrielle de l'Aéronautique [aeronautics technical and industrial department]), which was responsible for the air-to-air and ground-to-air missiles, as well as for target devices.*

By late 1945, the D.E.F.A. had already established within itself the C.E.P.A., a purely theoretical study agency, and, on 17 May 1946, in Vernon, it set up the L.R.B.A. (Laboratoires de Recherches Balistiques et Aérodynamiques [research laboratory in ballistics and aerodynamics]), more particularly responsible for studying and building equipment. In addition, the D.E.F.A. set up a design engineering bureau in its technical department, located at the Puteaux construction workshop (APX) in the Paris suburbs. The APX's first projects, in 1947, were the O.N.M. (Office National Météorologique [National Weather Bureau]) device, an improved version of the EA 1941, and the 4209 device. This department also had a testing area for small rockets, a few hundred yards away, in the trenches of the Mont Valérien Fort.

Arrival of the German Engineers and Technicians

In February 1945, a large number of people from Peenemünde had been moved to the region of Nordhausen-Bleicherode in central Germany to attend to the mass production of the V-2. A few months later, in April 1945, in view of the advancing Red Army, a few hundred persons were transferred to the Oberammergau region in Bavaria. In early May, they came under the control of the United States Army: this event ushered in a period of internment at Garmisch-Partenkirchen.

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* Editor's note: D.T.I.A. would soon issue specifications for all types of missiles.

From July to October 1945, some members of the Garmisch group came under British control for the purpose of Operation Backfire at Cuxhaven. From November 1945 to April 1946, a few of these people were taken on by the British in the establishment of the Ministry of Supply (MOSEC), at Cuxhaven and Trauen.

In addition, the 28 German aerodynamicists from Kochel, recruited by France, had been transferred to Emmendingen in the Baden area inside the French zone of occupation, in early 1946, where they constituted the Emmendingen Design Engineering Bureau. This bureau's basic mission was to design the wind tunnel of the Vernon LRBA and to oversee the construction work thereof. This wind tunnel was hence based directly on that of Peenemünde.

In the spring of 1946, Dr. Helmut Weiss, an engineer who had worked with the MOSEC, traveled to Emmendingen for a family reunion. There he heard about France's interest in rockets. Upon his return, he found two colleagues, Dr. Jauernick and an engineer named Helmut Haberman, who were interested in meeting the French authorities. This was done in Paris, in early May 1946, via the intermediary of Dr. Graf, a former administrative manager of the Kochel center, who had become the administrative head of the Emmendingen design engineering bureau. On 6 May, these three engineers signed a service contract with the D.E.F.A. Moreover, the French officials advised them that they were prepared to employ a number of German technicians from Peenemünde or from German institutes that were under contract to Peenemünde. The quotas were fixed at a maximum of 26 for guidance and 35 for propulsion. Dr. Jauernick was appointed to head the propulsion group, known as E.A.P. (Etudes Aérodynamiques Propulsion [Aerodynamic Studies, Propulsion]) and Dr. Otto Müller took charge of the E.A.G. (Etudes Aérodynamiques Guidage [Aerodynamic Studies, Guidance]) guidance group.

On 16 May 1946, and over the following days, 35 contracts were signed with former members of the Peenemünde personnel who had worked for the British at the MOSEC. Other individuals were contacted and added to this initial group. These engineers and technicians and their families were brought together in nearby cities (Riegel and Denzlingen), and they were attached to the previously created Emmendingen design engineering bureau, which was under the French military authorities in Offenburg.

They were assigned the task of reconstituting a number of dossiers pertaining to the A4 (V-2) and to the Wasserfall, and of reflecting upon the future organization of the facilities that should be set up in France for designing and building rockets.

It was in Riegel, in August 1946, in an erstwhile restaurant transformed into a design office, that a former Riedel assistant at Peenemünde designed a

40-ton thrust rocket engine with a gas generator, some of the research for which had taken place at the MOSEC. Many years later, this engineer, Heinz Bringer, became the designer of the Viking engine of the European launcher Ariane. Interestingly, this engine design had been proposed by Bringer to Wernher von Braun in 1942 for the V-2. It would have considerably simplified the V-2 propulsion system through the elimination of the turbopump, while at the same time increasing its range (from 320 to 550 kilometers). At the time, von Braun deemed the definition of the V-2 to be largely fixed, and he had refused the engine, although he had contemplated using it on the Wasserfall ground-to-air missile.

Some one hundred engineers and technicians and their families were gathered together in this part of Germany pending their transfer to France. At this site, they had no French technical supervision. Their representative vis-à-vis the French authorities was Dr. Graf, who handled all the administrative and logistical matters, and they received periodic visits from a few French engineers, who were responsible for checking on the state of progress of their work.

In parallel with this group that had remained in Germany, a dozen German engineers had arrived at the Puteaux construction workshop, beginning in October 1946. Four of them had been hired to complete the file of V-2 drawings supplied by the English.

In late March 1947, when the L.R.B.A.'s initial accommodations were ready, a score of Germans from the Emmendingen design engineering bureau were transferred to Vernon. However, they were not the first Germans to arrive at the L.R.B.A. Some fifty of their compatriots had been assigned there in late 1946, for the purpose of building a 1,000-H.P. tank engine. They formed the Maybach group, which came from Friedrichshafen, on the shores of Lake Constance. The remaining Germans were transferred in May 1947.

Thus it was that some ninety engineers and technicians, and even some secretaries from Peenemünde, or from institutes that had worked with Peenemünde, arrived in France to work at the L.R.B.A., at the Puteaux construction workshop, and in a few other establishments. On the other hand, none of the Kochel aerodynamicists came to the L.R.B.A. When their work at Emmendingen was completed in 1950, most of them were hired by the Franco-German Research Institute of Saint-Louis. All told, from 1946 to 1950, 123 former Peenemünde and Kochel employees worked for France.

The First Design Studies

Before undertaking the missile studies, Moureu had taken care to bring together the French authorities in this field. In addition to the distinguished indi-

viduals already in the C.E.P.A., he invited Robert Esnault-Pelterie and A. Ananoff to participate in the C.E.P.A.'s work. They declined the offer. Esnault-Pelterie was already well along in years and in poor health; however, he offered to provide Moureu with the studies and investigations that he had done in the prewar years with Professor P. Montagne. It should be noted that Montagne and Jean-Jacques Barré, Esnault-Pelterie's two disciples, were active participants in the work of the C.E.P.A.

In 1946, the first missile projects began to take shape. In August of that year, the army general staff adopted an overall program of self-propelled devices, listing its priorities as follows:

- First priority: studies of so-called "tactical" devices.
- Second priority: studies of so-called "strategic" devices, i.e. those with ranges longer than 300 kilometers.

At the time, the plans called for the heavy use of liquid propulsion in the design of these missiles. This was for the following purposes:

- Producing a long-range tactical missile. This was device No. 4209, using nitric acid, designed to carry a useful load of 50 kilograms over a distance of 100 kilometers.
- Producing a ground-to-air missile dubbed P.A.R.C.A. (Projectile Autopropulsé et Radioguidé Contre-Avions [self-propelled and radio-guided anti-aircraft projectile]).
- Perfecting the EA 1941 device, which was intended to become a probe rocket for the National Weather Bureau ("O.N.M." device).
- Producing a strategic missile, called the EA 1946 EOLE, also designed by Major Barré jointly with the SAGEM company: this missile was actually an extrapolation of the EA 1941.

The Reconstitution of the V-2

A report, dated 23 December 1946, noted that, before starting on projects for new missiles, it was advisable to assimilate the techniques utilized in the V-2. To this end the plan involved, on the basis of the documents and equipment retrieved in Germany, the reconstitution of several copies of the V-2. It was estimated that some thirty V-2s could be reconstituted, provided that certain components were produced in France, such as the guidance components that it had not been possible to bring from Germany. However, some of their manufacturing specifications had been recovered. All told, three-quarters of the parts

required for reproducing the thirty V-2s were available, and the C.E.P.A. had assembled or redrawn the blueprints for virtually all the V-2 parts, in particular those of the following:

- Nozzle
- Turbopump
- Fuel tank
- Rudder servo-motor
- Electronic systems linked to the gyroscopes and servo-motors
- Pipework units and electromagnetic and pneumatic-valve units
- Practically all the electromechanical systems governing the execution and command of the launching operations
- Structure of the missile
- Certain electronic systems that enabled the in-flight positioning of the various mobile elements
- Several other secondary parts.

At the time, it was deemed feasible to perform tests of an engine with a greater-than-25-ton thrust at the Vernon site. The search for a new site focused on the chasm of Bede, near Gramat in the Lot region, which offered better conditions of security and discretion. A mission appraised this site during the summer of 1946. The mission assigned to find a firing range decided, in November 1946, that the Guir region, southeast of Colomb Béchar in Algeria, could fulfill this requirement.

Although the expectations called for assimilating all the technologies with the help of the German technicians, and hence closing the missile gap within two to three years, it soon became evident that the reconstituted V-2s could not be flight-tested before 1952. In fact, it was necessary to build the whole infrastructure at Vernon, Gramat, and in Algeria, and, most importantly, it was necessary to set up the requisite teams of French army engineers: this prospect already loomed as something hard to achieve within the next two to three years.

In the light of these problems, a change of policy occurred in May 1947. Considering that the 1952 completion date was too distant, and that the V-2s that would have been reproduced by that time would represent an outdated technology, and also, above all, that the related financial outlay was disproportionate to the benefit that would ensue, the plan was altered to include resumption of the study of the A9, or super V-2, a project that had begun in 1944.

Two studies of long-range missiles thus got underway:

- The EA 46 missile (project 4211)
- The A9 Super V-2 missile (project 4212).

Let us note that, in 1947, a model of the V-2 was produced in the Puteaux construction workshop.

Project 4211/EA 46

This rocket, designed by Colonel Barré, was an extension of the EA 1941, and it was developed principally with SAGEM, without any overseeing by the German technicians at the L.R.B.A. An initial test bench trial took place in February 1949, and two in-flight tests were performed at Hammaguir, Algeria, in November 1952. The main features and performances:

- Total mass: 3.4 tons
- Useful load: 275 kilograms
- Engine thrust: 10 tons
- Anticipated range: 800 kilometers.

The failures of the two flights of the EA 1946 brought about the discontinuation of this program in late 1952.

Project 4212 "Super V-2"

In 1946, the L.R.B.A. began a study of the surface-to-surface missile that had the same exterior forms as the V-2, but that had a more powerful engine (40-ton thrust instead of 25-ton thrust): the investigation of this engine had been taken over by Heinz Bringer at Riegel. Three versions were studied, involving the following main features and performances:

The study of a fourth version was added later. This was a semi-ballistic version R2M, featuring two ram jets incorporated into the forward fin, designed to carry one ton for a distance of 3,600 kilometers.

The studies of the 4212 did not result in the production of complete missiles; the faint interest shown by France's official services in the implementation of strategic missiles led to the abandonment of this project in early 1948. However, the theoretical study had been fully completed, as had the manufacturing and experimentation of component prototypes (valves, turbopumps, fuel tanks,

etc.). Thus, a few days before Christmas in 1947, a gas generator designed for the 40-ton engine was tested several times on the bench. Interestingly, it was these tests that pointed out the advantage of nitric acid as an oxygen carrier from the standpoint of transport, storage, manipulation and performance.

It was also within the scope of this study that the L.R.B.A.'s main investments were made, in particular those pertaining to the fixed installations (test bench for engines and components).

Table 1

Version	Useful load mass	Range	Type of power supply	Propergol
R1	1,000 kg	1,500 km	Hypergolic gas generator	Nitric acid + kerosene
R2	1,000 kg	1,400 km	Turbopumps	Liquid oxygen + kerosene
R2S	1,000 kg	1,800 km	Turbopumps	Nitric acid + kerosene
	500 kg	2,250 km	Turbopumps	Nitric acid + kerosene

Veronique, P.A.R.C.A., Vesta, Diamant, Coralie, and Ariane

When the 4212 program was shelved in 1948, the L.R.B.A. devoted its efforts to the producing of a nitric-acid-and-kerosene engine with a four-ton thrust, and to the designing of the VERONIQUE probe rocket (project 4213) and to the P.A.R.C.A. ground-to-air missile.

In 1948, the E.A.G. and E.A.P. groups were integrated with the guidance and propulsion departments, directed, respectively, by army engineers Antonin Collet-Billon and Jean Corbeau, both of whom had just arrived at the L.R.B.A.

The staffs of these departments were gradually increased by the arrival of young French engineers. From the outset, the relations between the Germans and the French were somewhat strained. The Germans possessed know-how, whereas the French engineers had everything to learn from them; this placed the French in a position of inferiority when, actually, they outranked the Germans in their official staff standings. Moreover, memories of the war still rankled in

people's minds, and the Germans lay at the origin of these memories. Resentment understandably existed. A few weeks after arriving at Vernon, some of the German staff members went into town to attend the Fourteenth of July celebration; this triggered a few incidents with the local populace. Added to this were the difficulties of communication between French-speakers and German-speakers, plus conspicuous differences in working procedures.

In fact, as the months went by, these difficulties faded into the background and gave way to exemplary joint undertakings. The truth is that the freedom enjoyed by the Germans, including specifically their freedom to visit Paris and to carry on their family lives, definitely fostered better relationships. Indeed, this freedom was, for most of these Germans, the reason for their decision to come to work in France. The English offered them freedom only within a range of ten kilometers around the bases on which they were employed.

However, the absence of any ambitious policy regarding space launchers and ballistic missiles—in contrast with the situation in the United States and the U.S.S.R.—meant that the Germans began leaving the L.R.B.A. as early as 1951. In 1952-1953, the Maybach group returned to Germany. In 1953, Dr. Jauernick and a few others did likewise. In 1958-1959, Dr. Pilz and eight other engineers left for Stuttgart, for the Institut für Strahltriebwerke of Professor Sänger, who himself had worked in France until 1954. Most of them had returned to Germany to teach or to work in industry (MBB-ERNO) or at ELDO. A few of them went to the United States, while six of them went to work for the Egyptian government.

Those who remained at Vernon were incorporated into the S.E.P. in 1971. At both the L.R.B.A. and the S.E.P., they participated in the development of the VESTA probe rocket and the DIAMANT launcher, whose engine was of the same type as the one that had been designed at Riegel some twenty years earlier, and also in the development of CORALIE, the second stage of the European launcher. Whereas, until the mid-1960's, the French engines had been fueled by means of propellant pressurization in the chamber, a 40-ton-thrust turbopump engine was developed by Heinz Bringer and his team. It was this engine, with its thrust increased to 60 tons, dubbed VIKING, that would equip the first and second stages of the European launcher ARIANE.

Creativeness was undeniably one of the strengths of these Germans. In addition to Heinz Bringer's ideas, note should be taken of the original concept of initial guidance by cable exemplified in VERONIQUE, due to Dr. Pils; the Aquitaine radar; the first French inertial guidance platform, built in 1958; and certain types of homing heads, the ideas for which were applied both in France and in the United States, and which are credited to Dr. Müller's team; and,

lastly, the active magnetic bearings with which Helmut Habermann's name remains closely linked.

The German Contribution Other Than That of Peenemünde

In the Spring of 1945, as the French forces were advancing, the accompanying military engineers had the opportunity to discover the work of the many companies involved in aeronautical studies and productions. On April 1st, they were in Augsburg at the Messerschmitt works, a few days later at the B.M.W. plant in Munich-Allach, and, still later, in Fellsach, at the Mahle factory, belonging to a company that had done work on the nozzles of the V-2, of the Rheintochter and of the Wasserfall.

The enlightenment shed on these fields swelled the fund of knowledge coming from Peenemünde, which was confined to the sector of liquid propulsion rockets.

The German Contribution to S.E.P.R. (Société d'Etude de la Propulsion par Reaction [Company for the Study of Jet Propulsion])

In late 1944, when the war was not yet over, the S.C.E.P.R. (Société Civile d'Etude de la Propulsion par Réaction [Civil Corporation for the Study of Jet Propulsion) was founded for the purpose of developing rocket engines. In 1945, the S.C.E.P.R. changed its name and became the S.E.P.R.

In May and June 1945, a military mission was closely monitoring the French forces' advance in southern Germany and Austria; one of the mission's members was the founder of the S.C.E.P.R., Lieutenant Florio. The mission devoted considerable attention to the equipment and the manufacturing means that had been devised by the Germans in the realm of aviation. An extensive amount of information, notably concerning the jet planes Me 262 and 162, was yielded by German documentary records and provided by German technicians. There was also the discovery of aircraft takeoff-booster rocket engines, including the Walter 109-509 engine, which subsequently formed the basis of the knowhow of the S.E.P.R. This engine used as its oxidizer an 80 percent concentrate of hydrogen peroxide, called "T Stoff," and a fuel that was a blend of methanol, hydrazine hydrate, and water, called "C Stoff." This engine, mounted onto the Me 163, delivered a fixed maximum thrust of 1,700 kilograms.

Mass production of the engine began in 1944, and it was assigned to the Heinkel company at its plant in Jenbach in the Austrian Tyrol. With an eye to maximum protection from the Allied bombings, this company had scattered its

facilities over the region. An underground factory had been built near the Achensee, and an engine inspection plant stood at Kramsach on the banks of the Inn river. This plant made it possible, toward the end of the war, to monitor the proper functioning of each of the thirty engines that were turned out daily; this had required the installation of huge storage tanks for fuel and oxidants.

In February 1946, the order came to convey all of this plant's equipment to France. For the startup of its own activity, S.E.P.R. received a highly varied array of equipment, including test benches, all sizes of tanks and reservoirs, valves, pipings, manometers, pressure registers, safety valves, viewfinder window glass, eyeglasses, masks, gloves, protective coveralls, etc.

The most important element was recovered the following June. In fact, the French mission had learned that a variable thrust model of the Walter engine had been produced during the last months of the war and that a prototype of this engine, encased in a sealtight container, had been sunk in Lake Rehmsee, in a remote valley, to prevent its falling into Allied hands. After being fished out, this 109-509-C engine, complete with two combustion chambers and two thrust levels, was transferred to the S.E.P.R.'s testing center at the Fort of Villejuif.

Extensive additional data was also obtained in the French Occupation Zone in southern Germany concerning other systems and their propulsion methods. To quote only a few:

- The HS 293 gliding bombs (Walter, Schmiding, and Wasag engines)
- Airborne projectiles (B.M.W. and Schmiding engines)
- Rocket propulsion for fighter aircraft (Walter engine)
- Liquid- and solid-propellant-driven units
- The BMW 100-548 nitric acid and Tonka 250 propulsion units designed for the X4 air-to-air missile
- The BMW 109-558 propulsion unit for the Schmetterling surface-to-air missile.

Work was also commissioned by the Navy to equip an engineer vessel with a modified Walter turboprop engine powered by hydrogen peroxide, and the first trial runs were held in February 1950 on the Seine.

The German Contribution to the Aeronautical Arsenal

The Aeronautical Arsenal in Châtillon, near Paris, was attached to the D.T.I.A. In the pre-World War II period, it specialized in the designing and building of military aircraft.

In the fall of 1946, it was decided to appoint a small, seven man team to design a new type of weapon, which at that time was referred to as "special

devices," in other words, missiles. For many years, this team, known as E5, was headed by Emile Stauff, to whom the development of French tactical missiles is heavily indebted. This team's first assignment was to assess the documentary records and equipment items brought over from Germany. These items included a V-1, a few V-2 components, a surface-to-air missile called Enzian [Gentian], a small anti-tank missile dubbed "Rotkäppchen" [Little Red Riding Hood], an X4 air-to-air missile, and other electronic and mechanical hardware, as well as machine tools. As they perused the records, the French engineers made one discovery after another with regard to both technique and methodology. They discovered the explosive bolts utilized for the separations of missile subassemblies, and also an approach to system designing that was less empiric than the one then prevailing at the Arsenal. The Germans had attached greater importance than the French to the compiling of a complete design study.

In late 1946, a score of German engineers were hired to work at the Arsenal; eight of them were assigned to the "special devices" department, where they served in a consultant capacity. The others carried on activities more specifically focused on aircraft.

Among these "war prize" personnel, as they were sometimes called, there were two eminent theoreticians, Professor Ruden, an air-intake specialist, and Professor Sänger, an astronautics pioneer.

In early 1947, three tactical missile programs were decided on by the official services, for the development of an air-to-air missile AA10, a flying target CT10, and a small anti-tank missile SS10.

At the time, two conflicting general trends prevailed with regard to missile design. On the one hand, there were the enthusiasts who felt that fast technological progress could be achieved, and that it would culminate in the production of high-efficiency systems; certain of these observers believed it would be possible to rapidly "satellize" masses of a few kilograms. On the other hand, there were the skeptics, including a large number of military officials. Emile Stauff's achievement consisted of reconciling these two trends by choosing ample technological solutions, and by setting fairly modest goals that were hence more readily attainable. The following were decided on:

- The concept of small, self-rotating missiles
- Initial guidance by aerodynamic surfaces, followed by jet deflector
- Solid-propellant propulsion unit
- Engine based on the V-1 pulse jet
- Wire guidance
- Hollow charge technique.

One of the three projects adopted, the AA10 air-to-air missile (type 5101), was developed during 1947. Actually, this was a reconstitution of the German X4 missile propelled by a BMW liquid-driven engine. The AA10 engine, which was also powered by liquid propellants (nitric acid and tonka), was shelved early on, because of the lack of flexibility of its utilization, and due to insufficient safety, after testing done through 1950-1951 with a Junker-88 airplane. A second version of the AA10 (type 5103) was built which involved solid propellants, two stages, radio guidance, and a jet deflector. Over the ensuing years, several thousand missiles of this type, the AA20, were produced.

The CT10 target closely resembled the V-1, and it was designed for use in training in anti-aircraft fire, in fighter-plane piloting, and in the future ground-to-air and air-to-air missiles. This study, begun in August 1946, was rapidly completed. The first tests of a prototype mounted atop a LEO 451 aircraft began in January 1947 and continued through April 1949.

The CT10 launching ramp was largely patterned on that of the V-1, although in a simplified version. The French engineers possessed a considerable amount of information concerning the latter. A thick file of engineering data had been found in Germany, and several V-1 ramps had been installed in France, in the departments of Pas de Calais, Somme, Seine-Maritime and La Manche. After a second series of tests at Colomb-Béchar in the Sahara in March 1950, mass production of the CT10 was decided on. The plants at Châtillon and Villeurbanne shared the task of this production. It is noteworthy that the first operational CT10s were fitted with captured German components.

The SS10 was the last project launched in 1947. The anti-tank missile was heavily based on the German X7 "Rotkäppchen" missile, which, in turn, was based on the X4. Only a few copies of the X7 missile, manufactured by Ruhrstahl, had been tested on the eastern front in January 1945. As in the case of the AA10, two versions were built of the SS10. The first, called the 5201, wire-guided, with two fins, was soon replaced by the four-finned 5202 version, which featured improved aerodynamic stability.

The SS10 was actually France's first mass-produced missile, one that was exported worldwide (30,000 units), including to the United States.

Flushed with success, the Aeronautical Arsenal—which changed names several times, becoming, successively, SFECMAS, SNCAN, NORD AVIATION, Division des Engins Tactiques de l'Aérospatiale, and, finally, AEROSPATIALE MISSILES—turned to the designing of a whole series of tactical missiles for various applications, the best-known of which are the Exocet, the AS30 Laser, the Milan, the Hot, and the Roland.

The Role of Professor Sänger

The month of July 1946 witnessed the arrival at the Aeronautical Arsenal of Professor Eugen Sänger, accompanied by his collaborator, Irene Bredt. Sänger, who since 1924, had admired the work of Hermann Oberth, belonged to what certain observers have dubbed the "Vienna School." His research, both before and during the war, had concerned hypersonic aerodynamics, liquid hydrogen combustion, and ramjet engines. However, his name will remain attached to his rocket-bomber-plane project of 1942, designed to fly "with ricochets," on the upper layers of the atmosphere. From 1946 to 1954, when he returned to Germany, Sänger contributed to the following:

- Development of liquid- and solid-propellant engines
- Designing of the SS 10 anti-tank missile
- Studies for the "Griffon" turbo-ramjet experimental aircraft
- Development of the RO 10 ramjet missile.

In connection with the ramjet, Sänger helped to add to France's existing fund of knowledge. All this clearly underlies the strong position that France has been able to acquire and maintain in this field.

Liquid Propellant Research at the Arsenal

Research on liquid propellants was begun in early 1947, for application to tactical missiles, thereby perpetuating the German investigations, despite the fact that, early on, the Arsenal had decided on solid-propellant drive. The designing of a three-ton-thrust engine was undertaken. Frequent contacts occurred with Colonel Jean-Jacques Barré, who was working on the EOLE rocket, and with S.E.P.R. At the time, the latter was working on the matter of propulsion by the decomposition of hydrogen peroxide and on the nitric acid/tonka propellant combination, whereas the Arsenal was concentrating on liquid oxygen and methanol.

Barré was in favor of liquid oxygen and low combustion pressure (5 to 10 bars), whereas Sänger thought in terms of around one hundred bars, which was a rather ambitious figure at that time.

The three-ton engine was successfully tested about one hundred times on the test bench of Les Gatines, in the Bois de Verrières, near Paris, from 1948 to 1951.

This investigation, which had no direct applications, was discontinued in 1952, putting an end to the liquid propellant activities at the Arsenal, which

thenceforth, for reasons related to convenience of battlefield utilization, devoted itself to solid- propellant-missiles.

Another German Contribution to the Arsenal

Some of the German technicians at Châtillon had brought with them the project for the D.F.S. (Deutsches Forschungs Institut für Segelflug [Institute for Gliding Flight]) 346 rocket plane. In 1952, the Arsenal began investigating a plane extrapolated from the latter but fitted with a turbo jet, for lack of available rocket engines. Only a single prototype was built.

The Franco-German Institute at Saint-Louis

In 1935, the German Air Force's Technische Akademie, also called the Luftkriegs-Akademie (L.K.A.), had been founded at Berlin-Gatow, and it included a Ballistic Institute directed by Professor Cranz, one of Germany's rocket pioneers; in 1936, he was succeeded by Professor Schardin. Because of the relentless bombings of Berlin, the L.K.A. moved out of the German capital on 15 February 1945, and went to Blankenbourg in Thuringia, eventually settling in Biberach, further south, where the French First Armored Division arrived on 23 April 1945. One of the latter's officers, Major Lutz, who knew of the L.K.A.'s existence and was familiar with its work, immediately contacted the Institute's authorities.

Thereupon, the D.E.F.A., in the person of Captain Fayolle, perceived the advantage to be gained by having this outstanding potential of scientists in its service. The scientists sent a fact-finding representative to the French authorities. From 7 to 9 July, the Americans interrogated the German scientists, and they proposed to Professor Schardin that his team's work be continued in the United States. Since he had already made a pledge to France, Schardin refused the American offer. After considering the possibility of moving the group to Versailles, a prospect that failed to enchant the Germans, the D.E.F.A. eventually decided to install them at Saint-Louis in Alsace, a site closer to the German frontier. The first contracts were signed on 27 July 1946, and over the next few days, 32 German scientists, specializing in ballistics, materials, aerodynamics and armament technologies, formed the first contingent assigned to constitute in Saint Louis, on 16 August 1945, the annex of the Laboratoire Central de l'Armement [central weaponry laboratory]. One year later, on 13 August 1946, this annex changed its name, becoming the Laboratoire de Recherches Balistiques et Aérodynamiques (L.R.B.A. [research laboratory on ballistics and aerodynam-

ics]). This was the L.R.B.A. of Saint-Louis, created concurrently with the L.R.B.A. of Vernon. To prevent confusion, the Saint-Louis Laboratory took the name of Laboratoire de Recherche Technique de Saint-Louis (L.R.S.L. [Saint Louis technical research laboratory]) on 1 January 1951. In the first few months following its founding, the number of German personnel increased rapidly. In the wake of the initial group of 32 individuals formed in late July 1945, the number grew to 45 on 15 August 1945, to 64 on 1 December 1945, and it reached 77 on 1 December 1946. Subsequently, in 1950, when the Emmendingen design engineering bureau ceased its activities,* 19 of the 28 aerodynamics specialists of said bureau joined the L.R.S.L., thus increasing its staff to 96 German natives. Eventually, after 15 years of work in common between French and German scientists, the L.R.S.L. ceased to exist and became the Institut Franco-Allemand de Recherches de Saint-Louis [Saint-Louis Franco-German Research Institute]. The foundation of the institute was signed on 31 March 1958 and ratified by both countries' Parliaments on 22 June 1959.

The German Contribution to the O.N.E.R.A. (Office National D'Etudes et de Recherches Aerospatiales [National Office for Aerospace Studies and Research])

By the end of 1945, three laboratories, bringing together German scientists of various disciplines, had been created in the cities of Wasserburg, Uerberlingen and Tettnang, on the shores of Lake Constance. Some seventy-five of these scientists eventually came to work in the establishments of the O.N.E.R.A. It should also be noted that the Modane wind tunnel was built from the layout drawings and included certain of the elements of the one at Ötztal in the Austrian Tyrol. The disassembly of this wind tunnel, which was decided on 10 October 1945, had to be completed before July 1946, since the French Occupation Zone in which it stood was to become American at that latter date. Thus it was that 4,364 tons of sheet metal structures and equipment were transported to the Lyons region. Concurrently, it was necessary to find the elements that were still in the process of being manufactured in the various areas of Germany. There ensued a real race with the Americans for the retrieval of some 200 tons of equipment, with each country trying to appropriate the freight cars containing the goods. An agreement was finally reached between Messrs. Malavard, Perès,

* Editor's note: By virtue of laws passed by the Allied Control Council, all activity in the field of supersonics was forbidden in Germany.

von Kármán and Wattendorf, whereby France was assigned these 200 tons of equipment, as well as the parts that had already reached the United States.

The German Contribution to Manufacturers of Navigational and Guidance Instruments

Of the scientists in Wasserburg, thirty-five came from the Siemens, Askania, and Patin companies and were specialists in guidance and navigation systems. In February 1947, twenty-five of them were sent to Bagnères-de-Bigorre in southern France, to work at the G.E.R.I.A. (Groupe d'Etudes et de Recherches Industrielles Aéronautiques [industrial aeronautic research study group]). In September 1947, they were moved to Neuilly-sur-Seine, near Paris, to a newly founded company, the S.N.E.R.A. (Société Nationale d'Etudes et de Recherches Aéronautiques [national company for aeronautic research and study]), which, in 1948, became the S.F.E.N.A. (Société Française d'Equipements pour la Navigation Aérienne [French company of air navigation equipments]). In that same year, this company built France's first attitude control unit, containing three gyroscopes. But only seven or eight of the twenty-five engineers who had come to France the previous year joined the S.F.E.N.A. In the 1950's, their ranks were further reduced by the departures of those who had returned to Germany. Others went to Switzerland and to the United States. This was the case for Schaberg, an engineer who enjoyed a brilliant career with Singer-Kearfott.

The German Contribution to the S.N.E.C.M.A.

In the field of aircraft engines, the contribution made by German personnel was equally as great. The 120 engineers and technicians under Dr. Oestrich who constituted "Group O" at Lindau on Lake Constance, created the Rickenbach aeronautical atelier (A.T.A.R.) and, in October 1945, were commissioned to design a 1,700-kilogram-thrust turbojet engine. In June 1946, this group came to Decize in France, to work with the Voisin aircraft company and S.N.E.C.M.A.

Conclusion

It is undeniable that, from 1937 to 1945, Germany was the country that devoted the greatest amount of effort to designing and building rockets. Most of the concepts of rocket guidance, aerodynamics, propulsion, and general rocket

engineering were invented or validated at Peenemünde or in its related research facilities. After Germany's defeat, the United States, Great Britain, the Soviet Union and France shared this knowhow among themselves. France received a notable share thereof, which it owes largely to Professor Henri Moureu, who knew how to go about gaining access to the records, equipment, and specialists of Peenemünde. Beginning in 1946, 123 engineers and technicians from Peenemünde, or from institutes and organizations that had collaborated with Peenemünde, thus started working for France and conveyed their knowledge to French engineers. These scientists were fewer in number than those who went to the United States or to the Soviet Union, but they nonetheless formed an array that represented a broad spectrum of competencies. If the bearers of the great names of the German adventure—von Braun, Dornberger, Rees, Stuhlinger and others—pursued their research in the United States, France had certain distinguished figures such as Sänger and Ruden, in addition to a few lesser-known individuals, such as Otto Müller, Heinz Bringer and Helmut Habermann, whose discretion was on a par with their great competence and with the progress that they enabled French astronautics to achieve.

To the specialists from Peenemünde there must be added those from the realm of aeronautics proper—aircraft engines, guidance systems, navigation systems, servomechanisms—and from all the aeronautical disciplines. All told, some five hundred German engineers and technicians placed their abilities at the disposal of France.

There is no question that the assistance they provided to France in the immediate aftermath of the war enabled this country—whose industries had been reduced to a shambles by the occupation and the war—to narrow the gap of its technological lag behind the United States and the Soviet Union. Their role and their cooperation with French engineers and technicians significantly contributed to the fact that, by 1965, France had become the world's third-ranking space power, and that it stands to the forefront in the realm of missiles and aeronautical science. Moreover, by coming to work in France and returning to their homeland a few years later, as most of them did, these Germans proved themselves to be the true forerunners of space science and aeronautics in Europe.

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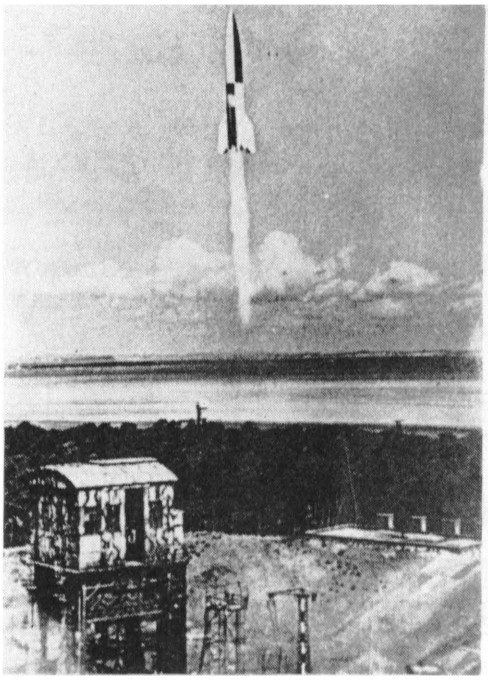
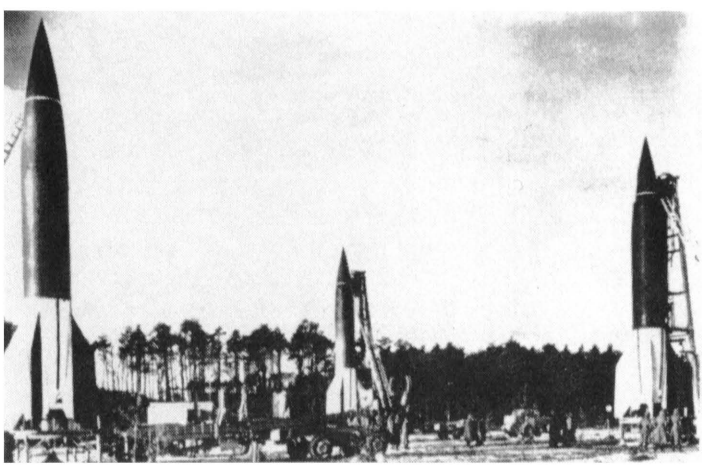
Illustrations



UN TIR DE V2
A
PEENEMÜNDE

LAUNCH OF V2
AT
PEENEMÜNDE

Launch of V-2 at Peenemünde.



V2
INSTALLES SUR LEUR
DISPOSITIF DE
LANCEMENT MOBILE
(MEILERWAGEN)

V2
ON THEIR MOBILE
LAUNCH SYSTEM
(MEILERWAGEN)

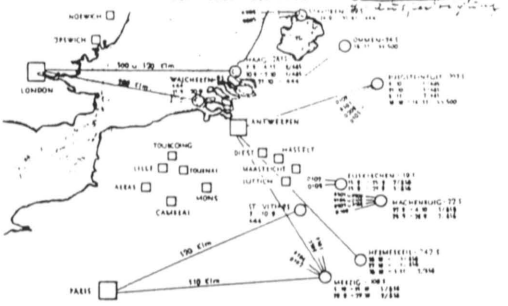
V-2s on their mobile launch system (Meilerwagen).

RF SS SB 2
Div. z. V.

1000 SCHÜSSE DER DIV. Z. V.
vom 7.9. – 26.11.44

	50	100	150	200	250	300	350	400	450	500 Schüsse
ENGLAND										
London (0101)	254									
Norwich (0204)	45									
Ipswich (0205)	1									
BELGIEN										
Antwerpen (0304)	556									
Lüttich (0103)	27									
Maastricht (0309)	19									
Hasselt (0301)	15									
Tournai (0107)	9									
Diest (0302)	2									
FRANKREICH										
Paris (0303)	19									
Lille (0102)	25									
Tourcoing (0104)	19									
Arras (0201)	6									
Cambrai (0202)	4									
Mons (0109)	3									

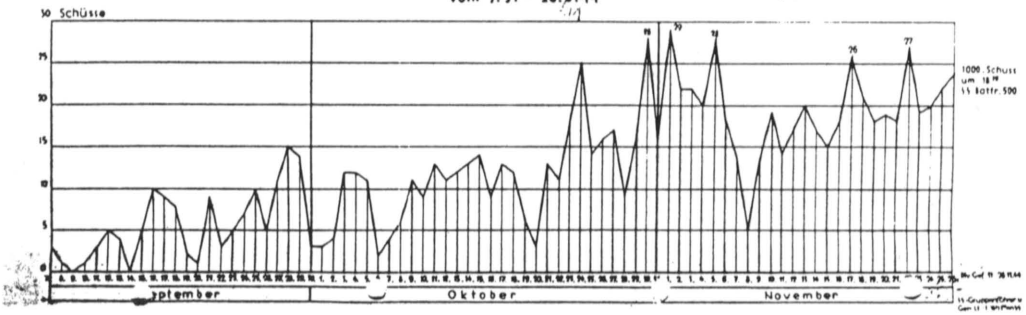
EINSATZRÄUME u. ZIELE DER DIV. Z. V.
vom 7.9. – 26.11.44

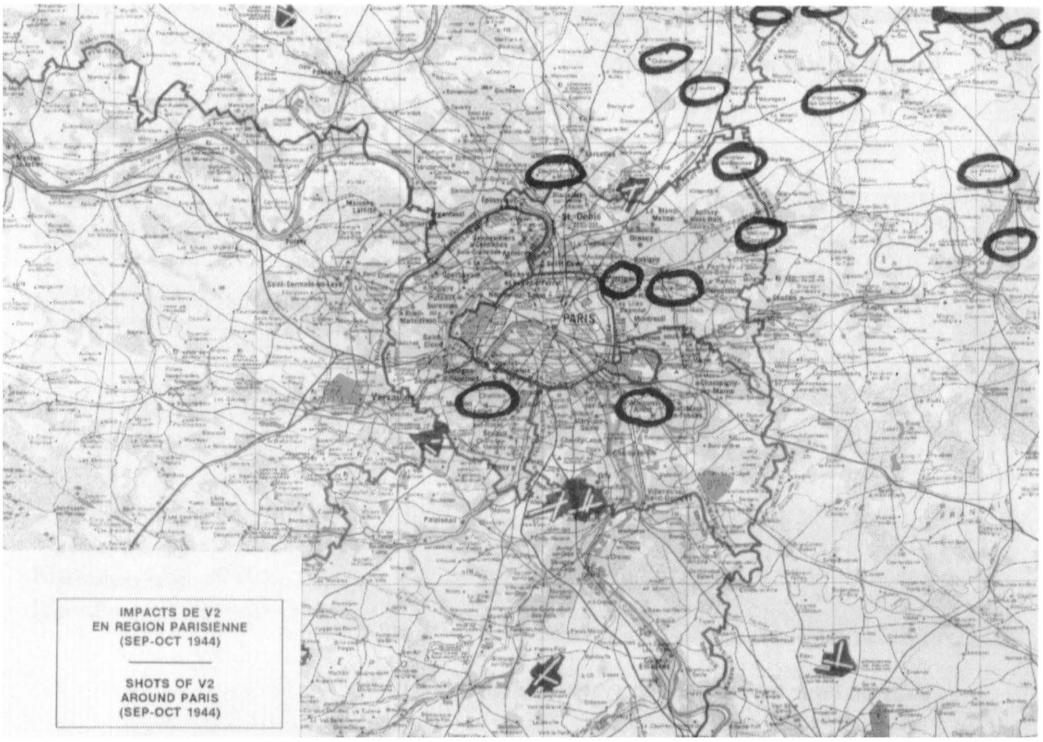


BILAN DES 1000 PREMIERS TIRS DE V2

RESULTS OF THE FIRST 1000 SHOTS OF V2

TÄGLICHER VERSCHUSS
vom 7.9. – 26.11.44





Le Chef de la Mission
Scientifique d'étude des Rockets en Allemagne

16 June 1945

TO: Supreme Headquarters, AEP
Frankfurt, Germany

Mandaté par Mr le Ministre de la Guerre et par le Général d'Armée, Chef d'Etat-Major Général de la Défense Nationale, j'ai l'honneur de vous prier de bien vouloir me laisser enlever de l'usine Dora (Nordhausen) le matériel suivant :

4 - V-1 complets (avec gyroscope et compas magnétique)

2 - turbines de V-2

2 - groupes perhydrol - permanganate

2 - ensembles montés avec venturis

1 - carcasse complète de V-2

1 - queue d'empennage de V-2

quelques exemplaires divers de petit matériel courant.

Je vous serais reconnaissant de mettre si possible à ma disposition quelques camions pour me permettre de transporter rapidement ce matériel dans la zone d'occupation Française en Allemagne.

Lt Colonel HENRI MOUREU
E. M. A. B. S. A.

1st IND

FROM: A.C. of S, G-2 SHAEF 18 June 1945

The above equipment is allocated to the French Government for disposal as directed by E.M.A.B.S.A.

For A.C. of S, G-2

G.H. SCHWEDERSKY
Colonel , CSC

Le Chef de la Mission
Scientifique d'étude des Rockets en Allemagne

16 June 1945

TO: Supreme Headquarters, AEP
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Mandaté par Mr le Ministre de la Guerre et par le Général d'Armée, Chef d'Etat-Major Général de la Défense Nationale, j'ai l'honneur de vous prier de bien vouloir mettre à la disposition du Gouvernement Français (Etat-Major de l'Armée, Bureau Scientifique de l'Armée, 10 fusées stratosphériques V-2 faisant partie des lots d'engins de ce type trouvés dans la zone d'occupation de l'Armée américaine en Allemagne.

Lt Colonel HENRI MOUREU
E. M. A. B. S. A.

1st IND

FROM: A.C. of S, G-2 SHAEF 18 June 1945

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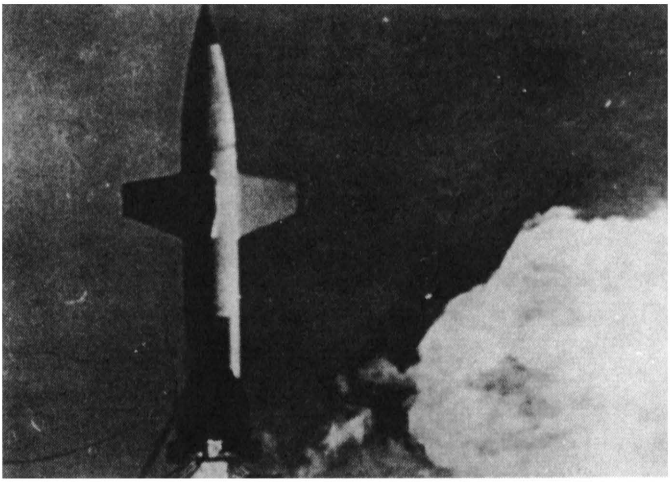
For A.C. of S, G-2

G.H. SCHWEDERSKY
Colonel , CSC

LA BASE DE LANCEMENT
DE V2
A WIZERNES
(PAS DE CALAIS)

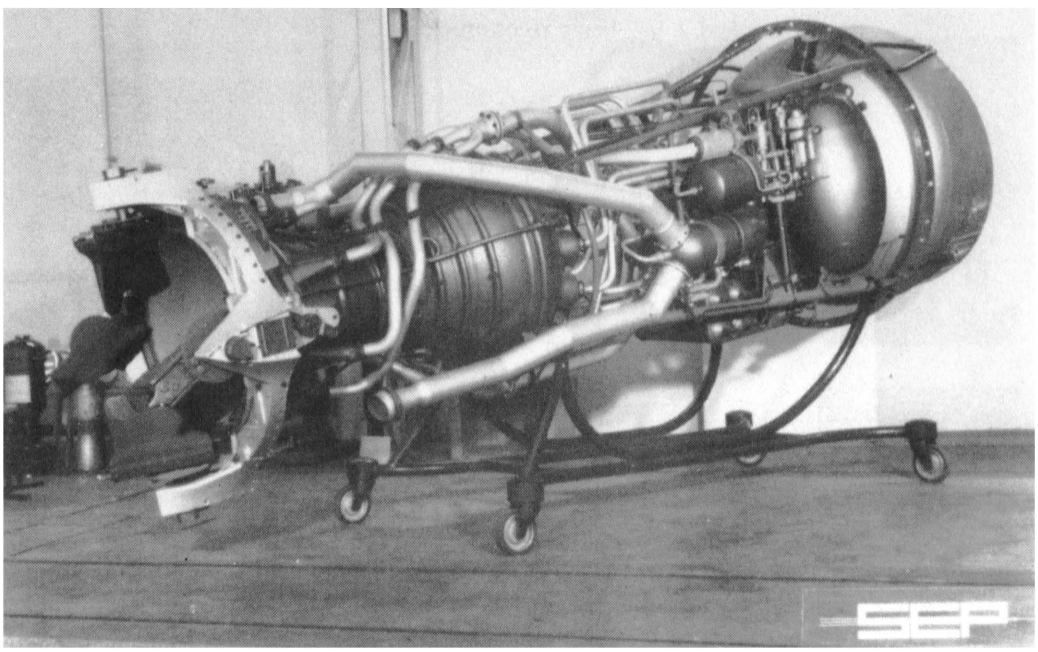
THE V2
LAUNCH SITE
OF WIZERNES
(PAS DE CALAIS)

The V-2 launch site of Wizernes (Pas de Calais).

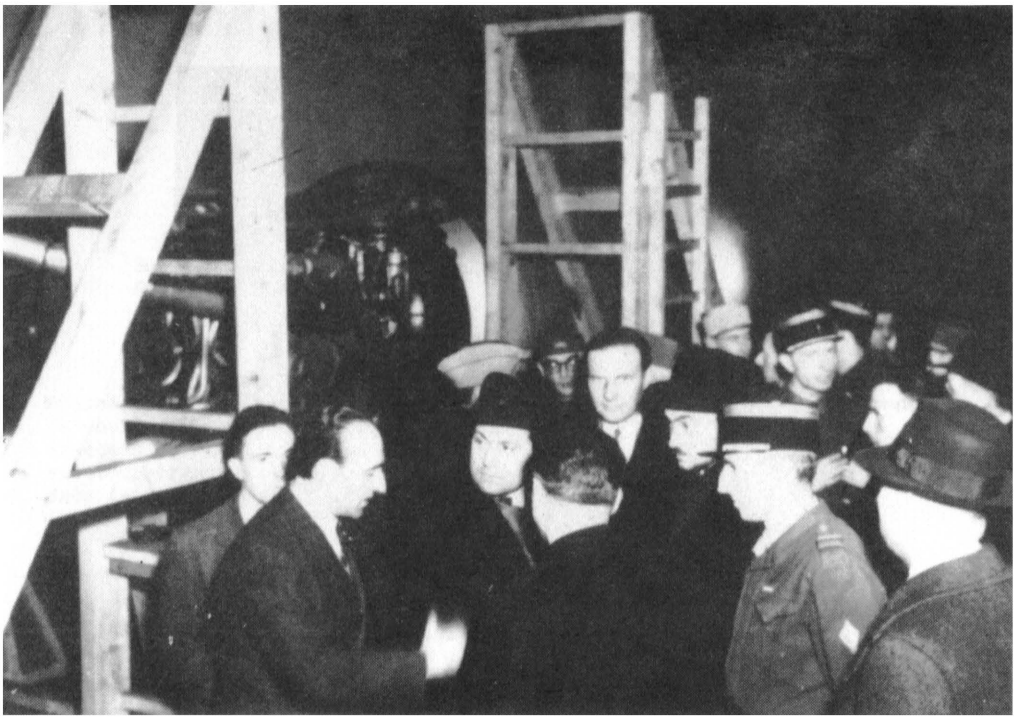


- TIR D'UN WASSERFALL A PEENEMÜNDE
- LAUNCH OF A WASSEFALL AT PEENEMÜNDE

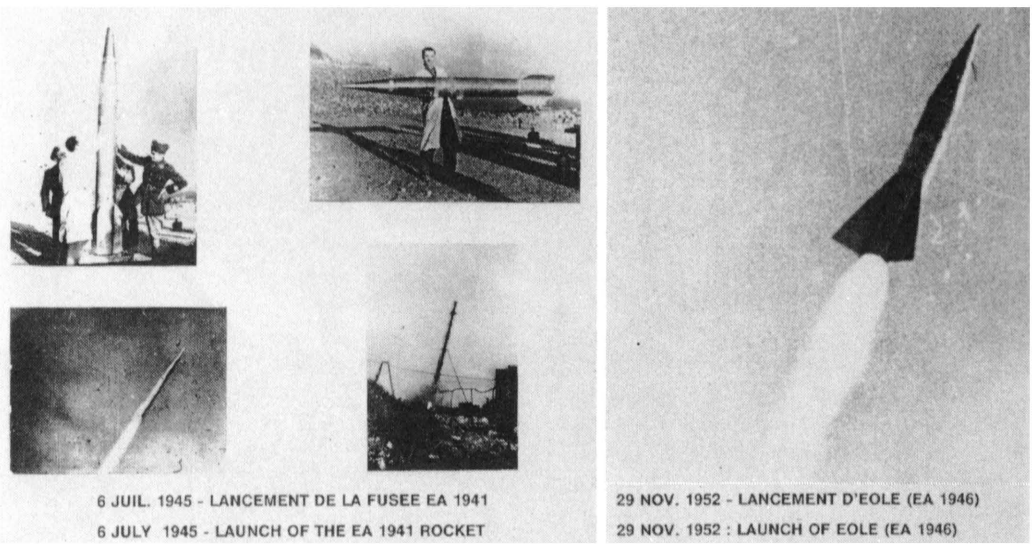
Launch of a Wasserfall at Peenemünde.



V-2 propulsion system.



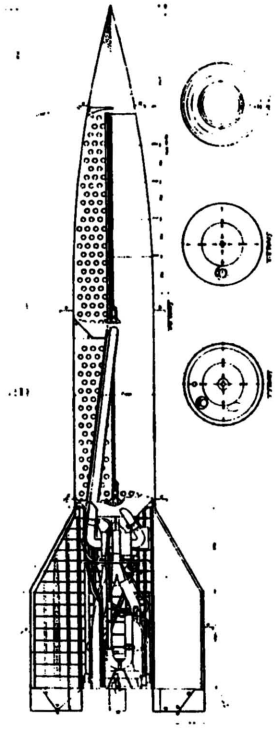
6 March 1947 at the Atelier de Puteaux: visit of the Minister of War, Mr. Coste-Floret, with PR. Moureu and the Chief Engineer LaFargue - in the background, a V-2 being reconstructed.



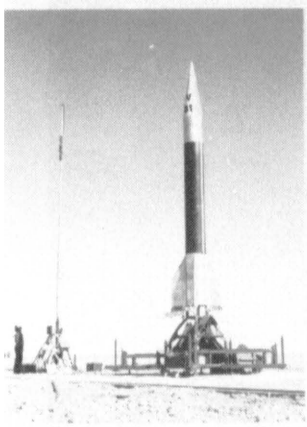
6 July 1945 - Launch of the EA 1941 rocket (left four photos). 29 November 1952 - Launch of EOLE (EA 1946) (right photo).

PROJET 4212
OU
"SUPER V2"

PROJECT 4212
OR
"SUPER V2"



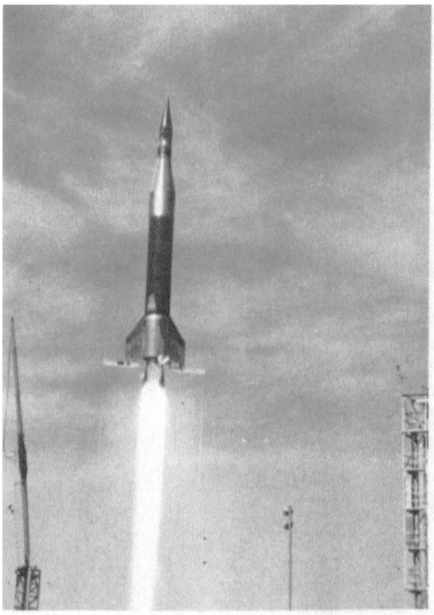
Project 4212 or "Super V-2."



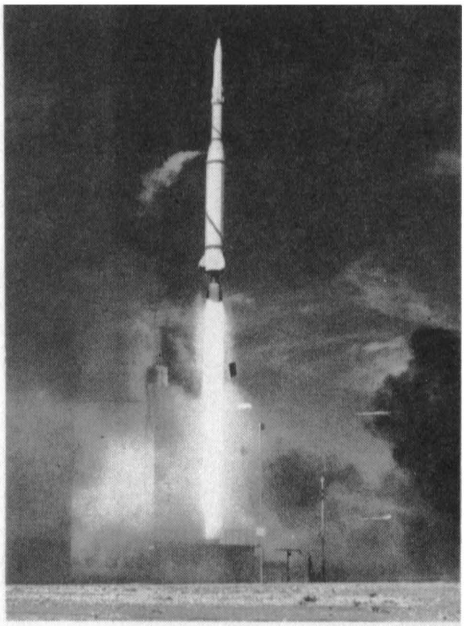
VERONIQUE

PARCA

VERONIQUE (left) and PARCA (right).

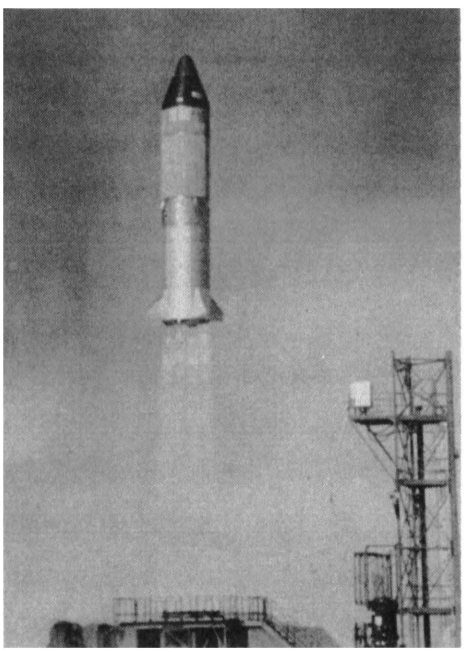


VESTA



DIAMANT A

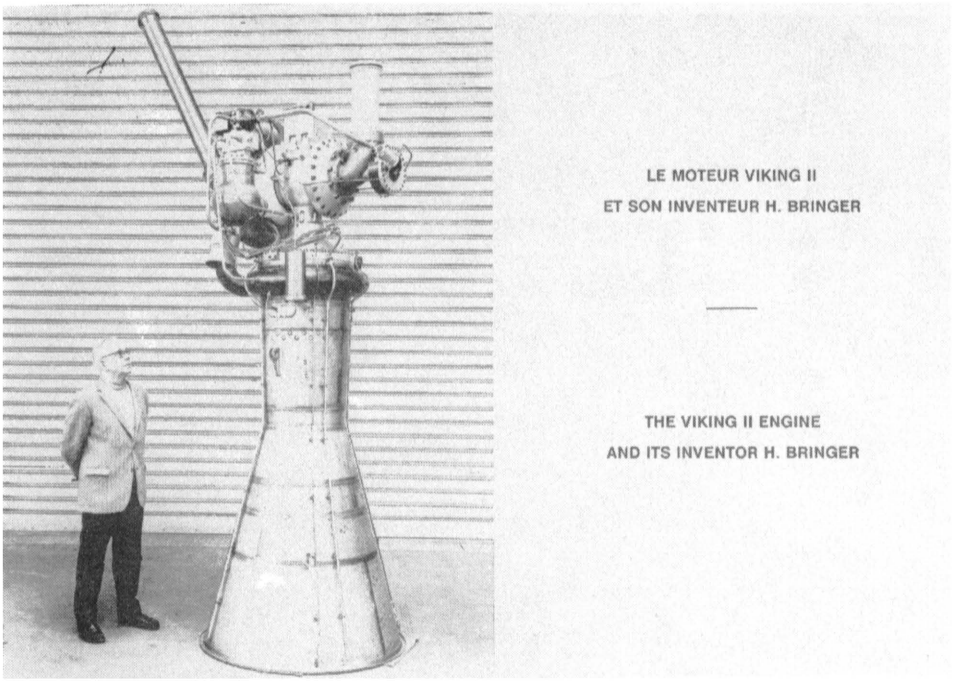
VESTA (left) and DIAMANT A (right).



ESSAI EN VOL
DE CORALIE (CORA)
2EME ETAGE
DU LANCEUR EUROPA

FLIGHT TEST OF
CORALIE (CORA)
2ND STAGE
OF EUROPA LAUNCHER

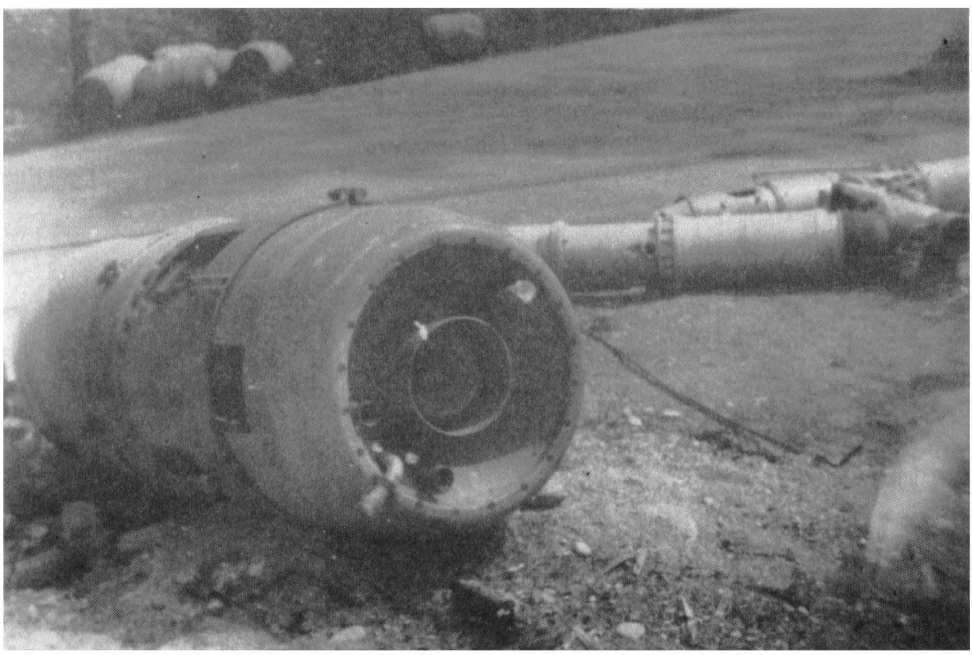
Flight test of CORALIE (CORA), 2nd stage of Europa launcher.



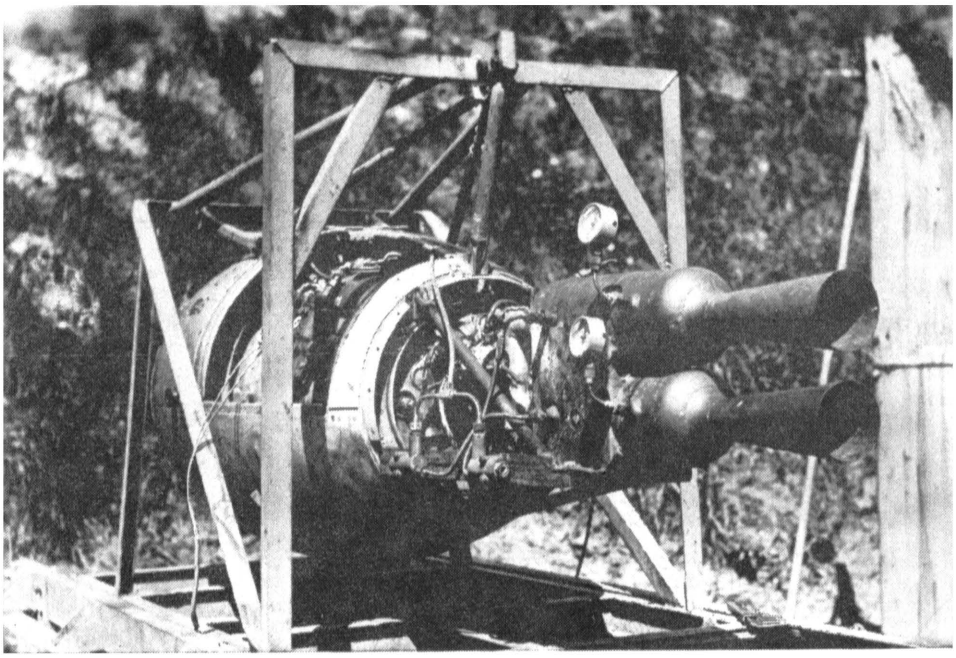
The Viking II engine and its inventor H. Bringer.

February-March 1946: removal of equipment from the Kramsach Keinkel plant (Austria).

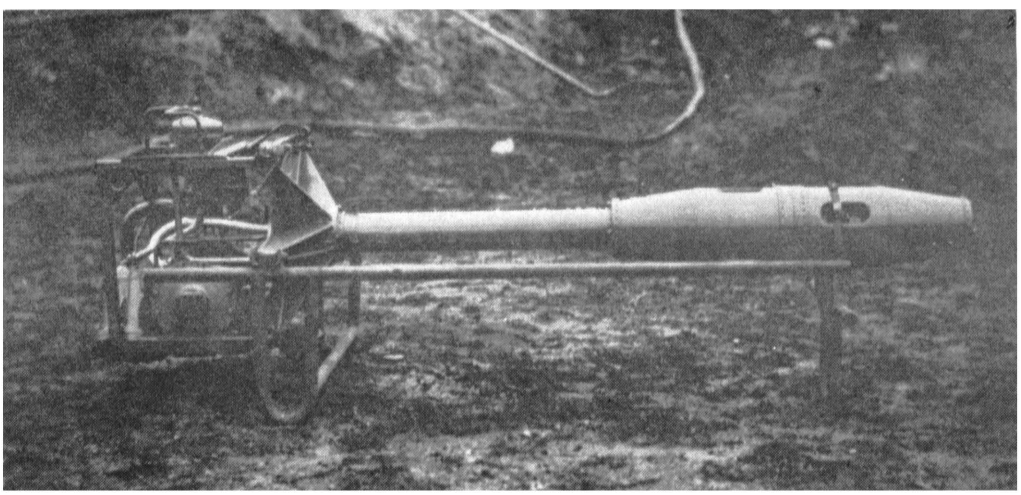
Spring 1945: München-Allach BMW plant—air-air X4 missile propulsion system.



Spring 1945: München-Allach BMW plant—take-off assistance engine.

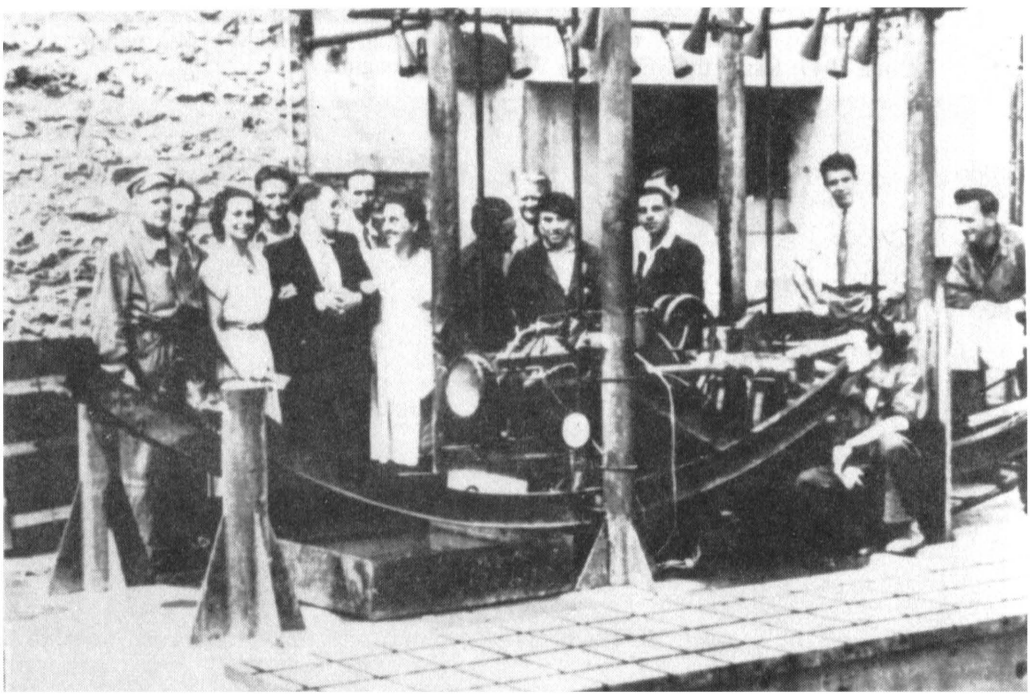


Circa 1947: test at the SEPR of a Walter T 500 engine.



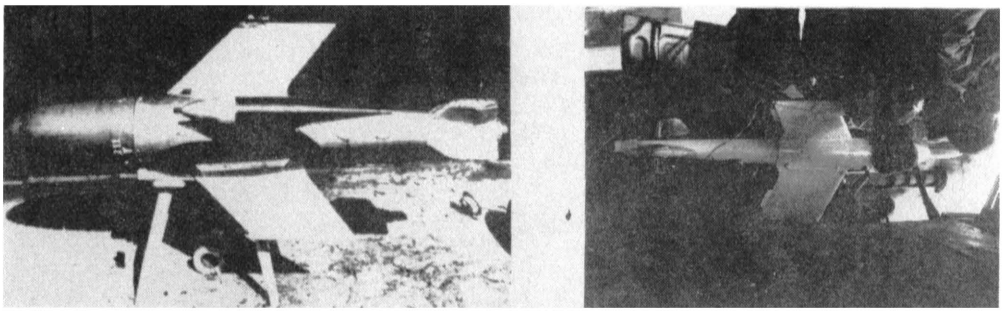
Circa 1947: SEPR - modified Walter 109-509 engine.

Test of a SEPR liquid propulsion system in the forest of Fontainebleau, circa 1946-1947.

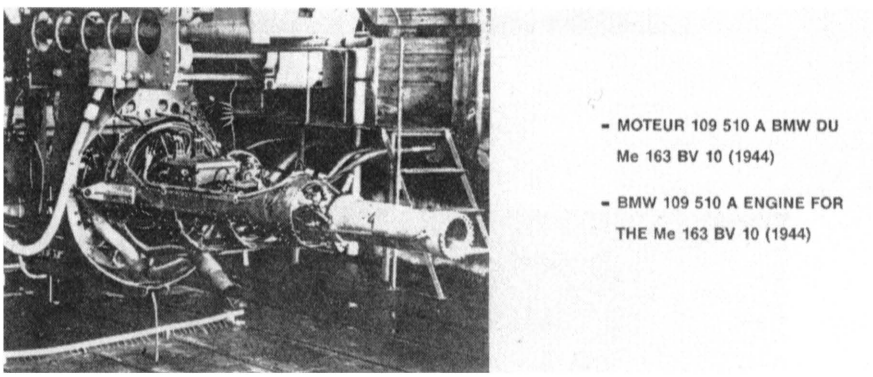


Test of a liquid propulsion engine at the arsenal de Châtillon (Les Gatines) in 1952.

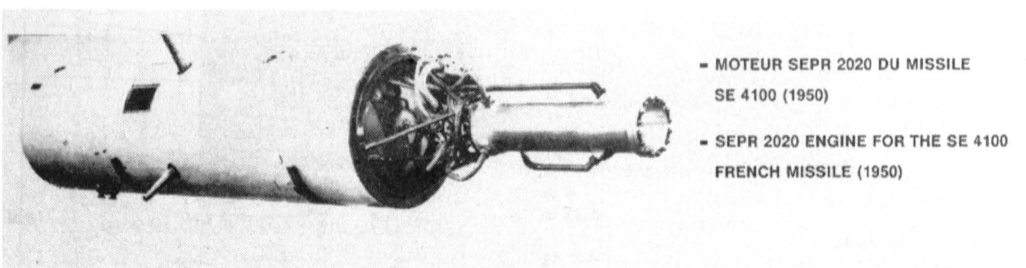
German and French Missiles: Some Similarities



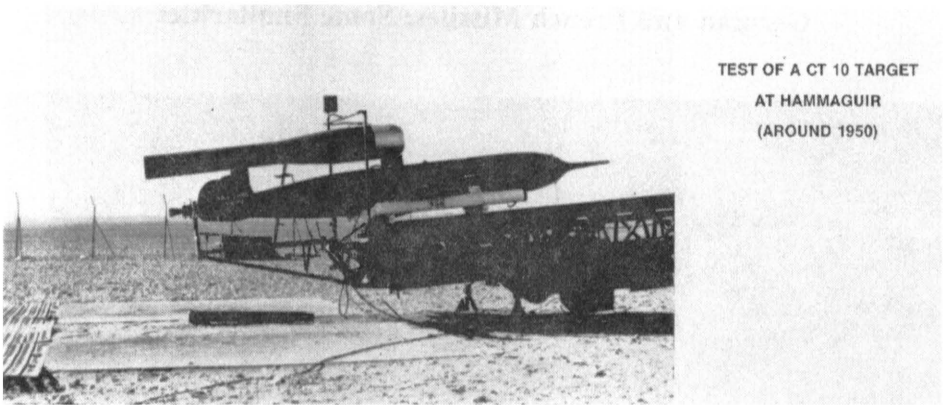
X4 German air-to-air missile (1944) (left); AA 10 French air-to-air missile (1947) (right).



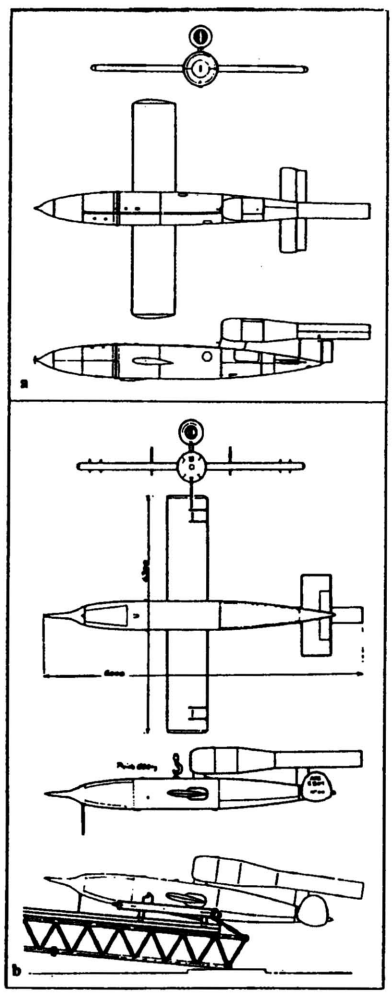
BMW 109 510 A engine for the Me 163 BV 10 (1944).



SEPR 2020 engine for the SE 4100 French missile (1950).



Test of a CT 10 target at Hammaguir (circa 1950).



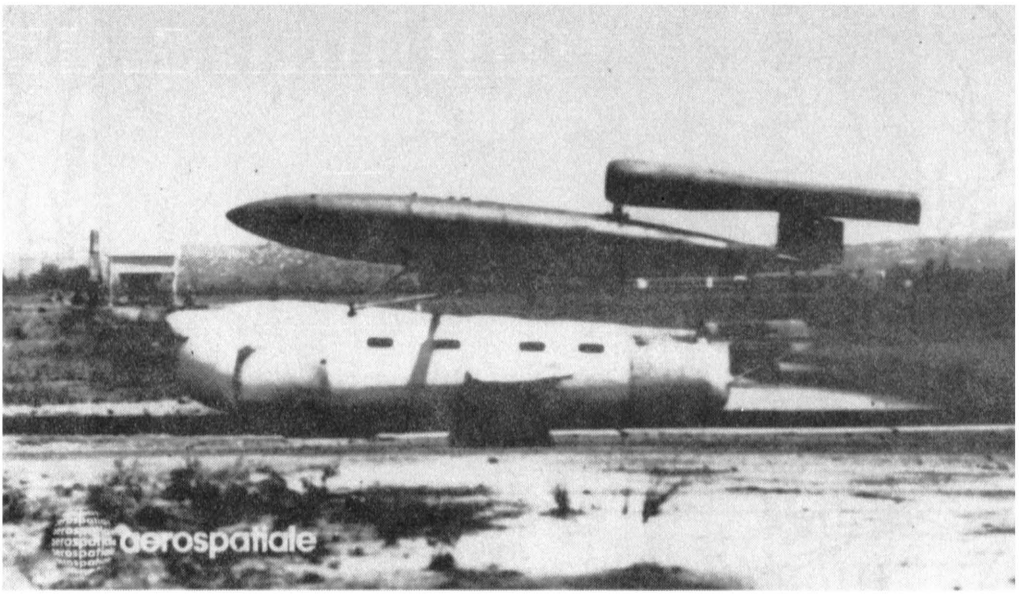
a - Plan trois vues du *V1, Fieseler Fi.103*

Longueur hors tout	**7,73 m**
Envergure	**5,18 m**
Poids (sans carburant ni explosif)	**850 kg**

b - Plan trois vues du *CT 10* de l'Arsenal

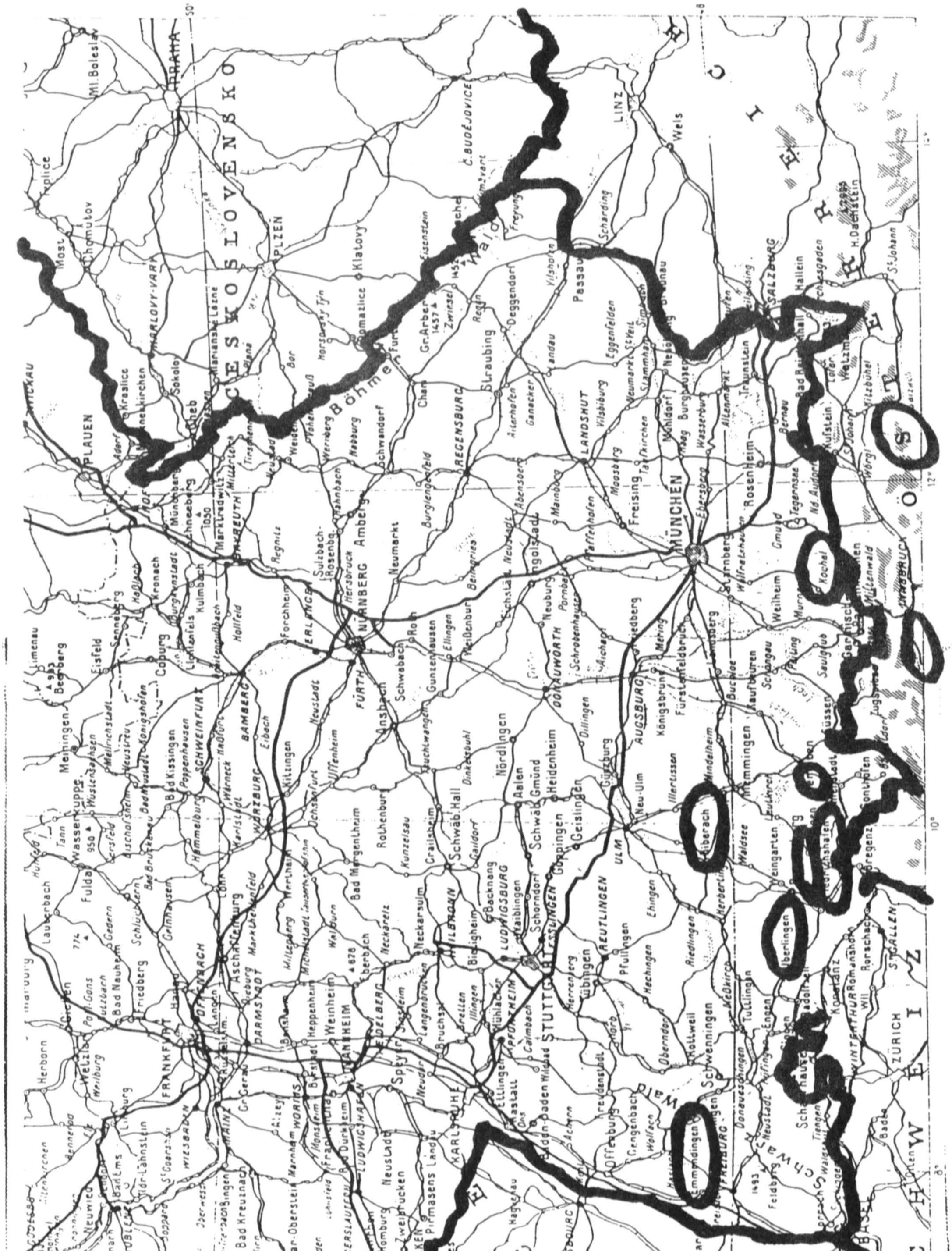
Longueur hors tout	**6 m**
Envergure	**4,35 m**
Poids (sans carburant ni chariot de lancement)	**450 kg**

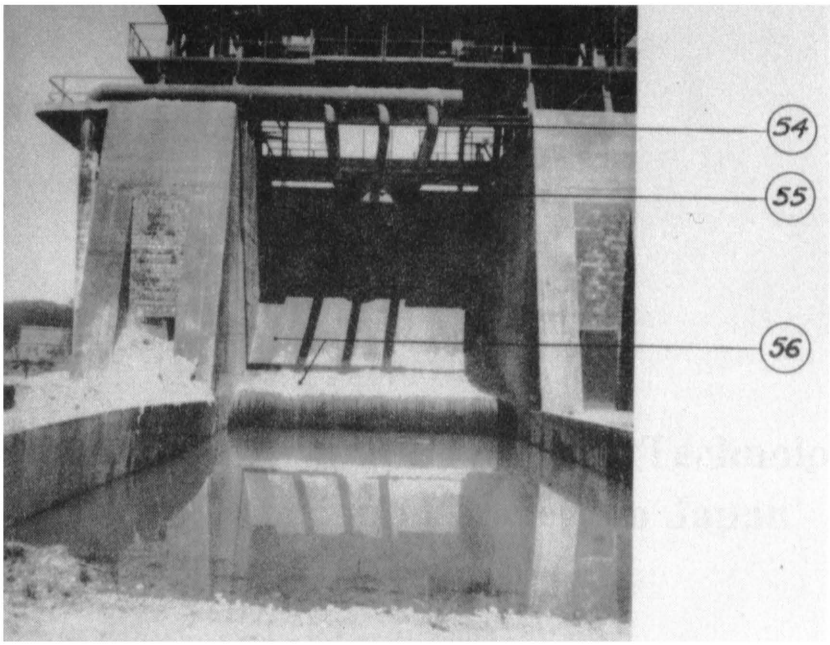
Comparison between the V-1 and the CT 10.



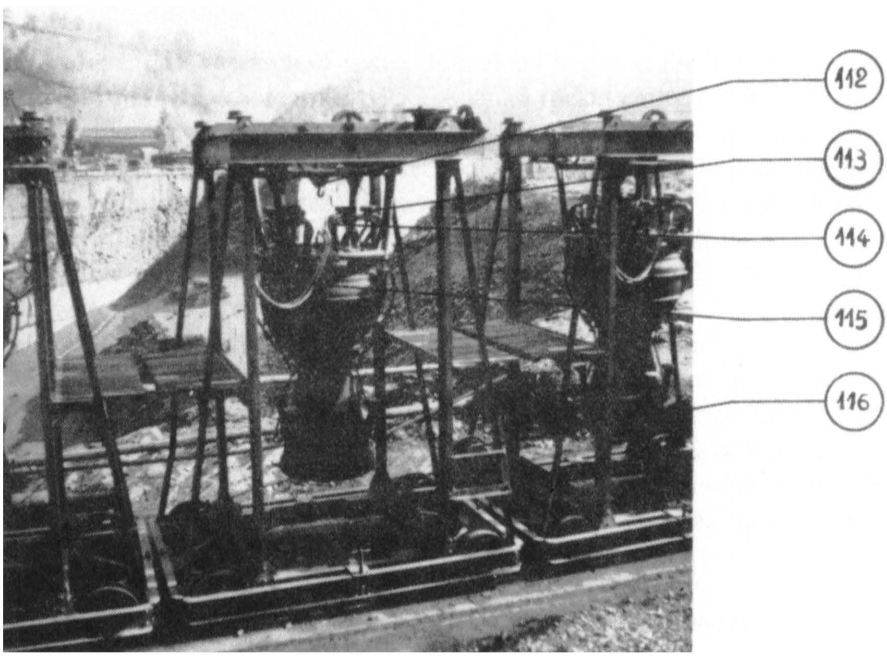
Test of a V-1 on the SE 1910 vehicle.

Site of the wind tunnel of Ötztal.


ČESKOSLOVENSKO
PRAHA
PLZEŇ
PLAUEN
LINZ
Passau
Wels
SALZBURG
MÜNCHEN
LANDSHUT
REGENSBURG
NÜRNBERG
ERLANGEN
FÜRTH
BAMBERG
COBURG
SCHWEINFURT
WÜRZBURG
AUGSBURG
ULM
STUTTGART
REUTLINGEN
LUDWIGSBURG
HEILBRONN
KARLSRUHE
MANNHEIM
HEIDELBERG
DARMSTADT
FRANKFURT
OFFENBACH
MAINZ
WIESBADEN
KOBLENZ
SAARBRÜCKEN
KAISERSLAUTERN
STRASBOURG
FREIBURG
BASEL
ZÜRICH
ST. GALLEN
INNSBRUCK
Rosenheim
Kufstein
Bregenz
Konstanz
Überlingen
Biberach
Emmendingen
Friedrichshafen
Kochel
SCHWEIZ
ÖSTERREICH
Böhmer Wald
Schwarzwald



V-2 test stand at Ober-Raderach.



Control of V-2 engines at Lehesten, arrival of the engines.